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No. 1,618.] *FRIDAY, NOVEMBER* 23, 1883. [*Vol. XXXII.*

ONE-HUNDRED-AND-THIRTIETH SESSION, 1883-84.

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Henry B. Wheatley, F.S.A.	Howard H. Room.	J. Oldfield Chadwick.

SESSIONAL ARRANGEMENTS.

The Second Meeting of the One Hundred and Thirtieth Session of the Society will be held on Wednesday, the 28th November. Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting.

The following arrangements have been made:—

November 28.—A. J. R. Trendell, of the Inner Temple, Barrister-at-Law, "The International Fisheries Exhibition of 1883."

December 5.—Thomas T. P. Bruce Warren, "The Manufacture of Mineral Waters."

" 12.—Thomas Fletcher, F.C.S., "Coal Gas as a Labour-saving Agent in Mechanical Trades."

" 19.—The Most Hon. The Marquis of Lorne, K.T., late Governor-General of Canada, "Canada and its Products."

For Meetings after Christmas:—

B. W. RICHARDSON, M.D., F.R.S., "Sanitary Progress."
W. H. PREECE, F.R.S., "The Progress of Electric Lighting."
DR. BRANDIS, F.R.S., "Forest Administration in India."
A. RECKENZAUN, "Electric Launches."
WILLIAM LANT CARPENTER, B.A., B.Sc., "Science Teaching in Elementary Schools."
C. R. ALDER WRIGHT, F.R.S., D.Sc., "Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues."
DR. PERCY F. FRANKLAND, "The Upper Thames as a Source of Water Supply."
W. G. PEDDER, "Historical Development of the Different Settlement Systems of British India." (Second communication.)
JOSEPH G. COLMER, Secretary to the High Commissioner for Canada, "Canada as it will be seen by the British Association in 1884."
PROFESSOR FLEEMING JENKIN, F.R.S., "Telpherage."
GENERAL RUNDALL, "Water Regulation in England."
EDWARD C. STANFORD, F.C.S., "Economic Applications of Seaweed."
J. M. MACLEAN, "State Monopoly of Railways in India."
B. FRANCIS COBB, "North Borneo."
DR. LEITNER, "Indigenous Education in India."
PROFESSOR WANKLYN and W. J. COOPER, "Manufacture of Gas from Limed Coal."

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—
January 29; February 26; March 18; April 1, 29; May 20.

APPLIED CHEMISTRY AND PHYSICS SECTION.

The meetings of this Section will take place on the following Thursday evenings, at Eight o'clock:—
January 24; February 21; March 27; April 24; May 8, 29.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—
February 15; March 7, 28; April 25; May 9, 30.

CANTOR LECTURES.

Monday evenings at eight o'clock:—

The First Course will be on "The Scientific Basis of Cookery." By W. MATTIEU WILLIAMS, F.C.S.

Lecture I. Dec. 3.—The Kitchen a Chemical Laboratory. Modes of applying Heat. Radiation, Conduction, and Convection. Roasting, Grilling, Baking, Boiling, and Stewing.

Lecture II. Dec. 10.—The Constituents of Flesh. The action of Heat on Albumen, Gelatine, Fibrin, &c. The Juices of Flesh and their nutritive value. Exosmosis and Endosmosis as operating in the Kitchen. Maceration. Caseine. The cookery of Cheese and its nutritive value. Milk, Butter, and "Bosch."

Lecture III. Dec. 17.—The nutritive constituents of Vegetables. The changes effected by cookery on Vegetable Substances. Ensilage of Human Food. May the use of Flesh Food be superseded by the scientific preparation of selected Vegetables?

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By THOMAS BOLAS, F.C.S.

Lecture I. Jan. 28.—New Developments of the Woodbury-Type Process.

Lecture II. Feb. 4.—Type Blocks from Line Drawings and Half Tone subjects.

Lecture III. Feb. 11.—Intaglio Plates. Collotypes. Photo-Mechanical Methods, as applied to the Decoration of Pottery. Miscellaneous Processes.

The Third Course will be on the "Building of Town Houses." By ROBERT W. EDIS, F.S.A.

Lecture I. Feb. 18.—Their Arrangements, Aspect, Design, and General Planning.

Lecture II. Feb. 25.—Sanitation, Lighting, Heating, and Ventilation.

Lecture III. Mar. 3.—Fittings, Planned Furniture, Constructive Decoration.

The Fourth Course will be on "The Alloys used for Coinage." By Professor W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint:—

March 17, 24, 31; April 7.

Lectures I. and II.—Gradual Development of the Processes of Coining. The Composition and "Standards of Fineness" of the Alloys used for Coinage in Ancient and Modern Times.

Lecture III.—Methods by which Accuracy of Weight and "Fineness" of the Alloys is ensured.

Lecture IV.—Questions connected with the liability to Reduction in Weight of various Coins by Wear during Circulation.

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. NORMAN LOCKYER, F.R.S., F.R.A.S.:—

April 28; May 5.

The Sixth Course will be on "Fermentation and Distillation," by Prof. W. NOEL HARTLEY, F.C.S.:—

May 12, 19, 26.

JUVENILE LECTURES.

The two Juvenile Lectures will be by J. MILLAR THOMSON, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London, on "Crystals and Crystallisation." The dates for these lectures are Wednesday evenings, the 2nd and 9th January, at seven o'clock.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country"

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED CHEMISTRY AND PHYSICS SECTION.—This Section was formed in 1874, for the discussion of subjects connected with Practical Chemistry and its applications to the Arts and Manufactures. It was enlarged in 1879, so as to include the consideration of subjects connected also with the Applications of Physical Science to the Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of from Three to Six Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person The subjects include the principal divisions of a Commercial Education, Sanitary Knowledge, Political and Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled :—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi,

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, H. T. Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

NOTICES.

DEATH OF SIR WILLIAM SIEMENS.

It is with feelings of the very deepest regret that the Council have to record the loss which the Society of Arts has sustained by the death of the Chairman of Council, Sir William Siemens. Their appreciation of the services which he has rendered to the Society of Arts, will, it is hoped, find fitting expression in a resolution which will be passed as soon as a meeting of the Council can be formally held for the purpose. A short sketch of his life and scientific labours will be found at page 7.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Friday, November 16th, at 4 p.m. Present—Mr. Andrew Cassels (in the chair), Sir George Birdwood, M.D., C.S.I., Mr. J. M. Maclean, Sir W. Rose Robinson, K.C.S.I., with Mr. H. Trueman Wood, Secretary, and Colonel Hardy, Secretary of the Section. The programme of papers to be read during the present session was discussed.

Proceedings of the Society

FIRST ORDINARY MEETING.

The First Ordinary Meeting of the Session was announced for Wednesday last, the 21st inst. As stated in last week's *Journal*, arrangements had been made for the holding of the meeting, and it was then hoped that Sir William Siemens's health would have permitted his delivering the address at a later period of the Session. When his sudden and quite unexpected death occurred on Monday last, the Council felt that, under the circumstances, they had no other course to pursue than to adjourn the meeting entirely, and notices to this effect were inserted in the newspapers.

With regard to the arrangements for the Session, the Council think it well to lay before the members the following brief sketch of the work with which it is probable the Society will be engaged. It was prepared with a view of submitting it to the members at the Opening Meeting:—

Ordinary Meetings.

The papers which have already been arranged for the Ordinary Meetings of the Society, have been announced in the *Journal*. Before Christmas there will be four meetings. At the first of these Mr. Trendell, who has been intimately associated with the conduct of the Fisheries Exhibition, has undertaken to bring before the Society a summary of its results. At the second meeting Mr. Bruce Warren, who has had considerable experience as a chemist in the subject, will deal with the manufacture of mineral waters, a manufacture which has been, during the past few years, of growing importance. At the next meeting after this Mr. Thomas Fletcher, to whom the Society were indebted three years ago for a paper on appliances for the combustion of coal-gas, will describe recent advances in the same direction. At the last Ordinary Meeting before Christmas a paper, which the Council anticipate with much interest, will be read by the Marquis of Lorne, upon the great Dominion, of which he has just ceased to be the Governor-General. Lord Lorne has, as the members are aware, not long since made a most interesting journey into the North-West Provinces of Canada, and will be able to speak with a personal as well as an official knowledge of the resources of the colony. Several important papers are also down for the meetings after Christmas. Amongst these may be noticed one by Dr. Richardson, a Vice-President of the Society, on Sanitary Progress. The value of Dr. Richardson's communications is too well known to make it necessary to say much about this, but it will doubtless gain additional interest from the fact that it will be delivered before the opening of the great Health Exhibition now in progress of arrangement.

Indian Section.

The Indian Section of late years has been specially fortunate in the character of the papers which the Committee of the Section have been able to secure. There seems every hope that the papers for the present Session will equal in interest and value those previously read before this Section. Mr, W. G. Pedder has promised a paper in continuation of that read last Session on the "Land Settlement of India." Mr. Maclean has promised to read a paper on the "State Monopoly of Railways in India," a subject of considerable interest at the present time. Dr. Leitner, who is now in England, will contribute a paper on "Indigenous Education in India," and it is hoped that arrangements may be made for a paper on the "Trade Routes to Afghanistan," by Mr. Griffin Vyse. Arrangements are also in progress for papers which will fill up the remaining evenings of the Session.

Foreign and Colonial Section.

The arrangements for the meetings of this Section are not yet entirely complete. As soon as they are, the usual announcements will be made in the *Journal*. Amongst the papers already promised, is one by Mr. Colmer, the Secretary to the High Commissioners of Canada, which will have for its special object the giving of those who join the meeting of the British Association at Montreal next year, some knowledge of the points of interests to which their attention may be specially directed. Mr. B. Francis Cobb has undertaken to prepare a paper on "North Borneo," and the Committee of this Section will have before them suggestions for papers on New Guinea, the Congo River, China, and New Zealand.

Applied Chemistry and Physics Section.

The papers anticipated for this Section include one by Dr. Alder Wright on the application of ammoniacal solutions of copper to the waterproofing of paper, &c., this being the process employed in the manufacture of the new waterproof paper which attracted a good deal of notice, as a material for building and other purposes, at the recent Fisheries Exhibition. Dr. Percy Frankland has promised a paper on "The Upper Thames as a Source of Water Supply." Messrs. Wanklyn and Cooper will bring their method of gas manufacture by the use of lime in combination with coal, before this Section, and there will also be a paper on the economic application of sea-weed, by Mr. E. C. Stanford. In 1862, Mr. Stanford received a medal from the Society for a paper on the same subject, and his promised communication will deal with the progress made since that date in this important though little known industry.

Cantor Lectures.

The first course of Cantor lectures, which will be delivered before Christmas, will be by Mr. Mattieu Williams, who is well known to the members for the interesting courses he has before delivered to the Society, especially the valuable course on the "Manufacture of Iron and Steel," in 1876. Mr. Williams' subject will be the "The Scientific Basis of Cookery." The lectures will be of a practical character, and the Council think they will be of general interest to the members of the Society. After Christmas Mr. Bolas will give a course which will be a continuation of the course delivered in 1878, on "Photo-Mechanical Printing Processes." Mr. Edis, who will give a course of lectures on the construction of London houses, is, like his two predecessors, no stranger to the Society. Professor Chandler Roberts, who has promised a course on the "Alloys used for Coinage," has not before lectured here, but the Council think the members are fortunate in having the opportunity of hearing so great an authority on this special subject. The same remark may be applied to Mr. Norman Lockyer's promised course on "Optical Instruments." This series, again, will, to some extent, be a continuation of previous courses of Mr. Lockyer's. The last course of the Session will be by Professor Hartley, on "Fermentation and Distillation."

Juvenile Lectures.

The two juvenile lectures of the present year will be delivered by Mr. J. Millar Thomson, the Lecturer on Chemistry at King's-college. Mr. Thomson has, for some years, been engaged in researches into certain points connected with the theory of crystallisation, and the subject is one which the Council think will lend itself with peculiar readiness to our juvenile lectures, admitting as it does of so many and such beautiful illustrations. The arrangements for the lectures will be the same as usual, and any member who applies will be furnished with a ticket admitting one adult and two children. The dates for the lectures are the 2nd and 9th of January.

Committees.

Besides the ordinary Standing Committee of the Council, there are now at work only two Committees, that on Patent Law, and that on Collisions at Sea. Though the work of the Patent Committee may be said to have been finished when the Patent Act of last Session was passed, the Council thought it well to reappoint them, with a view of watching the effect of the Act and the method of its administration. It is obvious that the whole value of the patent laws will depend upon the way in which the Act is administered. If it be administered in such a way as to consult the best interests of the inventor, and, therefore, the best interests of the country, the results of last Session's legislation cannot fail to be beneficial; but if on the contrary, it is administered in a purely official fashion, there is little hope of any good to the inventor, or to anybody else, arising from it. Should opportunities occur for the useful exercise of the Society's influence in this matter, the Council will be as ready to use their best efforts in procuring a good administration of the law as they were last Session in endeavouring to secure the passing of a satisfactory Act.

With regard to the Committee on Collisions at Sea, they hope soon to be able to present a report on the subject. They have had the advantage of the advice of many competent authorities; and they have also had before them a large mass of information which inventors, and others interested in the question, have been good enough to send in. All the information has been carefully digested, and will, it is believed, prove a valuable appendix to their report.

Premiums.

As stated in the Council report last Session, premiums have been offered from the funds provided from the following trusts:—John Stock, Benjamin Shaw, Howard, Fothergill, Mulready, and Owen Jones. In answer to the announcements put out, competing models, designs, drawings, essays, &c., have been received in the following numbers:—John Stock, 3; Benjamin Shaw, coal-mining, 8—manufacture, &c., of explosives, 3; Howard, 2; Fothergill, 17; Mulready, 8. The Council regret that offers which they certainly regard as liberal, have not produced larger results, and that a greater number of competitors have not offered themselves. The awards in each case will very soon be made known, as soon as the Council are furnished with the reports of the different Committees to whom the adjudication has been referred. As next January will be the 40th anniversary of Dr. Swiney's death, the prize founded under his will will have to be awarded in that month. The award is made jointly by the Society of Arts and the College of Physicians; the prize being offered to the author of the best published work on jurisprudence. Members who wish to bring any suitable work under the notice of the Council, are requested to send in notice at once. Besides the above prizes, the prizes offered by Mr. Wilson and Mr. Loder for plant labels are still under adjudication. A selected number of the labels sent in are now undergoing practical trial. The award will be made as soon as the trial has been continued for a sufficient period.

Examinations.

With regard to the Examinations, the Council have no alteration to announce on last year's programme. The examinations in practical music will be held in London in July, and probably at Liverpool on dates to be hereafter announced.

International Health Exhibition.

The members are aware, from the announcement made by H.R.H. the Prince of Wales, at the closing of the Fisheries Exhibition, that it has been decided to hold, on the grounds of the Horticultural Society, a series of Annual Exhibitions, the first of which will be devoted to Health and Education. As regards Health, His Royal Highness, the President of this Society, may be said to be carrying out, on a larger scale, work with the commencement of which he was closely associated in the Society of Arts. The Sanitary Conferences of the Society, held from 1876 to 1880, and the Conferences on Domestic Economy, with both of which series the name of the late Sir Henry Cole was so intimately connected, were held under the approval of the Prince of Wales, and it was at his initiation that the important Conference on Water Supply, in 1878, was held. What part the Society of Arts can take in carrying out His Royal Highness's wishes in regard to the South Kensington Exhibition yet remains to be seen. It may, however, be stated that the Council, in answer to a communication from the Executive Council of the Exhibition, have expressed their readiness to render any services which may be in the power of the Society to offer. The Society is represented on the Executive Council by their President.

Obituary.

SIR WILLIAM SIEMENS, D.C.L., F.R.S.

The Society of Arts has suffered a severe loss in the death of Sir William Siemens, its Vice-President and Chairman of Council, who has been struck down in the very midst of his active work. The loss the world has sustained by the death of one of its foremost men is widely and keenly felt, but nowhere will this loss be more deplored than among the members of that Society with which he was connected during the greater part of his active life. Although, as the members know by the announcement in the *Journal*, Sir William Siemens had been ill for a short time, no fatal consequences were anticipated by those around him. About a fortnight ago, he stumbled while crossing Hamilton-place, on his way home to Bayswater-hill, and a day or two afterwards it was found that some injury had been caused to the heart, but it was hoped that rest would in time bring about a restoration to health. On Monday last, however, he was taken with more alarming symptoms, and at nine o'clock at night he expired at his residence, 3, Palace-houses. At the *post-mortem* examination it was found that the cause of death was ossification of the heart, which might at any time have brought about a fatal issue. How strong was Sir William Siemens's feeling of interest in the Society over whose proceedings he presided with such assiduous attention, courtesy, and judgment, he himself expressed on the very last occasion when he took the chair, which was at the annual meeting held on the 27th June. When acknowledging the vote of thanks accorded to him, he said "that the Society of Arts had a very old claim upon him; it was, he might say, the first society with which he became acquainted, and the first which recognised his labours, by awarding him in 1850 its gold medal." He was elected a member on 21st November, 1849, and this medal was awarded in the following year, for his Regenerative Condenser. On April 21st, 1858, he read a paper before the Society, "On the Progress of the Electric Telegraph." The Albert Medal was awarded to him in 1874, "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the arts; and for his improvements in the manufacture of iron, and generally for the services rendered by him in connection with economisation of fuel in its various applications to manufactures and the arts." He has been continuously on the Council from 1874 until the present time, having been elected a Member of Council in that year; a Vice-President in 1870, and Chairman in 1882, and again in the present year.

In consequence of the postponement of the Conversazione to a later date than usual, the annual meeting was not the last occasion upon which he appeared as Chairman of the Council, and his munificence in connection with that Conversazione will long be remembered by all associated with the Society.

The announcement that Sir William Siemens would be unable to deliver the usual Chairman's address on the opening meeting of the new session was naturally received with great regret. The remembrance of the important address of last year caused large expectations to be raised respecting the one for the present year; but the disappointment experienced was tempered by the further announcement that the address would, it was hoped, be only postponed to a date to be hereafter fixed. A portion of the address had been written when Sir William was taken ill, and it was his intention to treat of measurement generally, and of that of electricity in particular, so that there is little doubt but that this year's address would have equalled that of last year in the originality of its conception and the interest of its contents.

Charles William Siemens was born at Lenthe, in Hanover, on the 4th of April, 1823. He was educated at the Gymnasium at Lübeck, afterwards at the Polytechnic School at Magdeburg, and finally at the University of Göttingen, where he studied under the distinguished Professors, Wöhler and Himly. In 1842 he became a pupil in the engine works of Count Stolberg, and here he laid the foundation of his engineering knowledge. It was to introduce to the English public a joint invention of his own and his brother Werner in electro-gilding that William Siemens first came to England. This was in 1843. Speaking, two years ago, to the members of the Birmingham and Midland Institute, Dr. Siemens, as he was then, gave an interesting account of the difficulties which not unnaturally beset the young foreign inventor, so ignorant of the language of the country that his first visit was to an "undertaker," under the impression that he was a suitable person to take up and bring out his invention. He was able to dispose of his invention so far successfully to Messrs. Elkington and Mason, of Birmingham, that he was induced in the following year to come back again on a similar errand. This time it was his "chronometric governor," an apparatus which, though not very successful commercially, introduced him into the engineering world, and was really the cause of his settling in this country. The chief use of this apparatus, intended originally for steam-engines, has been found in its application to regulate the movement of the great transit instrument at Greenwich.

The process of "anastatic printing," a process only superseded by recent advances in the application of photography to the same purpose, was due to William and Werner Siemens, and it was made the subject of a lecture at the Royal Institution, in 1845, by Faraday, whose last lecture there was on the advantages of the Siemens furnace. When, in 1874, Sir William Siemens designed his remarkable vessel, intended for the laying of the Direct United States cable, he named it, in remembrance of the famous philosopher, *The Faraday*.

His studies in the dynamical theory of heat, led him to pay special attention to methods of recovering the heat generally allowed to run to waste in various engineering and manufacturing processes. The first application of these researches was in the regenerative steam-engine which he set up, in 1847, in the factory of Mr. Hicks, at Bolton. In this, superheated steam was employed, but its use was attended with certain difficulties, which have prevented the commercial introduction of the invention.

The direction in which he was then working was stated in a paper he read before the Institution of Civil Engineers in 1853, on the conversion of heat into mechanical effect. This paper gained him the Telford Premium and medal of the Institution; and only last week the same Institution voted him their Howard prize, which is given quinquennially to the inventor of an improved process connected with iron-making, and has only been once awarded before—to Sir Henry Bessemer. In 1857, William Siemens, in connection with his younger brother and then pupil, Frederick, turned his attention to regenerative furnaces for metallurgical purposes. The regenerative gas furnace, as it is certainly the greatest invention due to the Siemenses, is the one in which William Siemens is believed to have had the largest share. The first successful application of these furnaces was in 1861. The earlier application of the principle of the regenerative furnace to steel and glass-making have been followed by its extension to many other industrial purposes in which great heat is required, the powers of the furnace being only limited in practice by the nature of the materials of which it can be constructed.

The application of the furnace to the making of iron and steel naturally led the attention of its inventor to other improvements in the same manufacture. In 1862, he endeavoured to reduce to practice the result of Reaumur's experiments in making steel by fusing malleable iron with cast steel. After some years experimenting, the Siemens process of steel making was perfected, and a little later still the Siemens-Martin process. In the latter, scrap iron is melted in a bath of pig iron on the hearth of the furnace; in the former, ore is reduced. The production of steel in this country, under Sir William Siemens's processes, was 340,000 tons in 1881.

It is, however, with the electric light that the name of Siemens is, at the present time, most closely associated in the popular mind. It was on the 4th February, 1867, that his paper on the conversion of dynamic into electrical force, without the use of permanent magnetism, was received by the Royal Society. Strangely enough, at the meeting of 14th February, when it was read, another paper in which the same discovery was enunciated by Sir Charles Wheatstone was read; while there is yet a third claimant, in the person of the late Mr. Cromwell Varley, who had previously applied for a patent in which the idea was embodied. As regards the Siemens discovery, the originator of the idea was Dr. Werner Siemens, who, on being shown an electrical motor constructed without permanent magnets, immediately saw that a generator without permanent magnets was equally possible. The details, however, of the construction of the Siemens machine, and the various improvements by which it has been brought to its present form—or, rather, forms, for there are, of course, several varieties—are due alike to the younger and the elder brother; generally of all the various inventions which emanated from the great firm of Siemens Brothers the same may be said.

In the installation of the electric light, the firm was among the foremost. At the Paris Exhibibition they were *facile principes;* at Munich, at Vienna, and at the Crystal Palace, they were alike conspicuous. Visitors to the lately-closed Fisheries Exhibition will remember how large a share of lighting there was effected by Messrs. Siemens. As regards the electrical transmission and conveyance of power, this is a field they have made peculiarly their own. The Berlin electric railway and that at Portrush, are alike the work of one or other branch of the firm. Working at the subject of the electric light had of late led Sir William Siemens to considerations of the nature of the light itself. The tendency of some of these thoughts is shown by certain of his recent communications to the Royal Society, including his last paper of all, in April last, "On the Dependence of Radiation on Temperature," and these, again, influenced by his earlier studies on the conservation of energy, led him to one of the most recent of his researches—that which produced his theory of the conservation of solar energy. Sir William Siemens was not so voluminous a writer as some of his contemporaries, but thirty-five papers are registered in the Royal Society "Catalogue of Scientific Papers" as due to his labours, and, since that work closes in 1873, several others might be added to the list. When it is remembered that each of these papers represents a discovery, or at all events a large amount of experiments, the great labours of his life become evident.

Honours were freely awarded to Sir William Siemens. The medals of the Society of Arts and the Institution of Civil Engineers have already been mentioned. He was elected a Fellow of the Royal Society in 1862, and he served on Councils of that Society in 1869-71, and in 1878-80. At the Exhibitions of 1851 and 1862 he received prize medals, and in 1867 he was awarded a *grand prix* at the Paris Exhibition for his regenerative gas furnace and steel process. In 1875 the Iron and Steel Institute gave him the Bessemer medal, and last April he was knighted, in recognition of his scientific services. He was honorary member of various foreign scientific societies, and possessed several foreign orders, among them that of the Legion of Honour. In 1870, the University of Oxford conferred upon him honorary degree of D.C.L., and some years later the University of Dublin and Glasgow followed with the degree of LL.D., and the University of Würzburg with that of Ph.D. He was the first President of the Society of Telegraph Engineers, and served a second time in that capacity. He had been President of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the British Association, and he served some years on the Council of the Institution of Civil Engineers.

In addition to a full account of the life and labours of Sir William Siemens, the *Times* of Wednesday, the 21st inst., contained an appreciative leading article upon his career, the greater portion of which is here reprinted:—

"The death of Sir William Siemens, at the comparatively early age of 61, deprives the world of the services of a singularly powerful and fertile mind. Had he been spared, as but for an accident it is reasonable to believe he might have been for many years to come, he would, beyond doubt, have yet further enriched the world with discoveries in the realms of speculative or applied science. * * * * For nearly forty years he has been an English citizen, and has devoted a large portion of his time and ingenuity to the perfecting of processes for the improvement of a staple English industry. His name recurs upon every page of the history of iron manufacture since he came among us; and although some of his inventions have not proved entirely suitable to English ores and English wants, it is impossible to exaggerate the importance of others, whether directly or through the stimulus they gave to the minds of English manufacturers. It has been thought fitting that one who has thus identified himself with us, and has achieved great things, not merely in that important department, but in chemistry, in engineering, and in electrical researches, should now be honoured with such public and formal recognition as it is in our power to give. It will be admitted by all that if we are to have a national pantheon, none can more justly claim a place therein than a man who has attained the highest eminence in the subjects which it is the boast of the present day to have carried to a perfection unknown before. Science now claims the services of the most powerful and highly-trained intellects; hence it is natural and proper that we should announce our belief in the worth and greatness of our chosen pursuits by doing honour to the men who enlarge the scope of scientific speculation, and add to the solid results of practical effort. Unfortunately, every claim of this kind raises questions which derive their relevancy and importance only from the poverty of our resources. We have no adequate means of doing honour to departed greatness, and the Abbey which we have converted to the uses of a pantheon has retained so much of its original character as to create a perpetual conflict between different orders of ideas. We have modernised it so far that it is difficult to resist the further demands of the modern spirit, yet so much of its original character remains as to give room for continual resistance. The question whether a man deserves national honour and commemoration, which in the case of Sir William Siemens would cause no difference of opinion, is complicated with the totally different question whether the means actually at our command are sufficient to satisfy an admitted claim.

"Sir William Siemens was essentially an inventor. In whatever direction he turned, his thoughts seemed to perceive new methods of working out old problems, or to discover new problems which it immediately became his province to solve. There is an abundance of most meritorious inventors who proceed upon one line of thought only, and show no aptitude for creative work in any other direction. But the inventor proper is one who, like Sir William Siemens, is continually throwing out original ideas in spheres where others find it sufficiently difficult to master what has already been done. His patents were numerous and various, but he invented many things which he never patented, and conceived many ideas which can never become the subjects of a patent. His improvements in the manufacture of steel have probably produced larger results than any of his other discoveries, but that is rather because the field of their operation is of great extent and importance, than because they are intrinsically greater than his achievements in other directions. Electricity is in its infancy, hence the most remarkable discoveries must, as yet, have comparatively restricted pecuniary results, but the vigorous growth of the new science is very greatly due to his early appreciation of the possibilities opened up by a method of converting force directly into electricity. He showed his usual versatility in perceiving the numerous ways in which the new and copious supplies of electrical energy can be utilised. His electric furnace, intended to melt considerable quantities of refractory substances hitherto fused only in minute beads, or by means of enormous and costly furnaces, is only an example of the readiness with which he applied new forces and new ideas. Whenever machinery was required for the carrying out of his aims, he seemed to invent new arrangements with the same facility. He found serious defects in the mode of insulating telegraph wires, and forthwith devised a machine for covering them effectively and cheaply with India-rubber. Ordinary ships were unsuitable in various ways, even after much ingenious adjustment, for the work of laying telegraph cables, so Sir William Siemens designed the *Faraday*, a vessel crowded with special provisions for her peculiar work, and capable of being turned, by a novel arrangement of her screws, upon her own axis. Some new construction of hydraulic presses and receptacles for compressed air had become desirable, and again Sir William Siemens produced the thing required. The measurement of high degrees of heat has always presented serious difficulties, but he invented a method of electrical measurement which gives any temperature, from that of the sea bottom to that of the interior of a blast furnace. These extremely diverse inventions, which are merely samples of his restless activity, may serve to convey some idea of the fecundity and originality of his mind.

"His practical labours, great and manifold as they were, left him time and energy for the most abstruse speculation. While astronomers quietly accepted the conclusion that the sun is cooling down, and will become at some distant and calculable epoch a mere cinder hung in space, he endeavoured to show that energy can no more be lost in the solar system than in the laboratory. The ingenious theory he advanced to show that force returns to the sun is based upon the assumption that aqeuous vapour and carbon compounds are present in interstellar space, and that the solar energy which is sometimes assumed to be lost in the empty void really acts upon these substances, and converts the universe into a kind of vast regenerative furnace. In some recent observations of the luminous extensions from the body of the sun, he found corroboration of his views. They were, of course, severely criticised, and may be admitted to amount to nothing more than an ingenious theory; but then there is nothing to set up against them except other views equally incapable of proof and considerably less ingenious. It must have happened to many men to feel the profoundly visionary character of many statements confidently put forth concerning the constitution of the universe, and they will at least be grateful to Sir William Siemens for rebelling against the tyranny of an induction founded upon extremely meagre knowledge. It is more scientific to believe, with him, that there is some restorative and conservative agency at work, than to suppose that the universe is gradually cooling down into balls of slag, were it only because his theory does not require an effort of creation at once tremendous and futile. It leaves us free to avoid contemplating a time when the solar system was not, and another when it will cease to be. In another and very different direction we find Sir William Siemens seeking relaxation in the less sternly practical applications of science. It occurred to him to try the effect of the electric light upon the growth of plants, and he succeeded in considerably accelerating their development. It has not been proved either that continual light is incompatible with plant sleep, or that it could be applied to successive generations without pernicious effects. But his experiments remain extremely curious, and form another illustration of the extraordinary originality and resource of the intelligence now prematurely quenched in death."

Miscellaneous.

PISCICULTURE.

By J. J. Manley, M.A.

Pisciculture, as applied to both salt and fresh-water fish, was well illustrated at the recent Fisheries Exhibition; and it is expected that an impetus will be given to its pursuit in this country, which has hitherto been somewhat backward in this matter, except as regards the artificial propagation of the *Salmonidæ* family. The culture and acclimatisation of salt-water fish has made little progress among us, and foreign countries have left us far behind. The Romans, in the time of the Empire, paid great attention to salt-water fish farming, rich men having extensive and elaborate vivaria for amusement sake and gastronomic pleasure, while others cultivated fish for profit. Arrangements were made for the fish to run into the vivaria from the sea and deposit their ova in them, and spawn was collected in the sea itself and brought into the vivaria to hatch. Exotic fish also were brought from long distances. But the artificial propagation of fish does not appear to have been practised till the fifteenth century, and in this country not till within the last fifty years; and we are still without any recognised establishment or enterprise for the culture of sea fish. The United States Government are thus far ahead of our own, and the shad has been artificially disseminated in many districts, to say nothing of the success in other branches of pisciculture. Other Governments are following the example of the United States; and in England it is hoped that the establishment of a marine biological station, or stations, will lead before long to an extensive system of marine pisciculture and the acclimatisation of foreign fish. The recent news from America, that the spat of the oyster has been successfully impregnated by artificial means, will give a further impetus to marine pisciculture.

In the matter of pisciculture in fresh water, other countries, notably France with its famous Huningue establishment, and Germany, are also in advance of us, notwithstanding many admirable private enterprises, such as those at Stormontfield, on the Tay, and of Sir J. Gibson Maitland, at Howietown. But there is no fear now that the culture of salmon and trout, and their allies, will not make continued progress, and it is already an established and remunerative industry. The culture of other and commoner kinds of fresh-water fish is another matter, and this, too, has, directly and indirectly, had fresh attention called to it by the Fisheries Exhibition; and it is to this branch of pisciculture the following remarks are directed.

The question seems to present three chief heads for consideration; the first, whether pisciculture applied to fresh water could be so carried out in this country as to supply an amount of food which would be a sensible addition to our resources; the second, whether the fish food thus produced would be acceptable to our tastes; the third, whether pisciculture would pay commercially. As to the first point, there can be little doubt but that the supply of fresh-water fish of the ordinary kinds might be immensely increased by proper culture. By ordinary kinds are meant jack, carp, tench, roach, dace, perch, chub, gudgeon, bream, and eels; but the culture of the *Salmonidæ* family is not included, as it forms a distinct branch of this question, and may be considered as an established and remunerative industry. Pisciculture, as applied to the common fresh-water fish of different countries, is a very ancient art. It was successfully practised by the Greeks and Romans, and probably by the Egyptians before them. It has been a branch of public industry among the Chinese for many centuries, and at the present time fresh-water fish form the cheapest and most plentiful food in that country. This is the case also to a very great extent in Japan, where, by the way, it is said that most fish are preferred in a raw to a cooked state. For many centuries the abbeys and monasteries in this country produced a large supply of fish food from their ponds and stews; and during the Church fasts, which were many and often of long duration, a large proportion of the population lived mainly on a diet of fresh-water fish. The monks, and country gentlemen too, in those days, must have had tolerably good ideas of pisciculture, as the different old books on the formation and management of fish ponds indicate; and it is certain that fish formed a very considerable portion of the food supply of the kingdom. With our improved knowledge of natural history, and especially of the method of expressing the ova from fish and artificially hatching them, whereby the increase of production is extended a thousand-fold, we could, doubtless, raise a very large stock of fish in our ponds and rivers; but, considering the great increase in the population, it is more than doubtful whether the supply thus obtained would be any very appreciable addition to our food resources.

But though the supply of "coarse" or common fresh-water fish, could be greatly increased, the acceptability of such fish as food to the mass of the population is very uncertain; indeed, the popular verdict seems decidedly against them, with few exceptions. They have all, more or less, a palpably muddy taste, and where this is not predominant, they have but little more flavour than stewed blotting paper. Even trout, from many streams that could be named, are either insipid, or partake to a great extent of the characteristic flavour of other fresh-water fish. Persons may be found, indeed, who will go into raptures over jack stuffed with the appropriate "pudding," or over carp and tench stewed *secundum artem*. Even roach, dace, barbel, and bream, find advocates; but in this matter, the *vox populi* is probably right; and it is more often the sauce or the stuffing which gains admirers than the fish themselves. It may be admitted that there is a vast difference in fresh-water fish, and much depends on the way of cooking them. Thames fish have a decided superiority over most others; and the wives of Thames puntsmen, and cooks at Thames-side hostelries, seem to excel in the art of serving up the fish from their river. The secret chiefly lies in cleaning the fish as soon as possible after they are caught, and thoroughly drying them when split open, in the sun and wind before cooking. Thames gudgeon, when properly cooked, are by no means bad eating, and are fairly entitled to the name of "fresh-water smelt." Thames perch also, and jack, are certainly eatable; and a Thames trout is undeniably excellent, but he is a *rarissima avis*. Thames fish, are however, an exception. Those from other rivers are mostly inferior; while it is no exaggeration to say that fish from stagnant water, or from ponds and lakes which have only a slight stream running through them, can hardly be considered as coming within the category of acceptable food. Even enthusiastic anglers can hardly dare to advocate the culinary merits of fish from the Norfolk Broads. As a rule, the poor will not eat fresh-water fish, even when they can get them for nothing, or when *paterfamilias* brings home a basket of "coarse" fish of his own catching, pretends to like them himself, and his family eat them out of compliment to the catcher.

When a pond or river is dragged, the owner, as a rule, can hardly find persons to carry away the carp, tench, and other such fish captured. As an instance of this, I once saw large heaps of fine roach, which had been netted out of the trout water round Wilton, lying on the banks, and no one caring to come for them, though a general invitation to help themselves had been given to all the country side. There is little or no market for coarse fish in London, except at particular seasons, when the Jews will buy them, following some "tradition of the elders." But this is a poor testimony to their goodness, when we find that barbel is the most favourite fish among the Jews, whereas most Christians would agree that this fish is the most unpalatable one our waters produce. It may be said that this popular estimate of fresh-water fish is all prejudice. Perhaps it is, to some slight extent. We know how prejudice militates against the use of Australian tinned meat. We know that a true Celt will not taste an eel; or a true Englishman a snail or a French edible frog. It would take many years of "raniculture" to make the latter an acceptable article of food. But it is not all prejudice in the matter of fresh-water fish. With the exception of trout, to which may be added gudgeon and perch from the Thames and some other rivers, and eels, which, like salmon, almost stand apart by themselves in this question, fresh-water fish have either a muddy or unpleasant flavour, or are simply tasteless; add to which, the abundance of large and small bones throughout them renders them still more unacceptable. Again, it might be alleged as a proof of present prejudice, that our forefathers, not only of the lower, but the higher classes, ate and appreciated these fish. True, but this was partly because of the cheapness of this poor food, and the scarcity of better, and partly owing to their want of good taste. This is not begging the question. The tastes of a nation travel forwards, so to speak, not backwards, and food which previous generations accepted is refused by those that follow them. This is a fact, however much as in certain respects it may be a subject of regret. Jack and carp can hardly be considered as generous dishes at modern, civic, or regal banquets, as they were of old, though I believe the latter fish is still served at Windsor Castle. But the Virginia water carp do not appear at the royal table till they have spent a considerable time in clear, sharply running water, arranged for the purpose, in which they, to some extent, are freed of their muddy flavour. And after all, this serving of the old Elizabethan stew must be more a matter of form and of keeping up old traditions, than based on any real appreciation it meets with. Of course scientific pisciculture might improve the quality of our pond and river fish; and proper feeding, due cleansing of the ponds, a proper regulation of the number of fish in any given space, and a cleansing of those about to be used as food in stews of swiftly running water, according to the old custom, might do much to make the fish more palatable; but I cannot imagine that the time will ever recur when the old saying recorded by Isaac Walton, "He that hath bream in his pond hath always a welcome for his guest," will be true either in reference to the poor-eating fish named, or to the other ordinary inhabitants of our waters. We cannot expect, by scientifie culture, to improve their breed as we have that of our flocks and herds. The salmon family and eels seem to be the only products of our fresh waters really worth cultivating from a food supply point of view, or as ministering to the pleasures of gastronomists.

If pisciculture is destined to supply us with any appreciable increase of palatable fresh-water fish food, it must be by the introduction of new species from other countries, and their acclimatisation in our waters. Several such have been proposed as most suitable, and some have actually been introduced by way of experiment. For instance, the *Silurus glanis*, or "sheat fish" of Central Europe, is thought by some as a very likely kind to thrive in our waters. It is excellent food, and grows rapidly, and to a great size. It was in reference to the enormous weight which this fish attains that a humorous contemporary suggested that, if naturalised in our rivers, it would show excellent sport when played with a chain cable attached to a crane, which should move on a tramway along the river's bank. The great lake trout of Switzerland has been successfully introduced into some of our waters, and so has the *Salmo fontinalis*, or American "brook trout." The black bass *(Grystes nigricans)* from the northern districts of America, and that from the southern and western known by the name of *Grystes salmoides*, have also been found likely to suit our waters. The Marquis of Exeter has been very successful in the acclimatisation of some species of black bass at Burleigh-house, and it is a fish which would probably thrive well in some of the waters of the East Anglian Broads and rivers, as suggested by Mr. Wilmot, the Canadian Commissioner at South Kensington, on the occasion of a visit some few weeks ago to the Norfolk Broads by gentlemen connected with the Fisheries Exhibition. The black bass is a fine sporting fish, and gastronomically to be commended. To these we may add, as suitable to some of our waters, the white fish *(Coregonus albus)* of Canada, which is very prolific, and most excellent eating.

The third point for consideration is—Would pisciculture pay? Even if our ordinary fresh-water fish were acceptable to consumers, it is doubtful whether the culture of them would commercially be successful. Under no circumstances could it be expected that they would be able to compete with salt-water fish in cheapness. The cost of cultivation would, probably, be greater than the advocates of pisciculture anticipate. Letting the water off ponds in succession, and cropping them with corn or vegetables, as proposed by the late Mr. Frank Buckland, and the after removal of the soil, would involve great labour and expense. Fish are but slowly growing creatures, unless supplied with abundance of food, and this represents a further outlay. During the summer months, Mr. Buckland suggested that putrefying flesh hung over the ponds would supply maggots, and that lob-worms might be gathered in the meadows after dark. But suitable flesh is not always obtainable, and for weeks in a drought not a lob-worm will show itself. The latter are often worth from a shilling to half-a-crown a quart for fishing, in dry weather, along the Thames side; and are actually imported by thousands from Nottingham, where "vermiculture," or rather worm gathering, is a recognised industry. The difficulty and expense of feeding the fish in the winter would be still greater. It certainly would not pay to supply them, as Mr. Buckland did his small fry of various kinds at South Kensington, with "chopped beef-steak and biscuits." Whether the quicker growth of foreign fish proposed for naturalisation would cover the expenses attached to their culture, is a matter on which it is almost impossible to give an opinion. It would be satisfactory to think that careful calculations as to the whole matter would give good grounds for expecting that any system of pisciculture in fresh water would answer the expectations formed of it by its advocates. At all events they will be benefactors who can make two fish to live where only one lived before, and will, by the introduction of new species, develop the capacities of our now generally ill-stocked waters. As an encouragement to such, it may be noted that in Germany the scientific culture of carp in ponds is found to be remunerative, as in that country, and in some other districts on the Continent, this fish is still specially popular as an article of food.

Perhaps the recent establishment of the National Fish-culture Association of Great Britain and Ireland, the honorary secretaries of which are Mr. R. B. Marston and Mr. W. Oldham Chambers, will do much towards the solution of the question. It is certainly one which may fairly be taken up by scientific and philanthropic members of the community; and perhaps many of the general, and especially the angling, public will supply funds for the acquisition of some suitable water or waters, for experiments in the way of pisciculture, not so much in the hopes of receiving a pecuniary return, at least for the present, as for the purpose of practically testing the possibility of improving our own fresh-water fish supply by cultivating the species already in our rivers, ponds, and lakes, or naturalising new ones. Such an attempt would have the sympathy of a considerable public interested in the subject, and could not fail to elicit valuable information. It is hoped that the remarks here made will not be considered as discouraging to such an inquiry. Even apart from the question of fresh-water fish as contributing to our food supply, their multiplication for the sport of the angling fraternity is a matter well worth attention, as the facilities for rational and wholesome recreation are no mean elements towards the well-being of a nation, and especially of its poorer classes.

REMARKS ON BALATA AND OTHER PSEUDO-GUTTAS.

By James Collins.

The great value of gutta-percha, the fear of the supplies, in time, not equalling the demand, has led to the recommending of various substances as substitutes, or as supplementary, to the present supplies of gutta-percha. The following notes may be taken as a short *resumé* of the subject, and indications are given as to the way in which these substances may possibly be utilised. For convenience, these various substances are grouped geographically:—.

I.—American Sources of Supply.

Natural Order, *Sapotaceæ.*

Balata Gum* (*Mimusops Balata*, Gærtner), known also as paardenvleesch (horseflesh), bullet tree, boerowé, bolletrie, &c., is found in Demerara, Berbice, British Guiana, Antilles, Jamaica, and Surinam.

Professor Bleekrod was one of the first writers on the subject, his communication being addressed to the Society of Arts, in 1857,† and the tree described and named by him as *Sapota Mulleri.* In 1860, Mr. Walker‡ communicated samples, &c., received by him from Dr. Van Holst, of Berbice; and, in 1864, Sir William Holmes§ also drew the Society's attention to the same subject.

The tree is a large one, with a trunk of about 6 feet in diameter, and furnishes a wood much liked for building purposes. The Dutch name, "paardenvleesch," is given on account of the wood being of the colour of horseflesh. The bark is thick and rough, and the fruit is of the size of a coffee-berry, sweet like a plum, and with a hard white kernel, which yields a bitter oil. The leaves are glossy, oval, and acuminated. The milk is drunk by the natives, and when diluted with water is used as a substitute for cows' milk. The tree grows in groups, and in alluvial soil.

The "Balata" gum is of a character somewhat between caoutchouc and gutta-percha, combining in some degree the elasticity of the one with the ductility of the other, freely softening and becoming plastic, and easily moulded if plunged in hot water. What small parcels were sent to this country met with a ready sale, and were remarkably pure and free from adulteration. But, unfortunately, through the difficulty of collection, the undertaking being dangerous and unhealthy, the supply of this excellent article has fallen off.

The Balata is collected by making incisions in the bark, about 7 feet from the ground, and a ring of clay placed round the tree to catch the milk as it exudes. The yield is said to be in profusion, especially at the time of the full moon, and the operation can

* The term "gum" is here used in its colloquial, not in its scientific sense.

† *Journal of the Society of Arts*, London, Oct. 8, 1857.

‡ *Ib.* Aug. 24, 1860.

§ *Ib.* Mar. 4, 1864.

be repeated every two months in the rainy season. It takes six hours to bring about coalesence by simple atmospheric influence, but very quickly by boiling in water. A large tree is said to yield as much as 45 lb. of "dry gum."*

II.—Indian Sources of Supply.

Natural Order, *Sapotaceæ.*

Pauchontee, or Indian gutta tree (*Dichopsis elliptica*), is the *Bassia elliptica*† of Dalzell, and the *Isonandra acuminata* of Cleghorn‡, and is found distributed through the Wynaad, Coorg, Travancore, Anamally, and Neilgherry Hills, Sholah Forest, Cochin, and the Sichars. According to General Cullen, it "appears to be common in all the forest tracts at all within the influences of the south-west rains."

This tree, which is now placed in the same genus as the true Malayan gutta-percha, is a large one, attaining a height of from 80 to 100 feet. The gum is obtained by tapping, a pound and a-half being obtained from one tree, by five or six incisions, a large tree yielding from 20 to 40 lb. of sap. Many experiments have been tried with the raw milk, and General Cullen and Dr. Cleghorn used every exertion to bring the substance prominently forward. The simply dried milk was found wanting in several essential qualities for telegraphic purposes, but has been recommended as a sub-aqueous cement or glue. When dissolved in ordinary gutta-percha solvents, it, after the evaporation of the solvent, remains some time soft and viscid, and partaking somewhat of the characteristics of bird lime. When cold it is hard and brittle.

Natural Order, *Euphorbiaceæ.*

Cattimandoo (*Euphorbia Cattimandoo*, W. Elliot), is found in Vizagapatum, and was first brought to notice by the Hon. W. Elliot, who was awarded a prize medal by the jurors of the 1851 Exhibition. This spiny euphorb grows to the size of a shrub or small tree, and the milk flows out freely when a branch is cut. The natives use the milk as a cement to fasten knives in handles, &c. Under the influence of heat it becomes soft and viscid, becoming very brittle on drying.

The Milk Hedge, Indian Tree Spurge, or Tirucalli (*Euphorbia tirucalli*, Linn), common in the Coromandel, Malabar, Bengal, &c., is a succulent unarmed plant attaining a height of about 20 feet. Its inspissated juice is used for various, chiefly medicinal, purposes in India, but has a very acrid character, rendering its collection a very dangerous operation to the eyes.

Natural Order, *Apocynaceæ.*

Alstonia, or Pala Gum (*Alstonia scholaris*, R. Br.).—This tree is found distributed through Travancore, Coromandel, Assam, and in Ceylon. It attains a height of fifty feet, and its wood and bark are much valued in India for their medicinal qualities. To Mr. Ondaartjee is due the credit of recommending Pala gum as a substitute for gutta-percha.* It readily softens in water, and retains, when cold, good impressions of any objects. Good specimens, properly prepared are, however, much wanted.

Natural Order, *Asclepiadaceæ.*

Mudar Gum (*Calotropis gigantea*, R. Br.).—This shrub is found distributed throughout the Peninsula and Southern Provinces of India, in waste places, and grows to a height of 6 to 10 feet. Ten average trees are said to yield about one pound of gutta-like substance, which is plastic in hot water, and in other ways behaves like gutta-percha. *Calotropis procera* is said to furnish a like product.

III.—Ceylon Sources of Supply.

Natural Order, *Sapotaceæ.*

Ceylon has many species of *Dichopsis*, *Isonandra*, and other closely allied genera, which are likely to yield a gutta-like substance. The late Dr. Thwaites, the talented director of the Government gardens at Peradenia, informed me that the natives did not collect any gutta, and one sample sent to the late Sir W. J. Hooker was unfavourably reported on. In some parts of Ceylon, the climate is similar, if not identical, with the Malayan Archipelago, the home of the true gutta-percha.†

IV.—African Sources of Supply.

At the Cape of Good Hope there are many species of euphorbias which yield a substance very similar to cattimando, but like the *Euphorbia officinalis*, Berg, the juice is so acrid as to give intense pain and irritation to any part of the body with which it may come into contact, especially the nostrils. The Rev. J. C. Brown, whilst botanist to the Cape Government, paid much attention to the subject, and the juice has been recommended as an anti-fouling dressing for ships' bottoms.

Mr. Barter, whilst on the Niger expedition, collected a specimen from a species of *Chrysophyllum*, which was said to resemble gutta-percha. Tropical Africa should undoubtedly yield some such substance.

With regard to these various substances, it may be said that Balata gum has an assured value of its own, and efforts should be made by cultivation or acclimatisation to utilise this valuable substance. With regard to the others, the consideration of some of the aspects of the gutta-percha question may throw some light on the subject.

The utilisable products existing in plants is a most important question in phyto-chemistry. As to their use and characteristics whilst in the plant we know little, and that little is almost entirely inferred from the characteristics of the products after they are extracted from the plant. Thus, indigo does not

* *Trinidad Chronicle*, Sept. 2nd, 1873.

† Kew Misc., iii., p. 36 (1851).

‡ Report on Pauchontee, Madras, 1858.

* *Journal of the Society of Arts*, London, vol. xii., p. 30, Feb., 1864.

† *Vide* Thwaites' "Flora Zeylanica" (preface).

exist as indigo (as we know it) in the plant itself, but is the result of fermentation after the juice is extracted from the plant. Sugar-cane juice too, furnishes us with an illustration as to how quickly products change after taken from the plant. The juice whilst in the cut cane even does not change, but as soon as it is expressed it speedily ferments, and uncrystallisable sugar is the result—a result which is retarded at least by the addition of lime. Thus with these and many other substances, exposure to atmospheric influences, induces change, and a new set of chemical combinations are inaugurated. Some products, such as alkaloids, acids, resinous matters, &c., are not used, so far as is known, in the economy of the plant, and are accordingly removed from young and active portions of the plant to store cells or reservoirs; whilst others, such as gums, starches, &c., undergo many changes, are changed from starch to gum and to sugar, and are freely used up in the sustentation and growth of the plant. In cinchonas it has been proved by analysis that those growing in hot valleys have a greater development of bark and a lesser elaboration of alkaloidal contents, whilst in the mountains the reverse is the case. This may arise from the alkaloid, or its primal constituents, being used up in the elaboration of tissue, or its larger formation being at the expense of tissue, or it may be from simple translocation, that is, a process of removing products from the active part of a plant to store cells or reservoirs.

With regard to gutta-percha, these facts have a very important significance, and are worthy of all attention, bearing as they do also on pseudo-guttas. Gutta-percha, as it flows from the tree, is a viscid fluid, acquiring milkiness and concreteness on exposure to the atmosphere, and unless arrested, the change results in two resins, *albine* and *fluavile*. Thus, according to M. Payen, the analysis of commercial gutta-percha gives—

	Per cent.
(a) Pure gutta (an hydrocarbon, milk-white in colour and fusible)	75 to 82
(b) Resins soluble in boiling alcohol, and consisting of two parts :—	
(1) Crystalbine or albine, a white crystallisable resin, crystallising out of the alcohol as it cools	16 to 14
(2) Fluavile, a yellow amorphous resin, falling in a powder on the cooling of the hot alcohol in which it is soluble	6 to 14

It is thus apparent that the change of pure gutta into a resinous-like mass takes place naturally, if means are not taken to stop it. This resinification I have often witnessed. If two bottles of equally pure and identical gutta be taken, and the one bottle hermetically sealed, and the other left exposed to the atmosphere, the first will retain its goodness, and the other will become resinified, and as brittle as shellac. Again, from experiments extending over years, both at home and in the East, I have found "getah muntah," or raw or "uncooked" gutta, soon become a resinous mass, being, in fact, in character like so much kowrie gum or cutch.

This change, I have proved experimentally, can be lessened, retarded, or altogether obviated, by thoroughly well boiling the product immediately after collection.

There is also another fact to bear in mind, with regard to this proneness to chemical activity in gutta-percha. In cutting through the bark to arrive at the laticiferous, or milk-bearing vessels, many other vessels and cells become ruptured, containing tannic, gallic, and other proximate principles, and the presence of these no doubt initiate and accelerate oxidation. In opening bottles of milky juices, a turbidity and effervescence is often noticed, owing to the formation of a brownish liquid, the colour of which is probably due to the presence of gallic acid, and gallic acid has been found to exist naturally in parenchymal cells and milk-ducts. In blocks of gutta-percha which have not been properly prepared, these foreign substances induce the presence of a brown, fermented, and putrid liquid, which decomposes the internal mass. Now, most of these foreign substances are soluble in water, and in the process of boiling the gutta would be eliminated.

These considerations seem to prove that some, at least, of these pseudo-guttas are worthy of, and indeed require, fresh trials before their utility can be certified, or otherwise.

To those who have the opportunity, I would recommend that samples should be collected in the manner I have already pointed out in the *Journal* of this Society.*

These samples and results, if submitted to competent authorities, would enable the question of these substances being utilisable as substitutes, or rather as supplementary sources of supply, to be set at rest.

PIURI OR "INDIAN YELLOW."

The following communication has been received from the India-office :—

Piuri is a yellow dye, used chiefly in painting walls of houses, doors, and railings. It is seldom used for dyeing cloth, owing to its bad smell. It is derived from two sources—(1) of mineral origin, imported from London; (2) of animal origin, manufactured at Monghyr, a town in Bengal. Sir Joseph Hooker has asked for information about the latter.

By inquiries in Calcutta, I found that piuri is made at Monghyr from the urine of cows fed with mango leaves. To substantiate the truth of this statement, I went to Monghyr, and there found that a sect of

* *Vide* "Africa," &c. Letter by James Collins, *Journal of the Society of Arts*, April 25th, 1879, p. 467. See also "Report on the Caoutchouc of Commerce," to Her Majesty's Secretary of State for India, p. 46, iv., 1872.

gwalas (milkmen), residing at a place called Mirzapur in the suburbs of the town, are the only people who manufacture the substance. They feed the cows solely with mango leaves and water, which increases the bile pigment, and imparts to the urine a bright yellow colour. It is said that the cows thus fed die within two years, but the piuri manufacturers assured me that this statement is wrong; and, indeed, I myself saw cows six or seven years old from which piuri has been obtained during the last four years. The cows, however, looked very unhealthy, and the manufacturers of piuri told me that, to keep up the strength of the animal, they now and then allow her grass and other fodder besides the mango leaf, but a mixed food reduces the proportion of the colouring principle in the urine. Owing to the injurious effect which the treatment necessary for the manufacture of piuri has on the cows, the occupation of making piuri is confied to a very small number of people, who for this reason are looked down upon by their fellow caste-men. I am told that in no other part of the country is the manufacture of piuri carried on. The cows treated with mango leaves are made to pass urine three or four times a day by having the urinary organ slightly rubbed with the hand, and they are so habituated to this process that they have become incapable of passing water of their own accord. The urine is collected during the whole day in small earthen pots, and in the evening put over a fire in an earthen vessel. The heat causes the yellow principle to precipitate, separating it from the watery portion. It is then strained with a small piece of cloth; the sediment is made into a ball, and dried first on charcoal fire and then in the sun, when it is ready for the market. The merchants (chiefly Marwaries), who advance money to the milkmen for the purpose, purchase the stuff at R. 1 (1s. 8d.) per lb., and export it to Calcutta on the one side and Patna on the other. The price of the imported (mineral) piuri is only 4d. per lb. The animal piuri is of an exceedingly bright colour, and is therefore considered very superior to the mineral piuri. The high price of the animal piuri is probably owing to the deterioration of the live stock consequent on the manufacture of the article, and the cost of procuring mango leaves, which are sold at the rate of Rs. 2 for the produce of a middle-sized tree, say 30 feet high. An average cow passes about three quarts of urine per day, which yields about 2 ozs. of piuri. The animal supply is said to be about 100 to 150 cwts.; but this seems to be an over-estimate, considering the small number of cows employed for this purpose.

I myself saw mango leaves lying before the cows, the collection of urine, and the manufacture of piuri. So the real source of this kind of piuri is now beyond any doubt whatever.

I have sent to Sir Joseph Hooker direct—(1) The mineral piuri brought to Calcutta from London; (2) Monghyr piuri purchased at Calcutta; (3) Monghyr piuri purchased from the manufactures; (4) a bottle of urine from which the piuri is obtained; (5) an earthen pot in which the urine is collected; (6) quantity of mango leaves.

T. N. Mukharji.

27th August, 1883.

Correspondence.

SOUR BEER.

In your last issue "Hampshire Brewer" invites suggestions for means of utilising, in some outside industry, the sour beer which he considers renders any fresh beers to which it is added unpalatable to the modern beer drinker.

Now, it is very difficult to conceive of any use to which "returns" could be put, without incurring serious loss to the brewer; for, although the beer is sour, still it approximates very closely to the sound article; and one may safely say, that no manufacturer could utilise, to their real value, all the various constituents of the sour beer which the brewer has been at so much trouble and expense to produce in their right proportions.

It therefore seems that steps should be taken rather to render sour beer suitable for mixing with fresh without the mixture appreciably differing in flavour from ordinary beers; and, in considering this matter, I wish to point out that there are two classes of sour beers:—Firstly, those that are more than normally acid, and are in course of undergoing the acid fermentation; secondly, those that are abnormally acid, but in which the acid fermentation has ceased; and a rough distinguishing test between the two is that, while the former are turbid, the latter are bright. But the microscope should be used to detect the presence of the acid ferment.

Naturally, the addition of the first class of sour beers, as such, would be fatal in every case, for the acid fermentation would attack the fresh beer, and additional loss to the brewer would be incurred. In the second class there is a difference. In the first place, there is no chance of a communication of the acid fermentation; and secondly, the following remarks will show that an intermixture in due proportions will not appreciably affect palatability. A very acid beer, in which acid fermentation has ceased, would not, as a rule, contain above 0·7 per cent. total acidity (estimated as acetic acid). New beer would contain 0·1 per cent. The addition of three gallons of the sour beer to thirty-three of the new, would yield a barrel containing 0·15 per cent. acidity, and this 0·05 per cent. acidity above the normal amount could not be detected by experienced beer drinkers. And there is no necessity to wait till the acid fermentation has ceased, thereby raising the acidity percentage above what it need be. Take a beer undergoing the acid fermentation, as specified above, in Class I., containing, say, 0·4 per cent. acid, destroy the acid ferment, and remove the other matters in suspension; now mix it off with fresh beer in the same proportions as above, and we have a barrel containing under 0·13 per cent. of acid.

The treatment of the sour ales of Class I., before intermixture, is too technical a subject to be properly dealt with in a letter; moreover, each individual case of beer restoration requires special treatment; but I may add that seldom, in my experience, has an exception been proved to the rule that, by proper manipulation, the ordinary sour beers may be utilised as above, without appreciable loss to the brewer.

EDWD. R. MORITZ.

72, Chancery-lane, W.C.
November 20, 1883.

General Notes.

EXHIBITION AT ROUEN.—The *Moniteur des Fils et Tissus* states that a national and district exhibition will be opened at Rouen on 1st January, 1884. This exhibition will comprise all the industries of the following departments:—Aisne, Calvados, Eure, Eure-et-Loire, Marche, Mayenne, Nord, Oise, Orne, Pas-de-Calais, Sarthe, Seine-Inferieure, and Somme. This portion of the display will include a scholastic group and an annexe devoted to retrospective art. The exhibition will, however, extend to the whole of France, as far as the woollen and cotton industries are concerned, and also with respect to the application of electricity as a source of light and power.

NEWCASTLE SCHOOL OF ART.—The prizes awarded to the students of this School of Art during the past year were presented to them by Earl Percy, M.P., on November 6th, in the Lecture-hall of the Newcastle Literary and Philosophical Society. The students who attended the school during the year have numbered 186, and two bronze medals and six Queen's prizes were awarded in the national competition, and twenty-one third or lower grade prizes. In the second grade examinations, conducted by the local committee in the month of May last, fifty-two candidates presented themselves for examination, of whom twenty-five were successful. In the science department, for building construction, four candidates presented themselves, of whom one obtained a first-class in the advanced stage, two a second-class in the advanced stage, and one a second in the elementary class. In the technological examinations for carriage building, one passed in honours, second-class; and in plumbers' work also, one passed in honours, second-class.

MARINE EXHIBITION AT TYNEMOUTH, 1882.—The concluding general meeting of the promoters and guarantors in connection with the North-East Coast Marine Exhibition, which was held at Tynemouth in the autumn of 1882, has just been held in the Wood Memorial-hall, Newcastle. The report of the executive committee stated that upwards of 250,000 persons had visited the Exhibition. There were about 630 exhibitors, from all parts of the kingdom, and the committee, upon the report of competent judges, had awarded 135 silver medals, 76 bronze medals, and 80 diplomas of merit. The total receipts had been £15,261 2s. 5d., and the expenditure £14,844 19s. 4d., leaving £1,116 3s. 1d. in hand available for distribution. They recommended that £750 be invested in trustees to form a nucleus of a fund for the foundation of a chair of Engineering and Naval Architecture in the Durham College of Physical Science at Newcastle, with power to establish scholarships until such time as the arrangements for founding a chair are completed. The available balance they recommended should be divided amongst local and national maritime charities and life-saving institutions. In the discussion which followed, Mr. F. C. Marshall announced that a local shipbuilder had sent him a letter to say that he would willingly subscribe £500 towards the proposed fund for establishing a chair of engineering and naval architecture. The endowment should not be less than £500 per annum, so that the chair should be worth at least £1,000 a year; and it would take £12,500 to do that.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 26...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Charles M. Doughty, "Travels in North-Western Arabia and Nejd."
Institute of Actuaries, the Quadrangle, King's College, W.C., 7 p.m. 1. Address by the President (Mr. T. B. Sprague). 2. Mr. D. J. McKenzie, "An Easy Method of forming Logarithms and Anti-Logarithms, correct to ten or eleven places, with the aid of Mr. Peter Gray's Tables for the Formation of Logarithms and Anti-Logarithms to twelve places."
Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, Nov. 27...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. W. T. Douglass, "The New Eddystone Lighthouse."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Dr. J. G. Garson, "The Cranial Characters of the Inhabitants of Timor-laut." Mr. H. O. Forbes, "Some of the Tribes of Timor." 3. Dr. G. B. Barron, "A Human Skull found at Southport."

WEDNESDAY, Nov. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. J. R. Trendell, "The International Fisheries Exhibition of 1883."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, Nov. 29...Antiquaries, Burlington-house, W., 8½ p.m.
Parkes Museum, 74A, Margaret-street, W., 8 p.m. Dr. Charles Kelly, "Diseases Caused by Sanitary Defects in Houses."
East India Association, Exeter-hall, Strand, W.C., 3 p.m. Edmund Kimber, "The Indian Railway Policy."

FRIDAY, Nov. 30...Royal, Burlington-house, W., 4 p.m. Annual Meeting.

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No. 1,619. Vol. XXXII.

FRIDAY, NOVEMBER 30, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SIR WILLIAM SIEMENS, F.R.S., D.C.L., LL.D.

Extract from Minutes of the Council of the Society of Arts, November 26th, 1883.

The Council of the Society of Arts desire to record their sense of the very heavy loss which the Society has sustained by the sudden death of their Chairman, Sir William Siemens.

Pre-eminent among those who have successfully devoted themselves to the advancement of knowledge, it was his peculiar merit to have applied the results of scientific research to industrial progress, and to the improvement of many of the conditions of human life.

From the versatility of his genius, and from the direction of his more important labours, he was singularly well fitted to lead the work of a Society which, devoted to many and very various objects, has for its special province the application of science to practical purposes.

This Society which, thirty-three years ago, honoured itself by the award of its gold medal in recognition of talents not then evident to the world, now mourns the loss of one who was long closely associated with its work, and who for some time back took an important share in the administration of its affairs.

His talents were the admiration of his contemporaries, but his rare personal merits could be known to those only who were fortunate enough to share his friendship. The facility with which he applied his powers to the solution of the most difficult scientific problems was equalled by the modesty with which he presented the successful results of his efforts.

While thus recording their sense of their loss, the Council desire further to express their deep sympathy with Lady Siemens and with Sir William Siemens's distinguished brothers, Werner, Carl, and Friedrich, who were so closely associated with his labours.

Funeral in Westminster Abbey.

The funeral service took place at Westminster Abbey, on Monday, 26th instant, at twelve o'clock, and was performed by the Dean and clergy of the Chapter, and the full choir.

The pall-bearers were Professor Huxley, President of the Royal Society; Sir Frederick Bramwell, Vice-President of the Society of Arts; Mr. Brunlees, President of the Institution of Civil Engineers; Mr. Percy Westmacott, President of the Institution of Mechanical Engineers; Sir William Thomson, representative of the British Association; Professor Tyndall, representative of the Royal Institution; Mr. Willoughby Smith, President of the Society of Telegraph Engineers and Electricians; and Sir James Ramsden, representative of the Iron and Steel Institute.

His Royal Highness the Prince of Wales, President of the Society of Arts, was represented by Mr. Andrew Cockerell, Groom-in-Waiting; and the Society by a large attendance of the Council, consisting of Sir Frederick Abel, C.B., F.R.S.; Sir Frederick Bramwell, F.R.S. (pall-bearer); Mr. Alfred Carpmael; Mr. Andrew Cassels; Lord Alfred Churchill; Mr. B. Francis Cobb; Mr. T. R. Crampton; Sir Philip Cunliffe-Owen, K.C.M.G., C.B.; Mr. Henry Doulton; Captain Douglas Galton, C.B., F.R.S.; Sir John Hawkshaw, F.R.S.; Admiral Sir Edward A. Inglefield, C.B., F.R.S.; Mr. T. V. Lister; Mr. W. H. Perkin, F.R.S.; Sir Robert Rawlinson, C.B.; Mr. Owen Roberts, and Lord Sudeley; with Mr. H. Trueman Wood (Secretary), Mr. H. B. Wheatley (Assistant Secretary), and Mr. H. H. Room (Accountant).

The Royal Society was further represented by the Treasurer, Mr. John Evans; the Secretaries Professor G. G. Stokes and Professor Michael Foster, and a large number of Fellows.

The Institution of Civil Engineers, and the numerous other societies with which Sir William Siemens was connected, were represented by the members of their councils and their secretaries.

At the conclusion of the service in the Abbey, the funeral procession proceeded to Kensal-green cemetery, where the body was interred.

COOKERY EXHIBITION.

An Exhibition of gas and other stoves, and the various apparatus and appliances used for cooking purposes, in connection with Mr. Mattieu Williams's Cantor Lectures on "The Scientific Basis of Cookery," will be opened on Monday evening, December 3rd, and will remain open, until December 17th, daily, from 10 a.m. to 4 p.m. (with the exception of Saturday, when it will close at 2 p.m.), and on the evenings of the lectures.

Members of the Society can admit their friends by use of the tickets supplied for the evening meetings and lectures. Persons not members of the Society may obtain tickets on application to the Secretary.

THE MARQUIS OF LORNE ON CANADA.

To enable a greater number of members than can be accommodated in the Society's own Room to hear the paper on "Canada and its Resources," by the Marquis of Lorne, on the 19th December, the Council have arranged for the meeting to be held at Exeter-hall, Strand (in the smaller hall). Members will be admitted as usual on signing their names, but the privilege of admitting friends will be restricted. Each member will be entitled to admit *one* friend only, either personally or by the usual ticket.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 28th 1883; Admiral Sir Edward Inglefield, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, Christopher, Hunslet Shed, Leeds.
Anderson, William, Lesney-house, Erith, Kent, and 3, Whitehall-place, S.W.
Andrews, John Joseph Frederick, 10, Cedar-terrace, Old Charlton.
Babb, Harry R., 21, Portland-square, Plymouth.
Banker, Stewart Melville, Avon-villa, Pellatt-grove, Wood-green, N.
Barber, Charles Albert, Bristol-house, Brighton, and 5, Furnival's-inn, E.C.
Barge, Samuel, Great Yarmouth.
Barker, John, Devonshire Villa, Grove-pk., Chiswick.
Barnett, Francis Thomas, Nyton-house, Chichester.
Barrow, Robert Philipson, 26, Old Broad-street, E.C.
Batchelor, Allan Edward, B.A., 73, Jermyn-st., S.W.
Beauchamp, Major Clayton Scudamore, R.E., 4, Mount-street, Berkeley-square, W.
Beeman, George Beaumont, 182, Earl's-court-road, S.W.
Blakey, James W., 46, Hyde-park-road, Leeds.
Bloomfield, John Caldwell, J.P., Castle Caldwell, Co. Fermanagh.
Brady, Thomas F., 11, Percy-place, Dublin.
Brereton, William Henry, 52, Nevern-square, South Kensington, S.W.
Broadbent, Thomas Oliver, 14, Cross-street, Manchester.
Brough, William Spooner, 71, New Bond-street, W.
Burnard, Robert, Cattedown, Plymouth.
Cameron, Duncan Grant, Quilon, Travancore, Southern India.
Casella, C. F., The Lawns, Highgate, N.
Clifford, Henry Charles, 1, Lansdowne-place, Blackheath, S.E.
Colmer, Joseph G., 9, Victoria-chambers, S.W.
Cook, John Mason, Ludgate-circus, E.C.
Cory, Edward, 5, Church-rd., Castelnau, Barnes, S.W.
Cosser, Frederick Chas., 97, York-rd., Lambeth, S.E.
Craven, George Pople, 14, Roland-gardens, S.W., and City Carlton Club, St. Swithin's-lane, E.C.
Crockford, William, 2, St. Peter's-road, Mile-end, E.
Cross, Charles Frederick, Brentford.
Crossley, Atkinson, Moor-end-house, Adwalton, near Bradford.
Dabbs, W. M., 11, Amhurst-park, Stamford-hill, N.
Dampier, Henry Ludwell, Frindsbury, Rochester, Kent.
Davis, Joseph, 6, Kennington-park-road, S.E.
Dawson, Charles Royal, Westbury, Grange-park, Ealing, W.
Day, Charles Aubrey, 321, High Holborn, W.C.
Donkin, R. S., Camp-villa, North Shields.
Dowler, Frederick, jun., 25, Frederick-road, Aston, Birmingham.
Drinkwater, Thomas William, M.D., F.R.C.P., 41, Chambers-street, Edinburgh.
Duff, William Pirie, 2, Champion-park, Denmark-hill, S.E.
Duncan, William Aver, Redhill, Surrey.
Durrant, Frederick William, Holland-lodge, Addison-road, Kensington, W.
Elwell, Paul Bedford, Wolverhampton.
Eno, James Crossley, Wood-hall, Dulwich, S.E.
Ernst, Emil, 80, Charlotte-street, Fitzroy-square, W.
Eskholme, George, J.P., Brass Works, Rotherham, Yorks.
Ettinger, Joseph, 30, Lawrence-lane, E.C.
Farmer, William Mortimer, 1, Collingham-rd., S.W., and Maynard-ville, Cape Town, South Africa.
Finch-Hatton, Hon. M., Haverholme Priory, Sleaford, Lincolnshire, and 6, Prince's-gardens, S.W.
Fleming, James, 136, Glebe-street, Glasgow.
Fowler, Captain Francis Hayman, The Lodge, Brixton-oval, S.W., & 9, Serjeant's-inn, Fleet-st., E.C.

Fry, Samuel, Sherington-house, Kingston-on-Thames.
Galbraith, Robert, jun., 21, Notting-hill-square, W.
Gardiner, Charles Lawrence Weare, The Temple, Goring, Oxon.
Glover, Arthur, Galley Hill-house, Swanscombe.
Gray, James, The Shrubberies, near Whitby.
Greig, Henry A., The Eaves, Belvedere, Kent.
Hamilton, Marquis of, 2, Belgrave-square, S.W.
Hammersley, William Archibald Leslie, Bath-street, Leek, Staffordshire.
Harrison, Hugh Erat, 2, Red Lion-square, W.C.
Hartmann, William, 18, Billiter-street, E.C.
Hawker, Thomas H. Seymour, Birmingham and Warwickshire (Brush) Electric Light Company, 110, Cannon-street, E.C.
Hawkins, Miss J. E., 5, Walpole-street, S.W.
Henderson, Charles J., 6, Drumsheugh-gardens, Edinburgh.
Hill, George Charles Singleton, Bedminster Mill, Bristol.
Humphrey, James Charlton, 22, High-road, Knightsbridge, S.W.
Imray, Oliver, 4, Dane's-inn, Strand, W.C.
Jackson, John Evans, The Hermitage, Carleton, near Horsforth, Yorks.
Jenkins, Thomas M., 5, Tavistock-street, Covent-garden, W.C.
Jetley, Victor, 8, North Audley-street, W.
Jeyes, Frederick Leslie, 32, Sussex-street, South Belgravia, S.W.
Johnson, Henry, jun., Dartmouth-terrace, West Bromwich.
Jones, Edward, 2, Westhill-terrace, Chapel Allerton, Leeds.
Jones, Walter William, Lambeth Savings Bank, Hercules-buildings, S.E.
Jupe, John, Lloyds', E.C.
Leon, John Temple, 26, Belsize-park-gardens, N.W.
Leverson, James, 72, Cornwall-gardens, S.W.
Lupton, Sydney, M.A., Harrow-on-the-Hill.
Macalister, James, 95, Bishopsgate-street Within, E.C.
Macdermott, Martin, Scott's-chambers, 25, Pudding-lane, E.C.
Markham, Thomas Thornhill, 102, Fetter-lane, E.C.
Marsden, R., 117, Acomb-street, Manchester.
Maxim, Hiram Stevens, 47, Cannon-street, E.C., and 59, Liebertz-street, New York.
Meihé, John Rudolph, 15, Abchurch-lane, E.C.
Morison, Robert Joseph, Arundel-lodge, Cathnor-road, W.
Morison, W. C., 18, Cromwell-grove, Shepherd's-bush, W.
Morris, Richard, Doncaster.
Morton, Mrs., 10, The Grove, Highgate, N.
Neale, Captain Melville T., 1, Southwick-crescent, Hyde-park, W.
Nurthen, Frederick Richard, 390, Strand, W.C.
Oakley, Richard, 235, High Holborn, W.C.
Orton, Charles James, Ferry-house, Twickenham.
Pemberton, Colonel Robert Charles Boileau, R.E., Lucknow, East India.
Phillips, F. C., The Hammond Electric Light Company, 110, Cannon-street, E.C.
Piper, John Townend, Vernon-house, Willesden-lane, Kilburn, N.W.
Pullman, Arthur, Westbrook, Godalming.
Quincey, Richard de Quincey, 76, Avenue-road, Regent's-park, N.W.
Ramm, Charles W., 9, Newgate-street, E.C.
Ravenhill, Charles, Bushey-house, Streatham-hill, S.W.
Richardson, Edmund, 24, New Bond-street, W.
Rocke, Colonel James Harwood, C.B., 10, Clarendon-road, Kensington, W.
Rumball, Thomas, 8, Queen Anne's-gate, S.W.
Ryle, John, 213, Brompton-road, S.W.
Santos, Flavis A., 88, Palmerston-buildings, E.C.
Sarkies, Martin, 1, Pump-court, Temple, E.C., and Wanderers' Club, S.W.
Schweder, Percy, 133, Gloucester-road, S.W.
Shepherd, William, 101, Bermondsey New-road, S.E.
Spence, Frank, Manchester Alum Works, Manchester.
Spence, William Heather, 40, Kyverdale-road, Stoke Newington-common, N., and 8, Quality-court, Chancery-lane, W.C.
Stanesby, Arthur John, 3, Kingsdown-villas, Wandsworth-common, S.W.
Staples, Sir Nathaniel Alexander, Bart., 4, Savile-row, W., and Lissan, Cookstown, Ireland.
Stenning, Charles, 3, Upper Hamilton-terrace, N.W.
Stevens, Charles Richard, 8, Woodstock-terrace, Burnt Ash-road, Lee.
Stevens, Leicester, Darlington Works, Southwark-bridge-road, S.E.
Stodart, Rev. George Earle, M.A., St. John's-vicarage, Leamington.
Stott, Alfred, Brighouse, Yorkshire.
Strangman, John Pim, Sarno, Province of Salerno, Italy.
Stuart, Charles, Bletchley Ironworks, Fenny Stratford.
Sutton, Francis, Norwich.
Sutton, John Edmond, 1, Shenley-road, Peckham-road, S.E.
Tebbs, C. Harding, M.A., St. Margaret's, Mitcham, Surrey.
Thomas, Edward Croft Greenway, 11, Harrington-road, South Kensington, S.W.
Thompson, Alfred, 3, Fenchurch-avenue, E.C.
Thomson, Alec, Preparatory School, 173, Union-street, Aberdeen.
Thornton, Alfred, LL.B., 7, Walbrook, E.C.
Turner, Henry Gribble, 14, St. James's-square, S.W.
Vaughan, James Henry, Spencer-house, Streatham-common, S.W.
Ventris, Arthur, 5, Tavistock-street, Covent-garden, W.C.
Warner, Benjamin, 9, Newgate-street, E.C.

Warre, Rev. Edmond, M.A., The College, Eton.
Whadcoat, John Henry, Crown-buildings, Crown-court, Old Broad-street, E.C.
White, Ernst Augustus, Afreba, 7, Cromwell-crescent, Earl's-court, S.W.
White, James Sewell, 34, Cornwall-gardens, S.W.
Whitehead, R. R., M.A., J.P., Borden Wood, Miland, Liphook.
Williams, Montague, J.P., Woolland-house, Blandford, Dorset
Woodrow, Ernest A. E., 19, Buckingham-street, Strand, W.C.
Wright, Edward Mounsteven, 91, St. James's-road, Brixton, S.W.
Younger, Robert, B.A., Brackenbury Hall, Magdalen-street, Oxford.

The CHAIRMAN, in opening the proceedings, said he was sure the subject uppermost in every one's mind must be the recent death of the Chairman of the Council, Sir William Siemens. It was not competent for him on that occasion to propose any resolution with reference to the matter, expressing the natural sympathy of the members with the relatives; but he would simply ask them to listen to the minute which was written at the Council meeting held on the same afternoon that Sir W. Siemens was committed to the grave. The resolution would be sent to Lady Siemens, as a token of what was felt by the Council of the Society with reference to the loss of their Chairman.

The SECRETARY read the minute of the Council (see p. 19).

The paper read was—

THE TEACHINGS OF THE FISHERIES EXHIBITION.

By A. J. TRENDELL.

One of the most singular phenomena incidental to social progress is the impatience of society for results. In regard to the operations of nature a certain amount of common sense prevails. Men do not expect to find a full-grown oak where a week before they had planted an acorn. Even in political affairs some recognition is occasionally made of the action of time, and a generation or two may be allowed to elapse before the full effect of some constitutional change is considered ripe for appraisement. But no sooner does it become a question of society—the least elastic and most conservative of human organisations—than everything is expected to undergo variation with the ease and rapidity of a kaleidoscope. Yet take, for instance, these very fisher-folk who are my subject to-night, and note with what limpet tenacity they cling to the rocks of wasteful, toilsome ignorance. For century after century, these poor toilers of the sea have adhered to the traditions of their caste with almost Oriental fanaticism, and have persisted in using their ancient instruments of hook, and net, and line, each generation treading precisely in the steps of their fathers, and their fathers' fathers before them; but at last—within, indeed, the last fifty years—that much praised, much abused instrument, the trawl, was introduced, and the wonderful changes for the better that the present generation have witnessed gradually recognised. But no sooner does an International Fisheries Exhibition take place, than markets are to be erected, fisheries to be opened, prices to be reduced, almost before the echo of the steps of the last visitor has died away. How long was a respite granted before practical results were expected to appear? A decade? A year? A month? Nothing of the kind. While the long vista of nets was still festooning the vast galleries, before the strains of the band had died out in the gardens, while expectant crowds were yet besieging the doors of the sixpenny fish dinner, voices were not wanting to clamour already for results, and to advertise their disappointment at not being able to see anything of what they are pleased to call practical effects. And now that all is over they are doubly importunate. What has the Exhibition effected, they say, and who will show us any good thing which has come out of it?

To commence then, I would maintain that there have not only been great social benefits already conferred, but that the lessons taught by the Exhibition show us how to secure immense practical advantages in the future. Among the social benefits already conferred none is more noteworthy than the discovery of the immense attraction for the British public of those simple open-air amusements that are such admirable features of continental cities. I read the other day that a recent number of a foreign magazine stated that, as a nation, we were incapable of combining for such forms of enjoyment, and that an English crowd required horse-play and music-hall singing to be really happy. We were told that we could not, like the French or Spanish, Belgians, Swiss or Germans, meet for reciprocal amusement without expanding, collectively, into a modified rowdyism. We, on the other hand, have seen day by day, for six months, an unprecedented congregation of our countrymen, of every possible class, enjoying themselves as heartily, as innocently, and as quietly as ever did any people on the Continent. From the eager morning to languid evening the masses of human beings have moved to and fro, thoroughly pleased, and entirely without misdemeanour. The guardians of peace and property soon discovered that stringent vigilance was uncalled for, and the vast collections of the Exhibition and the beautiful grounds have, therefore, been virtually confided to the common sense and the good feeling of the nation. And that confidence has been most honourably justified.

As for the indirect results, they must have been very far-reaching, multiform, and admirable, and we get a glimpse as it were of unsuspected spheres of influence in the pathetic exclamation of one of the Irish fishermen, brought over for a visit by the kindness of the indefatigable Mr. Brady. "Ah," said he, "if our poor people could only see England, they would know where to go for a friend!" But it is not in regard to the past that I have the honour to address you this evening, except in so far as it forms the basis for considerations of the future My task is to treat of what has been done, only in order to show what may be done; to aim at collecting some at least of the many valuable suggestions preferred by the experts who graced our conferences, to foreshadow in some sort the potentialities of development arising from this mighty undertaking—and, in a word, to elicit in a clear and succinct form the teachings of the Fisheries Exhibition.

In dealing with this subject, there are two distinct objects to be attained—the discomfort of the fish and the comfort of the fishermen. Alike for fisherman and fish, we need to know the habits, the haunts, the environment of every description. We trace the fish, as best we can, into their most secret hiding places in the depths of the sea, in order that we may lay snares for them with the greater efficiency; we search out the homes of the fishermen, that their households may become happier and their dwellings better, and in every way more worthy of them. We watch the habits of the fish, that we may the more easily compass their destruction; we desire to know the habits of our fishermen, that their industries may the more easily assume that importance with which the increasing demands of commerce and requirements of society invest them. We give our attention to the breeding of fish, that we may thereby obtain more food for our population; we desire to cultivate the welfare of our fisher lads, that they themselves may help to maintain those traditions of courage and endurance with which, for generation after generation, their race has adorned the State.

And for both these objects we require increase of knowledge, which is necessary for improvement of practice. To a certain extent, indeed, these two methods may be regarded as one, for growth in knowledge were but an idle thing unless it led to improvement in action; and, on the other hand, any attempt to innovate in practice were worse than useless, unless it were based on a more perfect knowledge. How much damage may be done to a fishery by an injudicious clause in an Act of Parliament, let the history of the salmon declare; how much benefit may be effected by judicious legislation, let the crabs and lobsters put in their word. Professor Lankester, in his admirable diagnosis of the scientific results of the Exhibition, points out the fallacy of conceiving any antagonism to exist between the scientific and the practical. "The contrast," he observes, "insisted on between the scientific and practical man becomes simply the contrast between the man who knows and the man who does not know, but acts in ignorance. As a matter of fact, there is no such antithesis. Your man of science is, or should be from the nature of his pursuits, more thoroughly practical than any one who affects to despise scientific knowledge, for he is accustomed to insure success in his experiments and investigations, by taking every means in his power to that end; above all, and chiefly, by guiding himself by reasonings based on the most accurate and extensive knowledge. So, too, indeed, every so-called practical man who is not a mere adventurer—a happy-go-lucky tempter of Fortune—makes use of accurate knowledge to aid him in his commercial ventures and speculations; so far as he can get it, he makes use of science, though he often calls it by some other name as soon as it becomes useful knowledge." The Professor then goes on to draw attention to the fact, though it gives us little cause for pride, that while the Governments of many foreign countries, notably of France and the United States, Norway, Sweden, Holland, Prussia, and Saxony, have enlisted the skilled services of zoologists in developing and managing the resources of their respective fisheries, Great Britain exhibited at South Kensington scarcely anything under the head of zoological science at all, that is to say, of science which illustrates the results of exact inquiry into the natural history of the fishes and other animals which form so great a part of our national wealth. The first grand teaching of our International Exhibition, therefore, I hold to be this, that zoological study must be made the basis for all improvement in practice, whether in regard to the preservation, the extension, or the working of our fisheries.

Knowledge, it is rather wisely said, is only an exchange of ignorance, but it must not be forgotten that at every exchange the world gains a little, inasmuch as ignorance is shifted on step by step to deeper problems, and nearer to the hidden roots of science. And an Exhibition like the Fisheries teaches us that it is only by the comparison of ideas, and a mutual bartering of experiences between individuals, companies, powers, and nations, that the standard of public knowledge can be raised to a uniform level of practical intelligence. Take, for example, what Mr. Cornish, of Penzance, tells us about the deep shoal seine. "Mackerel," he says, "shoal in deep water as well as in shallow. Our desideratum for a long time past, has been a seine which can capture the deep-water shoals. A gentleman named Cox, a Cornishman, has invented a seine, of which a model was shown in the middle of the Cornwall stall. He said that this seine could be worked at deep-sea shoals of fish; and, curiously enough, a model of a second seine on the same principle, but differing a little in detail, was exhibited on the same stall by Mr. Moses Dunn, of Fowey, and a third by Mr. Barron, of Mevagissy. Practical men saw these models, both before they came to the Exhibition and since, and pronounced them very pretty little toys, which might succeed in a fish-pond, but utterly unfit for use at sea. Now, a full-sized seine costs a large sum of money, and no hard-headed capitalist is likely to lay it out on a speculation which these practical men told him must inevitably fail. But mark what happened—the models came to South Kensington, the nets came here, and to them came an American expert, who said, 'You have the precise principle on which we are working deep-sea seines in America, and they succeed admirably.'"

A certain, at least a possible, advantage is the Greenway Breakwater, the merits of which I do not pretend to judge, but which have been certified, I see, by a bronze medal from the jury. Whether, therefore, the fishermen of Penzance will find in it the protection which they so earnestly desire, is a point which they must decide for themselves; but at least the Exhibition has been the means of showing them a device by which, if successful, all they desire may be accomplished at a cost which, as compared with a solid breakwater, is little more than nominal. Or, take another suggestion, as to that terrible problem bequeathed to us by the carelessness of our population, and the feebleness of our local administrations, namely, the cleansing of our rivers from the abominations of town sewage and other pollutions. The Exhibition has brought out, thanks to the admirable essay of Mr. Barrington Kennett, and the enterprise of competing companies, the difficulties which lie in the way of manufacturers and of local authorities, the means of surmounting them, and the utilisation—securing an actual profit to manufacturers—of waste substances. Let us take but one more example, not relating, however, to the fish, either for their preservation or destruction, but to the economy and domestic habits of the fishermen. One of the most remarkable contributions, in every way, to the literature of the Exhibition (as has been so truly urged by the Press), was the first of the series of conference papers, written by H.R.H. the Duke of Edinburgh, and read by H.R.H. the Prince of Wales on his brother's behalf. In it His Royal Highness advocates, with unanswerable argument, the institution of a mode of insurance amongst fishermen, similar to that which exists among the coastguard and other communities, enabling all—even the very poorest — to make some provision for his family, in the event of accident or death. Here, again, we see the immense advantage that results from comprehensive comparison of the social features of differing and distant communities—comparison that, but for the focussing of many interests within one exhibition, would have been impossible. And here I may be permitted to refer to this most important paper by His Royal Highness, as replete with the most valuable information, and fertile with the most practical suggestions.

I come now to the means by which that most important object, accuracy of zoological knowledge, may be obtained:—an increase of our acquaintance with the habits and natural foods of the fish, the bait which attracts them, the seasons in which they are found on different parts of the coasts, the course which they pursue in the ocean, the periods of spawning, the drifting of the fry into the estuaries, and all the other thousand points on which we may flatter ourselves as still possessing all the exterior decencies of ignorance. For such national purposes as these, there is no more reason why private enterprise should conduct the necessary inquiries than why it should collect the income tax. It is to the State, and the State alone, that we can look for an adequate biological survey of the resources of our ocean waters, similar in intent and purpose to the Geological Survey, which was undertaken by the State without question, as a natural function of the executive administration of the country. And it will be at once seen that this is a project which admits of a twofold form of execution—one by land and one by sea.

The proposal to erect a laboratory for carrying on investigations with regard to fishes and fishery animals is one which, though brought forward in England for the first time by Professor Lankester, with the support of the Duke of Argyll, during the late Exhibition, is already familiar to the Government and zoological students of more than one country in Europe. Naples boasts such an observatory, fitted with aquaria, glass apparatus, and all other necessaries for carrying on these fascinating and remunerative inquiries. Austria possesses a similar institution at Trieste; and France has no less than five—at Concarneau, Roscoff, Villefranche, Havre and Banyuls—besides a school for fishermen at Dieppe. As a matter of fact, our English Universities, and likewise the Committee of the British Association, subsidise the zoological station at Naples, for the privilege of permitting Englishmen to gain knowledge concerning fish and other marine animals, which they might at much less cost, and with far more completeness, acquire at their own doors. The establishment of such an observatory would not only be a worthy memorial of the popular Fisheries Exhibition, but would be a national gain of the highest order.

Thus far the land—now for the more kindred element, the sea. For many years, it might almost be said ever since a Fisheries Board has existed in any part of the kingdom, one persistent cry has gone up from the inspectors, time after time—and time after time in vain—for Government vessels to make thorough researches into the nature and number of the inhabitants which swarm the seas surrounding our islands. So familiar is the idea—far more familiar than that of a zoological observatory—that there is little need to dilate upon its advantages, or to illustrate the benefits which might be expected both for fisheries and fishermen. For certainly it would be to the last degree undesirable that such a survey should be conducted without direct reference to those on whose behalf it would be primarily instituted. Fishermen and fisher lads might be taken from time to time on board such vessels, and there habituate themselves, not only to habits of obedience and familiarity with improved apparatus and the best modes of capture, but also acquire elements of scientific training, and so prepare themselves for utilising the opportunities of accurate observation which their calling so abundantly affords. For who have better opportunities for observing the phenomena of the heavens and of the sea than those whose calling compels them to frequent the desolate ocean, out of sight for the most part, not merely of the dwellers upon the shore, but even of the passing ships which traverse the watery wastes.

Nor does there seem to be much difficulty in pointing out the spot where a beginning should be made; for, after all, if anything is to be done, a beginning must be made somewhere. I say nothing now of the political and social regeneration which could hardly fail to attend the resuscitation of certain energies of our kith and kin, too long dormant and undeveloped; but one thing I do say and urge, with all the energy I may be permitted to put forth, and that is that, if any reliance can be placed on the averments of fishermen or reports of inspectors, if any indications suffice to denote the presence of the shoals of fish short of the actual establishment of a fleet of fishing vessels, if the conformation of the coast, the evidence of men well acquainted with those seas, the general consensus of universal testimony, nay, if the result of experiment itself is to have any weight, then I say that the magnificent success attendant on the example set by that illustrious lady, the Baroness Burdett Coutts, at Baltimore, on the Irish coast, will not be allowed to remain unfruitful, and that the loan of a revenue cutter will be granted by the Government to make a biological survey, not only of the fisheries of the west coast of Ireland, but of other sections of the teeming acreage of waters, with a view to the logical development of those great repositories of a prolific food-supply for our population.

An endeavour, I understand, has already been made to obtain the loan of a Government vessel for the purpose of making biological researches off the coasts of Mayo and Donegal, on the condition that a committee is prepared to form a company for thoroughly working those fisheries, if the results of the investigation should give fair promise of success; and I hear also that the steps which have been taken have received the warm support of one of the most experienced of the Irish inspectors. Of the boon which would be conferred, should success attend the movement, upon the fishermen of the locality, upon the industries of Ireland, and even, one may say, upon the nation at large, it is needless for me to speak.

And here I may be permitted to quote from the *Times* of Monday last, a most interesting paragraph, showing what is being done in respect to fish exploration and culture in the deep seas, by our acute and far-seeing brethren across the Atlantic:—

"It is stated that the Fish Commission which has been issued in the United States has a threefold object; a study of pisciculture on the coasts, improved methods of fishing, and the introduction and multiplication of food fishes. America will be a long time before she makes the most of her splendid lakes and rivers for fish purposes. New England is the scene of the most active operations. A temporary laboratory has been constructed every summer, and naturalists have been busy collecting upon the shore, clearing out the beaches, or using dredge and trawl at as great depths as can be reached by a steamer in a trip of three days. The fishermen of Cape Ann are enthusiastic in their assistance, and during the last few years have vied with each other in their efforts to procure the rarer forms of life, which they have every opportunity of doing, since every halibut vessel sets, twice daily, lines from ten to fourteen miles in length, with hooks upon them 6 ft. apart, in water from 1,200 feet to 1,800 feet in depth. Fifty to sixty thousand specimens have been obtained in this way, comprising some thirty species of fishes not before known to inhabit American waters, besides about fifty other forms of life new to American fauna. No dredging has been done south of Long Island by the Commission itself, but agents are working in various localities."

Bearing in mind the laxity on our own part to which I have directed your attention, is not the teaching of this, that incalculable good would result to the British nation from the appointment by the State of a Fish Commission very similar to that which is doing such important work in the United States? I will only say that I conceive this to be the third great lesson taught by the Fisheries Exhibition.

Once more I must hasten onwards, conscious that indeed I ought already to have brought my remarks to a close; but there is a point which I cannot pass over in silence, and I may lay claim to the greater indulgence because it is connected with my own special department, and associated with the pleasantest privilege which I have enjoyed during the last six months, that of familiar intercourse with some of the highest intellects and most refined thinkers of our own and of foreign countries. If it be permitted for the book-cover to call attention to the book, if the bouquet-holder may be allowed to illustrate the beauty of the nosegay, then may I call attention to the literature of our Fisheries. To observe fresh facts, to investigate more deeply the causes of well-known phenomena, are not the only points, it may be that they are not the most important points, in regard to the development of our knowledge. Vital as is the acquisition of fresh knowledge, it may be questioned whether the diffusion of correct information is not of almost equal moment with its attainment, even as the sun itself would give us no heat if it never rose above our horizon. To this end our literary department has been framed. Under the modest title of "Prefaces to the Exhibits of the Different Countries," there appears in the catalogue what forms in reality a unique and almost complete system of State papers on the fish traffic of the world; and of the many acts of courtesy and usefulness by which the foreign Governments of the different countries represented have rendered us their debtors, none perhaps was more courteous or more useful than their graceful concession to the request of the Executive Committee that they would invite, each for its own territory, some person of authority and experience to draw up in brief a conspectus of their condition in respect to their fisheries and fishermen. It is proposed to re-issue these State papers in a separate volume, independently of the catalogue, as I conceive them to be among the most valuable of the literary contributions which passed through my hands. For such an epitome Mr. Brown Goode, the distinguished Chief Commissioner to the Fisheries Exhibition from the United States, told me, only the other day, that he had long experienced a desire, and certainly there is no one better qualified to appreciate its value, or whose writings in it give greater lustre to its pages. The same earnest desire to supply original information in a condensed form was kept in view, in relation both to the Conference papers and to the series of handbooks in which so many men of eminence have favoured us with their assistance.

As an illustration of the foregoing remarks, I may notice some of the points brought out with regard to the important science of fish culture, taking that as one of the most important of the subjects with which the literature of the Exhibition has dealt. It is now pretty generally admitted that, were it not for the exertions of the late Mr. Frank Buckland, the stock of salmonidæ in our rivers would by this time have been almost or altogether exhausted, and it is in a great measure due to his untiring energy, and absolute devotion to his self-appointed task, that we owe the comparatively flourishing condition of our salmon fisheries. Among the literature, the principal portions relating to salmon culture in our own country (for the limits of this paper do not allow me to touch on others) are: — "The Salmon Fisheries," by Mr. C. E. Fryer, of the Home-office; "The Culture of Salmonidæ and Acclimatisation of Fish," by Sir James Maitland; "Fish Diseases," by Professor Huxley; the admirable and exhaustive "Handbook of Fish Culture in general," by Dr. Francis Day. These four volumes form in themselves a *vade mecum* for all interested in this particular pursuit, and the subject is treated from all points of view. Mr. Fryer, as an assistant to the distinguished Government Inspector of Fisheries, can speak from the practical and quasi-official side. Sir James Maitland is probably the greatest proprietor of hatching stations in the three kingdoms. Professor Huxley's qualifications will nowhere be gainsaid, nor will those of Dr. Day.

But salmon culture is not an occupation for the delectation of all men, the royal fish patronising only lordly rivers, free from the pollution of factories, while riparian owners keep a sharp look-out for persons wanting to get a too near view of his ascent; and the ordinary angler, whose purse is not equal to his enthusiasm, must depend on what are ignominiously termed "coarse fish" for his particular benefit. For the advantage of this latter class, Mr. R. B. Marston, the accomplished editor of the *Fishing Gazette*, read, during the course of the Conferences, a most valuable paper on "Coarse Fish Culture." This paper was very well received, and I have no doubt has already widely commended itself to the class it more immediately concerns.

What may be called a new departure in fish culture (for we will treat crustaceans, &c., as fish for the purposes of this evening) is a paper by Mr. Saville Kent, on the "Artificial Culture of Lobsters," in which that gentleman gives his experiences on this head, and argues that lobsters can be reared as easily as the salmonidæ, and far more economically; their well-known habits of living near where they were hatched being a very important feature in the cultivation which renders the returns, like those of oyster and mussel culture, much more certain than can be the case with any species of fish the movements of which when turned out are, of course, beyond prediction. I have here but touched the fringe of the Fishery Literature, which, besides its more practical side, nowhere more marked with scholarship than in the many papers from the pens of the Foreign and Colonial Commissioners, is not wanting in charm and romance—witness the graceful essays of Mr. Philip Robinson and Mr. William Senior. There are also two works of special interest not yet completed, but which we trust soon to have ready for publication. The first of these is the enlarged edition of the Fisheries Map of the British Islands, which was announced in the first edition of the Official Catalogue. This production will not merely show the trawling and other fixed fishing grounds round our coast, but will also give particulars as to the seasons of the greatest catch for some five or six and twenty of the principal kinds of fish at different parts of the coast, the various spawning times, the fishing grounds frequented by the men of the different ports, and other particulars never before ascertained, but which have been collected from experienced men in the different localities, by Mr. W. Marsham Adams. As certain portions of the coast yet remain to be visited, I will only say that we are greatly indebted to the numerous fishermen, to the railway companies, and to the other public bodies and private individuals who have assisted his researches in every way, and that we trust, by means of this map, to combine in an accessible and attractive form those aspects of science, of practice, and of commerce which have been too long dissociated, and to forward at once the acquisition and the diffusion of fresh knowledge concerning our fisheries and fishermen. The other work to which I have alluded is one which I trust will combine in a collected whole the entire vast field of thought which has been generated by the Fisheries Exhibition. The official Report, with statistical tables, the Handbooks, the Conference Papers, the Prefaces, the Essays, the Map, the Jury Reports, the Catalogues, Guides, and miscellaneous papers, are all being carefully revised and re-edited, and will be published in a convenient form, constituting a series of about twelve volumes of records of suggestion and execution; and to the entire course I propose to append an index-digest, showing the place in which each several topic has been treated in any literary contribution, no matter of what kind. Such a digest will, I trust, tend to bring out the great value of the literary contributions with which we have been favoured by so many eminent writers, and will aid in the general diffusion of icthyological knowledge, wherein we shall find the most certain guarantee for judicious policy in legislation, for improved methods in practice, and for carrying out the teachings of the Fisheries Exhibition.

And now, how shall I conclude, and with what words shall I take leave of the subject? If, indeed, I were merely speaking in our private capacity, or if this were a common occasion, there would be no room for further words: but it seems to me as if the echoes of the familiar "Fisheries" were still sounding in our ears, and that I had the privilege of being the bearer to the public of a message from an honoured friend whose latest word is now being spoken. What, then, is the message? I have already endeavoured to state it at some length, but I will try to put it into a few words. It is that we should cultivate a better knowledge of our fish, and a more practical sympathy with the calling of our fishermen. For our fish, "the harvest of the sea," let us have observatories, Government vessels, and whatever other physical appliances are necessary for their investigation, preservation, and capture. For the fishermen, let us see how, by considerate and respectful sympathy, aid may best be offered without offence, as in the admirable institution, the Society for the Relief of Shipwrecked Mariners and Fishermen; and how, by systematic insurance, by labour-saving apparatus, by better homes, by more attractive systems of education for fisher-lads, and by all other kinds of moral inducement, we may alleviate the toil and enhance the condition of those patient toilers in a hard, and not very remunerative industry. For although, as I have already earnestly said, in another place, it is much to defend the natural wealth of our rivers and seas from the rapacity of greed and the recklessness of pollution; to provide improved harbour accommodation, and greater facilities for transport and commerce; to render the meals of the million more palatable, more wholesome, and, at the same time, more economical; yet all these things are comparatively less important than the safe-guarding of our fishermen's lives and the improvement of our fishermen's homes. These are objects in which all nations can cordially co-operate, because all mankind is interested in the result; and in no way can our island kingdom more gracefully or beneficially exercise the historic pre-eminence conceded to her upon the seas, than by promoting these interests in connection with such an enterprise as that of the International Fisheries Exhibition. And this, I think, is the last, though not the least, of the "Teachings" of that great Exhibition.

DISCUSSION.

The CHAIRMAN said among the many valuable points contained in the paper, he would particularly refer to the great improvement which had taken place in the implements used in fishing. When he first went to sea, whales were caught with harpoons thrown by men, but the harpoons were now projected by gunpowder, and of course the whales were caught with greater facility and certainty. Reference had also been made to the deep sea seine, which experience on the other side of the world had shown to be successful, though this was doubted by our own fishermen. Another useful suggestion was with regard to zoological observatories, and he hoped this would be carried out. He had known the late Mr. Frank Buckand for many years, and he knew how long that zealous naturalist exerted himself to obtain protection for salmon ova, which was formerly destroyed in immense quantities. The various handbooks published in connection with the Exhibition were of great value, and he had no doubt that the result would be to improve the condition of the fishermen as a whole.

Mr. P. L. SIMMONDS expressed the pleasure he had felt in listening to the paper, and regretted that he had not been able to visit the Exhibition, having been engaged at the time in connection with another international exhibition in Holland, where the prosperity of the capital was said to be founded upon fish bones. He had long taken an interest in, and had written upon the subject of fisheries and other industries connected with the sea, such as the sponge pearl, mother-o'-pearl, and other fisheries, and on the utilisation of seaweed, an article which was largely used for food in Japan and China. Fish had hitherto been chiefly a luxury of the rich, but much might be done, by facilitating transport, to popularise it as a cheap and useful diet for the people.

Mr. WILLIS-BUND said there was one point in the teaching of the Exhibition which had hardly been brought out so strongly as it might be, perhaps because Mr. Trendell held a different view upon it to his own, and that was with regard to State aid. Anyone who had compared the exhibits from the United Kingdom with those from other countries must have felt very proud of the fishermen of this country, unaided by a single penny of State money. It was all very well to talk of what had been done in France, Germany, and elsewhere, but our exhibits were not only equal, but superior to almost all of them. They had heard of the enormous fishing and breeding establishments in America and so on, but he thought that if the size of our English rivers was taken into account, it would be found that proportionately more was done in this country by private enterprise than was done in America by State aid; and that being so, they should pause before asking for State assistance in the fisheries. It was all right enough to establish an observatory, but anything in the nature of a subsidy, he hoped, would not be attempted. It would have to be accompanied by inspection, and of that he had a horror, though he was a Government inspector himself. He had been one of the Severn Commissioners since 1865, and he could only say that during all that time his experience had been that if anything went wrong the blame was thrown on the Commissioners, whilst if anything succeeded, someone else took the credit. He, therefore, thought one important lesson to be drawn from the Fisheries Exhibition was, that private enterprise should not be checked by Government aid and inspection. Let the State encourage the study of natural history by all means, but with regard to the fisheries themselves, the best thing it could do was to let them alone.

Captain J. D. CURTIS, R.N. remarked that, in the event of a war, the fishermen would form a most important and valuable portion of our naval reserve. He had been much amused by watching a discussion in the *Field* and *Land and Water* as to whether fishermen called fry spawn, or spawn fry; and on asking a practical fisherman about it, the reply he got was that eggs were eggs, and chickens were chickens. He thought that fishermen had fair cause of complaint with regard to the destruction of spawn by steam trawlers near the coast, and hoped that full inquiry would be made into the matter, and at any rate, the experiment might be tried of affording some protection at the particular season when the spawn was maturing into fry. Another important point was the utilisation of fish refuse for manure, an experiment in which he was much interested, from his father having manufactured fish guano in this way by mixing it with charred peat; and the manufacture was now being carried on on a large scale, though in a different manner, by Messrs. Johnson, at Belvedere, the refuse being taken down in iron tanks, and dried by superheated steam, the product fetching from £8 to £11 a ton. He might add that the workmen employed were particularly healthy. The refuse from Billingsgate would be very valuable if treated in this way, but at present it was useless, through being mixed with straw and other rubbish.

Mr. WILMOT (Canadian Commissioner to the Fisheries Exhibition) said he had listened with great pleasure to the able paper but he regretted to find that no mention whatever was made of Canada. That colony had taken a high plaee in the competition, and with regard to fish culture, he might say she set an example to all the world. He regretted that a stronger feeling had not been shown in favour of the protection of fish, for some objected to this altogether, and others said that, in order to be effectual, there must be international legislation. He thought this was unnecessary; it would be quite sufficient to protect the fish within the three mile territorial limit, and if they waited for international legislation, it would never come at all.

Mr. LIGGINS said the remarks already made proved the wisdom of those who organised the Exhibition, though he could not agree with what was said by Mr. Willis Bund. They were thinking of the ocean, not of the rivers, of the fish which swam all round the coast, which form a large portion of the food of the people, and not simply of the salmon which formed the sport and luxury of the rich. Having visited the Exhibition many times, he came to the conclusion that Canada was the queen of the whole in the excellence and simplicity of her boats and apparatus. It was very desirable that there should be a scientific head to some department which should have the care of the fisheries, for an immense deal of ignorance existed on the subject. Some years ago, when visiting the West India islands, he was much struck by finding that a large whaling industry was carried on there by the Americans, which he believed very few Englishmen were aware of, though the West Indies were English colonies. In the Canadian lakes, which were inland seas, there was any quantity of fish which might be canned and sent all over the world. He did not think scientific research would be of much practical use without State aid. There ought to be inspections, and the collection of information, which would often be very useful. Gunboats were already placed on certain stations in order to prevent quarrels amongst the fishermen of different countries, and their services might also be rendered available in a scientific way. Some of the most interesting conversations he had ever had were with sailors, on the various rigs adopted by fishing boats in different localities. One of the most important elements of safety was to have a stably constructed vessel with a rig, handy and suitable for the duty she had to perform. There had been much controversy as to the merits of the sprit sail, the lug sail, and other rigs, and within his recollection the Boulogne fleet, and also the Yarmouth, had entirely altered their rig. Of late years, too, the whole model of the Scotch herring boats had been altered and improved, much larger and safer boats being now used, and the result had been a great saving of life in proportion to the number of men employed. Fishing boats very seldom went down in a gale of wind except from a collision; and from inquiries he had made of men from different parts as to what caused loss of life, he found they all agreed that it was mainly from collisions in dark or foggy weather, not from what might be strictly called the perils of the sea. Some of the fishermen present at the last Conference, suggested that further meetings should be held at a time of the year when it would be convenient for them to attend, and he would venture to hope that this idea would be carried out.

The CHAIRMAN said he should have made some remarks himself with regard to Canada, but he preferred leaving more opportunity for other speakers, for he had a note before him that when there he had bought lobsters at two shillings a dozen. If they could be sold at such a price, in a climate so like our own, it seemed to him that something might be done here by cultivation. As Commander-in-Chief on that station, it was his duty to keep a certain number of gunboats on the coast of Newfoundland, to protect the fisheries, there being men there of different nationalities, and it was only the presence of the gunboats which prevented quarrels, and perhaps fighting. While he was there, a quarrel took place between the English and the Americans; the English had made a rule that they would never fish on Sundays, but the Americans had no such regulation, and when a fine school presented itself one Sunday afternoon, the Americans launched their boats and went to catch them. This aggravated the English, who cut their nets, and a regular fight ensued, which led to a great deal of correspondence between the two Governments. This showed the necessity of gunboats being present.

Mr. WILMOT said he had known lobsters caught in such vast numbers that they were sold at 4s. a hundred, or at ½d. to 1d. a piece singly, but in some places where they were so numerous two years ago they were not now to be found at all. The protective laws, in the case of lobsters, had to a certain extent failed, owing to the Government having been misled by the fishermen as to the proper time for enforcing the close season.

Mr. MARTIN WOOD, referring to the statement made in the paper with respect to the advantages of the loan of a revenue cutter, for the purpose of investigations into the fisheries on the west coast of Ireland, said it seemed very desirable that such aid should be afforded by Government, and there was no quarter where it was more needed, or would be more welcomed, than on the west coast of Ireland.

Captain CURTIS said he commanded the Coast Guard near Londonderry, from 1867 to 1870, when the Irish Society spent £48,000 in trying to develop the fisheries thereabouts, but he believed the mistake made was in paying the men regular wages, in lieu of shares.

Mr. CROSSMAN said that the purpose of the paper, which was conceived in a broad spirit, was to ascertain the practical teaching to be derived from the Exhibition. There was one thing characteristic of Englishmen, that when they began anything new, they did it in a confused kind of way, but as they went on they gradually evolved order out of chaos; and there is no doubt that it did seem to gentlemen like Mr. Wilmot, that the important fisheries round our coast had been utterly neglected, when he found that in some cases the bait ground had been utterly destroyed through the exercise of that individual liberty which one gentleman had so earnestly advocated. As a member of the Executive of the late Exhibition, he considered that the whole work would prove entirely evanescent, unless some permanent body were created to study and watch over everything connected with the fisheries. He did not see why there should not be a Fisheries Society, composed of scientific and practical men, who would be able to invite to their consultations eminent men from every country in the world. The papers which had been referred to were distributed, and no doubt diffused a certain amount of information, but that would soon be lost or forgotten, unless some steps were taken to establish a permanent centre. The Exhibition had been successful, and there would be a certain surplus after paying expenses; and he was glad to hear the Prince of Wales announce that whatever surplus there was should be devoted to the furtherance of the fisheries of the United Kingdom. If part of it were used to found such a society as had been mentioned, other minor societies having a similar object would merge into it, and something might really be done to protect the fisheries, and further the interests of the fishermen.

Mr. DIOSY said Mr. Trendell had seemed to doubt the propriety of the book-cover speaking of the merits of the book; but at any rate the reader might be permitted to praise the book-cover which had held the book together, and he would therefore say that he had never met with a more efficient book-cover than Mr. Trendell. Until this Exhibition took place, there was no such thing as a popular literature of fisheries. There was a scientific literature which was read by experts, and there were popular works on natural history dealing incidentally with fishes, and some popular books dealing with the various toils and pleasures of a fisherman's life; but at this Exhibition he believed the first attempt had been made to collect all the available information, and put it into such a form that it would not be necessary to go through a course of training at the proposed biological observatory before undertaking their reading—in fact, to produce such books as the million could understand. It might be said that the million were not concerned with the fisheries, but if they were to take the interest in the matter which, in his opinion, they ought to take, they really were concerned. This Exhibition had awakened an enormous amount of interest; and all who were interested in the fisheries of the world should see that this interest was not allowed to die out. He would ask whether it would not be well to hold international fishery congresses every year at different places where there were great fishing interests located. He was quite certain that it would be considered a great honour in Austro-Hungary to receive such a congress in Trieste or Fiume, and he believed all his foreign colleagues would say the same for their respective countries.

The CHAIRMAN, having proposed a vote of thanks to Mr. Trendell, which was carried unanimously,

Mr. TRENDELL, in reply, said he could only hope that he had thrown out some ideas which might lead to the consideration of important questions intimately connected with the welfare of the State. He had endeavoured to deal with these subjects in the broadest and most general manner, and had endeavoured carefully to avoid anything like putting one country in antagonism to another. He had referred to the State Commission, on the other side of the Atlantic, as suggestive of what might be done here. As to the Conferences to which Mr. Liggins had referred, and which were really models of what such meetings should be, he might say that they had not ceased to exist. At the close of the last one it was understood that they would be continued, it was hoped, under the auspices of the Fishmongers' Company, in January or February next, when practical fishermen would be again invited, and the subjects not yet dealt with thoroughly discussed. He had taken notes of the various remarks and suggestions which had been made, and hoped to be able to make good use of them.

Miscellaneous.

TELPHERAGE.

The following, which is taken from *Engineering*, refers to a subject upon which Professor Fleeming Jenkin, F.R.S., has promised to read a paper before the Society of Arts, in the course of the present Session.

The transmission of vehicles to a distance by electricity, independently of any control exercised from the vehicle, is called "Telpherage" by Prof. Fleeming Jenkin, and was the subject of the address he delivered at the commencement of the present session, to his class of engineering in the University of Edinburgh. He stated that in adapting electric motors to the old form of railways, inventors had not gone far enough back. George Stephenson said that the railway and the locomotive were two parts of one machine, and the inference seemed to follow that when electric motors were to be employed, a new form of road, and a new type of train would be desirable. The ease with which electricity can be transmitted and controlled, led him to conclude that upon electric railways the load might be advantageously distributed among many light vehicles following each other in an almost continuous stream, and that by this arrangement a cheap, light form of road, such as rods or metal ropes, carried on posts, might be possible, and this would require no bridges or earthworks. He had consequently elaborated a scheme in connection with Professor Ayrton, and a company had been formed who were now erecting an experimental line at Weston. It consisted of a series of posts 60 ft. apart, with two lines of rods or ropes, supported by crossheads. Each of these lines carried a train, and was divided into sections of 120 ft., each section being insulated from its neighbour. The rope or rod was supported at the post by cast-iron saddles curved in a vertical plane, so as to facilitate the passage of the wheels over the point of support. Each alternate section was insulated from the ground; all the insulated sections were in electrical connection with one another, and so were all the uninsulated sections. The train was 120 ft. long, and consisted of seven buckets and a locomotive, evenly spaced with ash distance pieces. The skeps hung below the line from V wheels, and the dynamo on the locomotive was also below the line. It was supported on two broad flat wheels, and was driven by two horizontal gripping wheels connected with the motor by nest gearing. The motor weighed 99 lb., and would give a maximum of 1½ horse-power. A wire connected one pole of the motor with the leading wheel of the train, and a second wire connected the other pole with the trailing wheel; the remaining wheels were insulated from each other. Thus the train, wherever it stood, bridged a gap separating the insulated from the uninsulated sections. The insulated sections were supplied with electricity from a dynamo driven by a stationary engine, and the current passing from the insulated section to the uninsulated section, drove the locomotive. The line would carry 15 cwt. on every alternate span of 120 ft., or 16½ tons per mile, which, with a speed of five miles per hour, would convey 92½ tons of goods per hour. It would require a station every ten miles.

MANUFACTURE OF CAMPHOR IN JAPAN.

It appears from a recent report by Consul Jones, of Nagasaki, that the manufacture of camphor is an mportant industry on the island of Kin Shin. From the port of Nagasaki there were exported in the year 1882, 15,186 piculs, the picul being equivalent to 133⅓ pounds, with a total value of £58,000. From other ports of the island not yet open to foreign trade, a large quantity was shipped by native merchants in native vessels to Shanghai and Hong Kong, whence it finds its way to India and England. The camphor tree grows abundantly all over the district of Kin Shin, and is found alike on high elevations and in the valleys and lowlands. It is a hardy, vigorous, long-lived tree, and flourishes in all situations. Many of the trees attain an enormous size. There are a number in the vicinity of Nagasaki, which measure ten and twelve feet in diameter. The ancient temple of Osuwa at Nagasaki is situated in a magnificent grove of many hundred grand old camphor trees, which are of great age and size, and are still beautiful and vigorous. It is said that there are trees at other places in Kin Shin, measuring as much as twenty feet in diameter. The body or trunk of the tree usually attains a height of twenty to thirty feet without limbs. It then branches out in all directions, forming a well-proportioned beautiful tree, ever green, and very ornamental. The leaf is small, elliptical in shape, slightly serrated, and of a vivid dark green colour all the year round, except for a week or two in early spring, when the young leaves are of a delicate tender green. The seed or berry grows in clusters, and resembles a black currant in shape and appearance. The wood is used for many purposes, its fine grain rendering it especially valuable for cabinet work, while it is used also for ship-building. In the manufacture of camphor, the tree is necessarily destroyed, but by a stringent law of the land, another is planted in its stead. The simple method of manufacture employed by the natives is as follows:—The tree is felled to the earth and cut into small pieces, or more properly speaking, into chips. A large metal pot is partially filled with water and placed over a slow fire. A wooden tub is fitted to the top of the pot, and the chips of camphor wood are placed in it, the bottom of the tub being perforated so as to permit the steam to pass up among the chips. A steam-tight cover is fitted on this tub, and from the tub a bamboo pipe leads to another tub, through which the enclosed steam, the generated camphor and oil flow. This second tub is connected in like manner with a third. The third tub is divided into two compartments, one above the other, the dividing floor being perforated with small holes, to allow the water and oil to pass to the lower compartment. The upper compartment is supplied with a layer of straw which catches and holds the camphor in crystal in deposit as it passes to the cooling process. The camphor is then separated from the straw, packed in wooden tubs containing 133⅓ pounds each, and is ready for market. After each boiling, the water runs off through a faucet, leaving the oil, which is used by the natives for illuminating and other purposes.

VEGETABLE WOOL OR SILK-COTTON.

By James Collins.

In the *Journal* for September 28, 1883, p. 972, there is a note, taken from the *Moniteur des fils et tissus*, respecting a description of "Vegetable wool" from Java, exhibited at the Amsterdam Exhibition, under the name of *Kapoc.*

Kapoc, or kapok, as it is more usually rendered, is a Malayan word, signifying cotton or a cotton-like substance, *i.e.*, silk-cotton; real silk being known as *sutra*. *Kapas* is also used in Malay for cotton or silk-cotton, the same vernacular name obtaining in Bengalee and other dialects; but in this latter case the term is restricted to true cotton plants (*Gossypium eps*).

Kapok silk-cotton is furnished by the *Eriodendron anfractuosum* DC., the *Bombax pentandrum* of Linnæus. The plant has been placed in various natural orders, some giving it a place in Bombaceæ, others in Sterculiaceæ, or in Malvaceæ.

The tree is from 50 to 60 feet in height, the trunk being prickly at the base, and the branches growing out horizontally. There are five to eight leaflets, lanceolate in shape, and either entire in their margins or serrated towards the apex. The capsule, or fruit, is five-celled and five-valved; the cells contain many seeds, covered with silky or cottony hairs, which form the kapok or vegetable-silk. The gum furnished by the tree, when mixed with spices, is used in India in bowel complaints, and the seeds yield a dark-coloured oil. The tree is of rapid growth, and is lofty and imposing in appearance. It is found in India, the Malayan Archipelago, and in Africa and other countries. In the East generally, Kapok is used for stuffing pillows, &c., and for tinder, but it has been found that the smoothness of the fibre prevents cohesion or "felting," so necessary and important for spinning purposes. In Africa the tree is looked on with veneration, and is termed the "god-tree," in some districts it being looked upon as a sacrilege to cut the tree down. Still the trunk is used for forming canoes, and although the wood is soft and liable to the attacks of insects, if soaked in lime-water it becomes much more durable. The silk-cotton, either alone or mixed with cotton, is largely utilised in Africa. The young leaves are used as food, and form not a bad substitute for "Ochro" (*Hibiscus esculentus*).

Another tree yielding silk-cotton in India is the *Cochlospermum gossypium*, DC., the *Bombax gossipinum* of Linnæus; a member of the tea order (Terustrœmiaceæ). It is a tree attaining a height of 50 ft., and the soft silky hairs surrounding the seeds are used for stuffing purposes. The tree has large conspicuous yellow flowers, and is not uncommon in Southern India, Travancore, and Coromandel. The *Calotropis gigantea*, or Mudah tree (Nat. Ord. Asclepiadaceæ), also yields a like substance.

In America, both north and south, various so-called "milk-weeds," as *Asclepias verticillata*, and other plants, such as species of *Bombax*, &c., yield silk-cottons, whilst the *Asclepias syriaca* obtained the attention of European agriculturists as early as 1785, and paper has been made from the cortical fibres of this plant. The young shoots of the plant too are said to equal asparagus in flavour.

These are only a few of the plants yielding silk-cotton, which might be mentioned. Silk-cotton has made its appearance in the markets from time to time, and in 1851, the jurors of the Great Exhibition recommended this substance for stuffing purposes, and in mixed fabrics, and notices respecting it have occasionally appeared in this *Journal*. For the lining of quilts, quilted petticoats, &c., silk-cotton seems to answer admirably, but its want of cohesion, or non-felting qualities, renders it of no use for spinning purposes, except as a mixture to impart a silky gloss to the fabric so mixed. The price is low, it is light in weight, elastic and soft, and is said to resist the attacks of insects.

Obituary.

LORD OVERSTONE.—This distinguished financier, who died on Saturday, 17th instant, in his eighty-eighth year, was elected a member of the Society of Arts in 1848. The Right Hon. Samuel Jones Lloyd, 1st Baron Overstone, the only son of Mr. Lewis Lloyd by Sarah, daughter of Mr. John Jones, was born on September 25th, 1796. He was educated at Eton and Cambridge, and graduated M.A. in 1817. He was the last representative of a Parliament of George III., having been elected for Hythe in 1819, for which town he sat till 1826. Several pamphlets on currency were written by him, and he was an ardent advocate of the principles which Sir Robert Peel subsequently embodied in the Bank Charter Act. The University of Oxford conferred upon him the degree of D.C.L. in 1850. When raised to the peerage he terminated his connection with the banking firm of Jones, Lloyd, and Co. In 1862, he was appointed one of the Commissioners to inquire into the working of the Patent Laws. Several volumes of early tracts on political economy were privately printed by his Lordship, and at the death of Mr. McCulloch he purchased the entire library of that famous political economist.

MR. JOHN ELIOT HOWARD, F.R.S., died at his residence, Lord's Meade, Tottenham, on the 22nd of November, at the age of 76. Although Mr. Howard was not a member of the Society, he occasionally attended the meetings and joined in the discussions. His scientific work with regard to the Cinchonas, and his many important publications thereon, are monuments to his memory of patient industry and scientific acumen, and these labours have met with recognition and honours from all parts of the world. He was the son of Luke Howard, F.R.S., one of the founders of the modern science of meteorology, and a descendant of the more famous John Howard, the philanthropist.

Correspondence.

SOUR BEER.

In reply to Mr. Moritz's letter, I hope the following facts may pave the way to the accomplishment of my object, viz., how the quality of beer might be improved, by giving information to brewers as to the disposal of the waste product, sour beer, otherwise than by blending it with new beer. Early in my long experience, I pursued the plan Mr. Moritz advises, but I have given it up for at least twenty years, and as my ale has improved thereby, so has my trade increased.

I found that the addition of three gallons to thirty-three of the new (the proportion that Mr. Moritz states) was disapproved by my customers, and so was even half that quantity.

I also at that period of my career neutralised the acidity of the sour beer, by the addition of whiting, and drew off the compound bright, after sufficient settling; but my impression is to blend this mixture with new beer is about "as sensible a thing as to add three gallons of water to thirty-three of beer." I am no chemist, and therefore I cannot say what constituents of beer would be remaining in sour beer "after destroying the acid ferment and removing the other matters in suspension." Would it be of more value than water? I can only say that I prefer to supply my customers without such an addition, and I feel, too, that in studying their interests in this respect I am not unmindful of my own, and if this applies to myself so does it to every brewer.

HAMPSHIRE BREWER.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

The following arrangements for the Wednesday evenings before Christmas have been made:—

DEC. 5.—"The Manufacture of Mineral Waters." By THOMAS T. P. BRUCE WARREN. Dr. B. W. RICHARDSON, F.R.S., Vice-President, will preside.

DEC. 12.—"Rheea Grass." By Dr. FORBES WATSON. Major-General HYDE, R.E., will preside.

DEC. 19.—"Canada and its Products." By the MOST HON. THE MARQUIS OF LORNE, K.T., late Governor-General of Canada.

CANTOR LECTURES.

The First Course will be on "The Scientific

Basis of Cookery." By W. MATTIEU WILLIAMS, F.C.S.

LECTURE I. DEC. 3.—The Kitchen a Chemical Laboratory. Modes of applying Heat. Radiation, Conduction, and Convection. Roasting, Grilling, Baking, Boiling, and Stewing.

LECTURE II. DEC. 10.—The Constituents of Flesh. The action of Heat on Albumen, Gelatine, Fibrin, &c. The Juices of Flesh and their nutritive value. Exosmosis and Endosmosis as operating in the Kitchen. Maceration. Caseine. The cookery of Cheese and its nutritive value. Milk, Butter, and "Bosch."

LECTURE III. DEC. 17.—The nutritive constituents of Vegetables. The changes effected by cookery on Vegetable Substances. Ensilage of Human Food. May the use of Flesh Food be superseded by the scientific preparation of selected Vegetables?

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Mattieu Williams, "The Scientific Basis of Cookery." (Lecture I.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 6 p.m. Mr. George Street, "The Decrease of Live Stock in Great Britain."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. W. Willis Bund, "The Agricultural Holdings Act, 1883."

British Architects, 9, Conduit-street, W., 8 p.m. Discussion on Mr. E. C. Robins's paper, "Fittings for Applied Science Instruction Buildings."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. H. G. Tomkins, "Recent Discoveries in Egypt in their relation to the Bible."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. G. J. Romanes, "Instinct."

Society of Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. H. L. Greville, "A New Residual Product from Coal Gas." 2. Mr. C. N. Hake, "Further Notes on the Stassfurt Industry." 3. Mr. A. Zimmerman will exhibit Drs. Raydt and Kunheim's Liquid Carbonic Acid Apparatus.

TUESDAY, DEC. 4...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. W. T. Douglass, "The New Eddystone Lighthouse." 1. Mr. W. H. Preece, "Electrical Conductors."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Mr. H. Rassam, "Biblical Nationalities in their Primitiveness, and as they exist at present." 2. Dr. J. Peters, "The Babylonian Origin of the Phœnician Alphabet."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. R. Bowdler Sharpe, "Notes on the *Diceidæ*." 2. Mr. J. B. Sutton, "The Diseases of Monkeys dying in the Society's Gardens." 3. Mr. H. O. Forbes, "The Habits of *Thomisus decipiens*, Forbes, a Spider from Sumatra."

WEDNESDAY, DEC. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Thomas T. P. Bruce Warren, "The Manufacture of Mineral Waters."

Geological, Burlington-house, W., 8 p.m. 1. Dr. Henry Hicks, "The Cambrian Conglomerates Resting upon and in the Vicinity of some Pre-Cambrian Rocks (the so-called intrusive masses) in Anglesey and Caernarvonshire." 2. Prof. T. G. Bonney, "Some Rock Specimens collected by Dr. Hicks in Anglesey and N.W. Caernarvonshire." 3. Mr. A. J. Jukes-Browne, "Some Post-Glacial Ravines in the Chalk Wolds of Lincolnshire."

Entomological, 11, Chandos-street, W., 7 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Messrs. Wyndham R. Dunstan, and F. W. Short, Report upon the Pharmaceutical Preparations of Nux Vomica (continued). II. "Notes and Suggestions upon Tincture of Nux Vomica." III. "Extract of Nux Vomica." 2. Mr. Edward Grindle Hogg, "Tincture of Cinchona." 3. Mr. Harold Senier, "The Purgative Principle of Croton Oil." 4. Mr. Harold Senier, "The Vesicating Principle of Croton Oil."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. C. H. Compton, "Brambletye House, East Grinstead." 2. Mr. Thomas Morgan, "Report on the recent Congress at Dover."

Obstetrical, 53, Berners-st., Oxford-st., W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. B. Haughton, "The Suez Canal choked at last."

THURSDAY, DEC. 6...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. Charles Darwin, "Posthumous Essay on Instinct." A discussion to follow.

Chemical, Burlington-house, W., 8 p.m. Ballot for the election of Fellows. 1. Dr. E. Divers and M. Rawakita, "The Constitution of the Fulminates;" "Liebig's Production of Fulminating Silver without the use of Nitric Acid." 2. Dr. H. E. Armstrong, "Note on the Constitution of the Fulminates." 3. A. B. Griffiths, "Experimental Investigations on the Value of Iron Sulphate as a Manure for Certain Crops."

London Institution, Finsbury-circus, E.C., 7 p.m. Rev. W. Green, "The High Alps of New Zealand."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W. Special Meeting. Mr. W. Anderson, "The Generation of Steam, and the Thermodynamic Problems involved." (Second Heat Lecture.)

Royal Society's Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Parkes Museum, 74A, Margaret-street, W., 8 p.m. Dr. G. V. Poore, "Coffee and Tea."

Philological, University College, W.C., 8 p.m.

Archæological Institution, 16, New Burlington street, W., 4 p.m.

FRIDAY, DEC. 7...Geologists' Association, University College, W.C., 8 p.m.

SATURDAY, DEC. 8...Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thompson, "The Static Telephone as an Instrument of Research," "A New Insulating Support," and "The First Law of Electrostatics." 2. Prof. J. Monckman, "Experiments illustrating the Attraction and Repulsion of Bodies in Motion." 3. Mr. Walter Baily, "An Integrating Anemometer."

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,620. Vol. XXXII.

FRIDAY, DECEMBER 7, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE MARQUIS OF LORNE ON CANADA.

To enable a greater number of members than can be accommodated in the Society's own Room to hear the paper on "Canada and its Resources," by the Marquis of Lorne, on the 19th December, the Council have arranged for the meeting to be held at Exeter-hall, Strand (in the smaller hall). Members will be admitted as usual on signing their names, but the privilege of admitting friends will be restricted. Each member will be entitled to admit *one* friend only, either personally or by the usual ticket.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 2nd and 9th, by J. Millar Thomson, F.R.S.E., F.C.S., on "Crystals and Crystallisation." The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

On Monday evening, the 3rd inst., Mr. W. Mattieu Williams delivered the first lecture of his course on "The Scientific Basis of Cookery," in which he likened the kitchen to a chemical laboratory, and dwelt on the necessity for a knowledge of certain chemical principles amongst those who had to conduct, or at least to direct, the processes of cooking. He described the different modes of applying heat by radiation, conduction, and convection; explained the difference between boiling, stewing, roasting, &c., and using, as an illustration, the effect of various degrees of temperature on albumen, showed how important it was that the precise heat required for each process should be attained and maintained. For instance, as boiling water never rises above 212 degrees Fahr., it is an obvious mistake on the part of the cook to attempt, by increasing the fire, to make water boil faster.

EXHIBITION OF COOKING APPLIANCES.

An Exhibition of gas and other stoves, and the various apparatus and appliances used for cooking purposes, was opened, in connection with Mr. Mattieu Williams's Cantor Lectures on "The Scientific Basis of Cookery," on Monday evening last, and will remain open until December 17th. It will be open daily, from 10 a.m. to 4 p.m. (with the exception of Saturdays, when it will close at 2 p.m.), and on the evenings of the lectures.

Members of the Society can admit their friends by use of the tickets supplied for the evening meetings and lectures. Persons not members of the Society may obtain tickets on application to the Secretary.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 5th, 1883, B. W. Richardson, M.A., M.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Crow, John Kent, D.Sc., 2, Colham-villas, West Drayton, Middlesex.
Cunliffe-Owen, Edward, 64, Inverness-terrace, W.
Henderson, Richard, The Grange, Kirkcudbright, N.B.
Latchford, Edward, 50, Penywern-road, South Kensington, S.W.

The paper read was—

THE MANUFACTURE OF MINERAL WATERS.

By Thomas T. P. Bruce Warren,

In this paper I have intentionally omitted to deal with the historical part of the subject. I mention this because I know that there are many firms in the metropolis who are very proud of their time-honoured connection with this business, and who may perhaps feel that I have acted with some discourtesy towards them on that point. The fact is, I found that so much time would be occupied in travelling over the historical part of this matter, that it would be better to leave it for another occasion. With these remarks, I feel confident that those firms which we regard as the founders of this important and interesting manufacture, will be assured that no unkindness is meant by the omission.

There is, however, an important link in the manufacture which cannot be overlooked. We cannot fail to be struck with the elegant and smart appearance of some of these bottled beverages, when we consider what they were a few years ago. It must have been the work of a man with a very strong nerve who first ventured to depart from the old-fashioned form of bottles. There is no doubt that these beverages have become much more fashionable from the fact that a dinner table can be laid out and decorated with them, especially when bottled in syphons. Why an untidy finish, until only a few years ago, was almost considered a necessary accompaniment to mineral waters, I have never been able to understand. Fig. 1 shows how the contents of a syphon should be allowed to fall into a glass.

Fig. 1.—Mode of Opening a Syphon.

Another fact, which deserves more than an incidental reference, is that the term "mineral water manufacturer" no longer defines the nature of the products which are now turned out from the "soda water works." Not many years ago, ginger, lemons, citric and tartaric acid and sugar were the only representatives derived from the vegetable kingdom; these, together with about half-a-dozen inorganic salts, constituted what we may call the *materia medica* of the mineral water manufacturer. A glance at this interesting collection of specimens which have been kindly sent here by Messrs. Stevenson and Howell, Bush and Co., Lichtenstein and Co., and others, will give you some idea of the present stock-in-trade belonging to a mineral water manufacturer As a very few of these materials are derived from the mineral kingdom, it is evident that the word mineral is inappropriate to a large majority of the beverages generally so classified.

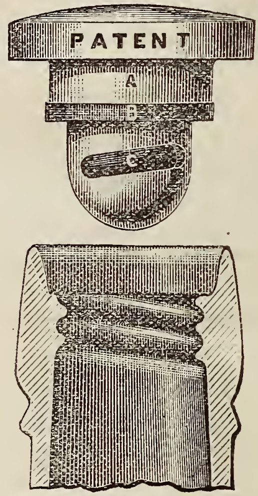
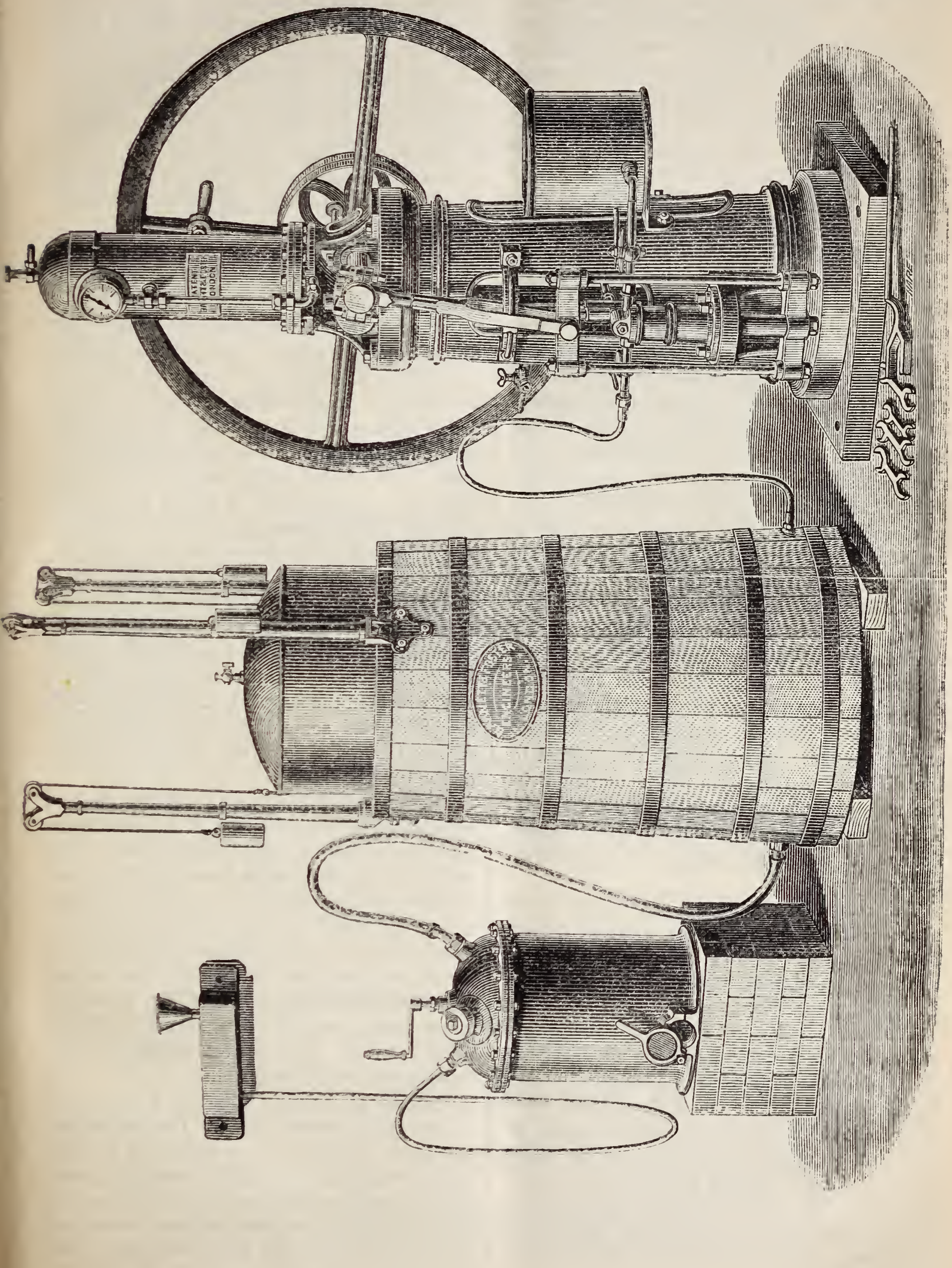


Fig 2.—Barnett and Foster's Stopper.

When people were content to drink these mineral waters principally as medicinal agents, or as media for diluting brandy, &c., there was no room for the development of that artistic skill which may be fairly said promises now to alter the taste of mankind in the matter of drinks.

The frequent disclosures which have now and then been made of the manœuvres carried on in the champagne trade, ought more strongly to reconcile us to the aërated fruit-flavoured beverages, which we know are wholesome and refreshing, and which I believe were first introduced by Messrs. Barnett and Foster.



Generator. Gasholder. Mixer.

FIG. 3.—BARNETT AND FOSTER'S MACHINE WITH NIAGARA MIXER.

It has been unfairly represented that these beverages are made of chemicals of a very doubtful character, as regards their harmlessness, and an attempt has been made to support this charge by selecting from a general trade-list a few seemingly obnoxious compounds, as though they constituted the sole ingredients employed in this business. The increasing demand for these beverages, and the fact that they form so important an element in the dietaries of the educated classes of this country, prove, to my mind, that Bacchus is becoming uneasy at the great stride which temperance has made, through the introduction of artistic skill in compounding non-intoxicating beverages which are alike palatable and captivating. Messrs. Bush have given a great deal of attention to the preparation of syrups and fruit essences for preparing these beverages.

In the manufacture of aërated waters, the matter of greatest importance is the purity of the water itself which is employed. Consumers of these waters, which are sent out by our largest and well known manufacturers, can rest perfectly contented that the most scrupulous care will be taken to secure a thoroughly wholesome water supply. From the results of an inquiry into the general London trade, I am able to state that manufacturers, as a rule, are fully alive to the importance of keeping their natural supply of water above suspicion. Few manufacturers, however, apply chemical tests themselves, but rely upon the water companies delivering the article as pure as circumstances will permit. There is, no doubt, a great difference in the suitability of he water supplied by the different metropolitan water companies for the requirements of a mineral water factory. The same remark applies, but with greater significance, to the water supplies of our different towns.

The recent alarm of cholera reaching our shores threatened to invest mineral waters bottled in this country with an unenviable character, somewhat to the advantage of the enterprising foreigners.

Without wishing to raise an unnecessary alarm, I think it would be to the advantage of the trade, as well as to the consumer, if some legislative enactment could be carried so as to prevent this trade being carried on either by ignorant or unskilled persons, or by those to whom notions of profit are of greater importance than the sanitary considerations necessary for conducting a manufacture which is so intimately associated with our daily wants as aërated waters.

With a view of assisting mineral water manufacturers, brewers, and others interested in the matter of water impurities, &c., I have designed a chemical cabinet containing all the requisites for such an inquiry, and for the general examination of trade products. One of these cabinets, fitted up for a mineral water manufacturer, is exhibited by Messrs. How and Co., Farringdon-street, and contains all that is necessary for the examination of water and the purity of the materials more generally employed in the manufacture. Mr. Cetti has sent a collection of apparatus for examining water, including the Bischoff evaporating arrangement (Fig. 16, page 49).

Cases are known where a damaged water pipe inside a factory has led to serious pollution of the water, although, as supplied by the water company, it was perfectly good when drawn from their mains. Frozen pipes, and the subsidence of newly-made ground, are not unfrequent sources of such accidents. Water drawn from a well may become contaminated by the infiltration of surface water through the upper part of the casing of the well being defective. Fortunately, a defect in a water pipe laid in the ground becomes too evident to be overlooked; well water, however, may become contaminated without the fact becoming evident; it is therefore safer to apply a few tests as frequently as possible, especially after heavy rains, and following upon long drought. Deep wells, if lined to a sufficient depth, are quite safe, provided the supply is drawn up through a pipe carried some distance down below the casing, instead of being drawn too near the top of the bore.

The considerations which should guide a manufacturer in sinking a well can scarcely be given here; but in a town supplied with good water, as regards freedom from organic matter, better waters may probably be made from the town supply than may be expected from a well, even if sunk to a considerable depth; for we must not lose sight of the fact that we are generally more liable to infiltration of surface water unless we put down a very costly and perfect lining. Faults from fissures are not unfrequent in very deep wells.

Most people have an idea that filtering will render any water fit to drink. There is nothing to be said against using a good and properly constructed filter; a water of ordinary quality may be improved, and even if free from organic impurities, may leave the filter no worse than when it went in; but the unfortunate thing about filters is, that people think that they last almost for ever without being looked to, or that any amount of water may be passed through them. In removing organic impurities by filtration we trust partly to mechanical separation and partly to oxidation Baker's high pressure filter is the best form for obtaining a large supply of good filtered water rapidly.

Other methods of removing or destroying organic impurities are distillation and boiling. The main difficulty in carrying out these operations on an extensive scale is the subsequent cooling, and in the case of distilling, the cost of condensing.

Boiled water is of great importance, as not only does boiling tend to remove or destroy organic impurities, but by subsidence a great number of inorganic compounds are removed, such as oxides of iron and manganese, lime, magnesia, and silica. The presence of oxygen is objectionable in the case of waters flavoured with essential oils or other principles liable to change by oxidation. Waters containing ferrous compounds can only be prepared successfully by the careful exclusion of oxygen in every stage of the manufacture.

There are two or three methods in use for bottling waters containing ferrous compounds; one consists in first filling the bottles with water highly charged with CO_2, and then emptying them so as to retain a quantity of the gas in the bottles. A fact of great importance is that most ordinary waters, under general conditions, contain considerably more oxygen than is contained in the same volume of atmospheric air. It is found by experiment, when the gases are obtained from ordinary water by boiling, that the air which is evolved is much richer in oxygen than atmospheric air is. This has led to the discovery of what is known in chemical physics as the law of partial pressures. We learn from this that in a mixture of gases, the co-efficient for the solubility of each gas in water has to be multiplied into the number expressing their relative volume pressures, in order to obtain the actual volume of each gas absorbed.

Under ordinary circumstances, a litre of good river water may contain about 7 c.c. oxygen and 13 c.c. nitrogen; the same volume of atmospheric air will contain 4·2 c.c. oxygen, and 15·8 c.c. nitrogen.

From certain experiments which I have made, and am still carrying out, it would appear as if this oxygen contained in the water acquires an enhanced chemical activity under certain circumstances, and although I am not able to prove that it becomes ozonised, I am certainly of opinion that the oxidation of oil of lemon in lemonade is in a great measure the cause of deterioration where sound and genuine ingredients have been used. Other substances liable to change by oxidation may, of course, alter in the same way.

In the ordinary manufacture of aërated waters belonging to the saline class, oxygen gas is not likely to do any harm, but it is impossible to regard its presence with indifference where essential oils or other easily oxidised materials are employed.

The examination of the gases contained in ordinary water is a tedious operation. On the table are two arrangements for conducting this; one of these, proposed by the late Dr. Miller, is, in my opinion, the most trustworthy.

The objections to air-impregnated water have not escaped the attention of manufacturers, and a system of bottling water free from atmospheric air has been recently perfected by Mr. F. Barrett, Messrs. Barnett and Foster, and Messrs. Hayward Tyler and Co. for patent stoppers.

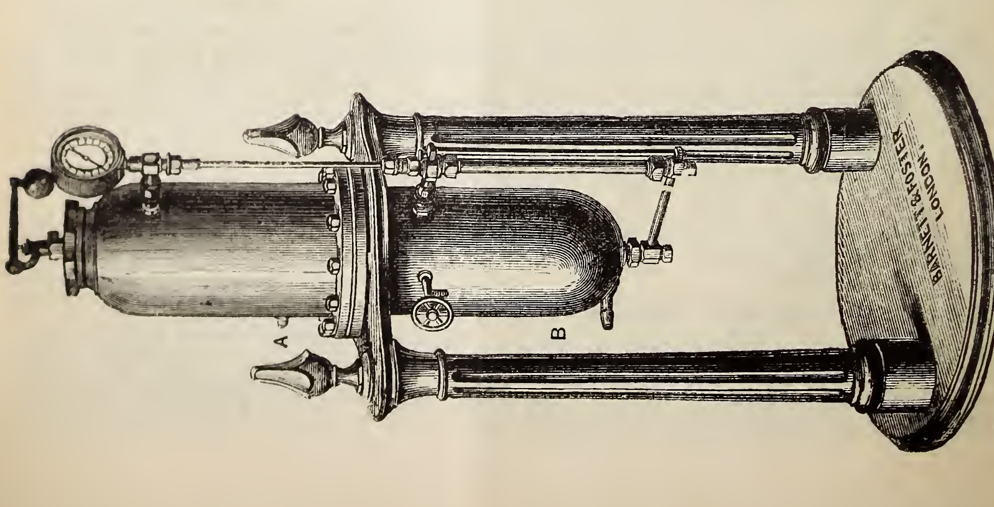
When a bottle of aërated water contains air, a portion of the contents are ejected with violence when the bottle is opened; it also prevents good aëration with the gas. By the more usual method of bottling, this cannot be avoided. The bottle to be filled is placed under a nipple, and the aërated water forced in. When the pressure in the bottle prevents any more liquid flowing in, the tap is closed, and the accumulated air and gas allowed to rush out; it is then re-placed securely under the nipple and filled up. In this way the water is bound to contain a very great deal of air.

By the new system, the liquid is poured or forced through a tube reaching to the bottom of the bottle, the bottle being inverted, so that on filling, the air is completely forced out, just as we would collect a jar of the gas by downward displacement, driving out the lighter air before it. Diffusion between the air of the bottle and the gas is avoided completely by the upward pressure of the gas.

Messrs. Pitt and Co., who use this system of filling, have sent a variety of their waters, which are not only very highly charged with the gas, but retain an active effervescence for a long time, and on opening, none of the liquid is ejected over the side of the bottle.

If we open a bottle filled by both methods, you will be able to see the remarkable advantage of what is now known as the "apneumatic" system. Before opening, it would be

Fig. 4.—Niagara Mixer.



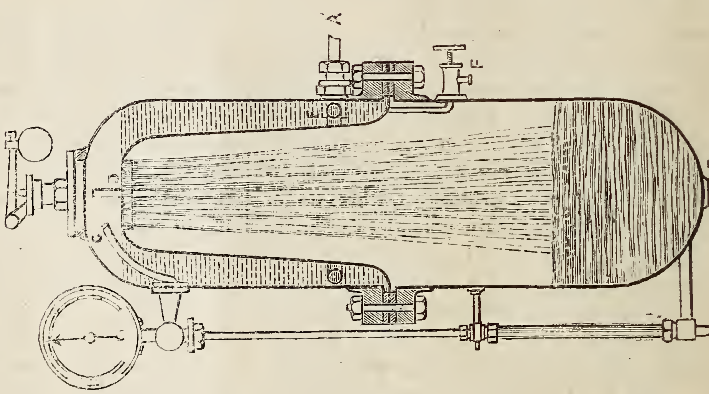


Fig. 5.—Niagara Mixer (Section).

Fig. 6.—Knee-bottling.

interesting to compare the pressure in each bottle.

By this method, and by excluding air from the water, and its ingress in any part of the operation, it is possible to obtain in solution ferrous compounds, which are among the most difficult materials to bottle up without depositing. With this method, we may be said to have attained perfection in making aërated beverages.

Mr. James Packham, of the firm of Packham and Co., Limited, of Croydon, has given a great deal of attention to the purification of water by distillation, and informs me that he

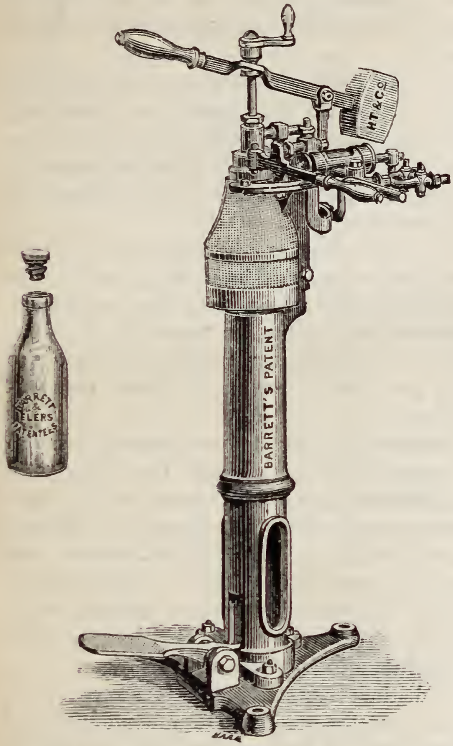


FIG. 7.—BARRETT'S BOTTLER FOR SCREW STOPPERS.

has no difficulty in distilling all the water required for their extensive trade. There is a fine display of the various waters made by this firm, and I have very great pleasure in stating that these waters have not only a high character, both in purity and general qualities, but are as near perfection as possible. I consider the fine flavours of these sweet beverages are preserved by the non-presence of oxygen gas or air in the water used in preparing them. After the air has been expelled from water by boiling or distilling, care should be taken to keep it closed up in tanks; it would even be better to impregnate the water slightly with carbonic acid gas, which would not only give a greater security against the absorption of air, but would, in a great measure, counteract the tendency to contamination when in contact with metals, &c.

As pure water has a much greater solvent action than ordinary water, extra precaution

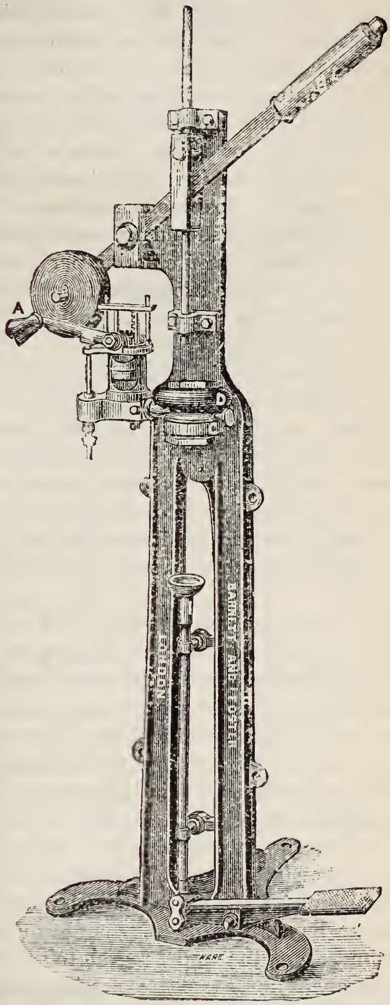


FIG. 8.—BOTTLER FOR CORKED WATERS WITH SYRUP PUMP.

is necessary to avoid contamination; Mr. Packham uses pure tin pipes, and when other metals are necessary, they are protected by a heavy coating of silver.

Another method of purifying water consists in removing its carbonic acid gas, whereby the carbonates of lime, iron, and magnesia are precipitated, together with silica and organic matters. This is effected by the addition of lime water. This method has been rendered more practicable by the application of the filter press, as carried out under the well-known Porter-Clark process. The presence of an abnormally large amount of earthy carbonates in a natural water is very undesirable. These can be removed by adding a little soda to the water, where such addition is not likely to be objectionable; after standing for a time, the earthy salts will be precipitated.

A good natural water for manufacturing aërated beverages should be free from organic impurities as near as can be, for very few waters, in a natural condition, are absolutely pure in this respect; it should not contain more than twenty or thirty grains of solid matter per gallon, and if it contain over this amount, it should be capable of being removed by a softening process. It should not contain much air; and the quantity of chlorine per gallon must not exceed one to two grains for ordinary water, although this quantity is considerably exceeded by deep well water.

A little experience is required in order to decide on the merits of a water from the results of analysis. An impure water would unhesitatingly be condemned, but a very pure water may involve us in trouble almost as serious; so that, without going into this part of the subject fully, it would be impossible to give much information which would be generally applicable.

We are tolerably well supplied with works on water analysis, from a sanitary point of view. A mineral water manufacturer requires much more than this, he requires to know how to find out the composition of a naturally occurring mineral water, and the details and methods of analysis far in advance of the works at present in print. I hope shortly to do something towards supplying this want.

It is of equal importance that a manufacturer should be able to tell whether the articles he buys are what they ought to be in purity and strength; and I regret to say that no work, as far as I am aware of, will give him much assistance in this direction. Although this business has advanced at such a pace that there are now over 2,000 manufacturers in this country, and we have some good trade journals, such as the *Mineral Water Trade Review*, and a few beside, we have nothing in the way of scientific literature; this I attribute to the transitional condition of the business. A new state of things is created, which involves more scientific knowledge than is possible for a manufacturer to keep up with.

The general plan [and] arrangement of a mineral water factory must be such that ventitation and cleanliness can always be secured; bad smells from any cause must be an impossibility; all water ways, drains, &c., should communicate with the outlets to sewers outside the buildings, and be well trapped; any drains in the factory should be closed with moveable coverings, so as to admit of their being well cleaned and swept out. Wood flooring, or anything likely to hold moisture or dampness, is unfit. No dust nor mildew should be allowed to accumulate on the walls or floors; and a current of fresh air should always pass through the parts of the building devoted to the more important parts of the work. Fig. 11 (page 45) shows the general plan of a factory plant.

The machinery should be so fixed as to be easily accessible for repairs or cleaning. Whiting should be well dried, and kept away from damp and dust. A plentiful supply of water for rinsing bottles and washing, is indispensable.

I have had the pleasure of going over several of the larger factories in London, and I could not help being struck with the scrupulous attention paid even to the minor details of the work; in this respect the contrast between what prevailed a few years ago is very encouraging.

Probably nothing has contributed more to the popularising of aërated beverages than the different kinds of stoppers, which have been so successfully developed by Messrs. Barrett and Elers, Mr. Codd, and others. As may be expected, this system of corking or stoppering has undergone some changes which pertain, however, more to the design of the stopper than to anything else.

A distinct feature which is an enormous advance on the preceding form of stopper, and which, from the fact of their being forced into the bottle in order to get at its contents, have been called "internal stoppers," is the patent screw stopper of Barrett and Elers, and the intermittent screw stopper of Barnett and Foster. Barrett's stoppers are made of ebonite tube, the thread being made by moulding the tube when softened by heat; the stoppering is rendered tight by an india-rubber washer. Mr. Barrett has kindly sent a variety of beverages bottled and corked according to his system, and also a variety of bottles and stoppers showing the growth of the new method of corking. We have, first, the somewhat barbarous looking "Jersey wood stopper," which, however convenient in use, can lay no claim to elegance or neatness; secondly, we have the ebonite stopper, which in turn was substituted for the glass ball stopper; lastly, we come to the screw stopper, which, although it was originally introduced for bottled beers, bids fair to supersede every other form of this kind of stopper for aërated waters.

There is a great difference of opinion respecting the merits of the old and familiar method of corking, and the use of the patent stoppers. I have no hesitation in saying that the driving of the stopper into the contents of the bottle is very objectionable, it promotes a rapid evolution of gas, and what is still worse, any dust or particles of straw contained in the neck of the bottle find their way into the tumbler when the contents are poured out. A metal capsule would remove the last objection.

This system of corking has, in spite of all that can be urged against it, been the means of developing a taste for these beverages among our artisans and the less wealthy of the middle class, and has no doubt stimulated the demand for waters where cork is used.

I am indebted to Messrs. Hayward Tyler and Co. for this display of bottles, designed by Lamont, and others, for their well-known system of corking. Messrs. Barnett and Foster have also sent Codd's patent bottles.

The fact that the screw stopper can be quickly replaced when a portion of the contents of the bottle has been poured out, adds very materially to its merit, the water retaining enough gas to bear opening a second time in a satisfactory state of aëration.

Messrs. Hayward Tyler and Co. have kindly sent a machine here, and my friend, Mr. H. Dowell, their engineer, has promised to have the same in operation. This machine is a perfect representation of the type involving the well-known Bramah hydraulic process, and is a unique specimen of workmanship and finish (Fig. 21, page 53).

The process of making unsweetened aërated waters consists of three distinct operations. The generating and washing the carbonic acid, the saturation of the water with the gas, and the bottling; with sweetened waters, the syrups and flavouring ingredients are added by a separate process, continuous with the bottling. K is the generator for obtaining the carbonic acid, as will be explained further on; the gas is passed through a washer or purifier, and thence into the holder, C, which is made of copper lined with tin, and which works in an oak tub or cistern, O. The combination of the gas with the water is effected by pumping into a stout copper vessel, D, called the condenser, under a very high pressure. This is the system almost universally used in this country. In this machine, the pump and condenser are placed on one frame for convenience and compactness. The pump is an inverted plunger pump, with valves at the top; gas is drawn in one side, and water at the other. G is the pump, H the valves, M the vessel from which the water or solutions are drawn. From the pump the water and the gas pass together into the condenser, D, which is lined inside with pure tin or silver; an agitator or fan, actuated by the cogwheels, F, works in the condenser; by a recent improvement this agitator is dispensed with by passing the gas and water together from the pumps into a perforated pipe, which gives the needful agitation in the condenser.

Messrs. Barnett and Foster exhibit a machine in which they effect the mixing of the gas and water by lifting the water and letting it fall through a series of fine perforations. Fig. 3 (page 37) shows the complete machine, with the generator and holder. Figs. 4 and 5 (page 40) show their Niagara mixer, in detail and section.

The condensers are sometimes fixed on separate frames from the pumps, and are generally worked in pairs. The pressure maintained in the condenser varies according to the water or beverage which is being made, and to the practice of the maker. Some makers work with a pressure as high as 200 lbs. per square inch in the condenser; from recent experience, however, a pressure of from 80 to 120 lbs. is found to be practically the best. From the condenser the water which is now aërated can be drawn off at the cock and nipple, E, as in the old process of knee bottling. (Fig. 6, page 40).

For machine bottling, a pipe leads from E to the machine. The bottling machine varies in its details, according to the form of bottle used and the means of closing it, whether by cork, patent stopper, or syphon. The various systems are well illustrated in the machines now exhibited, but the system of steam bottling, which is now rapidly taking the place of the older method, cannot be shown without steam-power. Fig. 7 (page 41) is Barrett's bottler for his patent screw bottle. Fig. 8 (page 41) is used for ordinary bottles. Syphons are filled as in Fig. 9 (page 44). A special form of bottler is shown in Fig. 10 (page 44) which fills any form of patent bottle.

The contamination of the water by contact with metals, has been a source of considerable anxiety to the manufacturers of waters, and also to the machines. Contact with lead or any easily oxidised metal must be avoided. There is no difficulty in securing this object by a coating of tin or silver, but when particles of metal

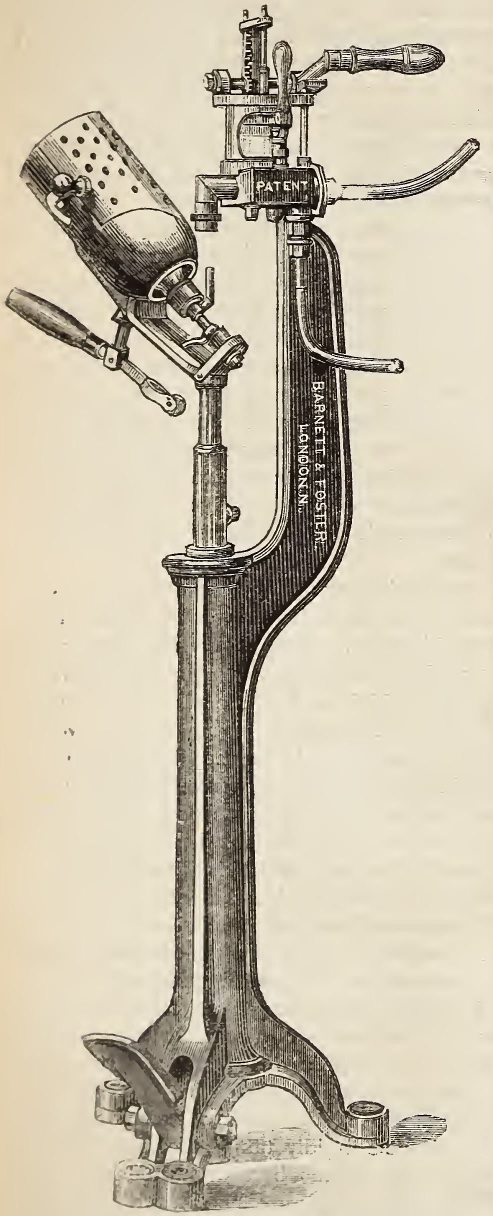


FIG. 9.—SYPHON FILLER.

are introduced by attrition, it is not so easy to suggest a remedy; this is completely avoided by the perforated tube introduced by Messrs. Hayward Tyler and Co., and already alluded to, or by the Niagara system of Barnett and Foster.

We occasionally hear of metallic impregnations in water, especially water containing citric or tartaric acid, and I would just suggest that, before we attribute this to defects in the mechanical appliances, it will be better to see if the materials are free from fault. These

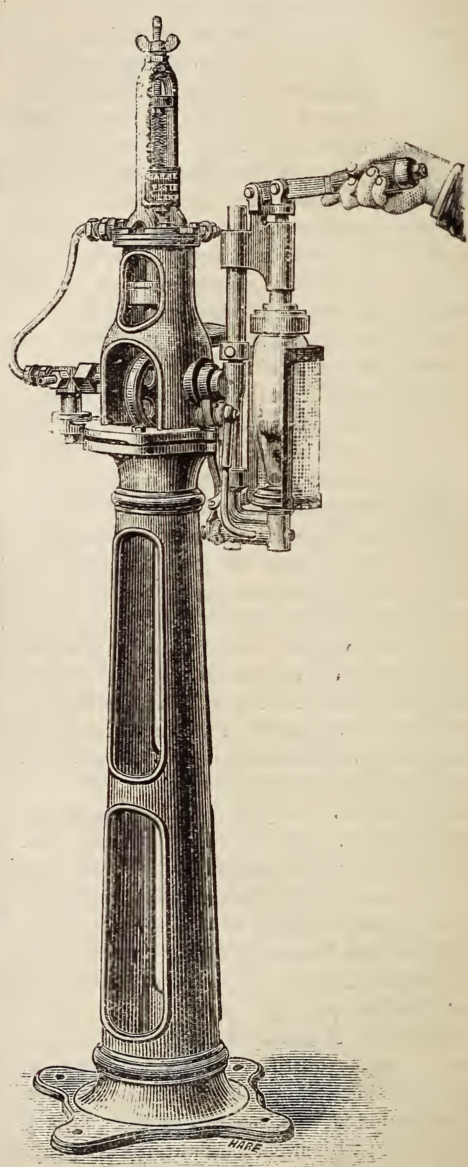


FIG. 10.—FILLER FOR ANY PATENT STOPPER.

acids are usually crystallised in lead-lined vessels, and are more frequently impregnated with this metal than most people are aware of. Cheap acids should be avoided. Messrs. Stevenson and Howell are directing their

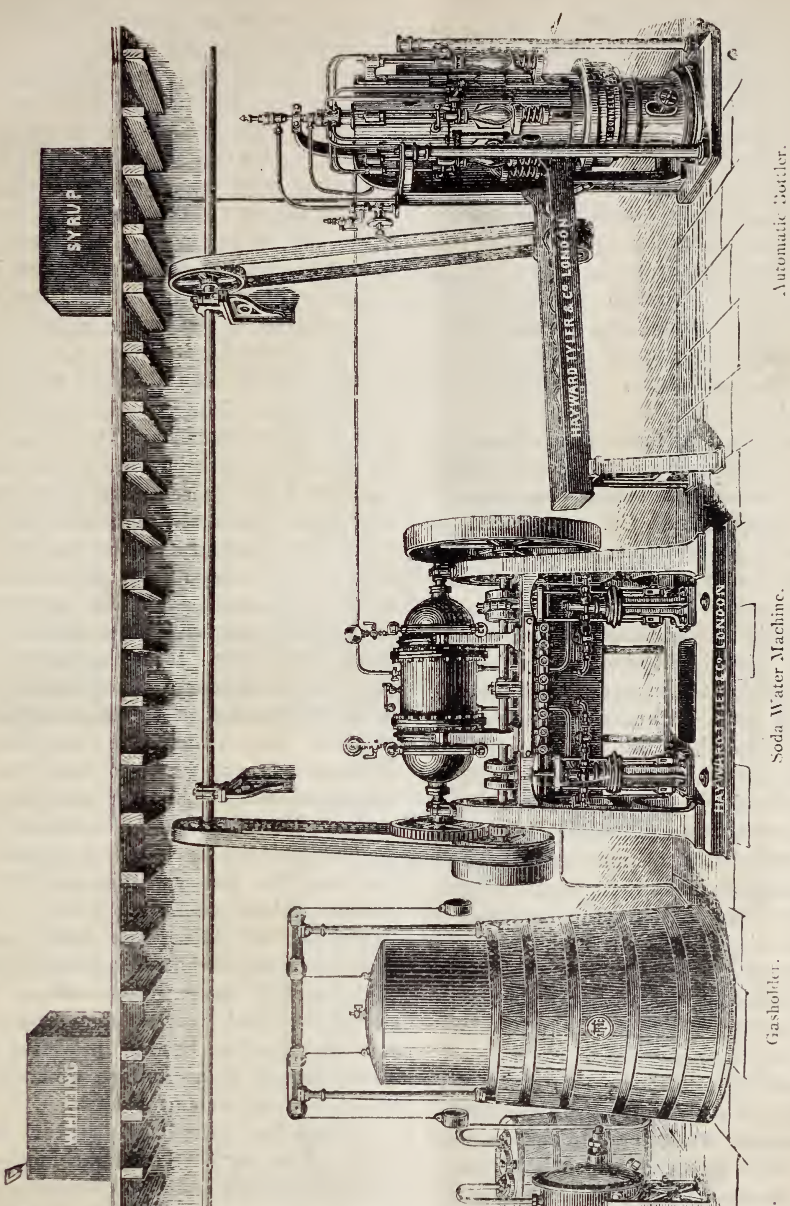


Fig. 11—Plan of Machinery capable of producing from 1,500 to 2,000 Dozen Bottles of Aerated Waters daily.

attention to this important matter, which has not only been overlooked by wholesale dealers generally in these articles, but has escaped the notice of our active analysts.

The manufacturers of machinery, used in the different parts of this business, must have had a severe task to keep pace with the march of improvement, and the rapidly increasing wants of the mineral water manufacturer. A few years ago the only mechanical arrangement in most factories was the agitating and forcing of the gas into the condenser, everyshing else being done by hand.

Bottles are now washed and rinsed by machinery, filled, corked, and wired, and the required quantity of syrups added, in the case of sweetened beverages, by mechanical arrangements.

The most important mechanical alterations have been in the process of filling, corking, and wiring the bottles. About 1840, Messrs. Hayward Tyler and Co. introduced a machine which in its simpler form constitutes what is now known as the bottling rack; this has become almost universally used, and is now supplied in various forms by the different makers of this description of machinery. Fresh demands have been made on the bottling rack, and in some instances it has been so ingeniously adapted, that its ancestral kinship is almost disclaimed. In its latest and most highly-developed form, it appears almost as if it were an automatic soda water maker; all that is necessary with this machine is to place the bottle and cork in their proper places, when the measured quantity of syrup is added; if required, the air is forced out by the ingenious process of filling, and the cork driven in; the completed bottle of water being delivered to the attendant for wiring, at the rate of from twelve to thirty-six per minute.

It is found by experience that the waters produced by this machine are superior in all respects to those obtained by the more general methods. This machine, which is known as Mr. Allen Macdonell's automatic bottling and corking machine, is becoming very extensively adopted. Fig. 18 (page 52) shews the machine.

The machine occupies a space of about three feet square, and stands on a cast-iron foundation, easily fastened down by bolts to the floor. The principal working part is an upright cylinder, revolving on a central pillar. The outer part of this cylinder is provided with six mouthpieces, very similar to those on an ordinary bottling rack, only that all the operations of syruping and bottling are performed automatically, by means of cams, &c., as the cylinder revolves. One attendant is all that is required to place the bottles and corks in their place, as each mouthpiece in turn comes round to the front. As the bottle passes round it first receives its charge of syrup from a glass pump; it then receives the aërated water, and allows the atmospheric air to escape in a manner similar to that accomplished by hand, but with all the accuracy and regularity of well-fitted machinery. The cork is then driven down—all by automatic action—and by the time the bottle has nearly completed its revolution round the cylinder it is ready to be delivered, by a self-acting guard, on to an endless band, which carries it to the wirers. It will thus be seen that the whole process of syruping, filling, and corking is reduced, as far as labour goes, to putting the bottle and the cork into suitable rests in the machine as it passes round. The speed of working is practically limited by the rate at which the attendant can supply the bottles and corks. In practice it is found that with a day or two's experience a youth can put in from 120 to 140 dozen an hour, and the machine is regulated accordingly. It is easy, however, to adjust the machine to turn out any smaller quantity, by throwing one or more of the mouthpieces out of work. This is often done when there are not wirers enough at hand to wire the whole out-put of the machine, or when the pumps will not supply the aërated water fast enough. The whole of the machine is driven by a single belt, and the power required is very small, probably about half-horse power. From the experience of those who have given the machine a somewhat lengthened trial, it is plain that it is easily understood by the attendants, and very seldom requires any special attention, beyond providing for the wear and tear of a machine which is getting through a vast amount of work.

It was first introduced to the trade, in England, in 1878. Some machines, made at Mr. Macdonell's works, at Newry, were set to work in one or two important factories, and soon afterwards the manufacture was placed in the hands of Hayward Tyler and Co., 84, Whitecross-street, London, E.C. The advantages of the system were evidently so great, that although it was brought out at first in an incomplete form, it was speedily adopted by the most intelligent and enterprising among the larger manufacturers. The machines can be depended on with entire confidence, both for simplicity and safety of working, and for the quality of their product, as may be seen by the reports of the distinguished firms who habitually use them.

The Macdonell Bottlers were at first only made in a form suited for large factories—each machine being capable of filling 160 dozen bottles in an hour. The success of these machines, of which a large number are at work, induced Hayward, Tyler, and Co. to bring out a size to fill 120 dozen an hour, and later, in order that the advantages of the system might be available for all classes of factories, they have introduced a machine, at very moderate price, to fill any quantity up to 60 or 70 dozen an hour, worked by one boy or girl.

In the larger machines, the bottles, as they are being filled, revolve around a central cylinder, several bottles being filled at the same time. In the smaller machines, the bottle is stationary as in an ordinary rack. It requires only to be put into its place by the operator, and is passed to the wirer by the machine itself without further trouble. These machines are all of great strength; they work perfectly steadily, and almost noiselessly; they occupy little room, and will run for years without repairs.

For the benefit of those who have not seen the machine at work, I will explain what the process is.

The attendant sits or stands in front, with the empty bottles at hand on one side and the corks on the other. With one hand he places the bottle on the bottle-rest, and with the other he places the cork in the mouth-piece. This is all he has to do; the bottle is held in its place by the machine itself, the cork-plunger descends and drives the cork into the tube. The bottle is then partly filled, then snifted, then completely filled, finally snifted, and the cork driven home. The bottle is released, and gently pushed off down a shoot to the wirer, all by the machine itself, without any further attention of the attendant, who has only to get his next bottle and cork ready to be put into place.

If syrup goods are being filled, the syruping process is also performed by the machine at the same time, so that the bottle is delivered, filled, and corked without any trouble at all.

With the May Davis Bottling Machine the above object is accomplished by hand. Soda water, of uniform aëration and superior to that to be obtained by any other method, is said to be produced with a pressure of from 65 to 80 lbs. in the cylinder, and all other aërated waters and beverages at proportionate reductions from the old standards. Beers, wines, or any sweetened or frothy liquors, may be passed through the cylinder, and bottled with facility.

The principle of the machine will be readily understood. The neck of the bottle being placed in the india-rubber cup, ready for filling, as in the ordinary rack-bottling machine, a tube is pulled down, by a lever, to the bottom of the bottle, a little additional pressure opening a valve admitting the liquid to the tube, and thence to the bottle. An automatic adjustable valve allows the escape of the air and superfluous gas from the bottle. By a simple lever movement the bottle is shifted from the filling to the corking position. Being filled from the bottom, the atmospheric air which the bottle contains is at once lifted to the top or neck, and is the first to be expelled, instead of being mixed up with the gas and water as hitherto. The whole process is quicker than that by the ordinary rack, as the bottle fills very rapidly and quietly. The machine is adapted for bottles of any size.

A prominent objection to rack-bottling, namely, the presence of cork dust driven into the bottle at the time of corking, is removed by an arrangement for washing the cork-cone or thimble, and the bottom of the incoming cork. The figure of this machine will be found at p. 53.

The process of wiring, by which the corks are secured, has hitherto been done by manual labour. Generally the wire, which is tinned iron, to prevent rusting, is cut into suitable lengths of about 10 or 12 inches. As these waters are bottled under a pressure of from 30 to 50 lbs. per square inch, the cork, when secured by wiring, is forced outwards, causing the wire to cut into the corks; to prevent this, which is not only unsightly, but frequently leads to leakages, some manufacturers place a piece of hard wood on the top of the cork, through which the wire cannot be forced. Some bottles are on the table with and without this addition, so that you may judge for yourselves of the superior appearance of the bottles where the wood disc is used. I am surprised that this is not more generally used; the pressure on the cork is uniform, and the non-yielding of the cork prevents leakage.

Mr. Howard, of the firm of Hayward Tyler and Co., has produced a machine by which the wiring can be accomplished by mechanical means entirely. Instead of using a single wire cut into lengths, as usual, he uses four parallel wires, each of which is continuous, one passes on each side of the neck, and the other two pass over the cork. They are

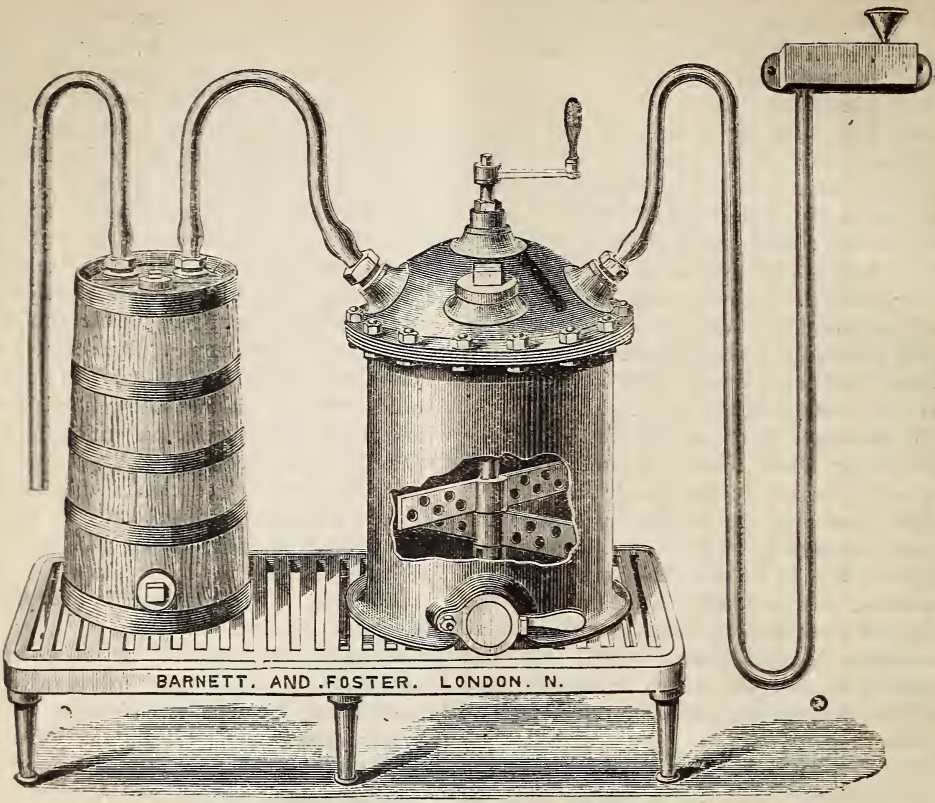


FIG. 12.—GENERATOR AND PURIFIER.

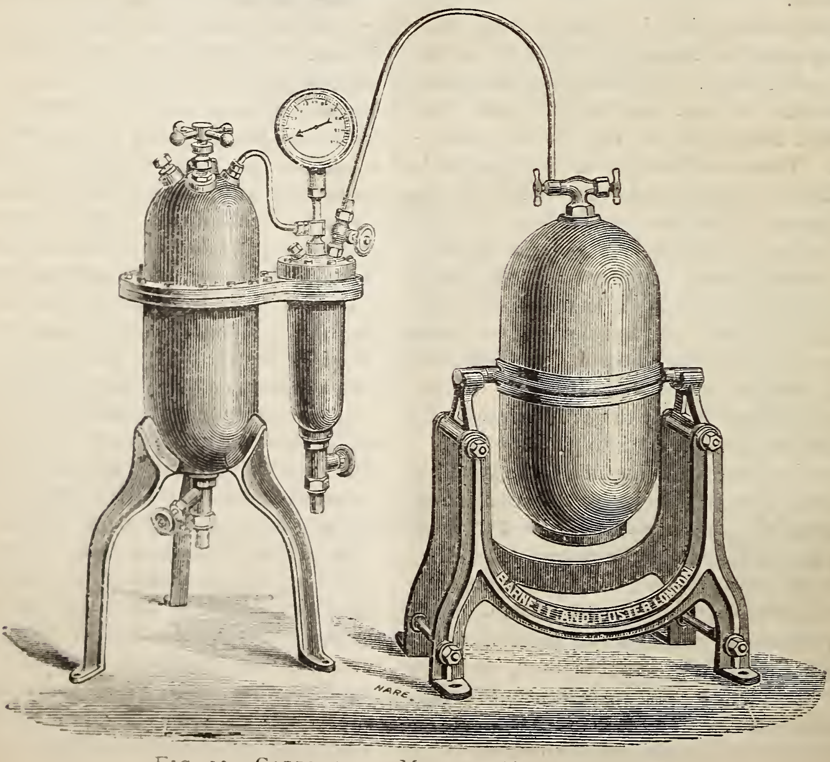


FIG. 13.—CARBONATING MACHINE (AMERICAN METHOD).

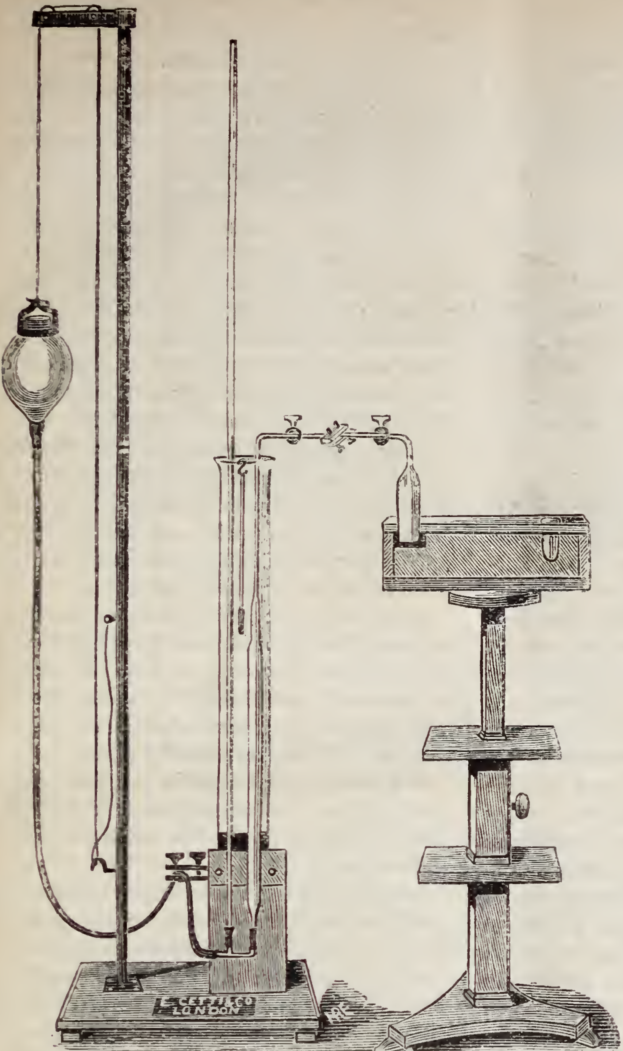


FIG. 14.—FRANKLAND'S WATER ANALYSIS APPARATUS.

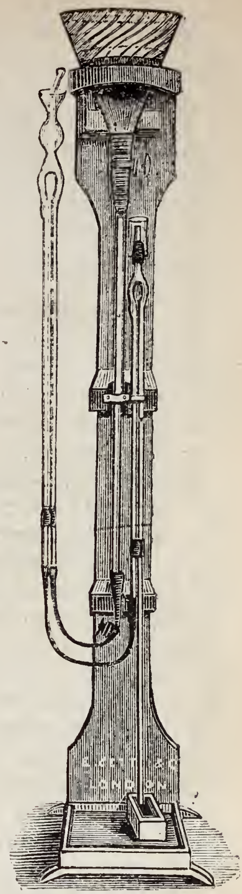


FIG. 15.—SPRENGEL'S MERCURIAL AIR PUMP.

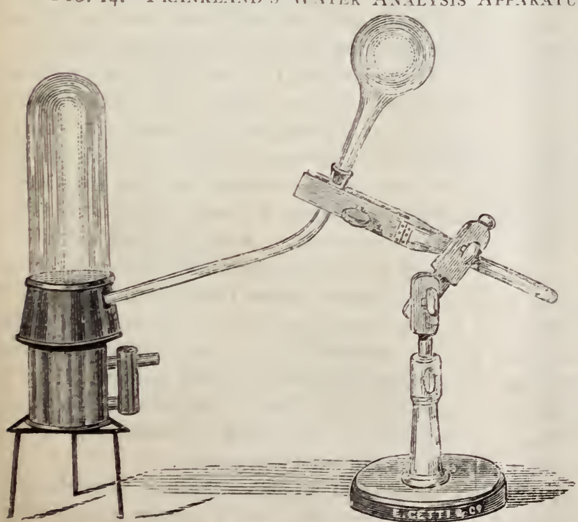


FIG. 16.—BISCHOF'S APPARATUS FOR EVAPORATING WATER.

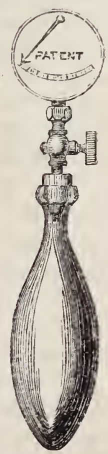


FIG. 17.—TESTING GAUGE.

twisted at each side, and cut off by a mechanical arrangement, leaving the necessary loop for untwisting by hand when the bottle is to be opened. Specimens of bottling wire are here, and also a few bottles wired by the old and more usual method, and by the exquisite arrangement of Mr. Howard.

A simple form of mechanical arrangement for holding the bottle whilst wiring, has been some time in use. The illustration will explain itself. Formerly, the workman held the bottle between his knees, without any means being adopted for securing the cork in its place during the operation. I will ask my friend Mr. Dowell if he will kindly show us the operation of wiring.

Carbonic Acid.—Fig. 12 (page 48) shows the generator and washer. The usual source of this gas is whiting, or marble, which are well known forms of calcic carbonate. The carbonates of the alkalies, or other alkaline earths, are not so suitable, partly from their greater cost, as in the case of soda, potash, and magnesia, and the poisonous qualities of the resulting salts where strontia, baryta, &c., are used. However carefully a manufacturer may carry out the various operations of his business, his labour will be in vain for the production of good palatable waters, unless particular attention is paid to the condition of his whiting, or other source of carbonic acid.

The native forms of calcic carbonate do not yield pure carbonic acid; the gas is liable to contamination from the organic matter present in the carbonates, which is much greater in whiting and chalk than the harder forms, such as marble; it is generally considered that by washing these impurities can be removed. When the gas is generated from an impure carbonate, it is by no means so easy to remove the impurities carried over with the gas into the holder or purifier.

Whiting should be kept in a dry, airy shed, protected from dust, and beyond the reach of gaseous emanations or odours; however good the whiting may be when received, it will rapidly deteriorate if stored in a damp, musty corner of the factory.

The quality of a water depends so much on the purity of the gas, that I cannot help expressing surprise at the little attention which has been directed to this part of the manufacture, until quite recently. By allowing the gas generated in the ordinary way to bubble slowly through a solution of potassic permanganate, or any other powerful oxidising agent, these impurities can be most effectually removed without in any way deteriorating the gas by exchange of contaminations.

The impurities which pass over with the gas from the generator, when sulphuric acid is employed, are sulphurous acid, sulphuretted hydrogen, carburetted hydrogen, nitrogen and sulphur compounds, together with the usual impurities given off by commercial sulphuric acid. It is generally considered that by washing the gas twice the impurities can be removed; if a saturated solution of sodic carbonate be used in the second washing, no doubt many of the volatile acid products can be removed, by their uniting with the soda, and liberating their equivalents of CO_2.

From repeated experiments, I am convinced that the only method for effectually removing these products is by the use of oxidising agents, for when the impurities are taken up by the wash-water, we simply drive them out again when fresh gas is passed through.

A perfectly pure whiting can be obtained by exposing freshly burnt and recently slaked lime to the air for a few days, or until its causticity is removed, care being taken that the air is fairly good. With pure sulphuric acid, the gas thus obtained is exceptionally pure.

We must not lose sight of the fact that the acids employed to decompose our carbonates also contribute to the list of impurities met with in the gas.

I may note here a few improvements which have been made in preparing and purifying the gas. A simple precaution which prevents air getting mixed with the gas is always to keep the generator, and connections with the washer and gas holder, full of the gas. In attempting to get rid of admixed air, manufacturers generally incur a large and needless waste of gas, without securing the desired object.

After charging the generator, the gas should be liberated very slowly, and a little collected into a gas pipette, which is transferred to a gas jar containing strong caustic potash solution. As soon as the sample of gas examined is entirely absorbed, we may rest contented that no air is present. A simpler plan would be to attach a flexible tube to the generator or gas holder, and to allow the gas to pass into an inverted test tube filled with mercury, standing in a mercurial trough; a few drops of a strong solution of caustic potash are passed up the tube and agitated; a minute bubble of unabsorbed gas will show when the gas may be considered sufficiently pure.

Instead of allowing the gas to rush in and out of the washer in a stream, arrangements are now in use for breaking the current of gas, and making it pass through a series of perforated diaphragms. The lower part of the washer contains cooled well-boiled water; the upper part is packed with granulated marble, or, preferably, with crystals of sodic carbonate. The gas thus washed is sufficiently pure for almost any purpose.

Carbonic acid is readily soluble in water, and if present in sufficient quantity, imparts to it a refreshing and slightly exhilarating effect. A very large quantity of water, simply aërated with the gas, is now consumed as a refreshing beverage, and with some people is regarded as an indispensable article for the dinner table. As a beverage for children in warm weather it is eminently appropriate, and is very much appreciated when mixed with a little syrup of lemon or ginger. Fig. 13 (page 48) shows a form of carbonating machine on the American system. These cylinders are now charged from an ordinary machine.

The solubility of the gas in water is effected by a great variety of circumstances, those of which we have the greatest experience being temperature and pressure ; others, which are now beginning to assert their importance, are the presence of other gases and liquids, and mineral salts, sugar, &c.

The principal thing to guard against in purchasing whiting is an abnormal amount of strongly moisture. It ought not to blacken when heated, nor destroy the colour of a dilute solution of permanganate of potash too rapidly.

To a manufacturer it is a matter of importance to know how to estimate the quantity of carbonic acid in a sample of water. Generally, the little arrangement known as the testing gauge, is used. We must not forget that pressure alone is no proof of the quality of the water. By means of a kind of hollow corkscrew, which has a hole a little way from the bottom, we allow the gas when the tap is opened to act upon an ordinary but delicate Bourdon gauge, the pressure being shown on the dial plate. The action of the arrangement can be easily shown. It may be used as a check against the bottlers, or to compare the products of different manufacturers. (Fig. 17, page 49).

The carbonic acid in a bottle of mineral water, such as soda, potash, seltzer, &c., is partly combined and partly free; we may estimate each portion separately. A large flask containing about 250 c.c. of strong solution of ammonia is fitted with a cork having two perforations; through one of these is passed a bent tube, reaching nearly to the bottom, and to the bent end is attached a flexible tube, connected to a cork borer, with a few holes drilled a little distance from the end. A tube containing fragments of glass, moistened with ammonia, is inserted into the other perforation, so as to catch every trace of carbonic acid. The borer should be inserted so that the holes are just below the cork ; the gas passes into the ammonia, its evolution is assisted by shaking the bottle, and, towards the end, by heating in a water bath until no more gas passes over. The contents of the flask and absorption tube are precipitated with calcic chloride, from which the amount of CO_2 can be estimated.

The combined carbonic acid is best obtained by evaporating to dryness the contents of the bottle, and decomposing the residue in one of the little forms of apparatus used for this purpose. Messrs. How and Co. have kindly sent a variety of these. The calcinimeter is an arrangement for measuring instead of weighing the gas. We are indebted to Mr. Cetti for the loan of this apparatus. A slight modification of this instrument, so as to measure larger volumes of gas, ought to be invaluable to a manufacturerer of aërated waters.

To make a complete examination of the gases contained in a bottle of aërated water, necessitates the use of eudiometric methods. The apparatus designed by Dr. Frankland for the analysis of water residues by the combustion process is eminently adapted for this purpose. (Fig. 14, page 49.)

The gas is allowed to escape into the laboratory tube, which contains a little saturated solution of caustic potash ; more gas is passed up as the absorption goes on. Any gases remaining unabsorbed can be passed over into the measuring tube, and again transferred to the laboratory tube; a few drops of a strong solution of pyrogallic are passed up, and the tube slightly shaken ; a dark coloration being produced, shows the presence of oxygen ; the gas remaining unabsorbed may be taken as nitrogen, which may be again passed over into the measuring tube, its volume noted, that of the oxygen being obtained by difference.

A good description of this apparatus, and the details necessary to be carried out, can be found in Frankland's "Water Analysis," or Sutton's "Volumetric Analysis." Mr. Cetti has shown us a convenient form of Sprengel pump for use with this apparatus (Fig. 15, page 49).

A word or two may be necessary respecting sulphuric acid ; on no account should any other

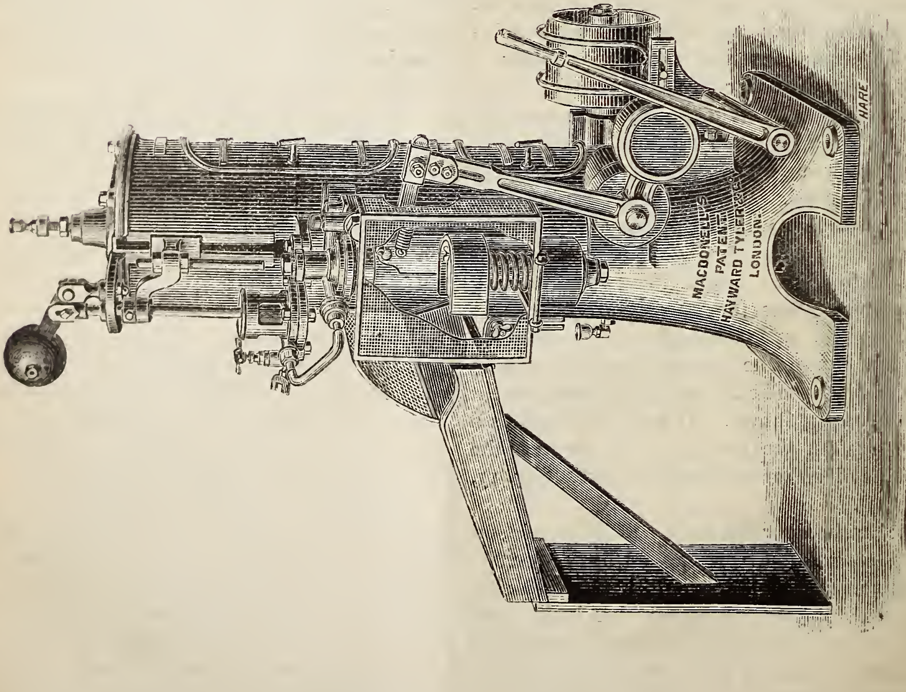


FIG. 18.—MACDONNELL MACHINE.

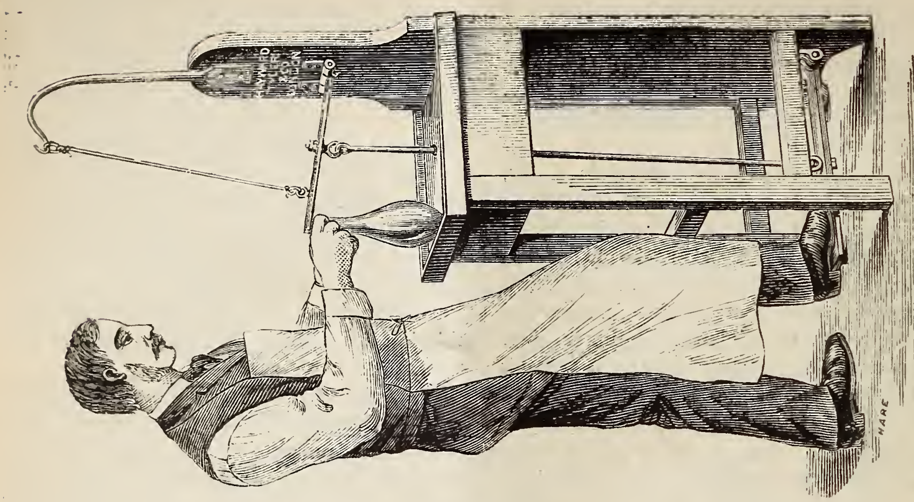


FIG. 19.—WIRING MACHINE.

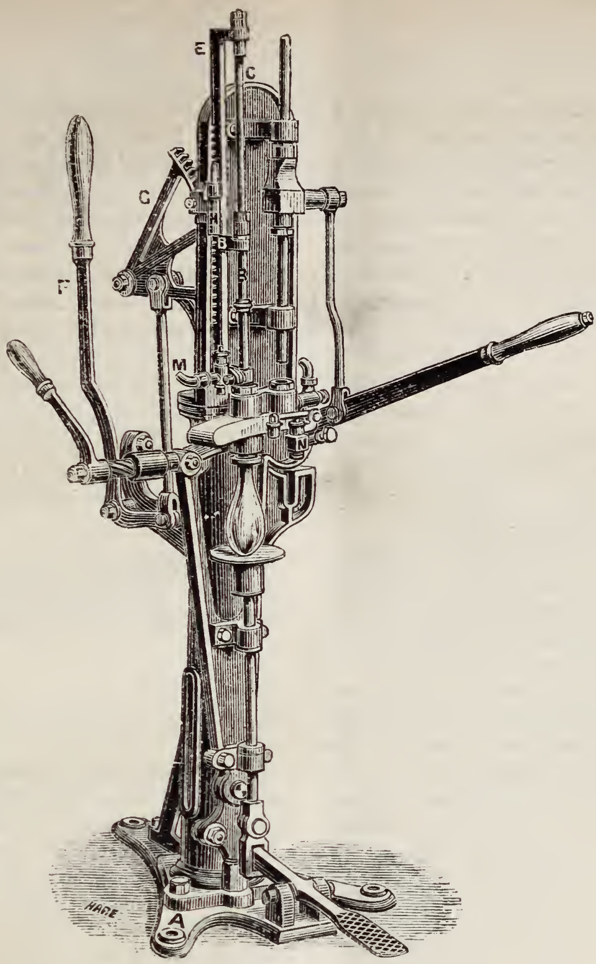


Fig. 20.—The May-Davis Bottler.

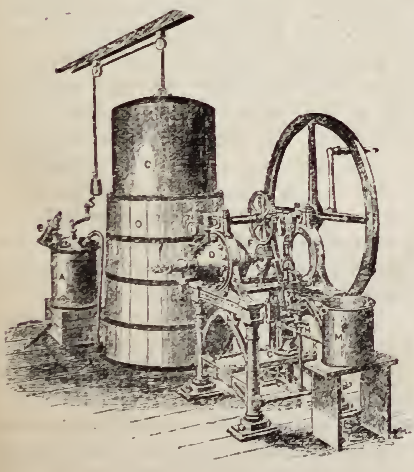


Fig. 21.—Improved Bramah Machine.

acid be employed but the white or colourless acid. If purchased according to density, care should be taken that we are not purchasing a dilute acid, containing fixed sulphates to give it the appearance of being what it is not. A few drops heated on a piece of platinum foil should leave no residuum.

Care should be taken to prevent pieces of straw, cork, &c., falling into the acid; this can hardly be avoided in pouring from a carboy, but a luxury unknown a few years ago is now in use in most factories for decanting the acid, thus avoiding contamination, waste, and danger from spilling. The American syphon pump is the best for this purpose.

The solubility of salts, preparation of syrups, tinctures, &c., are most important subjects to the manufacturer of waters, but are beyond the scope of the paper, as regards time. These subjects may be dealt with on a future occasion, and also the method of compounding artificial mineral waters from the result of analysis. No one has given so much attention to this branch of the business as the late Mr. William Hooper, of Pall-mall East; the waters manufactured by the present firm have earned a well deserved distinction. It is no exaggeration to state that we have at present no scientific mineral water maker; this has been accounted for by stating that the demand for this class of waters has given place to others. I believe it is due to the fact that we want an enterprising spirit to take up the manufacture of the new mineral waters which have been more recently introduced, in the same way as Mr. Hooper took up the manufacture of the numerous German spas, and which, in nearly every case, he successfully accomplished.

The manufacture of lithia water is a striking illustration to the point. An eminent physician, I believe Dr. Garrod, had written a book on gout, and suggested lithia as a remedy, to be administered as an effervescent beverage. I was sent by Mr. Hooper to inform Dr. Garrod that he would be very pleased to prepare this, and to gain any information I could on the subject. There was absolutely nothing to start upon; carbonate of lithia could only be had in small quantities, and at the price of about 24s. per ounce, and was scarcely known. In spite of these obstacles, lithia water was manufactured, and introduced to the medical profession within four days after the publication of Dr. Garrod's book. The demand for lithia water is now very great, and the carbonate can be had, at the present time, for about 8s. per pound. Our worthy chairman can inform you that this is not to be taken as an indication of our becoming more gouty as a race, but that the water is found to be a very beneficial beverage. A great variety of mineral waters are exhibited by Hooper and Co., the excellence of whose manufacture, especially that of seltzer water, is too well known to require any further remarks from me.

In conclusion, I wish to express my obligation to those firms who have so liberally supplied the information which has been sought for. As manufacturers of waters, I would especially mention Messrs. Hooper and Co., Mr. James Packham, Messrs. Barrett and Elers, and Messrs. Pitt and Co. As manufacturers of machinery I am particularly indebted to Messrs. Hayward Tyler and Co., and to Messrs. Barnett and Foster, Messrs. Dows, Clark, and Co., Mr. Davenport, and Mr. H. Favarger.

Mr. Favarger had promised to send for exhibition the well known and ingenious system known as Mondollet's system, but in a letter which I received from him, a week or so ago, he expressed his regret that, through having to leave England for some time, he would be unable to exhibit his machine.

I am perfectly conscious of many omissions in reference to several other useful appliances. I have endeavoured in this paper to intoodnce technical details, only where improvements have been made, and to generalise the information so as to represent the progress which has been made in appliances and processes, in order to keep pace with this rapidly increasing and very important branch of industry.

[Messrs. Hayward Tyler and Co., and Messrs. Barnett and Foster, have kindly lent the blocks which have been used to illustrate this paper.]

DISCUSSION.

The CHAIRMAN said this was quite a model paper, from the great care and conscientiousness with which it was constructed; and to all who, like himself, were interested in the cause of temperance, it must be singularly interesting, inasmuch as it showed that there was an important rivalry with those drinks which they regarded as injurious to mankind, and a strong movement in favour of those which they considered simple in their character, useful, and free from all danger. It occurred to him that the whole of the paper and the apparatus in the room showed that the quantity of aërated drinks consumed must be very large; he had no conception of the number of patents which had been mentioned in connection with these beverages, and the way in which they were preserved; and was altogether surprised at the extent of the business which was being done. The public ought to be grateful to those who were engaged in this manufacture, not only for their skill, but for the attention which they paid to the purity of the water they used. He recollected quite well having tasted some bottled water, which was strongly impregnated with paraffin, and being quite unable to account for it, since he was sure it could not have been introduced intentionally. They had now heard that it might have been introduced by the chalk from which the carbonic acid was produced having come in contact with the vapour of paraffin in the shop, a very shrewd observation, which did Mr. Warren great credit. He was also pleased to find that care was being used with regard to the sulphuric acid, for physicians knew long ago that this was a common source of impurity in these waters. With regard to mineral waters proper, no doubt they could be made in this country in great perfection, and it would be quite unnecessary to import the foreign mineral waters. All that was required could be attained by artificial means, and the more so as doctors were now coming to the view that perhaps these foreign mineral waters were not of so much benefit as the journey which the patient had to take in order to get them. Perhaps they had heard of the famous letter which Dr. Arbuthnot wrote to Dean Swift when he was talking of going abroad to take the waters. He advised Swift to take the Geronster waters, because they could not be carried; by which he no doubt meant to convey that the journey to the waters which would do the Dean more good than what he drank. There were, however, some mineral waters which were considered very good, and to be of real service, and they might be manufactured in this country. It would be a great boon to members of his profession if they could feel that there was a firm of thoroughly scientific mineral water manufacturers to whom they could look for what was correct chemically in those mineral waters which they considered serviceable. It was very usual now to prescribe mineral water to be taken at table, and thus to make medicine an article of diet rather than to give drugs in a less pleasant form. Mr. Warren had refrained from going into the history of the subject, but it would be very interesting if he had done so; it dated, however, further back than the time he had named; for they were indebted for aërated waters to the illustrious discoverer of oxygen, Dr. Priestley. Priestley first manufactured waters with gas under pressure, and the possibility of doing so was first publicly demonstrated by him before a meeting of the College of Physicians in London. At the time, it was thought that the discovery would have very important results in the cure of disease; and what was called the antiphlogistic treatment—giving effervescing drinks in fevers, sprang from that demonstration of Dr. Priestley's. The administration of effervescing medicines in the sick room had now almost passed away, as it was found much more convenient to give them in the form of drink. He was sure all men of science who were present would join with him in thanking Mr. Warren for his valuable and interesting paper.

Mr. Maignen said Mr. Warren had referred to the mistake people made with regard to filters, in not taking care to cleanse them, and one particular filter had been selected for praise. He hoped he might be allowed to say that his invention, the *filtre rapide*, which obtained the gold medal at the Fisheries Exhibition, was in use in several soda-water manufactories. One difficulty with regard to sweetened and flavoured water, was that the syrups were not always bright, and he had devised a filter for the especial purpose of removing this difficulty.

Mr. William Botly said it was very fortunate they had Dr. Richardson in the chair on this occasion, as he was an authority on the subject. Very few of the aërated waters now made seemed to possess the delicate flavour which he remembered when simpler materials were used. He agreed with the Chairman that it was very desirable that the manufacture should be carried out on thoroughly scientific principles, and also with what he said about the beneficial effects of travel. He thought it very likely that in the case of Bath, Cheltenham, Harrogate, Tunbridge Wells, and other places, artificially prepared waters would not have the same effect as the natural springs, because the patient would not have the benefit of the change of scene, society, and travel.

Mr. Lloyd (of Messrs. Hayward Tyler and Co.) said it might be interesting to give some figures showing the enormous increase in the aërated water trade. In 1815, his firm made the first machine, which would produce about 150 dozen per day of ten hours. At the present time, or last year, say, the aggregate machines sold would produce three million bottles of soda water per day; and the large machines now made, instead of producing 150 dozen per day, would produce 3,000 dozen. He knew one firm which turned out 17,000 dozen per day. One remark of Mr. Warren's might perhaps be misunderstood, when he said that the Macdonnel machine was cumbersome, and only suited for a large manufactory. The largest machines might be so described, but machines were made suitable for the smallest manufactory, and the user of these small machines would find that water bottled by it would contain a greater pressure in proportion to the pressure in his cylinder than that bottled by hand; it would be all of uniform quality, and the corks would be all driven to the same level.

Mr. Bush thought it was a pity that Mr. Warren had not given some sketch of the history of this trade; and mentioned one or two facts, showing the enormous increase which had taken place. Since the Great Exhibition of 1851, great improvements had been made in the machinery employed, and also in the introduction of essences which made the drinks more palatable, and gave a greater variety than when there was nothing but soda-water and lemonade. In 1851, his firm first got the idea of introducing these essences, and he contended they had conferred a great boon on the temperance body in giving them some hing more palatable than tea, coffee, or soda-water.

Mr. Forster said the great object to be aimed at was purity in the product, and that could only be attained by perfection in the machinery. The true test of perfection was the amount of carbonic acid they could get the water to take up. Several means had been devised for this purpose. Some used distilled water, and others boiled the water, whilst others again filtered it; and he might say that so much was the trade developed that there was as much competition amongst the makers of apparatus as amongst the manufacturers of aërated waters themselves. His firm had a machine for extracting the air from water, thus allowing more room for the carbonic acid, and they watched most narrowly every way by which metallic contamination was possible, and endeavoured to avoid it. For this purpose they had done away with the mechanical agitator, and introduced the perforated pipe. The gas and water were not forced through the perforations, which would mean work and friction, but it was raised to a sufficient height, and then falling by gravitation was broken up into spray, thus effecting the necessary admixture. His screw-necked stopper was not developed for the purpose of aërated waters, though it was applicable to them, but for malt liquors, but he might inform the Chairman that by his process for removing the air he could produce a malt liquor without alcohol, but still retaining its beneficial properties. He found that when the atmospheric air was removed from malt liquor, the alcohol, being mixed with air, came away with it to a great extent, and the beer was rendered non-intoxicating. Having done that, he charged it with carbonic acid, which made the beer fit for immediate consumption, and prevented after fermentation. The reader of the paper had perhaps hardly done justice to the revolution in the trade caused by the patent stoppers, and also by the introduction of "splits," which enabled manufacfacturers to work all the year round, whereas formerly they were almost stopped in the winter. He could only hope that publicans would see it to their interest to reduce the price which they charged to the public. He did not suppose there was any trade so heavily handicapped as the aërated water trade; manufacturers only got a fair living profit, but the publicans, hotel keepers, and chemists who retailed the waters made 400 or 500 per cent.; 1s. 3d. per dozen was considered a fair price for the maker to charge the publican, but the seller put a price of 4d. or 6d. a bottle upon it; and while that was the case, there was no wonder that the respectable working man preferred a glass of beer, or a "split," with a dash of bitter in it. If the retail prices were reduced, it would do more than anything else to assist the temperance movement, and at the same time both aërated water makers and machinists would benefit by it.

Mr. H. Trueman Wood, the Secretary, read a letter received from Messrs. Pitt, of 28, Wharf-road, City-road, saying that on Tuesday, Wednesday, and Friday, in next week, between the hours 3 and 4 p.m., they would be happy to show any member of the Society, or any one interested in the subject (not connected with the trade) over their factory. (The factory is about five minutes' walk from the Agricultural-hall.) He also wished to draw the attention of aërated water machinery manufacturers to the Exhibition to be held next year, at South Kensington, of matters connected with Health, Food, and Drink. There would be a special section for aërated waters, and it struck him that it would be very desirable for some of the large makers of machinery to make early application, and set up a complete plant there, so that the public might have an opportunity of seeing the process and trying the results.

The Chairman then formally moved a vote of thanks to Mr. Warren, which was carried unanimously, and the proceedings concluded by a general examination of the machinery exhibited, and the sampling of the various beverages.

CATALOGUE OF THE EXHIBITION OF COOKING APPARATUS AND APPLIANCES.

1. Anglo-American Tin-stamping Company, Stourport.
   Enamelled iron ware, plain and printed in colours.

2. Billing & Co, Smart's - buildings, W.C. :—
   "Sun Dial" gas cooking stoves, with movable copper reflector for use as a combined heating and cooking stove.
   Cooking utensils for use with stove.

3. Brown & Green, Limited, 69-71, Finsbury-pavement, E.C :—
   Patent smoke-consuming kitchener, with self-acting damper, and an arrangement for supplying fuel at the bottom of the fire.
   "Gem" portable cooking stove.
   Patent smoke.consuming cottage kitchener.
   Special cooking utensils for kitcheners.

4. W. S. Burton, 88, Oxford-street, W :—
   Oven for roasting fish, as recommended by Sir Henry Thompson.
   Egg cooker, hot-water cooking pan.
   Fish saucepans and strainers, &c.

5. Charles Churchill & Company, 21, Cross-street, Finsbury, E.C. : —
   American cake mixer.
   Combined sausage stuffer, fruit and jelly press.
   "Enterprise" and "Gem" cherry-stoners.
   American ice chisel.
   "Eureka" and "Triumph" egg-beaters.
   Improved potato parer.

"Gold Medal" and "Lightning" apple parers.
"Climax" apple corer and slicer.
Smith's patent nutmeg grater.
Houchin's patent revolving grater.
"Enterprise" meat chopper.
Various forms of lemon squeezers, &c.

6. T. and C. CLARK & COMPANY, Shakespeare Foundry, Wolverhampton :—

Cooking utensils of various kinds, tinned inside, or lined with patent non-poisonous enamel.
Patent enamelled wrought iron ware.
Patent "Digester" cooking pot, with valve in the lid for the escape of steam.

7. T. J. CONSTANTINE, 61, Fleet-street, E.C. :—

Patent "Treasure" cooking range.
Patent "Treasure" cooking pots.

8. H. & C. DAVIS & COMPANY, 200, Camberwell-road, S.E. :—

"Combination" metropolitan family gas kitchener, fitted with boiler for self-supply, and adapted for heating with either coals or asbestos fire.
Metropolitan gas kitchener.

9. DEAN & COMPANY, 46, King William-street, E.C. :—

Fletcher's patent asbestos stove for heating or roasting.
Fletcher's patent gas cooking range, with reversible burners for grilling.
Fletcher's patent gas oven.
Fletcher's patent gas attachment for fire ovens.
Fletcher's patent quick grill.
Fletcher's patent quick coffee roaster.
Fletcher's patent ventilated hot-air oven, with radial burners.
Newport's patent "Gem" mixer or egg beater.
Dolby's beef tea extractor.
Captain Warren's cooking pot.
Parisian potato masher.
Brawn press, &c.

10. GENERAL GAS-HEATING & LIGHTING APPARATUS COMPANY, 74, Strand, W.C. :—

Leoni's "Nonpareil" gas kitcheners, coated by an inoxidation process, to prevent rust.
Patent incandescent radiant gas fire, for heating or cooking purposes.

11. GRIFFITHS & BROWETT, Bradford-street, Birmingham. :—

Loysel's patent hydrostatic urn, for the table.
Bevan and Fleming's patent thermoterion or nursery heat retainer, for keeping milk, &c., warm.
Carey's patent "Hecla" coffee pot.
Steam egg boiler, for table use.
Dolby's beef-tea extractor.
Muller's patent domestic coffee roaster.

12. GROOM & COMPANY, Liquorpond-street, E.C. :—

Registered milk saucepan.
Bower's patent potato steamer, and fish or poultry steamer.

13. G. KENT, 199, High Holborn, W.C. :—

Kent's patent cooking appliances.
Patent cabinet ice safe.
No. 3 filter.
Beef-tea cooker.
Universal press.
Thermoterion.
Masticator.
No. 2 mincer, with R. Hopper's egg beater and bowl.
No. 2 whisk.
Miniature ice preserver.
Miniature ice maker.
Four-quart salt extractor.
Lemon squeezer.
Apple parer.
Lemon parer.
Potato parer.
Coffee roaster
Coffee-mill.
Wheat-mill.
Cocoa-mill.
Milk saver.
No. 06 minute churn.
No. 1 soup strainer.
Jelly strainer.
Marble bread cutter.
Pudding mixer.
No. 1 potato masher.
Marmalade cutter.
Bean cutter.
Horizontal freezer (2 quarts).
Patent rotary knife cleaner.

14. J. F. LOVELOCK, Broadway Works, George-street, Hackney, E. :—

Improved coffee-mill.

Improved sausage-making and general mincing machine.

15. NEWTON, CHAMBERS & COMPANY, Thorncliffe Ironworks, near Sheffield :—

Improved "Thorncliffe" patent close and open fire cooking range.
The "Economist" patent portable open and close fire range.

16. NYE & COMPANY, 143, Oxford-street, W :—

Improved press for brawn, tongue, &c.
Improved bread-making machine for household use.
Grating-mill for bread crumbs, &c.
Bread-slicing machine.
Egg-beating and mixing machine.
Patent domestic wheat-mill.
Vegetable-slicing machine.
Patent mill for grinding cocoa nibs, &c.
Patent small mincer or masticator.
Patent coffee-mill, sausage machine, &c.

17. PAUL PFLEIDERER, 37, Farringdon-street, E.C.:—

Patent "Universal" kneading and mixing machine.
Vermicelli and macaroni press for household use.

18. PISTON FREEZING MACHINE & ICE COMPANY, 314, Oxford-street, W.:—

"Self-Feeding" Cabinet Refrigerator or Ice Safe, for use with block or rough ice.
Ash's kaffee-kanne, or table urn for making coffee.
Patent Norwegian self-acting cooking apparatus, or travellers' kitchen.
Ash's patent "Piston" freezing machine.

19. H. RIOTTE, 14½, Swallow-street, W. :—

Lager beer cabinet and cooler, with aërating pump.

20. SELIG, SONNENTHAL & COMPANY, 85, Queen Victoria-street, E.C. :—

Patent "Victoria" mincing machine.
Patent chopping machine.

21. SIDDAWAY & SONS, West Bromwich: —

"The Paragon" gas cooking stove, double-cased and lined with non-conductor.

22. SILBER LIGHT COMPANY, 47, Lower Whitecross-street, E.C. :—

Silber's patent "Miratus" petroleum cooking stove, with fittings.

23. SPONG & COMPANY, 226, High Holborn, W.C :—

Mincing and slicing machines.
Apple corer and cutting machine.
Grinding mills.
Bread and cake slicing machine.
"Lightning" egg cutter.
Lemon squeezer, toasting fork, &c.

24. A. TOZER, 53, Rupert-street, Haymarket, S.W :—

Universal "Muller," lined with earthenware, for keeping tea and coffee pure and free from any metallic flavour.

25. WOODCOCK & HARDY, Eldon-place, Sheffield :—

Tea pot and tea urn fitted with registered strainers

26. JOHN WRIGHT & COMPANY, 155A, Upper Thames-street, E.C. :—

The "Eureka" and other gas cooking stoves.
Improved steamer cooking pot.

Miscellaneous.

TURIN EXHIBITION, 1884.

The preparations for the National Industrial Exhibition, to be held in Turin next spring, are proceeding fast. A large number of intending exhibitors have sent in applications, and it is anticipated that the show will prove how great has been the national progress since the first Italian Exhibition held in Florence in 1861. As might have been expected, there are many exhibitors of furniture, some of them extensive producers.

After the lapse of 22 years, a remarkable development it is expected will be observed, not only in the chemical, and textile, and other manufactures, but in the mechanical and engineering industries, then in their infancy, but which have since increased beyond all recognition. Machinery of various kinds is said to be rapidly approaching in excellence that of Northern Europe; railway carriages and plant will assume an important position; telegraphy and electrical apparatus of various kinds will be likewise conspicuous. Food products will be largely represented, one-third of the

1,900 exhibits being devoted to wine. Next in order will be oil, butter and cheese, but apparently the produce of the soil has attracted comparatively few exhibitors; and under the heads of horses, cattle, and poultry, the numbers amount only to about 55. The hope has been expressed that Italy will improve the natural advantages of climate she possesses in so high a degree by paying more attention to her agricultural interests, and reforming the very absolute institution of the *Mezzadria*, which regulates the relation between the owner of the soil and the actual cultivator, so as to render it possible for the scientific farmer to control and direct the latter; for large farms, it is argued, must in our times be far preferable and more profitable than the infinitesimal subdivision of property in the hands of uneducated country people.

The most novel, and one of the most attractive features of the Exhibition will, it is said, be the Mediæval Piedmontese castle, erected on the banks of the Po, in the splendid grounds, which embrace a panorama of some 200 miles of the most glorious Alpine scenery, from the Monte Rosa to the confines of the ancient territory of Nice. In this castle and its precincts everything will be in keeping with the feudal times—the furniture, the costumes and the arms. All around are grouped the huts and humble cottages of the serfs, constituting a village of the fourteenth century, each dwelling fitted up so as to be inhabitable. The hostelry, the various artisans' and peasants' dwellings will be recognised, nor will the inhabitants themselves be wanting to give life and reality to a fairy scene, which is intended to show the manners and customs of by-gone days. Another portion of the Exhibition which is expected to be a success, is that of educational books and appliances, in which 565 exhibitors are already inscribed; scientific and literary productions have attracted other 138 exhibitors; while provident institutions and appliances, with all which is connected with public health, comfort, and security, embrace some 700 more exhibitors. When the kingdom of Italy first came into existence, excepting in the north the lower classes were uninstructed, and the rural population never dreamt of schools, and only one-third of the inhabitants were able to read.

RICE-PLANTING IN THE STRAITS SETTLEMENTS.

Consul Studer, of Singapore, says that the chief agricultural implement used by planters in the Straits Settlements is the hoe, termed in the Malay language "chankoli," and the system of planting by Europeans and natives is a very primitive one, namely, a number of coolies furnished with as many hoes. The hoes are all of the same shape, about six inches wide and eight or nine inches in length, and are nearly all made by Chinese blacksmiths, and purchased at the rate of about one shilling each. With these common hoes, the coolies do all the planting, dig ditches, make excavations, and fill the baskets that serve in lieu of wheelbarrows for removing earth, *débris*, or stones. They carry two baskets at a time, suspended from either end of a pliable stick or bar, carried across their shoulders. An effort has been made to induce the coolies to use wheelbarrows, but hitherto without success. For the removal, however, of objects too heavy for one or two men to carry any great distance, they use two-wheeled hand carts, which are large unwieldy vehicles, and on which they pull and push very heavy loads. The rice-planting natives, when planting lowland rice, have an article resembling a plough, made of very hard wood, and drawn by buffaloes. It consists of a beam, into which a sharpened broad stick of wood is inserted, the beam having simple arrangements at either end for guiding and drawing the implement. With this, after the rice field is covered and watered, they stir and loosen the mud, then women come with bundles of rice settings, grown in seed-beds near their houses, and, armed with a sharp stick, plant a few settings to a hill, the hills being about one foot apart each way. When the crop is ripe, they do not use scythes, but with a very small sickle they cut it about two-thirds the length of the stalk up from the ground, and carry it to a shed under cover. The Chinese and Siamese, instead of threshing it, tread it with buffaloes on hard clay ground. This process separates the unhulled rice, called "paddy," from the stacks. To remove the hulls from the rice, and polish the kernels, the paddy is taken to mills or hand-machines, the latter being clumsy, hard to work, and very primitive in their construction. The Malays, not having buffaloes, separate the paddy from the stalks by hand, and, as a rule, they plant no more than they need for their own use. For the cultivation of upland rice the natives use the common hoe, breaking the soil as deeply as possible, and they transplant their settings when the rainy season commences. This species of rice is not so yielding, the kernels being smaller than is found in marsh paddy. The hill rice is of excellent quality, but only sufficient for home consumption is planted. Consul Studer says, that there appears to be a rooted objection on the part of the planters to use ploughs, as they incline to the belief that it would be impossible to break up with them land which was covered with stumps and lubricate masses of large and small roots, and that they would be useless in "lallang fields," "lallang," in Malay, meaning a species of long and very tough grass, growing very thickly and luxuriantly, used chiefly for thatching roofs. Tracts of "lallang" are met with in many provinces, and each tract indicates an abandoned rice field, or a gambier or pepper plantation. Soon after cultivated land has been abandoned, "lalling" grass, especially on heavy clay soil, will spring up, and so thickly that seeds blown from trees in the jungle, or carried by birds, wil find no chance to take root.

Correspondence.

INTERNATIONAL FISHERIES EXHIBITION.

I beg leave to make a few remarks upon Mr. Trendell's admirable paper anent the "Teachings of the Fisheries Exhibition," contained in the last issue of the *Journal*. With respect to his proposed exhaustive biological survey of our territorial waters, much all but voluntary assistance might be obtained from the fishermen independently, who, for a very small consideration, would willingly save and deliver, or forward to some district station, samples, with a note as to local habitat, of the innumerable marine organisms gathered in their daily dredging and trawling operations, and which they have hitherto been accustomed to throw overboard as rubbish. Before, however, we can look to the fishermen for mportant aid in this direction, it is requisite that they should, to a certain extent, be educated in the rudiments of marine zoology. Now, the readiest means of imparting to this industrious, but relatively uneducated class, the necessary amount of zoological knowledge, is undoubtedly through the sense of sight. In this connection, I would suggest that, under Government auspices, a series of charts should be prepared for distribution among the fishermen, illustrative of every class of marine animals, and in which should be included a characteristic, though rough figure, of every known British representative of its respective class, be it fish, mollusk, worm, or crustacean.

Printed matter might be added to these charts, indicating those species of animals about which we chiefly require accurate information, concerning their distribution, spawning seasons, and other habits. Brief instructions might likewise be added as to the method in which the various species should be preserved. Fitting rewards might furthermore be offered as an encouragement to those fishermen who, in the course of the year, shall have contributed the most important collections or information to the central depôt. Through the enlistment of aid of this description from the fishing community, the Government of the United States, as Mr. Trendell has already told us, have derived much of their most important material and information concerning the habits and distribution of their own ocean fauna. The coastguard might also be advantageously ememployed as receivers and storers in the practical working of this biological survey.

The investigation of the life-histories and possible means of artificially propagating certain of the more important of our marine food fishes, is another important object of research. Already in this direction a most valuable initial experiment has been carried out during the past autumn, at the instance of the Fishery Board for Scotland, with relation to the herring. The attempts then made for the first time, to artifically fecundate and develop the eggs of the fish, were attended with the most signal success, insomuch so that the committee engaged in these experiments arrived at the opinion that the artificial hatching and turning into the sea, at a single station, of many millions of herring-fry, would be a perfectly easy task, and might, moreover, be accomplished, reckoning from the time of fecundation of the eggs until they were hatched, within so short a space as a single fortnight. As a matter of fact, the number of eggs produced by a single herring varies from 30,000 to 50,000, and these eggs are so minute that 20,000 may be deposited in a single layer upon a sheet of glass having an area of but one square foot. Whether the artificial propagation of herrings, mackerel, pilchards, and other pelagic or migratory fish, would be of practical use beyond supplying abundance of bait for attracting shorewards shoals of larger fish, is at the present moment an open question, but in the case of other sedentary or non-migratory species, which are undoubtedly becoming scarce on our own shores through over-fishing, too much importance cannot be attached to the success that has been achieved in the case of the herring. In the opinion of the committee just referred to, soles, turbot, and other valuable fish might be artificially propagated under similar conditions, and our waters restocked with their fry, if we only knew more concerning their habits; a recommendation is made by the Board for further means wherewith to carry on the work of investigations in this most desirable direction. A *sine qua non* of success in these propagating operations is the possession, close at hand, of a marine laboratory or hatchery, wherein the eggs after fecundation may be successfully developed. Fortunately one such building, belonging to the Edinburgh University, was placed temporarily at the disposal of the Scottish Fishery Board, in connection with their experiments upon the herring. If, however, these propagating operations are to be carried out on a sufficiently extensive scale as to be of practical good, it will be found desirable to establish hatching stations on every available point of our coast line. Such hatcheries, having tanks suited for the reception and development of the eggs, might be constructed at small cost, and so arranged that the water might circulate through them with the rise and fall of the tide, thus obviating the expense of machinery. Fitting custodians of these hatcheries might here again be enlisted from among the ranks of the coastguard; members of which, moreover, might be instructed in the simply mechanical process of manipulating and fecundating the eggs of the fish brought in by the fishermen.

The question of these hatcheries necessarily leads to that of zoological stations or marine observatories, for the more purely scientific investigation of marine organisms. Where these stations are to be set up, is a matter that awaits determination. The coasts of Devonshire or Cornwall, or the Channel Islands, with its from 40 to 50 feet alternations in the rise and fall of the tide, exposing at low ebb literally miles of rock-pools replete with every form of marine life, might be severally named in connection with the southern district. In Wales, the neighbourhood of Bangor, adjacent to the exceedingly rich fauna of the Menai Straits, might invite the authorities of the newly-founded North Wales University to co-operate in the establishment of a station in the above-named township subject to their control. An observatory, however small, might doubtless be found of immense importance in connection with the migration of our food fishes, and for the observation of deep-water forms, if established in that most northerly point of our jurisdiction, the Shetland Islands.

It might be suggested that the proprietors of the various aquaria about the country, greatly to their own advantage and to that of the nation, might be invited to lease or loan their tanks to the Government, or to a responsible society, for the purpose of scientifically cultivating and studying the habits of fish, and all other aquatic animals, and for conducting experiments in the direction of this artificial propagation. If to the custody of such tanks, space for fitting up an efficient laboratory was likewise conceded, the problem concerning the establishment of our zoological stations would be solved at a very little cost. The fine aquarium at Brighton, within an hour's journey from London, would be eminently suited for such a station, while those of Great Yarmouth and Scarborough might become most valuable observatories for the eastern coast line.

Valuable scientific observations respecting the habits and life-histories of marine oganisms need not, however, be exclusively conducted at zoological stations, nor even at the seaside. The following facts, among many others, that have fallen within my observation among my several years' connection as naturalist with certain of the larger public aquaria of this country, some situated at the seaside and some inland, may be cited in demonstration of the great utility in the fisheries interest to which, under intelligent control, these institutions might be made subservient. Thus, various species of the smaller oviparous and viviparous sharks and rays, have been bred at the aquaria of Brighton, Manchester, and Southport; providing the material for the recent very important monograph, by Professor Parker, on the embryology of these fishes. The remarkable developmental phases of certain flat fishes, *pleuronectidæ*, have likewise been supplied for scientific investigation from examples cultivated at the Southport Aquarium. Herring spawn has been hatched out at the Brighton Aquarium, while herring in that more advanced condition of growth known as whitebait, was successfully conveyed by myself to the Manchester Aquarium in the year 1875, and cultivated to the adult state; these hitherto supposed distinct species of fish being then, for the first time, practically demonstrated to be identical. At the same inland aquarium I also succeeded in rearing lobsters from the egg, through their numerous metamorphoses, to the ambulatory form of the adult. The success attained in this direction convinced me that, conducted upon an extended scale, the artificial culture of lobsters might be developed into a highly profitable industry. This subject was referred to, for the first time, in a paper upon the construction, management, and utility of aquaria, I had the honour of reading before the Society of Arts in March, 1876. The further details of these experiments, embodied by me in one of the Conference papers of the recent International Fisheries Exhibition, has already brought forth fruit to the extent that arrangements are now being made for initiating the artificial culture of lobsters, as a commercial undertaking, next season on the coast of Ireland. Through the conduct of similar operations on all suitable portions of our coasts, there is no doubt that our well-nigh exhausted inshore lobster fisheries might, in the course of a few years, be completely recuscitated.

Many kindred facts might be recorded, but enough has been said to illustrate the direction in which our public aquaria, even as they now exist, might be utilised for the advancement of marine biological knowledge. More especially, however, I would wish to emphasise, in this communication, the very important and valuable assistance to State-aided research in the department of pisciculture that has been afforded by the Executive Committee of the International Fisheries Exhibition through their generously placing at the disposal o the Government the series of tanks and fittings belonging to the Exhibition aquarium, wherein kindred experiments may be conducted, and in connection with which will doubtless be hereafter associated some of the most important "teachings" of the bygone eminently successful Fisheries Exhibition.

W. Saville Kent.

SOUR BEER.

From "Hampshire Brewer's" remarks on my last letter on this subject, I gather that, not even in the early part of his career did he pursue the plan of treating sour beer as suggested by me a fortnight ago; and, as regards the neutralisation of acidity by addition of whiting, I quite endorse his opinion that such a course would lead to unpalatability of the beer treated, and a consequent loss of trade. In answer to his query:—Would sour beer, after destruction of the acid ferment and removal of suspended matters, be of more value than water? I beg to state that a comparison between the two is quite out of the question; for the beer treated in this manner would possess a gravity only a very little lower than when it was sent out fresh from the brewery. Moreover, most of its constituents would be practically unaltered both as to quantity and quality.

"Hampshire Brewer's" arguments have failed to convince me that returns should be used for purposes other than blending; for, firstly, the value of such returns in any industry outside brewing would bear no comparison to their worth; secondly, he has not gone beyond the application of whiting in treating his beer before blending, such neutralisation by alkaline substances not having formed a part of the manipulation suggested.

EDWARD R. MORITZ.

72, Chancery-lane, W.C.,
December 4th, 1883.

General Note.

THE LATE SIR WILLIAM SIEMENS.—Mr. Meyerstein, a member of the Society, has undertaken to prepare a steel plate engraving from a portrait of the late Sir William Siemens. The engraving will be printed in 4to. Imperial size ($10\frac{1}{2} \times 14\frac{1}{2}$ inches). As soon as the plate is finished, proofs will be placed on view in the Society's library, but members and others desiring to procure copies must communicate with Mr. Meyerstein direct, at the offices of the Universal Printing Company, 280, High Holborn.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

The following arrangements for the Wednesday evenings before Christmas have been made:—

DEC. 12.—"The Preparation and Use of Rheea Fibre." By Dr. FORBES WATSON. Major-General HYDE, R.E., will preside.

DEC. 19.—"Canada and its Products." By the MOST HON. THE MARQUIS OF LORNE, K.T., late Governor-General of Canada. Sir ALEXANDER GALT, G.C.M.G., will preside.

CANTOR LECTURES.

The First Course will be on "The Scientific Basis of Cookery." By W. MATTIEU WILLIAMS, F.C.S.

LECTURE II. DEC. 10.—The Constituents of Flesh. The action of Heat on Albumen, Gelatine, Fibrin, &c. The Juices of Flesh and their nutritive value. Exosmosis and Endosmosis as operating in the Kitchen. Maceration. Caseine. The cookery of Cheese and its nutritive value. Milk, Butter, and "Bosch."

LECTURE III. DEC. 17.—The nutritive constituents of Vegetables. The changes effected by cookery on Vegetable Substances. Ensilage of Human Food. May the use of Flesh Food be superseded by the scientific preparation of selected Vegetables?

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Mattieu Williams, "The Scientific Basis of Cookery." (Lecture II.)

Royal Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m. Mr. W. W. McNair, "A Visit to Kafiristan."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Sir William Wedderburn, "The Indian Ryot."

TUESDAY, DEC. 11...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. William Henry Preece's paper, "Electrical Conductors."

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., $8\frac{1}{2}$ p.m.

Photographic, 5a, Pall-mall East, S.W., 8 p.m. Discussion on Mr. Jabez Hughes's paper, "Thirty Years of Photographic Progress."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. A. W. Howitt, "Some Australian Ceremonies of Initiation." 2. Dr. R. G. Latham, "The Use of the terms Celt and German."

Royal Colonial, Prince's Hall, Piccadilly, W., 8 p.m., The Right Hon. the Marquis of Lorne, "Our Relation with Canada, and Great Colonies."

WEDNESDAY, DEC. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. J. Forbes Watson "The Preparation and Use of Rheea Fibre."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Dr. J. H. T. Flögel, "Sections of Diatoms."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 1 p.m. Annual Meeting.

THURSDAY, DEC. 13...Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. G. W. Henslow, "The Glaciers of the Alps."

Telegraph - Engineers and Electricians. Annual General Meeting. J. E. H. Gordon, 1. "An Instrument for Measuring the Strength of a Magnetic Field." 2. "A Method of Calculating the Total Horse-power Expended in a Network of Conductors (such for instance as a system of street mains)."

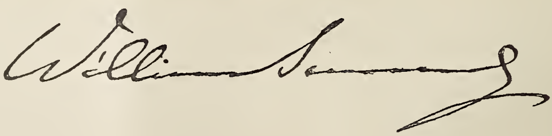
Philosophical Club, Willis's-rooms, St. James's, S.W., $6\frac{1}{2}$ p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Lord Rayleigh, "The Form of Standing Waves on the Surface of Running Water." 2. Mr. W. J. C. Sharpe, "A Method of Finding the Plane Sections of a Surface, and some Considerations as to its Extension to Space of more than Three Dimensions."

FRIDAY, DEC. 14...Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., $8\frac{1}{2}$ p.m.



Journal of the Society of Arts.

No. 1,621. Vol. XXXII.

FRIDAY, DECEMBER 14, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE LATE SIR WILLIAM SIEMENS.

The portrait of the late Sir William Siemens, D.C.L., LL.D., F.R.S., Chairman of Council, which accompanies the present number of the *Journal*, is from a photograph taken by Mr. Van der Weyde, on the 12th June, 1882. The reproduction is the work of the American and Continental Engraving Company, Munich. Any member wishing for an uncreased copy of the portrait, for binding with the volume of the *Journal*, can have one on application to the Secretary.

CHAIRMAN OF COUNCIL.

On Monday last, 10th inst., the Council elected Sir Frederick Abel, C.B., F.R.S., as Chairman, in place of the late Sir William Siemens.

SHAW PRIZE.

The gold medal, or twenty pounds, offered under the terms of this prize for the best plan for obviating or diminishing risk to life in the operations of coal-mining, has been awarded by the Council to Mr. H. A. Fleuss for his apparatus, enabling persons to breathe in mines and other places filled with vitiated air or irrespirable gases.

The Council regret that they are not able to award the second Shaw prize, which was offered for the best plan of obviating or diminishing risk to life in the manufacture, storage, and transport of explosives, nothing having been submitted which, in the opinion of the judges, deserved a medal.

THE MARQUIS OF LORNE ON CANADA.

The attention of members is drawn to fact that the Ordinary Meeting, on Wednesday, 19th December, when the Marquis of Lorne, late Governor-General of Canada, will read a paper on "Canada and its Products," will be held at Exeter-hall, Strand (in the smaller hall).

As a large attendance is expected, the Council have found it necessary to restrict the members' privilege of admitting friends. Each member will be entitled to admit *one* friend only, either personally or by the usual ticket. Members will be admitted as usual on signing their names.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 2nd and 9th, by J. Millar Thomson, F.R.S.E., F.C.S., on "Crystals and Crystallisation." The lectures will commence at seven o'clock. Nearly all the tickets having now been disposed of, the issue will be stopped on Monday next, December 17. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

CANTOR LECTURES.

On Monday evening, the 10th inst., Mr. W. Mattieu Williams delivered the second lecture of his course on "The Scientific Basis of Cookery." The lecturer described the chief constituents of flesh, and explained the action of heat upon albumen, gelatine, fibrin, &c. He alluded specially to the important investigations of the Gelatine Commission of the French Academy, and pointed out the source of the fallacy which vitiated the conclusions they came to adverse to the nutritive value of gelatine. Further investigations had replaced gelatine in its former high position. It was not capable of sustaining life alone, but taken with other nutritive substances, it was of the greatest value. Mr. Williams then proceeded to treat of various processes of cooking, directing special attention to the frying of fish, and to the need of supplanting the ordinary frying pan, for this purpose, by a pan deep enough to hold sufficient fat to cover the fish completely. He explained the reason why fish fried in plenty of fat is less greasy than when a small amount only is used. In conclusion, he detailed the philosophy of browning, as obtained by cooking.

EXHIBITION OF COOKING APPLIANCES.

The Exhibition of gas and other stoves, and the various apparatus and appliances used for cooking purposes, in connection with Mr. Mattieu Williams's Cantor Lectures on "The Scientific Basis of Cookery," will be closed on Monday evening, December 17, after the conclusion of the third lecture.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 10th, 1883, Major-General HENRY HYDE, R.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Bennett, John William, Carisbrooke, Bromley-common, Kent.
Chaytor, Edward Clerevaux, Elstree School, Herts.
Coleman, Thomas Henry, Regent-street, Wrexham.
Ellis, George Henry, Knighton Hayes, Leicester.
Fielden, John Ashton, Cruton-vale, Todmorden.
Lovelock, James Frederick, Rokeby-house, Bishop's-road, Highgate.
Smith, William, Sundown-house, Clifton-down, Bristol.
Willis, William H., Ochhorn-house, Culverden-road, Balham.

The following candidates were balloted for and duly elected members of the Society:—

Anderson, Christopher, Hunslet Shed, Leeds.
Anderson, William, Lesney-house, Erith, Kent, and 3, Whitehall-place, S.W.
Andrews, John Joseph Frederick, 10, Cedar-terrace, Old Charlton.
Babb, Harry R., 21, Portland-square, Plymouth.
Banker, Stewart Melville, Avon-villa, Pellatt-grove, Wood-green, N.
Barber, Charles Albert, Bristol-house, Brighton, and 5, Furnival's-inn, E.C.
Barge, Samuel, Great Yarmouth.
Barker, John, Devonshire Villa, Grove-pk., Chiswick.
Barnett, Francis Thomas, Nyton-house, Chichester.
Barrow, Robert Philipson, 26, Old Broad-street, E.C.
Batchelor, Allan Edward, B.A., 73, Jermyn-st., S.W.
Beauchamp, Major Clayton Scudamore, R.E., 4, Mount-street, Berkeley-square, W.
Beeman, George Beaumont, 182, Earl's-court-road, S.W.
Blakey, James W., 46, Hyde-park-road, Leeds.
Bloomfield, John Caldwell, J.P., 7, Nightingale-terrace, Willesden, N.W.
Brady, Thomas F., 11, Percy-place, Dublin.
Brereton, William Henry, 52, Nevern-square, South Kensington, S.W.
Broadbent, Thomas Oliver, 14, Cross-street, Manchester.
Brough, William Spooner, 71, New Bond-street, W.
Burnard, Robert, Cattedown, Plymouth.
Cameron, Duncan Grant, Quilon, Travancore, Southern India.
Casella, C. F., The Lawns, Highgate, N.
Clifford, Henry Charles, 1, Lansdowne-place, Blackheath, S.E.
Colmer, Joseph G., 9, Victoria-chambers, S.W.
Cook, John Mason, Ludgate-circus, E.C.
Cory, Edward, 5, Church-rd., Castelnau, Barnes, S.W.
Cosser, Frederick Chas., 97, York-rd., Lambeth, S.E.
Craven, George Pople, 14, Roland-gardens, S.W., and City Carlton Club, St. Swithin's-lane, E.C.
Crockford, William, 2, St. Peter's-road, Mile-end, E.
Cross, Charles Frederick, Brentford.
Crossley, Atkinson, Moor-end-house, Adwalton, near Bradford.
Dabbs, W. M., 11, Amhurst-park, Stamford-hill, N.
Dampier, Henry Ludwell, Frindsbury, Rochester, Kent.
Davis, Joseph, 6, Kennington-park-road, S.E.
Dawson, Charles Royal, Westbury, Grange-park, Ealing, W.
Day, Charles Aubrey, 321, High Holborn, W.C.
Donkin, R. S., Camp-villa, North Shields.
Dowler, Frederick, jun., 25, Frederick-road, Aston, Birmingham.
Drinkwater, Thomas William, Ph.D., F.R.C.P., 41, Chambers-street, Edinburgh.
Duff, William Pirie, 2, Champion-park, Denmark-hill, S.E.
Duncan, William Aver, Redhill, Surrey.
Durrant, Frederick William, Holland-lodge, Addison-road, Kensington, W.
Elwell, Paul Bedford, Wolverhampton.
Eno, James Crossley, Wood-hall, Dulwich, S.E.
Ernst, Emil, 80, Charlotte-street, Fitzroy-square, W.
Eskholme, George, J.P., Brass Works, Rotherham, Yorks.
Ettlinger, Joseph, 30, Lawrence-lane, E.C.
Farmer, William Mortimer, 56, Stanhope gardens, S.W., & Maynard-ville, Cape Town, South Africa.
Finch-Hatton, Hon. M., Haverholme Priory, Sleaford, Lincolnshire, and 6, Prince's-gardens, S.W.
Fleming, James, 136, Glebe-street, Glasgow.
Fowler, Captain Francis Hayman, The Lodge, Brixton-oval, S.W., & 9, Serjeant's-inn, Fleet-st., E.C.
Fry, Samuel, Sherington-house, Kingston-on-Thames.

Galbraith, Robert, jun., 21, Notting-hill-square, W.
Gardiner, Charles Lawrence Weare, The Temple, Goring, Oxon.
Glover, Arthur, Galley Hill-house, Swanscombe.
Gray, James, The Shrubberies, near Whitby.
Greig, Henry A., The Eaves, Belvedere, Kent.
Hamilton, Marquis of, 2, Belgrave-square, S.W.
Hammersley, William Archibald Leslie, Bath-street, Leek, Staffordshire.
Harrison, Hugh Erat, 2, Red Lion-square, W.C.
Hartmann, William, 18, Billiter-street, E.C.
Hawker, Thomas H. Seymour, Birmingham and Warwickshire (Brush) Electric Light Company, 110, Cannon-street, E.C.
Hawkins, Miss J. E., 5, Walpole-street, S.W.
Henderson, Charles J., 6, Drumsheugh-gardens, Edinburgh.
Hill, George Charles Singleton, Bedminster Mill, Bristol.
Humphrey, James Charlton, 22, High-road, Knightsbridge, S.W.
Imray, Oliver, 4, Dane's-inn, Strand, W.C.
Jackson, John Evans, The Headlands, Carleton, near Horsforth, Yorks.
Jenkins, Thomas M., 5, Tavistock-street, Covent-garden, W.C.
Jetley, Victor, 8, North Audley-street, W.
Jeyes, Frederick Leslie, 32, Sussex-street, South Belgravia, S.W.
Johnson, Henry, jun., Dartmouth-terrace, West Bromwich.
Jones, Edward, 2, Westhill-terrace, Chapel Allerton, Leeds.
Jones, Walter William, Lambeth Savings Bank, Hercules-buildings, S.E.
Jupe, John, Lloyds', E.C.
Leon, John Temple, 26, Belsize-park-gardens, N.W.
Leverson, James, 72, Cornwall-gardens, S.W.
Lupton, Sydney, M.A., Harrow-on-the-Hill.
Macalister, James, 95, Bishopsgate-st., Within, E.C.
Macdermott, Martin, Scott's-chambers, 25, Pudding-lane, E.C.
Markham, Thomas Thornhill, 102, Fetter-lane, E.C.
Marsden, R., 117, Acomb-street, Manchester.
Maxim, Hiram Stevens, 47, Cannon-street, E.C., and 59, Liebertz-street, New York.
Meihé, John Rudolph, 15, Abchurch-lane, E.C.
Morison, Robert Joseph, Arundel-lodge, Cathnor-road, W.
Morison, W. C., 18, Cromwell-grove, Shepherd's-bush, W.
Morris, Richard, Doncaster.
Morton, Mrs., 10, The Grove, Highgate, N.
Neale, Captain Melville T., 1, Southwick-crescent, Hyde-park, W.
Nurthen, Frederick Richard, 390, Strand, W.C.
Oakley, Richard, 235, High Holborn, W.C.
Orton, Charles James, Ferry-house, Twickenham.
Pemberton, Colonel Robert Charles Boileau, R.E., Lucknow, East India.
Phillips, F. C., The Hammond Electric Light Company, 110, Cannon-street, E.C.
Piper, John Townend, Vernon-house, Willesden-lane, Kilburn, N.W.
Pullman, Arthur, Westbrook, Godalming.
Quincey, Richard de Quincey, 76, Avenue-road, Regent's-park, N.W.
Ramm, Charles W., 9, Newgate-street, E.C.
Ravenhill, Charles, Bushey-house, Streatham-hill, S.W.
Richardson, Edmund, 24, New Bond-street, W.
Rocke, Colonel James Harwood, C.B., 10, Clarendon-road, Kensington, W.
Rumball, Thomas, 8, Queen Anne's-gate, S.W.
Ryle, John, 213, Brompton-road, S.W.
Santos, Flavis A., 88, Palmerston-buildings, E.C.
Sarkies, Martin, 1, Pump-court, Temple, E.C., and Wanderers' Club, S.W.
Schweder, Percy, 133, Gloucester-road, S.W.
Shepherd, William, 101, Bermondsey New-rd., S.E.
Spence, Frank, Manchester Alum Works, Manchester.
Spence, William Heather, 40, Kyverdale-road, Stoke Newington-common, N., and 8, Quality-court, Chancery-lane, W.C.
Stanesby, Arthur John, 3, Kingsdown-villas, Wandsworth-common, S.W.
Staples, Sir Nathaniel Alexander, Bart., 4, Savile-row, W., and Lissan, Cookstown, Ireland.
Stenning, Charles, 3, Upper Hamilton-terrace, N.W.
Stevens, Charles Richard, 8, Woodstock-terrace, Burnt Ash-road, Lee.
Stevens, Leicester, Darlington Works, Southwark-bridge-road, S.E.
Stodart, Rev. George Earle, M.A., St. John's-vicarage, Leamington.
Stott, Alfred, Brighouse, Yorkshire.
Strangman, John Pim, Sarno, Province of Salerno, Italy.
Stuart, Charles, Bletchley Ironworks, Fenny Stratford.
Sutton, Francis, Norwich.
Sutton, John Edmond, 1, Shenley-road, Peckham-road, S.E.
Tebbs, C. Harding, M.A., St. Margaret's, Mitcham, Surrey.
Thomas, Edward Croft Greenway, 11, Harrington-road, South Kensington, S.W.
Thompson, Alfred, 3, Fenchurch-avenue, E.C.
Thomson, Alec, Preparatory School, 173, Union-street, Aberdeen.
Thornton, Alfred, LL.B., 7, Walbrook, E.C.
Turner, Henry Gribble, 14, St. James's-square, S.W.
Vaughan, James Henry, Spencer-house, Streatham-common, S.W.
Ventris, Arthur, 5, Tavistock-street, Covent-garden, W.C.
Warner, Benjamin, 9, Newgate-street, E.C.
Warre, Rev. Edmond, M.A., The College, Eton.
Whadcoat, John Henry, Crown-buildings, Crown-court, Old Broad-street, E.C.

White, Ernest Augustus, Afreba, 7, Cromwell-crescent, Earl's-court, S.W.
White, James Sewell, 34, Cornwall-gardens, S.W.
Whitehead, R. R., M.A., J.P., Borden Wood, Miland, Liphook.
Williams, Montague, J.P., Woolland-house, Blandford, Dorset
Woodrow, Ernest A. E., 19, Buckingham-street, Strand, W.C.
Wright, Edward Mounsteven, 91, St. James's-road, Brixton, S.W.
Younger, Robert, B.A., Brackenbury Hall, Magdalen-street, Oxford.

*** This list contains 138 names, and it may be interesting to members to know that it is the longest list of elections into the Society since the meeting of December 3, 1862, the year of the International Exhibition, when 218 members were elected.

The paper was on—

THE PREPARATION AND USE OF RHEEA FIBRE.

By Dr. Forbes Watson.

What is rheea? This is a specimen of rheea of one length. This is another specimen of rheea of a different length, and here is a specimen of rheea in the dry, semi-succulent state. When green and fresh, these specimens are of course different to what they appear now, and they have characteristics which I shall notice farther on. Unfortunately, I am not in a position, at this season of the year, to present you with more than this solitary green specimen, for the illustration of one or two points which I should like to lay before you before proceeding with my subject, which, instead of being in the form of a written paper, will consist of remarks which I shall endeavour to make as clear as I can. You will observe, on breaking this sample of green rheea, I succeed in getting off a certain quantity of green fibre, tearing it down in this manner. I wish to refer, in the first place, to the composition of the component parts of this bark. The outside portion consists of a film to which a very distinguished chemist has applied the term cutose. Below that there is a bark which contains the green colouring matter of the plant, that is called vasculose, and next to that comes the fibre itself. That fibre, and the bark attached to it, is united to the stem by another principle, which is called pectose. Now, the problem of getting the bark separated from the fibre constitutes the great difficulty which has hitherto impeded the use of this fibre. In China they succeed in removing the bark and otber matters, to a certain extent, by means of scraping. They scrape off the whole of the bark substance as far as possible, and they produce it in the condition of what is called China grass, of which this is a sample. You will observe from the appearance of the plant itself, that it has nothing of the character of a true grass, and belongs to the exogenous class of plants. Now, up to the present time, the whole of this fibre, as it has appeared in the market, has been prepared by hand. There has been a certain quantity prepared in the dry state by applications which I will afterwards refer to, but so far, in China, the whole of the China grass which has been introduced into the market has been prepared by hand, with the result that the cost of the fibre has never yet been reduced to an extent to make it pay, and you never can have the fibre at a less cost than from £49 to £50 per ton. It is this which has impeded the introduction of the rheea fibre and so-called "China grass," and their extended use in this country. During the last twenty or twenty-five years, many attempts have been made to manufacture this, and as far back as the year 1860, when I had the honour of reading a paper in this room upon the plants of India, I showed then a number of most interesting samples, sixty in number, which had been prepared in Bradford from this fibre. At that time, and subsequent to that, a large amount of capital had been expended upon the manufacture of the China grass, and the various fibres; and a great deal of money has been lost within my own knowledge. I should say I could add up £150,000 of capital which have been sunk in this fibre since that time, all arising from the difficulty of getting it sufficiently cheap. The moment you excited a demand for the fibre, the price rose; it has even gone up as high as £85 a ton; and this killed the trade. What we have to do to-night is to see whether there are any elements which would lead us to suppose that we can now get it cheaper—that is really the object of my story to-night. The Government of India has for a great number of years—going back to the days of the East India Company, which took a warm interest in this matter, I may say for the last eighty years, at least—devoted very considerable attention to the question of the introduction of this fibre. The East India Company directed attention to it by importing regularly, year by year, considerable quantities. About five tons, if I remember rightly, was annually sent to this market to afford an opportunity of trying it. It was considered, after a time, that we had a sufficient knowledge of the fibre and its properties to warrant the authorities in discontinuing the importation. However, in 1869, Lord Mayo, who took an active interest in all agricultural matters in India, offered a prize of £5,000 for a machine which would extract this fibre from the green rheea; and our Chairman superintended those experiments, which were afterwards carried out in 1870 with this object, and his report, I must say, is a model of what a report should be on such a subject. The result of these trials were negative, in the sense that only one machine presented itself for trial, and after examining the whole of the evidence about it, General (then Colonel) Hyde reported that it was not sufficiently good as regarded both the quality and the out-turn. It did not fulfil the conditions which the Government indicated should be fulfilled, and only a small prize, £1,500, was awarded to the machine. After that the matter was referred to the India-office, and various attempts were made, with which I had somewhat to do, to see what could be done in order to have a test of machines in this country; and at one time I was in hopes that we might obtain a sufficient quantity of green material to have a practical trial here on the spot, and that we should have at least one opportunity of testing the fibre in its green condition. Those hopes were not fulfilled. A certain gentleman kindly promised to let me have the whole of his crop of fibre, which he expected to cover something like twenty-five acres; but his imagination had been such that, on my sending to a district not far from Marseilles, and making arrangements with the railway companies to have the whole of the crop conveyed *grande vitesse*, there was only about two or three acres planted with rheea, and the crop was very inferior, not to say "scrubby," throughout; consequently, I only got 1½ tons instead of 25 tons; therefore, that attempt failed. A good many experiments were made to see whether it would be possible to extract the fibre from the stalks in their dry state, and these experiments showed that it was quite possible to prepare satisfactorily the fibre, which was worth about £15 a ton less than China grass, but was still sufficiently good to give hopes that, if you got the rheea dried, it might be a matter of consideration whether something might not be done. The Government of India, however, saw the difficulty of extracting the fibre from the dry stems; inasmuch as you cannot get them dried except during certain seasons in India; it would require artificial means to dry the stems properly, which would be much too expensive a plan. Hence the method of preparing the fibre from dry stems had to be given up, and the Government of India, after a certain time, resolved to re-offer this prize; and two or three years ago another competition took place, but with the same result as at the first one. No machine at this second competition was considered worthy of a prize on that occasion, and I believe that no portion of one was awarded. The samples which were sent for examination to this country were examined by my colleague, Mr. Collyer, and other brokers, and declared to be very far inferior from what it should be if it were to be comparable in quality with China grass. That represented the position of matters up to very recently. About two months ago, I was asked to go to Paris for the purpose of examining a process by which one could succeed in stripping the stems very readily, subjecting them to chemical treatment afterwards. I had a double object, in addition to finding out and seeing what could be done by this process—it was a *dernier ressort* if we could not get a machine to do the work, and said, "Let us get the next best thing;" and, accordingly, I went to Paris for the purpose of examining this process, and I will describe the results which I saw, which were very interesting. The method is a conjoint one, and is known as the "Favier-Fremy" process. It consists, in the first place, in facilitating the removal of the bark, with all its adherent fibre, by the action of steam. Immediately after it is cut, it is not difficult to remove the bark, and almost all the fibre attached to it, leaving a very little fibre behind. If the plant is allowed to lie a certain time after cutting, a few hours will make a great difference, the quantity of fibre left on is largely increased. I find it goes up in this way to nearly as much as 15 per cent. in stems which were several days old before they were peeled. When cut fresh, you get off, by the hand, nearly the whole of the fibre—it peels off—there is a little fine fibre remaining, but very little; this, however, must be done immediately the plant is gathered. The process of steaming—putting the stems into a box with a false bottom, and letting steam in below, so facilitates the separation of the bark, that you get everything, and this dark rough fibre is the result of the steaming upon some of the rheea stems, grown in

Hampshire, which I took from this country to Paris with me for experiment. I may mention that I found the rheea which I got here was very much longer and better grown in some respects than that which I got in Paris. That process facilitates the getting off of the bark, but having got this off, the question is what to do with it. Now, M. Fremy, the distinguished French chemist, and his able assistant, M. Urbain, made a number of experiments, with a view of determining the best way of getting rid of all this black bark—I will call it black bark; I am not using scientific language—and they came to the conclusion that it was necessary to employ a high-pressure boiler, in addition to a solution of caustic soda, for that purpose; and, in testing this process, I found the pressure was very considerable indeed, the temperature in the boiler, as I ascertained by experiment, being 295 degrees of Fahrenheit; and at the end of the operation, which extended over four hours' time, the fibre was taken out of the boiler, still in a black condition. But the theory was, that the high pressure had aided the caustic soda in dissolving the whole of the gums, including the bark, which is the difficult thing to get rid of. Now this bark and fibre, as removed from the boiler, was then placed in a solution of hydrochloric acid, and almost at the moment it touches the acid, that which looked a black, dark mass, speedily clears, and you see the beautiful fibre making its appearance. I felt that this settled the question of getting the fibre in a very nice condition. When I came to examine it more minutely, however, I found this alteration was one of appearance only; the bark to a large extent was simply in a changed condition, not dissolved by the alkali; it still remained there, and continued to do so throughout the greater portion of the subsequent operations. I can only now give you some of the general features of the case, but shall be happy to enter more minutely into the matter at any time at Mr. Collyer's office, No. 141, Fenchurch-street. I found that this process did produce a certain effect upon the material. This sample is a dried sample of the fibre as it leaves the Fremy boiler, and it contains a very considerable proportion of gum undissolved; it contains very nearly as much as China grass, which is prepared in the other way. It is true it is looser, and more easily dissolved out, but there it is. Here is a sample of fibre from the acid solution, which is the same as that which was afterwards in this state placed in a chlorine solution of some strength, and I find this loses a very considerable per-centage of its weight. However, the point I am coming to is this; after leaving Paris I made experiments to see whether it was necessary to have this high-pressure boiler at all. It is anything but a simple operation; when you come to operate upon many tons of material it is difficult to manage, and a high-pressure boiler always means expense. Thus came the question, was it necessary? and I was desirous to find out (whilst I was very pleased with the Favier portion of the process, as it got the fibre off the stems very readily), since no machine was available, whether a future, so to speak, might not be opened up by adopting this process. I was anxious to get rid of the high-pressure boiler, and my experiments—made in my own laboratory—show clearly enough that it is not necessary. I have here samples (I have them in a fresh condition) which are in a sticky-looking mass. They have been simply boiled in the Fremy solution, and I find all my barkh ere is just as readily removed as that from the boiler. It is, perhaps, a little more adherent together, but in after operations that can be got rid of as readily as possible. Therefore I had to come to the conclusion that the high-pressure boiler was not required—that we could get all these results without it—and that would be one great gain. That is a very important consideration. This represents the position, so far, of the matter when I returned from carrying out these experiments in Paris.

I now come to what happened next. Fortunately, I had asked the nobleman who, year after year in times past, had allowed me to have, for the use of my Department, all the rheea stems which grew in his garden, and he has been good enough to allow a certain proportion of the stems to be left standing for experiment on my return, and I had thus the materials for carrying out some experiments, the results of which will appear at the end of my paper. I had heard, when recently in India, of Messrs. Death and Ellwood's machine, the invention of Mr. H. C. Smith, as a very ingenious machine, which had been successfully used for extracting the fibre from leaves of the Agave plant, similar to those now before you. For instance, here is a specimen of the sort of leaf with which that machine would deal. Here is another kind, and here are several other leaves to which I shall have occasion to refer presently. I knew it had dealt with these successfully, but I had no idea that it would do for rheea. In fact, I had come to the conclusion (though I never put it in writing, by-the-bye) that we should never get a machine that would do for the rheea. I could not conceive of any machine which we could apply without crushing rollers in some way or other. I saw no difficulty in getting a machine which would extract the fibre, but the point was to get one which would do this, and leave it in a good condition as regards quality. When asked to test this machine, I did so very willingly, and my test was this: I had in stock at the time a considerable quantity of rheea stalks nearly five feet long, and some of very much shorter lengths. That is to say, I had rheea stalks as thick as my thumb, and nearly five feet long, and others smaller than my little finger. With these I tested the machine, and was surprised for the moment to find that the large and small sticks were operated upon with equal readiness. Here is an actual portion of the fibre prepared on that occasion, from these very stems. The secret of the success of this machine lies in this, that one-half of it is, so to speak, water. Now, I will explain what I mean by this, as it seems a somewhat out-of-the-way remark. Imagine this tumbler that I hold in my hand to be the cylinder of the machine, 18 inches in diameter. It is provided with what are called beaters, that is to say, a certain number of projecting ribs, and it revolves in front of a feeding table at a great rate. It is worked at 600 revolutions a minute. This operation goes on in front of the feeding table, as it is called, and this constitutes the whole machine, as regards the mechanical portion, with the exception of the water. Below, and at an angle of about 45°, a strong flattened jet of water passes, and I will tell you what the effect of that is. The cylinder, remember, is rapidly revolving; you feed in at the side here, the beaters catch and break up the sticks into very small pieces, and the jet of water, coming from below, meets the fibre, and keeps it up against the beaters, so that it is really beaten in a stream of water. The result of this is, you not only get the fibre cleared of a large portion of its gum, but you have next to no waste, and what little there is, is excellent for many purposes—it can be made use of, as most other waste products can. Thus is explained the secret of the success of the invention, and how it solves the problem of a machine for cleaning rheea.

I may mention, with regard to this rheea which I experimented upon, that it was three days old. In order to obtain the full success, the rheea cannot be too freshly cut. I should say that it ought to be operated upon within six hours, and that it should be kept in the shade until operated upon. I took some stems, which looked to me perfectly fresh, but when I broke them I found that the colouring matters and the gums had sunk into the fibre, which, if it had been quite fresh, you would have been able, after scraping, to blow through, but you could no longer do so, thus showing the necessity of having the stalks quite fresh to operate upon. I again made a series of experiments to try this machine in preparing other fibres, and I have here to-night a large number of specimens. For instance, there was one very interesting series of experiments which I made with the Moorva (*Sanseviera zeylanica*). This plant grows as a weed in Madras and other parts of India. In fact, it is such a nuisance that the people sometimes do not know what to do with it; but this machine tells us what to do with it. The sample which I hold in my hand was prepared upon the occasion to which I have alluded, Here is a sample which is prepared on the commercial scale in India by this machine, and, I may say, with regard to that particular fibre, that it has been proved that it will compete fairly with Manilla hemp, which occupies a very important place in this market. Here is a sample of cord made from it, and you can all see how beautiful and white it is. This cord is made by one of the principal makers in the kingdom, and his report is that it is 7·4 stronger than Manilla, and over 4 per cent. lighter. This machine has been the means, already, of bringing this new and important fibre to notice, and it operates upon the plant which produces it with great facility. Then I had some large aloe leaves, some of the leaves being as thick as my arm. Here is a specimen of New Zealand flax which was prepared by the machine. I am indebted to Mr. Christie for this sample, which, I believe, has come from Africa. The surprising thing is the ease with which the machine operates upon all sizes of leaves and stalks, taking them all, little and large indiscriminately, without any special adjustment or setting whatever; this fact, therefore, shows that the character of the action was a very simple and effective one. With regard to the question of setting, I may just mention that the beaters were adjusted at a quarter of an inch away from the table, so that it was clear the New Zealand flax which I have just shown you was not struck by them. All these stalks and the others received rapid blows from the beaters, but this could not have got any, because the leaf is not one-tenth of an inch thick; therefore, the total action arose from the beating of the water, the leaves being held up by the current, and the beaters coming round and round, worked the whole of the refuse out of it, and produced the fibre which I have shown you. In short, this machine is what I venture to call a universal fibre cleaner. It cleans every fibre, and it will extract the fibre from every plant into which nature has put one.

There is one other question, namely, will it extract the fibre from jute? I reason in this way. Jute is a plant very succulent in its nature, and something like China grass. The stem is about the same thickness, and in many other respects it is the same, so that I think the inference I draw is a fair one, and that this machine will clean jute, and thus be the means of introducing a superior class of this important fibre into the market. Jute is now prepared by a retting process. If done, as one gentleman whom I see here has prepared it, in a running stream, you get rid of the rotting or retting, and obtain the fibre in the best possible condition; but if it is prepared in a stagnant pool, with lumps of mud to keep it down, it becomes partially decomposed, and you will necessarily get weak fibre. Jute prepared by this machine—as I said before, is likely to supply a new class of jute, one taking a high place in the market. In the same way the machine will settle one or two other moot points. It will afford, I believe, the means of cleaning another fibre which has attracted a great deal of attention, namely, *mudar*, or *Calotropus gigantea*, which grows as a weed all over India. The juices of this plant are more difficult to deal with than even those of the rhea, being of a gutta-percha character; and if, as anticipated, it is found possible to clean it by this machine, it may be the means of introducing another new fibre to commerce.

Let us now look at the character of the machine. It is a very simple machine; I have described it to you, and there are photographs of it here, and arrangements can be made for those who are really practically interested in it, seeing the machine at work. It is easily worked. The power it requires is small; 1 horse-power being sufficient. Of course the question of the supply of water is an important one. Now, there are two ways of doing this, the first being from a height. In a hilly country you can have a tank some sixty feet up, which will give you the pressure required, which is only thirty pounds; or you may use the pump which is attached to each pair of machines to give the necessary pressure. The pump is specially adapted for working the machine, and is not liable to get out of order, not being a valve pump; and it will be found, I believe, to be admirably adapted for the purpose. The quantity of water required for working the machine amounts to about 400 gallons an hour. That is a good deal, perhaps, but you can use the same water three or four times over, if you let the refuse sink away from it, and draw it back by means of a hose, so that 1,000 gallons a day will represent the quantity of water necessary to work with. With regard to the question of water, there is this to be borne in mind—that it is very desirable that the water should be secured and turned to account for helping the plants to grow; that is to say, it should be used for irrigation, for it contains a great deal of the nutriment of the plants. We all know that if you wish to grow crop after crop of any plant, it is necessary to restore the constituents in the form of artificial manure, where in this case, if the water is put upon the land, the soil will repossess itself of what has been taken out of it. In the same way the broken up stalks should be collected, and used for manure or fuel. I may say this, that with regard to the question of the number of crops that you expect of China grass or rheea fibre, some people will tell you that there will be as many as four or five, and I have met enthusiasts who spoke of six or seven. No plant can be grown on the same soil, time after time, unless great care is taken to restore the elements to the soil which have been taken out, and that is the case particularly with regard to rheea. In China they manure and till the ground very carefully.

Now, one word more about the machine, with regard to the important question of out-turn. The experiments which have been made here are very interesting as regards the quality of the fibre, but they are no guide as to the quantity of out-turn, and, therefore, I have to depend for this upon the evidence which has been laid before me, and which has led me to the conclusion that a pair of machines will turn out from 140 to 250 pounds of clean fibre in a day, according to the assiduity and skill with which the machines are worked. If a man dawdles over his work, he will not turn out so much as the man who goes to work with a will. There are other elements which should be considered. The other day a complaint was received from a gentleman to the effect that the machine worked capitally, but he could only get forty pounds out of it in a day's working. The next mail brought a letter to say that he had been thinking of making a suggestion with regard to the working of the machine —namely, that they should take off the roots from the plants, because he found that the earth which was attached to them rather interfered with the working of the machine! This gentleman had been putting in roots and all, and then complained that the out-turn was not so good as might be expected.

Returning to rheea, what are its prospects *now?* I have indicated that, for the last 25 years, or more, the great search has been for some machine to clean it. That machine we have now got, or, at least, I believe so. I think the facts which I have mentioned point clearly in this direction. I started by pointing out that it was not possible to sell China grass in this country under £49 to £50 a ton, that is to say, the cost of preparing it by hand prevented its being sold at a cheaper rate. To clean one ton of China grass, it would take upwards of a thousand Chinamen one day, that is to say, each pair of hands can clean only from one to two pounds. In experiments which were carried out by Mr. Thompson and Mr. Mylne at Baheea, they found that only a few ounces could be cleaned by one person—nothing, in fact, at all approaching the two pounds which the Chinaman cleans, which is a considerable quantity, and the result of great practice. If, however, we get a machine which will do it, as I believe we now have, it will reduce the price very considerably.

With regard to the cost of working, I will mention to you what appears to me to be a fair estimate, after making every allowance, including the cost of labour, the carriage and cutting of the material, the cost connected with the engine, and of fuel, &c., and this estimate shows that it is possible to clean fibre with it at a cost of from about £7 to £1 a ton calculated on 100 lbs. of fibre for the working day per machine. Suppose it is only 50 lbs., which is dependent, as I said before, on the assiduity with which the machine is worked, it will only come to probably between £10 and £12. Such being the case, the result will be that China grass may be introduced at a much cheaper price than hitherto. What that price will be, I cannot say, but I think it will be possible to sell at £30 to £35 a ton—possibly less; still it will always be an expensive cultivation. I am satisfied that those who think they are going to grow this plant at a very cheap rate, are mistaken. Great care must be taken in its cultivation, but in any case it will still always command a good price. The demand for it is likely to be very large, and it will, in consequence, continue to fetch a good price; those who grow it need, I believe, have no fear upon that point.

As to the yield per acre of rheea, there are no fresh facts since I went into the question for my report in the year 1875. I am aware that there are some notable facts which have been founded upon experiments made in Algiers. Estimates have been made, showing that you could get forty tons per acre, but I think these will require to be verified before we can accept them. Any way, I do not see that we can conclude at the present—I hope I shall be mistaken—that each crop will yield more than 250 lbs. per acre. You may, however, obtain three crops, or even four in the year, which would bring it to 1,000 lbs. per acre.

The question of cutting and storing of the plant are practical questions which will have to be considered hereafter. One of my objects, in the experiments which I carried out in Paris, was to determine, as far as I could, the height to which the plants should be grown in order to give the largest yield of fibre. Some people say that the plant should be grown to the height of 6 feet; some say they should not be more than 3 feet; but the results of my experiments, as you will find from the table at the end of my paper, point to the fact that 3½ to 4 feet is about the right height to grow them. If the length is not more than 2 feet, the fibre is very fine, but the chances are you get more waste, and not such a good per-centage of fibre. In the long stems the fibre is not so fine as in the medium ones; in short, the medium stems from 3 ft. to 4 ft. are about the right length to cut. This has an important bearing upon the question of the number of crops which can be obtained. It is clear that if you allow the plant to grow 6 or 8 ft. high, you cannot expect to get as many crops as when only 4 ft. Moreover, there is this characteristic; all these stalks which you see here are from the same plant, that is to say, the shoots have come from the same root. Having determined the proper length, the stems should be gathered accordingly, only those being cut which have attained the right height; in this way a continuous crop may possibly be secured.

We find that with China grass there is a great variety in quality. Here is a sample of short China grass, and here are others which are much longer. These variations in quality gives rise to the complaints which are frequently made. If you grow it, however, a certain standard length, it will be likely to produce it of a definite quality, and that is what is wanted for commercial purposes.

With regard to the comparison of the machine-prepared rheea fibre and ordinary China grass—here is a sample of the former, and those who have an opportunity of examining it will find the fibres are separate, and nearly fit for spinning. There is a very small amount of gum in these fibres, and if you take the China grass in your fingers, you will find that it is very stiff, owing to the large quantity of gum that is left in it. In the machine this gum is washed out; but by merely scraping, you leave it in. The amount of gummy matter in the machine-prepared sample is about 19 per cent., as compared with from 25 to 35 per cent. in China grass. I feel satisfied that in this sample, had the stems been operated upon when freshly cut, the proportion of gum would have been considerably less. If it is 19 per cent. in this, I should say that if it had been cut fresh it would have gone down to 15 per cent., or even less; but these are points upon which I hope to make experiments in India, where I shall have an opportunity of doing so on a larger scale.

Now, what is rheea good for? It is difficult to say what it is *not* good for. It is the strongest fibre in nature. According to the experiments made by Dr. Forbes Royle, it is two and a-half times as strong as the best Russian hemp. Compare it with flax. Many years ago, one of the largest flax spinners in the kingdom spent a considerable sum, £20,000, I believe, in trying to use China grass in the place of flax, but the experiment was given up, owing to the hairy character of the yarns produced. It is, however, quite possible to prepare rheea in a way which would enable it to be spun on flax machines; and we find table-cloths and beautiful fabrics of this material equal to anything that could be produced from flax. It is also an admirable substitute for wool, especially for mohair and other lustre wools. On the table are illustrations of what it is good for, and many of these specimens show what can be done with it in that respect. From what I hear, there is likely to be a run upon lustre wool shortly, as it appears likely dead surface wools will go out of fashion, and lustres come into vogue again, thus leading to an increased demand for rheea. Then, as to silk. Rheea is prepared in various ways, so as to leave the gloss upon it, giving it all the appearance of silk, and it is certainly far superior even for mixing with silk than jute. Many of the ladies present know that the silk dresses which they buy now are very inferior as compared with what they used to be some years ago, the difference arising from their being adulterated with jute. No doubt the ladies would like to see the persons who mix jute with silk locked up for life, and most men will agree that the scoundrel who dares to put jute into sailcloth deserves to be hanged, for that might often mean death on a lee shore.

I do not know that I have much more to say upon this subject. My story has been rather a long one, but I have done my best to give you some idea of the present position of the matter, and how it is likely to be altered by the existence of this machine, the result of the genius and intelligence of Mr. H. C. Smith. It is interesting just to think of how he came to invent it. What first suggested it to his mind was noticing the great aloes, the stems of which grow up to 30 or 40 ft. Mr. Smith observed during the monsoon in the Mauritius that where the inner leaves were dashed against these great stems, they were broken up, the result being that the pith got washed away, and the fibres were left hanging. This suggested, to his mind, the idea of a machine in which a rush of water would play the same part, and he was fortunate enough to find in Messrs. Death and Elwood a firm possessing the largest experience in the manufacture of fibre-cleaning machines for a similar object in South America and elsewhere. The result of this combination has been the production of the present simple and highly effective machine.

With regard to the exhibition of the machine previously referred to, it will not be possible to show it at work upon fresh rheea, but there is a supply of Agave and other leaves which will show its action upon them, and there is some rheea now on its way from Algiers, which may come in time for a trial on Tuesday next, although it will be far from fresh. The various samples now exhibited will be on view at Mr. Collyer's rooms, 141, Fenchurch-street, and I shall be happy to give any special information which it may be in my power to afford.

TABLE SHOWING RESULTS OF EXPERIMENTS WITH RHEEA GROWN IN HAMPSHIRE AND AT REOLLI, NEAR BORDEAUX.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
		Stalks as fresh cut.							Strippings (Bark and Fibre, &c.)				Dry Fibre produced (Frémy's process).							
			Number				Per-centage.		Weight.		Per-centage.		Weight.		Per-centage.		Yield, per 1,000 stalks.			
Number.	Where grown.	Number of bundles.	In each bundle.	Total.	Average length.	Weight in avoirdupoise pounds.	Water in entire stalks.	Dry matter in stripped stalks.	In pounds and decimals.	In Grains.	In fresh stalks.	Of dry matter.	In pounds and decimals.	In grains.	In fresh stalks.	In fresh strippings.	In pounds and decimals.	In grains.	General Observations.	Number.
					ft. in.															
1	Hampshire.	1	50	50	5·10	19	80·87	12·58	4·497	31,479	23·67	27·66	·3742	2,620	1·970	8·323	7·485	52,400		1
2		1	50	50	5·8	12½			4·064	28,448	32·51	30·69	·3281	2,297	2·625	9·210	6·562	45,940		2
3		1	50	50	5·6	13			3·046	21,322	23·43	29·16	·2992	2,094	2·301	9·820	5·984	41,880		3
4		1	50	50	5·2	11			3·102	21,714	28·20	27·00	·2764	1,935	2·512	8·911	5·528	38,700		4
5		1	50	50	5·0	9			2·447	17,129	27·19	29·82	·2110	1,477	2·344	8·623	4·220	29,540		5
6		1	50	50	4·10	8			1·973	13,811	24·66	26·83	·1753	1,227	2·191	8·884	3·506	24,540		6
7		1	50	50	4·8	8			2·054	14,378	25·68	29·31	*		*	*	*	*	* Sample reserved for further experiment.	7
8		1	50	50	4·3	7			1·907	13,349	27·24	33·33	·1510	1,057	2·157	7·916	3·020	21,140		8
9		1	50	50	4·2	7			1·689	11,283	24·10	27·66	*	*	*	*	*	*	" " "	9
10		1	50	50	4·0	6			1·432	10,024	23·87	27·77	*	*	*	*	*	*	" " "	10
11		1	50	50	3·10	6			1·389	9,723	23·15	37·50	*	*	*	*	*	*	" " "	11
12		1	50	50	3·8	5			1·338	9,366	26·76	23·86	0·860	602	1·720	6·427	1·720	12,040		12
13		1	50	50	3·6	4½			1·205	8,435	26·78	32·00	*	*	*	*	*	*	" " "	13
14		1	50	50	3·2	3½			1·107	7,749	31·64	27·00	·0720	503	2·053	6·349	1·1440	10,060		14
Totals.		14		7 0		119½			31·250	218,210			1·9733	13·812	...					
15	Reolli, near Bordeaux.	1	50	50	4·0	6			1·642	11,497	22·50	46·15+	·1663	1,164	2·558	10·125	3·326	23,280	+ This seems somewhat too high: it has not before been employed in calculating the means.	15
16		9	50	450	3·9	26			7·749	54,244	27·43	33·84	·7993	5,595	2·829	10·314	1·776	12,433		16
17		{ 1 3	50 100	250	3·2	11			3·688	25,818	34·30	32·14	·2788	1,952	2·328	7·560	1·1152	7,808	§ Mean of nine samples.	17
18		3	100	300	3·0	10			3·523	24,660	27·37	30·00	·2360	1,651	2·144	6·609	·7866	5,503		18
19		3	100	300	2·6	9			2·943	20,602	30·18	33·33	·2056	1,439	2·108	6·984	·6853	4,797		19
20		2	100	200	2·3	5			1·647	11,528	29·81	32·00	·1131	792	2·057	6·870	·5655	3,960		20
21		3	100	300	2·0	6			2·025	14,177	31·15	34·28	·1355	949	2·085	6·693	·4517	3,163		21
22		2	100	200	1·8	2½			·721	5,046	26·21	33·63	·0429	300	2·077	5·944	·2145	1,500		22
Totals.		27		2,050		82·0			23·938	167,572			1·9775	13,842						
Grand Totals.		41		2,750		201·5			55·108	385,782			39·508	27,654						
Mean results English Rheea			50	50							26·35	29·26			2·208§	7·940§				
Mean results French Rheea											28·62	32·75			2·273	7·637				
Aggrgte. means.											27·49	30·00			2·241	7·789				

TABLE SHOWING RESULTS OF THE FIBRE-ANALYSIS OF RHEEA STALKS (FRESH AND DRY)

A	B	C			D			E			F			G			H
					PER-CENTAGES.												
Number.	Description of samples.	Diameter of stalk.			Stripped stalk.			Strippings (Bark and Fibre).			Pure white Fibre (dry).			Water (moisture).			Mean per-centage of fibre (*calculated*) on fresh stalks.
		I. ins.	II. ins.	Mean ins.	I.	II.	Mean.	I.	II.	Mean.	I.	II.	Mean.	I.	II.	Mean.	
1	Fresh Stalks.	·45	·45	·45	63·639	64·587	64·118	36·361	35·413	35·432[1]	2·686	2·574	2·630	82·76	82·32	82·54	...
2		·40	·42	·41	64·227	64·090	64·158	35·773	35·910	35·842[2]	2·609	2·782	2·695	81·15	80·58	80·86	...
3		·62	·64	·63	76·247	76·167	76.207	23·753	23·833	23·723[3]	3·200	3·384	3·292	74·50	75·44	74·97[4]	...
4		·55	·54	·525	75·109	73·334	74·221	24·891	26·666	25·779[3]	2·500	2·596	2·548	80·34	80·02	80·18	...
Means............		...	...	**·504**	...	...	**69·678**	...	...	**30·212**	...	...	**2·791**	...	...	81·20[5]	...
5	Air-dried Stalks, 3ft. 6in.	·38	·36	·37	...	...	...	...	...	...	15·325	15·065	15·195	9·02	9·36	9·28	3·148
6		·40	·40	·40	...	...	...	...	...	...	15·294	15·441	15·368	8·70	8·26	8·48	3·156
7		·35	·36	·355	...	...	...	...	...	...	14·348	14·237	14·293	9·88	9·55	9·70	2·975
8		·38	·39	·385	...	...	...	...	...	...	12·952	12·500	12·726	10·14	10·26	10·20	2·666
Means............		...		**·377**	...	...	...	...	...	...	...	...	**14·395**	...	...	9·42	**2·986**
9	Air-dried Stalks, 2ft.	·27	·27	·27	...	...	...	...	...	...	11·789	11·684	11·736	10·50	10·40	10·45	2·460
10		·27	·29	·28	...	...	...	...	...	...	11·736	11·923	11·829	10·50	10·96	10·73	2·232
11		·19	·19	·19	...	...	...	...	...	...	11·860	11·395	11·627	9·76	9·48	9·62	2·425
12		·19	·21	·20	...	...	...	...	...	...	11·610	11·145	11·377	10·82	10·72	10·77	2·396
Means.........		...	...	**·235**	...	...	...	...	...	...	...	...	**11·642**	...	...	10·39	**2·353**

I — Observations.

1 Containing Bark = 16·85.
2 ,, ,, = 17·71.
3 The bark could not be separated with sufficient accuracy for the determination of its per-centage *per se*.
4 This sample was apparently not quite so fresh as the others.
5 Calculated upon Nos. 1, 2, and 4 only.

In conclusion, it is my duty to express my thanks to Messrs. Garnock, Bibby & Co.; A. Donisthorpe & Nephew; J. Glazebrook & Co.; J. Grathvohl; George Hall & Co.; Richard Harris & Sons; Herbert E. Hounsell, Limited; Charles Rhodes; F. Wilkinson; and very specially to Mr. W. Whitaker, for the interesting series of specimens exhibited on this occasion; as also to Mr. Howson and to Mr. Lascelles Scott,—to the former for assistance in connection with the trials of the machine, and to the latter for assistance in the investigation, a small portion of the results from which only appear in the Tables, pages 73 and 74.

Amongst the specimens exhibited in illustration of the foregoing paper were rheea and China grass in various stages of preparation, from the stalk to the finest bleached fibre, also many fabrics, including lace and other curtains, shawls, hosiery, handkerchiefs, muslins, sailcloth, &c., made entirely from rheea; also some ropes and twine spun from "Moorva," fibre produced by Messrs. Stains and Co., from the plants growing wild on their Madras Government concession in the Coimbatore district.

DISCUSSION.

Mr. Wm. Haworth said he could confirm what Dr. Forbes Watson had said with regard to rheea and all other such fibres of India, that the stem should be acted upon, if possible, immediately after it was cut from the ground. It was as easy to separate the fibre in that state as it was difficult to do so afterwards. In 1842, he grew rheea, just for a sample; he cut it, and placed it immediately in a running stream of hot water from a condensing engine, and by this means the bulk of the fibre was very easily separated by hand. All the gummy matter appeared to be separated, and a more beautiful sample he never saw. The moment the stem was taken from the water, and just held at the tip, you could draw the whole circumference of the bark and fibre away from one end of the plant to the other; then, drawing it through your hands again, you could separate the bark, and all that was required was to wash the fibre in hot water. He held that if this machine could be placed on a plantation where the plant could be cut immediately it was ready, especially if hot water were used with it, it would accomplish all that could be done by hand, and would give a very satisfactory result. Rheea would make the warps of the finest cotton goods, and the wefts could be made of Sea Island or other fine cotton. He had seen it used in Lyons for the warp of piece goods, and very beautiful goods they were. It could be used for the very finest materials up to the coarsest. He had seen plants growing near Calcutta from seven feet to ten feet in height; and the time to cut them was just when they were begining to flower. Next after it would come the mudar, the only trial of which yet made had been from plants growing wild, spreading out into a number of branches, and forming seed pods, like flax; but if this were sown more closely, it would grow much taller, nearly all stem, and would make even a more beautiful plant than rheea, though not so strong. He was quite sure there was a great future for all these Indian fibres, if they were looked after and treated in the way now described.

Mr. Martin Wood remarked that the large prize offered for the machine for cleaning rheea fibre was the first special effort made by Lord Mayo towards developing the special industries of India. His own impression was that Mr. Greig's machine scarcely had fair play. The time announced was 1st April, but the trial did not come on until the end of August. He believed Lord Northbrook, who witnessed the experiments, considered the machine a decided success. It turned out something like 150 lbs. per day, which came within the condition of costing less that £50 a ton. That, however, was now an old story. He was anxious to see the machine described succeed, because it seemed just what many had been wishing to have introduced for the purpose of developing the fibres of India. Dr. Watson was, no doubt, enamoured of the rheea plant, but for his own part, there were many reasons which made him take more interest in what he might call the Cinderella fibres—the aloes, the mudar, and others. However important and interesting these results were with regard to the rheea, it was a hundred times more important that these commoner fibres should be utilised. If this machine could be worked with 1 horse-power, it could perhaps be worked by hand, and if so, it was one of the most invaluable inventions India could have, for the great difficulty there was to get motive power. The cultivation of rheea was limited, because he believed it would not grow in the plains, but only at an elevation of some 2,000 feet, or in the hilly districts at any rate; and it would involve the outlay of considerable capital. These common fibres, however, cost nothing, they were within the reach of the mass of the people, and if they could be utilised by the aid of our wonderful mechanical appliances, they would be a most important adjunct to the food crops and coarse agriculture of the country.

Mr. Kahlert said his firm had had a sample of rheea grown in Sumatra, on the plains, near the northern coast.

Mr. W. Haworth said his experiments in growing rheea were made on plains near Calcutta, than which you could not find any place much lower. He had found it growing wild on the slopes of the Himalayas, at Darjeeling.

Dr. FORBES WATSON said the best sample he had seen was grown in Egypt.

Mr. LIGGINS would suggest that a drawing should be published, so that they might see the nature of the plant, and also information given as to how far apart the plants would grow best. Within his recollection the sugar-cane was planted 3 feet apart, but it was discovered in Barbadoes that they grew much better 5 feet apart, and, he believed, that on some of the most fertile lands they were planted from 7 to 8 feet apart. If a larger production of cane was produced in this simple way, at the same time decreasing the cost of planting, the same result might be produced in the case of this plant. He should also like to know whether it required a swampy soil, and whether it would stand the heat of the tropics without frequent rains. The esparto grass in the West Indies would not grow except on swampy soil, and possibly this would be the same. Between thirty and forty ago he was much interested in trying to get perfected in England similar machines to that now described, but it was found that nothing could be done without an amount of water in connection with the rollers, which rendered it impossible to work at a profit. The aloe, which grew in great profusion in the West Indies, was not utilised because of the difficulty of separating the gummy matters for want of a sufficient supply of water. He and his friends found that they could not get English manufacturers to alter their machinery to use a new material. About the same time, he imported a considerable quantity of a very beautiful substance called silk cotton, but no manufacturer in England or France would take the trouble to look at it. So it was, some years ago, with esparto; the difficulty always was, with a new material, to get manufacturers to alter machinery. He was much pleased with the specimens of cordage shown, and could speak from experience as to the importance of reducing both the weight and size of ropes used for rigging.

Mr. C. F. CROSS said Dr. Watson had spoken of the jute industry in connection with this machine, but he thought its application would revolutionise the present trade. He had pointed out, from an examination of the fibre, that the whole of the jute imported into the country represented degraded fibre, and he had satisfied himself, by chemical examination of the nature of a large number of bales of jute, that there was sometimes a considerable developed degradation of fibre in the centre, especially when it was packed with the least dampness, involving the passage of the constituents of the fibres into soluble matters, and consequently great depreciation in value. He inferred that not only were the portions to be examined degraded, but probably the whole bulk. He was far from wishing to say anything in depreciation of this new machine, but he should like to ask whether some of the lesser practical questions might not be lost sight of in view of the great theoretical triumph accomplished. He thought these might out-weigh, in the case of the Cinderella fibres which had been referred to, the advantages. In the first place, it would be very difficult to organise the jute industry into any concerted action for the adoption of a machine of this kind, the qualification being in the hands of a large number of small producers, each of whom worked his own fibre. Then, of course, the cost of production had been put from £7 to £10 a ton, and when they remembered that jute was retailed at about £18, it seemed to him the margin left was somewhat narrow. Dr. Watson called the machine a universal fibre cleaner, and it might prove to be so; but chemists still believed that there was a certain future for chemical manipulation in the case of fibres which it was impossible to treat mechanically. When you had simple bast, as in the case of rheea jute, the handling of the fibres was easy, but where you had the bast built up into internal stems, such as wood—where you had fibre to deal with like straw, where the bast elements were solidified into curiously complex substances—there was a great future for chemistry. There was no doubt that chemistry, and this remarkable machine, would have to run a considerable race until the functions of the two were properly adjusted on a chemical basis. He was interested in certain new processes, which had been worked at a considerable cost for the chemical treatment of fibres. With regard to rheea and other fibres which had been treated by this machine, he thought they were apt, in the face of new results, to over-estimate a little the value of the fibre. It must be remembered that affinity of rheea for colouring matters was very weak, and, therefore, he thought its substitution for silk was perhaps more than they could expect, or for other things where the property in taking a fast colour was desirable. In the Favier and Fremy process there was a conjunction of chemical and mechanical treatment, but this machine of Mr. Smith's did not seem to be worked in connection with any chemical treatment; very likely under previous chemical manipulation of a large number of these complex structures, the isolation of the fibres would be more easily accomplished, and the fibre produced would be of considerably higher order than would be produced by the machine alone. Lastly, he would ask if the inventors had any hopes of being able to apply it to the flax industry, which was a very important one, particularly in Ireland, where such a machine was greatly needed, for he did not think there was any product which came into the market in such varying quality as flax.

Mr. T. CHRISTY remarked, with regard to the price of rheea fibre coming down, it might not be known to many present that since it had come into the market, experiments had been made for turning it into a material closely resembling leather. Comparing the two, he might say that the value of leather bands was about 5s. a lb., and that of rheea fibre 1s. a lb. at the utmost. These bands had been tested, and a 3-inch rheea fibre band was found to do the work of a 9-inch leather band. That being so, there was not much fear of rheea going down. One other important fact, not mentioned by Dr. Watson or by Mr. Cross, was this, that if the fibre were wetted, it was most difficult afterwards to perform many of the chemical operations upon it. Mr. Ekman had had most excellent results in his process by treating the rheea after it had been worked in Mr. Smith's machine. That was a very great feature in this new process, and might be the means of enabling a dyer to bring up the colour of the fibre, which, at present, had been found very difficult.

Mr. Collyer said Dr. Forbes Watson had asked him to reply to the various points raised, as he, unfortunately, was not able to hear them. It was very evident that Mr. Martin Wood had but a very partial knowledge of the rheea plant and of its mode of cultivation. His own impression was that it grew more favourably in rich alluvial soil than on the hills; certainly, he had himself had samples both from high and low levels, and he thought that the lower ground plants were the best; at any rate, there was not much difference. As Dr. Watson had said, the finest he had seen was grown in Egypt. With regard to Mr. Liggins' questions, no doubt superior cultivation would give a better result than merely trusting to wild plants. It stood to reason that with rheea, like all other plants, cultivation improved the fibre, and a great result would be obtained, and probably a more economic result, if it were carefully attended to. With regard to close or open planting, he did not know that there were any facts yet ascertained, but his impression was, taken from analogy, that growing rheea for the sake of the fibre, it would be better to grow it rather closely together, because if it were grown far apart, you would get a wide bushy plant, which meant a great number of breaks in the fibre; the straighter you could have the stem, and the fewer leaves upon it, the better. He could hardly speak as to the nature of the soil, but he thought a rich alluvial soil was best. As to esparto growing in swamps, it struck him as being new, for he always thought it grew on stony, mountainous soil.

Mr. Routledge said the esparto grown in Jamaica was declared by authorities not to be really true esparto.

Mr. Collyer said with regard to the quantity of water required for the machine, he was told by the engineer that it required less than the quantity now used for washing the fibre when prepared by other processes. As to silk cotton, that hardly came within the range of the paper, but he might say the Dutch were far in advance of us, as he had noticed it in the Amsterdam Exhibition, and in Holland it could be sold for 8d. per pound, whereas in England you could not get 2d. The quality of it was better however. As to the rope, the makers told him the breaking strain was 7,705 pounds, which was something greater than a similar rope of best Manilla hemp. The smaller cord, which was made for fishing lines and net purposes, stood a strain of 80 pounds, and broke at 81, which gives 7·4 greater strength than the best quillot Manilla, and, at the same time, was 4·72 per cent. lighter, which was 12 per cent. in favour of the yarn made of this fibre. He could not say the cost, but if it weighed 5 per cent. less, and was 7 per cent. stronger, he should argue the cost would be much less than if made of Manilla.

Mr. Liggins asked if it was liable to rot.

Mr. Collyer said he could not answer that question, because until this machine appeared on the field none of this fibre ever came to England in commercial quantities, though he had known it in samples for twenty-five years; it was, practically, the creation of the machine. He had sent samples to various people, and none gave an unfavourable opinion; the worst was that it was at least equal to Manilla. It was a new fibre brought into the market for the first time, and was the first attempt of the natives to use the machine, so that it had not yet been practically tried. He agreed with Mr. Cross that jute was a degraded fibre, and one of the greatest merits claimed for this machine was that it would stop that degradation; that it would give all the fibre nature put into the plant in the purest and strongest condition, for this reason, that the action of the water was peculiar, and different to any other process. When the skin of the plant was broken, all the acids contained in it at once set up a deleterious action, and commenced to injure the plant, but the advantage of this machine was that the deleterious matter and strong acids, which tended to weaken and discolour the fibre, were at once swept away before they could act upon the fibre. Incidental to that was the fact that it did away with the necessity of retting. Wherever this machine went, retting would become a thing of the past. It would have the same effect on flax, if they took the flax young enough. He firmly believed it would do away with retting altogether as regards flax, hemp, and every other fibre, including jute. They had to deal with 800,000 tons of jute a-year, 50,000 or 60,000 tons of Manilla hemp, and a great many thousand tons of other fibres, which showed what an enormous product of fibre there was throughout the world. He personally claimed for the machine that it was the best for every fibre, always excepting bristle fibres. As to chemistry, it seemed to him the great advantage of this machine was that they did not want a chemist at all. According to their belief, rheea was not bast at all; jute was bast. As to the affinity of rheea for colouring matters, he had lately made a tour amongst the principal manufacturers of Europe, and they all told him of the difficulties that did exist in dyeing it;

fast colours had been, by recent improvements, effectually obtained. His information was that, at £30 a ton, there was no limit, practically, to the quantity which could be sold; at £40, it would go slowly; at £50, with the present price of wool, it was barred. One man said to him, "If you bring it down to £35, you will sell a lot; if you bring it down to £30, nobody knows the quantity we can use." In addition to all the present outlets, there were many new things constantly coming under notice, such as Mr. Christy had referred to. A new one sprang up only the other day, and he believed that in a short time felted carpets would be made of wood instead of wool. Of course, for a time the increased supply of fibre may have an inconvenient effect on the market, but the fittest would survive, and if any had to give way, it struck him it would be the old-fashioned people not those who had the best fibre, at the lowest price.

Mr. W. HAWORTH said jute was not so much bast as rheea, but neither was really bast. Bast was always taken from the interior of the bark of a forest tree. Jute was called "a lie," but how was it so much came into consumption? He remembered the first 35 bales shipped from Calcutta as a sample by the East India Company, and when it came home there was great difficulty in disposing of it, but now the consumption, in Great Britain, was about 2,200,000 bales of 400 lbs. each, and the whole quantity required to be produced in India was upwards of six million bales. If, therefore, it was an inferior article, there was nothing yet which would take its place, unless it was rheea. He believed the younger persons in the room would see a larger quantity of that come into use even than jute.

The CHAIRMAN, in proposing a vote of thanks to Dr. Forbes Watson, said he would say a few words drawn from his experience in India, where he had superintended the experiments instituted by the Government. With regard to this fibre, the rheea plant for these trials was cultivated in the Botanic Gardens at Serampore, which was practically on the plains; and Mr. Sandys also cultivated the plant at Baugulpore, which was in the delta of the Ganges. The Government also cultivated it in the Botanic Gardens at Calcutta, in order to enable machinists to obtain a supply to use in their endeavours to design a machine for preparing it. In Assam it grew wild, and with regard to its rotting, he might say it was used there for fishing lines, and he did not think any fibre which was liable to rot would be used for such a purpose. He had a fishing line from Assam which had been ten years in his possession. No doubt this plant required careful attention, and as far as he could ascertain from what was done in the Botanic Gardens, Serampore, the maximum amount of crops would be three in the year. But there was another question which had not been touched upon: it was a very quick growing plant, and in that part of India grew best in the rains, and in Calcutta during the hot stagnant atmosphere of the rainy season. For fourteen days he carried on the experiments, and he had found the crop was very different at the end of that time from what it was at the commencement, showing a considerable growth in the stems. It was quite certain that, to secure an excellence in fibre, the stems should be cut at a certain point, and therefore considerable care must be exercised in regulating the growth to enable the crops to be cut in proper succession. All this was a question for the future, because little attention had as yet been paid to the cultivation of the plant. There were two factories in India where the rheea was prepared, one began by Colonel Thelwall in the Deyrah Dhoon, the other in the Dhoons of Kangra. In these, some attempts to prepare the rheea by machinery was made, but the work was done mostly by hand, the method employed being to scrape the fibre after it had been stripped from the stalk on a table with a sensitive machine, namely, the hand and the knife. This machine of Mr. Smith's appeared to provide a substitute for the hand in the film of water which held the rheea up to the scraper, and it would probably be better prepared by that means, because the way in which it was held up was better; all previous attempts had been to scrape the fibre. Mr. Greig asserted that he adjusted the rollers of his machine so that the fibre was scraped between two knives, but as the fibre was only about $\frac{1}{1000}$ inch, it was obviously impossible to adjust two rollers to travel with that nicety. The result was that the machine did not scrape the fibre, and it was found that as the supply of water was increased, the condition of the fibres turned out improved. This was entirely confirmed by what Mr. Haworth said; he pointed out that they put the fibre into a stream of running water, which softened the gum and carried it away. This gum was of a remarkable character.* One Saturday in September, Mr. Greig had broken up in his machine a large quantity of fibre, there being a close murky atmosphere. The fibre was placed in a shed, and remained there until Monday morning, and on the Monday morning the mass, as high as that table, was like a large mass of isinglass glued up together with the fibre in it, nothing could be done with it, and it had to be thrown away. That showed the absolute necessity of attacking the stem the instant it was cut, with a running stream of water to carry the gum whilst it was in its natural state. It was then easily attacked, but let it wait or dry in any way, then

* When the experiments with Mr. Greig's machine were concluded, all the rollers, &c., were found to be thickly covered with a very hard varnish, so hard, that it could only be taken off by a chipping chisel. It had the appearance of lac. The analysis of this dry juice gave as follows:—"The juice contains 62 per cent., by weight, of oxalate of lime; and, besides this, some alumina, oxide of iron, and other mineral matters which dissolve in hydrochloric acid, the residue, insoluble in dilute hydrochloric acid, consists of colouring and resinous matter, and forms 2·5 per cent. by weight of the dry juice."—H. H.

the difficulty commenced and increased. The colour of the fibre also darkened in proportion with the delay in removing the juice. Mr. Greig's machine consisted of two rollers with scrapers, but there was another machine from America which was not tried, which broke the stems in a somewhat similar manner to this machine of Mr. Smith's, only there was no water employed, and hence it failed. The excellency of this machine was in its simplicity and in the application of water. The jet of water held up the mass of stems to the beaters; the instant the beater scraped off the bark, and all that adhered to keep the mass together, the fibres got separated, and they were so fine that they fell through, and into the film of water, leaving only the agglomerated portion to be worked upon by the beaters, thus the fibres are cleaned all round, while in the hand process they are only cleaned on upper and lower surfaces. That was a kind of self-adjusting sensitive cushion, and on its results the machine depended.

The vote of thanks having been carried unanimously, the proceedings terminated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION, LONDON, 1884.

It is proposed to hold, during the year 1884, an International Health Exhibition, which shall also illustrate certain branches of education, and which will occupy the buildings at South Kensington, erected for the International Fisheries Exhibition. (See Vol. xxxi, p. 1030).

The object of the Exhibition will be to illustrate, as vividly and in as practical a manner as possible, Food, Dress, the Dwelling, the School, and the Workshop, as affecting the condition of healthful life, and also to bring into public notice the most recent appliances for elementary school teaching and instruction in applied science, art, and handicrafts. The influence of modern sanitary knowledge and intellectual progress upon the welfare of the people of all classes and all nations, will thus be practically demonstrated, and an attempt will be made to display the most valuable and recent advances which have been attained in these important subjects.

The Exhibition will be divided into two main sections—Division I. Health; Division II. Education; and will be further sub-divided into six principal groups.

In the First Group, it is intended specially to illustrate the food resources of the world, and the best and most economic methods of utilising them. For the sake of comparison, not only will specimens of food from all countries be exhibited, but the various methods of preparing, cooking, and serving food will be practically shewn. The numerous processes of manufacture, connected with the preparation of articles of food and drink, will thus be exemplified; and, so far as the perishable nature of the articles will admit, full illustrations will be given of the various descriptions of foods themselves.

In the Second Group, dress, chiefly in its relation to health, will be displayed. Illustrations of the clothing of the principal peoples of the world may be expected; and a part of this Exhibition, which, it is anticipated, will be held in the galleries of the Royal Albert Hall, will be devoted to the history of costume.

In the Third, Fourth and Fifth Groups, will be comprised all that pertains to the healthful construction and fitting of the dwelling, the school, and the workshop; not only as respects the needful arrangements for sanitation, but also the fittings and furniture generally, in their effect on the inmates. The most improved methods of school construction will be shown, and the modes of combating and preventing the evils of unhealthy trades, occupations, and processes of manufacture, will form portions of the Exhibition.

The Sixth Group will comprise all that relates to primary, technical, and art education, and will include designs and models for school buildings; apparatus and appliances for teaching; diagrams, text-books, &c. Special attention will be directed to technical and art education, to the results of industrial teaching, and to the introduction of manual and handicraft work into schools.

It is proposed to arrange collective exhibits in connection with some of the above classes, illustrating, among other subjects, the dwellings of the poor, the care in the dwelling for the welfare of the children and of the sick, model nurseries, sleeping apartments, completely fitted kitchens, fully equipped gymnasia for adults and for the young, model laboratories and collections for health-teaching, model schools, workshops, &c., and also collections having reference to special trades.

It is also proposed to hold an International Congress in June or July next, on each of the main sections of the Exhibition—Health and Education.

Lectures will be given, and Conferences will be held, on the various subjects illustrated in or cognate with the Exhibition; they will be explained by practical demonstrations and experiments, and reports on each group will be issued.

Processes will be shown in actual operation, and practical tests will, from time to time, be made of the inventions submitted to the juries.

The Executive Council of the Exhibition was appointed by H.R.H. the Prince of Wales, President; and consists of the Duke of Buckingham and Chandos, G.C.S.I., Chairman; Sir James Paget, Bart., F.R.S., Vice-Chairman; Sir Frederick Abel, C.B., F.R.S.; Mr. Edward Birkbeck, M.P.; Dr.

George Buchanan, F.R.S.; Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.; Sir Joseph Fayrer, K.C.S.I., M.D., LL.D., F.R.S.; the Marquis of Hamilton; Mr. Ernest Hart; Sir John Lubbock, Bart, M.P., F.R.S.; the Right Hon. the Lord Mayor; Mr. Samuel Morley, M.P.; Dr. G. V. Poore; Lord Reay; and Sir John Rose, Bart., G.C.M.G. The Secretary is Mr. Edward Cunliffe-Owen, M.A.

This Council is now meeting regularly, twice a week, at the Society of Arts House, by permission of the Council of the Society. A large General Committee is also in course of formation. From among the members of the General Committee, the following Sub-Committees have been appointed:—1. The Dwelling; 2. Workshop and Factory Sanitation; 3. Food—raw materials; 4. Food and Cookery; 5. Heat; 6. School and Education; 7. Ambulance; 8. India; 9. Colonial. They will meet for the present at the Society of Arts, and will have under their superintendence the arrangements necessary for securing the efficient representation of the objects of the various sections of the Exhibition. It is announced that persons wishing to exhibit in any of the classes should apply to the Secretary, Mr. E. Cunliffe-Owen, at the offices of the Exhibition, South Kensington. These offices, it may be added, are in the buildings formerly occupied by the Fisheries Exhibition.

TROUT BREEDING IN OTAGO.

Although much attention has been paid to the artificial rearing of fish in England and in America, little has been done in the Australian colonies towards this object. The *Otago Daily Times*, however, gives a full account of a series of experiments carried out by Mr. W. S. Pillans, of Otago—who has raised some 6,000 trout—from which the following particulars are taken:—"This gentleman's property, known as Manuka Island Station, is situated a few miles from Balclutha, near the bank of the river. It boasts no natural advantages for pisciculture, and what has been done has been done by dint of hard and persevering work. The number quoted (6,000) does not, however, by any means sum up the extent of Mr. Pillans' operations so far. He has, it is said, given a quantity of fry to the Acclimatisation Society; and, exclusive of these, he has now at his nursery 57,000 ova in course of hatching, 6,000 yearlings, and nearly 250 two-year-old fish, all apparently thriving exceedingly well in the limited space at their disposal.

"The earliest process is 'stripping' the fish, and upon this it is unnecessary to dwell at any length. Most people are acquainted with the manner of obtaining spawn for artificial incubation, and are aware that it is a process requiring care and skill. Mr. Pillans is indebted, in this respect, to Mr. Steele, who has for some years past allowed him to take trout from a portion of the Wairuna River for the purpose of stripping. The process of hatching the ova, which commences from this time, occupies something like seventy-five days, and although it is not attended by all the difficulties met with in rearing young fish, it is nevertheless a trying time for the breeder. The ponds, hatching-troughs, &c., comprised in Mr. Pillans' establishment, are all situated in the immediate neighbourhood of his residence, as is necessary in view of the constant attention they require. The hatching-house is a small, barn-like structure, with thatched roof, and a very elaborate and ingenious arrangement of shallow wooden troughs. These are placed upon gradually-declining levels in such a way, that a running stream of clear water can pass on to each in turn. In those troughs, sometimes on a gravel bottom, sometimes in trays of wire netting, lie 50,000 odd of this year's ova in various stages of development—an array of small pinkish globules, the peaceful and insignificant appearance of which is wholly disproportionate to the anxiety and trouble they entail now and hereafter. The interior of Mr. Pillans' hatching-troughs is invariably carbonised, and this is to avoid the formation of fungus, which is, perhaps, the most fatal of the ills referred to. If it once fastens upon the woodwork, it spreads its invisible hold with immense rapidity, and the owner will be fortunate if the owner save a very small proportion of his ova. The sediment, which is carried in even the clearest water, is another source of danger, and this Mr. Pillans obviates by filtering his little stream very carefully, and further, by placing some of his ova on trays of galvanised iron wire, which allows them to be easily cleansed. The troughs have also to be kept carefully closed against the visits of living animals; and even then there is a second class of fungus (known as *Byssus*), for which a watch must be kept. This forms on the eggs themselves, and kills them rapidly in numbers. To prevent the spread of this, the troughs have to be examined daily, and the dead eggs, which may be detected by their change of colour, must be carefully removed. The newly-hatched fish are about half an inch long, darkly transparent, and rather resembling a splint of wood. They are still attached to the egg yolk (technically known as the 'sac'), and for a period of about five weeks they live by the gradual absorption of this. The younger of these trout, 'alevins,' display no sign of animation save an occasional wriggle if disturbed; but the older ones, which Mr. Pillans has separated into other troughs, are far more lively.

"Those who have consumed their sac, and therefore passed the 'alevin' stage, Mr. Pillans has transferred to what he terms his nursery-ponds. In this confined area they take their first artificial food, consisting of curds, which are sparingly scattered upon the water at regular intervals. In three larger ponds, Mr. Pillans has disposed the elder portion of his family. A trout, 14 inches in length, will eat one of seven inches, and it is inability and not fraternal feeling that prevents him attempting those of larger growth. Thus Mr. Pillans has found it necessary to distribute his yearlings in two small ponds (about 3,000 are contained in each), and a very marked difference in size is noticeable between these two assortments. Even with this precaution cannibalism exists among the youngsters. It was only recently that Mr. Pillans noticed a fish swimming placidly about with the tail of an undigested brother protruding from its jaws.

"The food upon which Mr. Pillans raises his trout is a kind readily procurable in the country—viz., rabbits' flesh. To the smaller yearlings is administered a diet of curds mixed with the liver of the rabbit very finely minced. The larger yearlings take the liver alone, and the more tender parts of the flesh, and the tougher portions are similarly minced and thrown into the pond of the two-year-olds. About 240 very fine trout are at present contained in this pond. They vary in weight from half a pound to a pound and a quarter, and appear to have thriven excellently upon the above-mentioned diet, to which has been sometimes added the larvæ of the bluebottle fly. There are at least half a dozen of these fish measuring some fifteen inches in length, and the average weight of the lot would probably be about three-quarters of a pound. They are all broad, well-developed fish; and if this year's hatching turns out as successful, Mr. Pillans will have a very valuable stock of trout upon his hands.

"A large additional pond, sixty feet or seventy feet in length, is in course of construction near the others, and this would be capable of containing enough fish to supply the Dunedin market when other sources failed."

Correspondence.

INTERNATIONAL FISHERIES EXHIBITION.

In my communication to last week's *Journal*, I inadvertently referred to the operations of the Fishery Board of Scotland, concerning the artificial fecundation and development of the egg of the herring as the "first attempt," accompanied by success, that has been accomplished in this connection. Writing direct from the published report, such impression was conveyed to my mind. I have, however, been since informed that similar operations, on a far more complete and extensive scale, were carried out many years since by the German Fishery Commission, and that the Scottish Fishery Board had, consequently, the advantage of such experiences for the conduct of their recent experiments. A full reference to these earlier achievements of the German Commission will be found in the lecture upon the herring delivered by Professor Huxley, at Norwich, in the year 1881.

W. SAVILLE KENT.

SOUR BEER.

Referring to the correspondence on "Sour Beer," which has taken place in the last two or three numbers of the *Journal*, may I be allowed to suggest that "prevention is better than cure," and that if a beer becomes acid, it is the result of either carelessness or ignorance.

As to what should be done, should some unfortunately turn sour, I quite agree with "Hampshire Brewer" that it is highly probable that it would spoil good beer if the two were mixed.

I can only suggest that it should be given to the pigs—if they will take it.

H. S. CARPENTER.

The Metropolitan Laboratory,
32, Holborn Viaduct, E.C.

General Notes.

PAPER has been made from cedar bark in Massachusetts, and the trials are considered so satisfactory that works have been started at New Bedford for manufacturing on a large scale. The paper is said to be specially suitable for laying under carpets, because it has the property of keeping away insects.

EXHIBITION AT LUCKNOW.—An Exhibition was opened at Lucknow, on the 6th November, called the Soldiers' Industrial Exhibition. The articles sent to the Exhibition, by 241 exhibitors of the various regiments on the station, are said to include many of excellent manufacture and novel design. They consist of carpenters', coopers', and joiners' work, turnery and fancy woodwork, ironsmiths' work, tin and wire-work, cutlery, jewellery, and highly-finished metal-work, leather work, machinery models, coach building, painting, photography, plans, maps, and designs, printing and lithography, needlework, lace-making, taxidermy and skin dressing.

CALCUTTA EXHIBITION.—The first International Exhibition ever held in India was opened on Tuesday, December 4th. The Viceregal party, with their Royal Highnesses the Duke and Duchess of Connaught and Sir James Ferguson, Governor of Bombay, arrived at 4.30, and took their seats on the daïs, Colonel Trevor, Vice-President of the Executive Committee, read an account of the rise and progress of the scheme, and in the absence of the Lieutenant-Governor, requested the Viceroy to declare the Exhibition opened. The total area of covered space is 400,000 square feet, independent of the little shops scattered about the enclosure, and this is considerably larger than the Exhibition of 1851. The open air occupied space is 40,000 feet, and the wall space 30,000 feet more. Great Britain has 837 exhibitors, the Australian Colonies 1,311; Foreign

Europe 347, and the Foreign East 700; making a total of 3,195 exhibitors.

Hungarian Exhibition.—A national exhibition s to be held at Budapest during the summer of 1885, and it is proposed to add to it an international section, to which the assistance of English manufacturers is asked. Hungary is an agricultural country, and it is suggested that makers of novel implements would find new outlets for their trade at this exhibition, while makers of engines and tools might open up a market, not only in Budapest, but in the neighbouring countries to the east and south. The objects to be exhibited are engines, machines for working wood, metals, and leather; textile machinery; machines and tools for hatters, brushmakers, potters, horn-workers, millers, bakers, printers, lithographers, and bookbinders. Application must be made before the last day of February, 1884.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

The following arrangements for the Wednesday evening before Christmas have been made:—

Dec. 19.—"Canada and its Products." By the Most Hon. the Marquis of Lorne, K.T., late Governor-General of Canada. Sir Alexander Galt, G.C.M.G., will preside.

Cantor Lectures.

The First Course will be on "The Scientific Basis of Cookery." By W. Mattieu Williams, F.C.S.

Lecture III. Dec. 17.—The nutritive constituents of Vegetables. The changes effected by cookery on Vegetable Substances. Ensilage of Human Food. May the use of Flesh Food be superseded by the scientific preparation of selected Vegetables?

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Mattieu Williams, "The Scientific Basis of Cookery." (Lecture III.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. The Discussion on Mr. J. W. Willis Bund's Paper, "The Agricultural Holdings Act, 1883."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. J. Tarver, "English Architecture and Monuments of the Sixteenth and Seventeenth Centuries."

Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. William Thomas Gray, "The Probable Effect of Withdrawals on the Rate of Mortality among Assured Lives."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 3 p.m. Mr. W. F. Sinclair, "The Fishes of Western India."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. Ambruster, "The Musical Dramas of Richard Wagner."

Tuesday, Dec. 18...Civil Engineers, 25, Great George-street Westminster, S.W. Annual General Meeting.

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Prof. Leone Levi, "Statistics of the Revenue of the United Kingdom from 1859-1882, in Relation to the Distribution of Taxation."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. E. B. Poulton, "The Tongue of the Marsupials." 2. Mr. J. Wood-Mason, "Contribution to our Knowledge of Embidæ, a Family of Orthopterous Insects." 3. Dr. Franz Leuthner, "Monographic Revision of the Lucanoid Sub-family Odontolabini."

Wednesday, Dec. 19...SOCIETY OF ARTS (in the Lower Room, Exeter Hall, Strand), 8 p.m. The Most Hon. The Marquis of Lorne, "Canada and its Products."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hon. Ralph Abercromby, "The Explanation of certain Weather Prognostics." 2. Mr. G. M. Whipple, "Preliminary Inquiry into the Variations in the Reading of Black-bulb Thermometers in Vacuo." 3. "Report on the Phenological Observations for 1883." 8 p.m. Special General Meeting, to consider certain alterations in the Bye-Laws.

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. W. Davis, "Some Remains of Fossil Fishes from the Yoredale Series at Leyburn, in Wensleydale." 2. Mr. J. J. H. Teall, "Petrological Notes on some North of England Dykes." 3. Mr. C. Parkinson, "The Droitwich Brine Springs and Saliferous Marls."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Messrs. R. M. and F. J. Bancroft, "Chimney Construction, with Examples of Existing Shafts, in Brick, Stone, and Wrought Iron."

Thursday, Dec. 20...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. O Bower, "Structure Stem *Rhynchopetalum montanum*." 2. Mr. J. R. Greene, "Glands of Hypericaceæ." 3. Mr. Alban Doran, "Ear Bones of *Rhytina*." 4. Mr. C. Potter, "Starch Grains in Lacteal Cells of *Euphorbia*." 5. Mr. Walter Gardner, "Stipulated Glands of *Coprosma Baueriana*."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. C. O. Sullivan, "Researches on the Constitution of the Gums of the Arabin Class." 2. Dr. W. Ramsay and Mr. Sydney Young, "The Decomposition of Ammonia by Heat." 3. Dr. W. Ramsay and Mr. Franklen P. Evans, "The Dissociation of the Halogen Compounds of Selenium."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor W. H. Flower, "Whales."

Royal Historical, 11 Chandos-street, W. 8 p.m. Mr. Oscar Browning, "The Triple Alliance of 1788."

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Friday, Dec. 21...Philological, University College, W.C., 8 p.m.

Folk-Lore Society, 22, Albemarle-street, W., 8 p.m. 1. Mr. E. Clodd, "The Philosophy of Punchkin." 2. Mr. W. G. Black, "An Additional Chapter in Folk-Lore Medicine."

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FRIDAY, DECEMBER 21, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

On Monday evening, the 17th inst., Mr. W. Mattieu Williams, F.C.S., delivered the third and last lecture of his course on "The Scientific Basis of Cookery." He drew special attention to the nutritive value of cheese, and described the various modes of cooking it, a subject which he said was much neglected in the kitchen. In his remarks on milk, butter, and "bosch," Mr. Williams said that the latter substance was a fair substitute for butter, if made of good material, but, of course, it should be sold for what it is. The nutritive constituents of vegetables were next described, and the lecturer hinted that in the future it might be possible, by scientific treatment, to obtain direct from vegetables that nutriment which now we obtain from flesh food, without the vegetables passing through the body of animals. A vote of thanks to Mr. Williams for his interesting course of lectures was moved by the chairman (Dr. Mann) and carried. The publication of these lectures will be commenced in the next number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 2nd and 9th, by Mr. J. Millar Thomson, F.R.S.E., F.C.S., on "Crystals and Crystallisation." The lectures will commence at seven o'clock. All the tickets having been disposed of, the issue is stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 19th, 1883; the Hon. Sir Alexander Tilloch Galt, G.C.M.G., late High Commissioner for Canada, in the chair.

[The meeting was held in the lower hall, Exeter-hall, Strand.]

The following candidates were proposed for election as members of the Society:—

Appleton, R. H., Woodside-hall, Eaglescliff Junction, by Darlington.
Houston, Frederick H., Carlisle-terrace, Belfast.
Pott, Henry, 81, Cornwall-gardens, S.W.
Prosser, William Owen, 5, Trinity-place, Swansea.
Rea, Russell, 19, Primrose-hill-road, N.W.
Tomkins, Daniel, The College, Great Yarmouth.
Wildsmith, James H. S., 131, Upper Kennington-lane, S.E.

The following candidates were balloted for and duly elected members of the Society:—

Crow, John Kent, D.Sc., 2, Colham-villas, West Drayton, Middlesex.
Cunliffe-Owen, Edward, B.A., 64, Inverness-terrace, W.
Henderson, Richard, The Grange, Kirkcudbright, N.B.
Latchford, Edward, 50, Penywern-road, South Kensington, S.W

The Chairman, in commencing the proceedings, said it was not necessary to introduce the Marquis of Lorne with any lengthened remarks, but he could not help drawing attention to the distinguished services he had performed as Governor-General of Canada during the last five years. Those connected with that colony knew that during his administration there he had not only done his duty to his Queen, but had made himself most useful to the people over whom he presided. Canada had had, under Lord Lorne's administration, five years of unexampled prosperity; there had been no discontent, but loyalty had reigned through her wide borders, and his lordship had the satisfaction of knowing that he returned his government to the Queen in a state which all of her subjects must rejoice to see. Besides the political services which Lord Lorne performed in Canada, as head of the Government, he devoted himself to acquiring a perfect knowledge of its resources, from the

Atlantic to the Pacific; and he (the Chairman) trusted that the paper about to be read would contain some account of the Marquis's numerous journeyings. He hoped also that he would be able to say something on the Indian question of North America. They were proud to believe that the Indians of British North America had been contented, and free from those feuds and bloodshed which had distinguished them in the neighbouring republic. Under the Government of the Queen they had found good faith observed towards them, and they found that honesty and justice were characteristic of the British Government. He hoped also that they would hear something of British Columbia, which Lord Lorne visited in company with the Princess Louise; a country not very well known, but which was destined to become one of the brightest jewels in the crown. It was not necessary for him (the Chairman) to say much about the dominion of Canada, but no one in this country, seeing the social questions which were agitating the public mind, could doubt that it was of the utmost importance to have, within little more than a week's sail from our shores, abundance of good land, and a contented people, ruled over by the same sovereign, enjoying the same civil rights, and ready to receive those who from any cause were unable to get a livelihood at home. One point he must say a word upon, and that was the question of the Irish in Canada. He was proud to say that amongst the Roman Catholics of Canada, numbering nearly a million, the most loyal sentiments were entertained. It was a proud thing to be able to say that the same sovereign that ruled Ireland ruled Canada, and the Irishmen there, with scarcely an exception, were as happy and contented as those that came from England and Scotland.

The paper read was—

CANADA AND ITS PRODUCTS.

By the Most Hon. the Marquis of Lorne, K.T.

Late Governor-General of Canada.

With respect to the climate of Canada, so often held up as a terror, except upon the sea coast, there is but little moisture in the air; and although the thermometer goes down far below zero during some of the winter nights, men feel the cold far less than on the sea coasts of England and Scotland. I remember visiting a place in the plains of the central part of Canada, where perhaps the cold causes the mercury to fall to the lowest point it reaches in the Dominion. I was met by a number of the residents, who were good enough to come to tell me of their experiences in their new homes. With settlers from the Eastern Provinces were mingled others who hailed from England, Ireland, and Scotland. I had received satisfactory accounts of the year's excellent crops from all, and then put questions to them as to the advantage or disadvantage of the climate as compared with that of other places. Several had borne evidence of the healthfulness and purity of the air, and to their preference for it as compared to that of any region they had known, when up pushed a sturdy Irishman, who said :—"I want you to tell this to my people at home. I come from the County Armagh; and I was thatching my house last year in the cold weather, and I felt it far less than I did the last time I thatched my house in Armagh."

When agents of railway companies, and men interested in the South, try to persuade settlers to go down to the South and settle in some parts which are notorious for their cyclones, snakes, and centipedes, it is well to remember how healthy the conditions of life in the North are, to what a great age men usually live. Throughout old Canada and British Columbia, and to the north of the Great Plains, there is not any place where the settler can want for wood and fuel. People, indeed, get too much of the forest; but what a blessing it is that the stove can always be replenished with logs of any size at will, that a house as comfortable and as warm as any can be put up in a few days for so little money, and that, unless a man voluntarily exposes himself to the weather, he need never fear the consequences of the cold season; and where the pine woods fail on those great prairies, of which so much is now said, what is now happening? One great railway already traverses these plains throughout their entire breadth of 800 miles. Branch lines are being rapidly formed, and each train may carry firewood enough for the use of half a settlement for the winter. But these trains are now carrying more than wood, for under the shadow of the Rocky Mountains lies a province, recently named Alberta, where is a great zone lying for hundreds of miles north and south, and with a breadth from east to west of thirty or forty miles, the country is found to be rich in excellent coal. There is a fine specimen in the room from the mines of Sir A. Galt, who has taken land in several places, and the Canadian Pacific Railway regularly uses that procured from his works. As you approach the mountains, the coal seams become always of a better quality, until in the mountains anthracite itself is found. Comparatively nothing but mere surface scratchings have as yet been undertaken, and to judge from the coal lumps washed down by each of the streams near the hills, and the exposed sections often visible, there must be a vast quantity. Deep borings will no doubt now be undertaken. Already the railways carry the stuff for one and a-half cents. the mile, and the price of coal fuel will readily decrease as more works are opened, and more seams are worked. The quality hitherto found closely resembles what is procured from Vancouver Island, where mines are worked near the water's edge, and the produce taken to San Francisco, fetching a higher price than any at that port.

Away beyond the mountains, and down the Pacific Coast, we come upon a land whose climatic conditions are totally different, namely, a land called British Columbia—an immense land of mountain, forest, and flood, the Alpine ranges soaring in some of their peaks to the height of Mont Blanc—a land in the main so deeply and wonderfully forested that you may, on its sea coast, cut timber thirty and forty inches square, of a uniform size for one hundred feet—a country where the rivers rush impetuously through tremendous gorges, to run in shorter navigable reaches into harbours which are defended by a gigantic natural breakwater formed by the immense rocky island of Vancouver. Here, on this island, we have a climate like that of the south of England. All the shrubs which are familiar to you in the gardens about this city, and many more which would be too delicate to grow here, thrive in that favoured island. A great deal of it is mountainous, and practically unknown. To the north of it lie other great groups of islands and more mountainous coast, and the climate is again mild, but the rainfall is heavy. In the interior of this Canadian Switzerland you have strange variations of climatic condition within narrow areas; you may have a farm in a beautiful rich valley, surrounded by magnificent woods, and five miles off you may go and pay a visit to your friend who has another farm, and find that his place has such dryness that not only will it not support the heavy timber growth with which you are familiar on your own homestead, but your friend has even to bring water to irrigate his garden, which, with this provision, will produce even more richly than your own.

And now let us turn to the gigantic enterprise, the Canadian Pacific Railway, involving so much outlay and so much labour, and now being pushed with such energy and success.

You have heard how an American company, some years ago, constructed the railway which runs through the Mormon settlement of Salt Lake City; you may also have been told how another line now sweeps round by the south of California, and by the frontiers of Mexico, and across by the cactus-covered deserts, and wild torrid sands of Arizona and New Mexico, until it reaches the East and the connecting lines of the Atlantic companies on the Missouri and Mississippi. You may also have been told lately of the remarkable progress made by the Northern Pacific in the Northern States, thus giving the Republic three lines which cross from shore to shore, but in none of these cases have the lines been pushed with the speed, certainty, and thorough workmanship which has been exhibited on the Canadian line. The American Northern Pacific Railway Company was incorporated as long ago as 1865, nearly twenty years ago; whereas the Canadian company has been at work less than three years. Richly endowed with magnificent lands, the equal of which can only be found in the favoured American States of Illinois and Ohio, the British company has spared no expense to make the track so perfect that trains passed over it at great speed as soon as it was laid. In one week, during the last summer, no less than between twenty-five and thirty miles of railroad were laid and completely finished; and almost incredible as it may seem, it is yet a fact, that on the Saturday of that week over six miles of track were put down. It is a beautiful exhibition of perfect organisation to watch the manner in which this is done. First come the engineers with their levels; closely following them an army of spade men, who raise the embankment, or cut through the earth mounds, removing by blasting any obnoxious rock. Then, to the end of the completed track, and piled on vehicles drawn by well-equipped numerous teams, arrive the ties, or as they are in this country called, the sleepers, or wooden cross beams. Quickly these are scattered along, and laid by gangs in order. Instantly up comes a car laden with steel rails —steel rails, which, by-the-bye, have been imported all the way from the Old World. With iron hooks the men grapple these rails one after the other, and as each pair is laid upon the sleepers, boys place a couple of great nails along the line, and the sturdy hammermen with a few strokes drive these into the wood, fix the rails, and onward over the fresh joint of railway goes the car, until all its load of steel rails have been deposited. Imagine the perfection of the organisation which, in the prairie untrodden as yet by men, or still worse, in the rock-strewn and mountainous country, can on a single line of rail arrange for the accommodation of men, for the transport of material in wood, iron, and provisions, and can send on train after train to the end of the track, arranging the sidings as they proceed and accomplishing such feats as that recorded of the week of which I have spoken to you. You may ask how it is that such expenditure can be incurred, that work can be so quickly and so perfectly finished by such armies of workmen; for many thousands have been labouring during the last year, and are still labouring at this great national enterprise. The secret is in this, that the lands in the central portions of the Continent which have been granted to the company are of such excellence, that from their sale alone a certain remuneration can be expected. Emigration has poured into that region in a manner unexampled since the days of the settlement of the great western commonwealths whose chief and most remarkable city now is Chicago. In spite of opposition encountered from interested rivals, the fact of the excellence of the soil has become so patent that there was no difficulty in finding the money for the first great expenses, and the initial cost is always far the greatest. With the Americans, the Germans, the Russians, the Icelanders, and the English, Scotch, and Canadians, who are now flocking into the country, to the tune of 40,000 or 50,000 in each season, the traffic which must be developed to supply their wants in wood, coal, and the necessaries as well as the luxuries of life, must continually increase. It was only two years ago that the line left the suburbs of Winnipeg; it was only yesterday that it touched the mountains of the west, and already a vast increase in its traffic receipts are noticeable. It is not as though it started from no basis, and ended in no important terminus, or passed through barren lands on either side; it will rest upon two great oceans, and throughout the middle portion of the continent it has land, not only along its line, but also to the north and south of it, unrivalled on the continent of America. The branch lines, whereever they stretch towards the north, must feed its energy, and supply it with nutriment, for there is practically no limit to the vast area of wheat which may be created along the banks of the North Saskatchewan River, and the immense country lying towards that mighty stream, the Peace River. There is everything to attract settlement, and nothing to repel it. The man who desires to farm should have £100 to £500, according to his wish for a large or small farm; the labourer, the blacksmith, the bricklayer, and mason, may go with the assurance of finding work.

There is nothing so interesting as the first exploration of a new country destined to be a highway. Until this autumn, it was doubted if any good passes could be found through the Rocky Mountains, west of the Selkirk Range. Mr. Sandford Fleming, formerly chief engineer to the Canadian Government, was this year commissioned to accompany the present Canadian Pacific Railway engineer, Major Rogers, through these mountains, and to report. He had a hard time of it; but his account shows that although the passes are steep, involving heavy gradients, there is nothing that cannot easily be graded.

Let me give you a few extracts from his note-book, which I have only just received. The ground is all new, and he and his party went through country where no white man, and, probably, no Indian had before trod, in the transit across the central range, between the two great bends of the Columbia. You will see that the tourist and artist will have wondrous scenery on the Canadian Pacific Railway. In ascending from Morleyville "the valley is from three to eight miles wide, extending in a generally western direction between the foot hill of the Rockies. There are no sudden ascents, and the prairie country is gradually continued into the heart of the mountains by this valley. David Macdougall informed us that he has seen the valley black with buffalo, and from an eminence not far from Morley he has beheld at one view a herd estimated at not less than a million buffalo. As we advance, the prairie diminishes in extent, and we pass through park-like scenery. We find groups of trees at intervals, and the Bow River gleams in the sun at its various turns. A magnificent geological expanse presents itself. The mountain to the north of us is nearly perfectly bare, for 1,500 feet high nearly vertical, and possibly two miles in length, the lines of strata can be distinctly traced, all dipping in a westerly direction. Four miles above Padmore, we are completely in the mountains, the sound of hammer and drill echoing and re-echoing on every side. The Cascade Mountain has a small stream issuing from its side, possibly 1,000 feet high, and reaching the valley by a single leap. This is the most striking mountain we have yet seen in the valley. The engineers, whom we met a short way from the spot, had measured the height at 5,060 feet above the plain. We had a pleasant canter for twelve miles up the valley, between mountains of the grandest description; to the south of us two of great prominence present themselves. They command a valley leading to Vermillion Pass. They are of striking beauty, and one of them is crowned by a cubical mass covered with perpetual snow. The other is pyramidal in form. We proceed westwards, and we behold Castle Mountain to our right. The resemblance to Cyclopean masonry has doubtless suggested its name. This is very marked in its huge masses and tunnelled flanks.

"Our ride to-day is most agreeable, part of the way through Banksian pine, and occasionally by an immediate bank of the Bow River, which is still a large stream—larger a good deal in volume than the Thames at Richmond.

"The current is very strong, and it would prove a hard task to canoe up stream even with poles, as on the rivers of New Brunswick. At other points we ride through burnt wood, where fire has recently destroyed the groves of young timber. In consequence of the fires the air is smoky, and we cannot always see the mountains, but occasionally a snow-covered peak appears far above the dense smoke below. To the south of us we see what the map shows to be Mount Lefroy, but there are several lofty summits, any one of which is sufficiently remarkable to be named after the distinguished general. One of these is crested like the back of a huge camel. Another rose up to a sharp cone. Looking across the lake to the south, a vast mountain with snow-filled crevices stretches. This is a remarkable mountain, and makes a grand picture with its reflection in the bright lake. We cross the outlet of this lake by fording a clear, cold stream, some 40 feet wide and 16 inches deep. This is the commencement of Kicking Horse River, a stream which we have to follow for some days. It received its name, the Indians informed us, in Dr. Hector's time, who, it is said, was kicked by a horse not far from where we are now. The valley goes by the same name. The Indian name is something more euphonious —Shawatu Nowchata Wapta (Horse Kicking River). We are now entering, as our guide informs us, the worst five miles on the road to Columbia. It proves bad enough, and we move at a snail's pace. The poor horses have to scramble as best they can over rocks and other obstacles, in many places almost perpendicular. Three packs come off, and one horse rolls down the side hill, turning a complete somersault, but the pack being firmly secured to his back, probably saved him from injury. He is soon relieved by Wilson and Dave cutting the pack ropes, and lifting him to his feet again. We are seldom in the saddle, it being safer and pleasanter to drive the horses before us. The river comes in sight now and then, and passing over foaming rapids inclined at a general inclination of from 1 in 5 to 1 in 8, the water is soon churned into liquid. Before we reach our camp ground for the night, there opens up to our view a magnificent mountain spectacle. Looking up at an angle of probably 60 degrees, we see high in the heavens a great mural crown, variegated with the different coloured strata, nearly horizontal, and lighted with the bright sun. Separated from this mountain top by a great depression there is another equally lofty, and both are undoubtedly fully a vertical mile above our heads. On the mountain last referred to, some distance from the summit, we observed a great glacier overhanging a precipice below it, and presenting a vertical face of hundreds of feet in thickness.

"Our journey to-day proves exceedingly rough. We have to cross many gorges, some of them so narrow that a biscuit may be thrown from the last horse descending to the bell horse six hundred feet ahead. The fires have been running through the woods; they are still burning, many of the half burnt trees have been blown down, obstructing the way, and making it difficult to proceed. The delays are frequent, and ascending a long slope by a narrow path the footing of one horse gave way, and down he went, rolling over and over half a dozen times. Of course we thought he was killed, but Dave and George unfastened the load, and speedily got him on his feet from a depth of some fifty yards below the trail. As we proceed, our travelling does not improve. We have many miles through burnt woods. Fortunately the air is still, otherwise we would have the blackened trunks falling around or upon us and still more impeding our progress. Down and up gorges hundreds of feet deep, across rocky slides where the poor horses had to clamber, or between sharp points, running the risk of breaking their legs. The trail, to avoid a series of precipices, running sheer up from the boiling river, has been carried along a side hill to an elevation of some seven or eight hundred feet. The sloping ground is so steep that not a vestige of vegetation is to be seen on it for a long distance. The path we have to follow is exceedingly narrow, so narrow in places that there is scarcely a foothold. For five or six miles we have to travel over ground of this description, fitted only for the mountain goat or the chamois. We crossed clay slides and gravel slides at a giddy height. One cannot look down. Some three miles from the mouth of the Kicking Horse River, we met Major Rogers and Major Hurd, and secure our first glimpse in the distance of the Selkirk range. The sun beats down with great power. We are wet with perspiration. At last we reach the valley of the Columbia, where it is some twelve miles wide from peak to peak. We have travelled the whole length of the Kicking Horse River. From the summit to the flats of the Columbia the distance is nearly 50 miles, the descent about 2,700 feet, and the average fall about 57 feet per mile. Of this fall the first six miles gives a descent of 1,200 feet, or 200 feet per mile. The last ten miles the river falls on an average of 60 feet per mile, leaving for the intervening 32 miles an average fall of less than 30 feet per mile. We reached this point by a tributary from the east, the Kicking Horse River. This mountain torrent rises in the main crest of the Rocky Mountains, and flows for a great part of its course with tremendous impetuosity. For the first six miles from the summit, and the last ten miles, it passes through canyons. The descent in the upper canyon is violent, but the volume of water in the lower canyon makes the stream much more formidable before the Kicking Horse joins the Columbia."

Down the Columbia.

"*Saturday, September 1st.*—The Columbia River rises some seventy or eighty miles north of the International Boundary Line. It flows north-westerly 180 odd, or 200 miles, to a point on the 52nd parallel, known as the Boat Encampment. At the Boat Encampment it turns almost completely around, and flows nearly due south for more than 300 miles. Thence it takes a westerly course to the Pacific coast. Before crossing the International Boundary Line, it flows 400 miles through Canadian mountains. The second half of its course is through the United States. On Monday morning we will descend the Columbia in a canoe or boat, and overtake the horses a day's journey from here.

"*Sunday, September 2nd.*—This is a delightful Sunday morning in the valley of the Columbia, with the great Selkirk range in front of us. We see high peaks as far as the eye can scan, away to the east and north-west. We do not see the Rockies, as we are at their base, and they are concealed by a high terrace, but we can never lack company in presence of the mighty Selkirks. A great glacier is visible to the south, and huge snow fields lie between the peaks of the mountains generally. This is not fresh snow, as none has fallen for some time. This, therefore, has remained from former years. There are, in descending this river, long reaches of comparatively smooth water, then ravines which form simply a rapid portion of the river, where its waters pass through a somewhat contracted portion of the channel. There is nothing to prevent canoes or boats safely running these rapids. Indeed, a steamboat could go down, and it is less turbulent than the rapids of the St. Lawrence. There would, however, be difficulty in getting any kind of vessel up. The Indians in this country do not use canoes to any great extent. When they travel, they generally take horses with them, and follow trails where trails are possible. After leaving the canyon, we travel along the edge of the river, through flats, to our camping place for the night, opposite the mouth of the Beaver River, which falls in on the Selkirk side. We are now some thirty miles north-westerly from the mouth of the Kicking Horse River."

Crossing the Selkirks.

(Ascending from the East.)

"Leaving the River Columbia behind us, to be again seen and recrossed, we trust in about a week, after we have ascended and descended the Selkirks, we follow a roughly and recently made trail by the edge of the Beaver River. The Beaver River is quite a large stream, and, passing through an open canyon for some four or five miles, is quite unnavigable. There are few places where it could be forded. After passing the contracted valley near the mouth of the Beaver River, the hills recede, and we pass through a flat and well-timbered valley from a half to a mile or more in width. There is a dense growth of cedar, spruce, and cotton-wood. Cedar as much as four feet in diameter, and spruce three feet in diameter, are quite common. The undergrowth is now decidedly the flora of the Pacific slope. Everywhere the prickly auralia, or devil's club, ferns, skunk cabbage—all of rank growth—are to be seen on the low ground. There is no pasture for the horses. We followed Bear

Creek to the west for a short distance, passing through a tall forest until we reach a regular mountain defile leading up to the summit. The mountains are high above our heads, and although late in the forenoon, the sun is hidden by them. We cross many old avalanche slides. On the southerly side of the valley great scours in the mountains are seen filled with snow, some not more than two or three hundred feet above the bottom of the defile through which Bear Creek flows. To the north there is a great glacier, possibly fifty yards thick where it terminates. It comes from a point far back beyond our view. Underneath the glacier there are traces of a very heavy snow slide, where trees have been broken and crushed in all directions, and judging from the age of the timber, this slide must have occurred a considerable time back. It was caused probably by the breaking off of a large portion of the glacier. We are sitting on a rich meadow 4,600 feet above the sea, surrounded by great mountains of all forms, some pyramidal, some rounded and serrated with glaciers between them. Looking west there is an open valley with great peaks in the dim distance, and looking north in the direction from which we have come, there is certainly the grandest view of all. The valley is completely enclosed by what seems to be impenetrable mountains. The defile through which we have entered is not visible, and high up near the lofty peaks there is a series of glaciers stretching out a mile or two from north to south. The entrance through which we have come opens up faintly to view."

Descending the Western Slope.

"Leaving the grassy plain at the summit, we descended very rapidly, coming in sight within half-an-hour of a conical peak to the south-east, of great prominence. This cone was possibly a thousand or fifteen hundred feet above all the other mountains, and terminates in a sharp cone.

"Our journey this morning begins as it ended yesterday, along the edge of a rapidly descending stream, walled in by mountains thousands of feet high. Fourteen miles from here we find two large patches of snow or ice, one on each side of the river. This, we were informed, had been seen three years ago, but then they were much larger, and formed a bridge across the river. An avalanche had slid down from the mountains, but how long ago no one knows. All that we do know is that the remains of the avalanche was seen at this point three years ago, with a passage underneath for the water to flow. The walking is dreadful, climbing over and creeping under fallen trees of great size, the men soon feel the burdens they carry, and rests are frequent. It is hot work for all. The wet bushes make us wet from without, and the perspiration makes us wet from within. We meet with obstacles of every description, including millions of devil's clubs. We have to rest every fifteen or twenty minutes, and proceed again. The travelling, however, is varied from time to time in climbing up or down the rocky slops, to walk through alder swamps, treading down skunk cabbages, and fighting the prickly auralias. The toil continues hour by hour, with intervals of short rest, until half-past four in the afternoon, when, the men tired out, and unable to go further, a halt becomes necessary at the best spot which we can secure. We select a high bank, overlooking the Ille-celle-wate, and there rest for the night. The Ille-celle-wate here has increased from a tiny brook to a raging torrent more than forty yards wide. The colour of the water is much the same as that of the Thames in London. The valley we are in is very narrow. It is bounded by lofty mountains, wooded a long way up. Their summits are generally concealed from us by the forest, but occasionally during the day we have seen snow peaks peering over the lower elevations. In some portions of them never a stray sunbeam reaches them. The vegetation, in consequence, is peculiar, and mosses of every variety are found. The ferns, where the soil is rich, are as high as a man's head, and the auralias and skunk cabbages are as rank as possible. Here and there, on some rocky point above the deeper portions of the valley, we found many berry-bearing shrubs, the fruit of which was extremely palatable to us, although all were somewhat acid. We reached the lower canyon of the Ille-celle-wate, where we are compelled to clamber around from rock to rock, holding on to, or swinging ourselves by, the stunted trees and twigs which grow at intervals. At some places the men had to be unpacked, and they had to draw each other up by hand from one ledge of rock to another. At other points we had to climb along narrow ledges, creeping under a cascade, or over a point of a precipitous rock. But we at last reach camping ground. n about a half-a-mile from our starting point, we reach a jam of logs not far from the lower end of the canyon. Tree after tree has been piled here, for nobody knows the number of years, until a space of some hundreds of feet up and down stream is filled in inextricable confusion, to a height of at least thirty feet above the level of the water. Here is an accumulation of material which, if in London, would make a fortune for any man. We trudge along at a brisk rate through ground much the same as yesterday. Abundance of devil's club and fern, brush and logs, and every conceivable thing impeded our progress. We follow the same system of travelling as was found so excellent yesterday, resting five minutes every twenty minutes. We halted for lunch at noon, and it was suggested that we ought to be within the hearing of a gunshot on the Columbia. We expected a party from Kamloops with supplies to meet us, and they ought to be at the Columbia before this. Accordingly, I fired two rifle shots. In a short time we heard a gunshot. Our hopes were immediately raised. In reply, three more shots were fired in rapid succession, and in a little time we distinctly heard in reply one, two, and three shots. Our delight can well be imagined. Hurrah! hurrah!! hurrah!!! We have our connection with our party from Kamloops. Our lunch is soon over, and we are off, greatly excited, to get the first glimpse of the Columbia River. But we have a good way to travel still, and a five minutes' rest is called for. Here we fire another shot. Immediately we hear two shots in reply, more distinctly than before, and we are off in a bee line in the direction indicated by the shots. Soon we are out of the green woods, and in sight of the Columbia. We see smoke ascending from a camp on the opposite shore a mile away. It is undoubtedly our Kamloops friends. We see two canoes crossing the river, which is here known as the Great Eddy of the Columbia. We wait patiently on the high sandy bank in full view of the Eagle Pass directly opposite. Our hopes are soon dispelled, the canoes contain Indians who can speak no English, but, with the help of a little Chinook jargon, we learn, to our great disappointment, that no one has arrived from Kamloops. The Indians replied to our shots, and they belonged to a small hunting and fishing party who had been encamped at this place for some four weeks. They have seen no one whatever from Kamloops. Every joint ached. Our flesh was lacerated in places. Our hands were festering from the pricks of the devil's club. We knew we would have a great deal more of it before we could reach Shuswap Lake, and our food was very limited. We were short of men to carry it. We were terribly disappointed that the Kamloops party had not arrived. We were not ahead of time, but they were behind the time named. They were engaged by the Hudson Bay Company to meet us without fail. The head offices of the company were informed repeatedly that we would be absolutely depending upon them for food. True, we had one alternative. Providentially, the Indians were available, and we could possibly persuade them to paddle us down the Columbia to Fort Colville, and from this find our way to Victoria by the Northern Pacific Railway; but we could not entertain the idea of making a flank movement. We started to reach Kamloops on as direct a course as possible from Calgarry This is the work which we set out to do, and we have not yet done it.

"*Wednesday, September 12th.* — The much expected party from Kamloops has arrived. Five men issued from the woods on the flats of the Columbia a short distance from our camp. They have been sent with supplies to meet us at this point, and, on their first appearance, they were hailed with great joy. To-day we pass along a path used by the Indians for carrying carriboo and other game from the mountains. Near this the partridge berries were very large, almost like small grapes, and pleasant to the taste. We saw also abundance of large huckleberries and blackberries. Surely, when fruits grow here so luxuriantly, garden fruits might find a home in this sheltered valley. We are fast ascending towards the summit. The valley is probably a quarter of a mile wide, walled in by parallel mountains, for the most part wood to the top. As we proceed we pass through a fine grove of open wood, chiefly hemlock, suitable for railway construction. We cross the summit stream several times, and about five p.m. encamped on its western side, in a small spot which we find free from devil's club, and great cedars four feet in diameter rising like the columns of a temple around us. Within a circle of a hundred feet radius the eye may count forty of these large trunks. We are at the summit of the Eagle Pass, although scarcely yet in the heart of the Columbian range. We are only four hundred feet above the Columbia, and to-morrow we will be following a stream falling towards the west. Then through a series of lakes they pass down the Eagle river, which leads them to the British Columbian lakes, whose steamers take the lumber through beautiful wildernesses, and reach Kamloops, where the railway is all but completed, and then down the Thompson and Fraser gorges to the sea-coast, where we have no time to follow them, very interesting as hose regions are."

We can now return to the plains, and look at the Indian Nomad tribes. A law exists throughout our territories against the sale of whiskey, a law vigorously enforced. Whiskey is the bane which drives the savage wild, and is the fruitful cause of every crime amongst the white men in the American western villages; and the prohibition placed upon its use does much towards preserving order among the young communities of a British soil. You do not hear in villages in our land, as you do hear it said further South, that "shooting was pretty lively here last night." There is a story that, in a Colorado ball-room, it was necessary, on account of the manners and customs of the inhabitants, to write in large letters over the head of the unfortunate gentleman who had been detailed to perform music for the evening's amusement, "Please don't shoot the pianist, he is doing his best." If trouble occur in our Canadian West, it is promptly suppressed, and the guilty ruffian handed out. Ample provision is made, as the country settles up, for school purposes, nor are the spiritual wants of the people left unheeded. The Roman Catholics were early in the field, but Anglicans, Presbyterians, and other denominational bodies have quickly followed in their steps, and many a devoted servant of his church is at present labouring among the scattered population of every part of the territories. It is interesting to see how originally wild savage bands are becoming tame and half civilised.

It is only a few years ago that, near our line, a band of Sioux, under the leadership of a chief named Sitting Bull, achieved a victory over a civilised force which has no parallel in the annals of any recent war between civilised and savage troops, except the single case of Isandula. General Custer, one of the most gallant officers of that gallant Northern Army—a man distinguished for intrepidity and skill in the war against the Southern Confederacy—had been appointed to a command of cavalry not very far from our frontier line. As is too often the case, unnecessary quarrels had led to unnecessary fighting between Uncle Sam's boys and the braves under Sitting Bull. Custer, coming upon their camp in a place chosen with rare skill by the savages, impetuously ordered an attack. Accounts vary of the struggle which ensued, but the story must necessarily come chiefly from one side, because no American soldier lived to relate the tale. The Indians say that the white men advanced in two columns; that they had, to a certain extent, by twisting willow-growth and grass together, been able to make some defence, but the ground was favourable to the repelling of the assault; that the Indian women were sent out of camp, but that a child had been forgotten, and, just before the battle was joined, the chief's wife came riding up, and took the child up, and rode away with it, while already under range of the American carbines. As the troops came on they were greeted by a hot fire, and an impetuous charge of the red men, who, by this time, had partially surrounded the attacking troops. Something like a panic seems to have ensued, for the Americans broke and ran—several, as it is narrated, blowing out their own brains in order to avoid falling into the hands of the merciless foe who, mounted on swift ponies and armed in addition to their rifles with the terrible coupe-stick, or battle mace of stone, carefully carved into double points, and roughly fastened to a pliant and long handle formed of buffalo skin, dealt the flying enemy a blow on the head or back which caused him to sink dying on the grass A terrible fight, without quarter, it was, for the ghastly bodies of the dead soldiers, with the bleeding skulls where the scalps had been torn off, were alone left to tell what had occurred. It was greatly to the credit of the American people that when years afterwards we wished to get rid of Sitting Bull, who had taken refuge on Canadian soil, amnesty was granted to him and his people, and in reply to the query addressed by the Canadian Government as to his probable treatment should he surrender to the Americans. Mr. Evarts, United States Secretary, replied, "He will be treated as a great nation always treats its prisoners of war." We were anxious to be rid of his presence, for he and his 5,000 were eating up the scanty game of our own Indians, and he himself, from his well-known astute and warlike character, gave anxiety to us, in that we never knew whether he were not harbouring against our republican friends some evil design. He was often reported as about to embark in a raid or cattle-lifting expedition, an amusement for him which it would have been difficult for us, at that time, to prevent, and which might have yet led to a rupture of that friendship and excellent understanding which has most happily always prevailed along our north-western borders. The redoubtable Sitting Bull and his tribe are now safely placed upon an American reserve of land, where the old warrior will be allowed to end his days in peace, and in whatever comfort the industry of his people and the generosity of the United States Government may bring him. After the Sioux, the most interesting people now left, and still retaining much of their aboriginal traits and customs, are the Blackfeet. Their braves say that their first ancestor received from the morning star, their war god, a magic ointment, wherewith if he anointed his feet, he would be endowed with such swiftness that the antelopes would flee in vain before him. There are many stalwart men amongst these people, and it was most interesting to observe them in the great councils we held with them in 1881. They came to the appointed place of meeting mounted, and in full battle array, firing their Winchester repeating rifles in the air, and shouting and waving their weapons. Behind them tripped, in gay colours, the women, bringing their children, for the children could not be left in camp, and the women must see what their lords and masters were after in their conference with the white chief. Arrived close to the tent where I awaited them, they sprang from their horses, and advanced to shake hands, which ceremony was performed by the chiefs and the head men; these then sat down in front of me, the chiefs in the front row, the head men behind, and ranged around in a deep half circle was the rest of the tribe; on the right an allied set of cousins, with their aunts and sisters behind them; while on the left, in triple ranks, crouched on the ground, sat the warriors, round limbed and lithe young fellows, clad with little but paint on the body, and with long war locks, braided with brass, depending from their temples; the rest of their hair—after being gathered up upon the crown, so that if an enemy wanted to have a good tug at the scalp, he could do so without trouble—being allowed to fall in long dark masses over their shoulders.

From the flank of the line of braves, round in front to the right, stretched the ruck of the tribe and the women and children. A good deal of quiet sitting and smoking was indulged in before a word was spoken, and then it was always necessary to look on at a dance for some time longer, before business was opened up, for nothing could be done until the pipe had been smoked and a dance had been performed. Strange, and weird, and uncouth these dances are; the magicians sit on the ground beating a tom-tom, and in a circle, following each other in single file, strut, and bow, and jibber, and jig the braves detailed for the duty, making hideous noises, and pretending occasionally to be in pursuit or in flight, round and round they go until the music ceases, when all sit upon the ground. Sometimes the young men would insist on recounting their deeds in war, boasting of stealing cattle and of killing their foe. When by these processes the chiefs have sufficiently gathered together their thoughts to be able to detail their desires, each man rises in succession, and speaks, while the interpreter stands listening, and at intervals turns to the white chief, and tells him in substance the eloqnent and fervid harrangue to which all are listening. Usually, amid much flowery rhetoric, the speech resolves itself into a demand for more favours, and is, in short, nothing but an exclamatory beggar's oration. Often the interpreters will not take the trouble to render all the flowery language, although they themselves are half-breeds. On one occasion, after much eloquence had been exercised for an hour, and the interpreters had said nothing, it was asked, "Why do you not interpret—what does he say?" All the translation vouchsafed was,—"Oh! he say grub!" The pleading for this very necessary article was backed by the certainly very cogent argument that the coming of the white man had taken from them their land, or rather, what they valued upon their land, that is to say, their great game, the buffalo; each year the white man's presence had marked a decrease in the buffalo; and what was the Indian without the buffalo; how could he get skins for himself, for his house; how procure food or sinews to sew the clothing together; how live without his beloved buffalo. The argument would certainly hold good, for although it is the improvement in the weapons of the chase, and the introduction of fire-arms, which has mainly contributed to diminish the numbers of the buffalo, yet the very introduction of these fire-arms was due to the coming of the stranger. And what does the white man give in return for the evil thus inflicted? He gives 5 dols. for every man, woman, and child in the tribe, every year, to the chief to be apportioned for the good of his nation; he gives, also, when he is obliged to do so, a ration of flour; and he gives above all, and every year to an increasing degree, that knowledge of husbandry which can alone save the red race. Already, in 1881, although these Blackfeet, of whom I am speaking, had but lately been engaged in hunting parties, some effect could be produced upon them by speaking of the advantages of potato growing. After haranguing them upon the subject, the chief warrior rose when the council had finished, and grasping my hand, and putting round my arm the bridle-cord of his horse, he asked me to accept the animal as a present (which, of course, could not be accepted), and repeatedly assured me that, although he had hitherto been the first in fighting, he would now be the first in working. I am sorry to say, he did not seem very much pleased when he afterwards received a fowling piece instead of a rifle for a present, but the latter would have been of no use to him for duck shooting, and I hear that he has kept his promise, and got his own potato patch this year. There is another great and scattered people, the Crees, and yet another with a stranger name, dwellers in the rocky country on this side of Winnipeg, but calling themselves the Ojibbeways. Differing in origin and language, the red men fought constantly against each other, and these wars, and the epidemic diseases to which, as they averred, they had become subject after contact with the whites, made them less numerous than the enormous extent of country over which they hunted would lead us to suppose. It is, however, only when the savage cultivates in some measure the ground that he can greatly multiply. Champlain and Frontenac found the Indians of the St. Lawrence growing corn. There is no evidence that the wild horsemen of the plains ate of any plant sown by their hands. In warfare they employed some methods of defence and communication which show that recent European army regulations enjoin practices long known to Sioux and Blackfeet. Thus, pits, whence the archers could discharge their arrows, are seen within the lines of old entrenchments; and when the Canadian Mounted Constabulary regiment first entered the "Lone Land," they found that their movements were signalled to the tribes by a very good "heliograph" system of "flashes." No such signalling was at that time known in our armies, and the troopers, as they rode along over the vast grass-covered plains, could not at first understand the twinkling of the sun on the little mirrors of the "intelligence department" of the savages.

Amongst all these tribes the custom was formerly universal, and still obtains, to a great extent, to have a great annual feast called the Sun Dance, which is the occasion appointed when the young men may show of what mettle they are made by undergoing a voluntary torture. If I shock you with the details of these proceedings, pray stop me. The medicine man, the sage herbalist, doctor, and mystery man, stands in a great circular tent made of boughs, or skins, fantastically adorned with head-gear, and painted with streaks of orange, crimson, or blue; he has in his hand a gleaming knife, and when he is about to perform the final ceremony, the victims have already fasted for many hours. They come one after another and stand before him, and on the chest of each he makes four cuts, so as to divide the flesh into two bands; in the bleeding wounds he places two long spigots of wood, lifting the muscles so as to pass these through the incisions in the flesh. He then attaches to each end of each spigot of wood, cords, which are run up round a central pole. Then the drums and tom-toms beat, and while all stand admiring their courage, one youthful warrior after another tries to break away from the attached cords. The muscles start and strain, and the flesh is extended far from the chest; the wounds gape, and the sight becomes horrible, for the agony is dreadful. Still the wild dancing or hanging on the cords goes on, until the man falls exhausted, but free. It is almost inconceivable how much can be endured by these young men in their efforts to prove themselves worthy, in the eyes of the women and others of their tribe, of the manhood which gives important privileges that belong to him who has shown himself bravest in the camp of the savage. Buffalo heads, guns, and other heavy objects are dragged about attached in the same horrible manner, while it used to be considered a proof that the man would be the best at stealing horses who attached himself by the shoulder-blade to horses whose every motion as they stooped to feed brought a fresh pang of pain.

But enough of these terrible rites: they still continue, but the number who undergo the torture is diminishing year by year, and we may trust to missionary efforts to put an entire stop to it before long. Much is said of the knowledge possessed by the squaws of simples; it is certain that they are very clever in producing decoctions and in making poultices from various trees and shrubs whose healing properties are well known to science. Thus, from the bark of a certain species of willow, a preparation can be made which staunches hemorrhage, and quickly heals a wound. Strange tales were told us of the efficacy of some of their medicines. A gentleman employed in botanical research was puzzled by an application made to a slight wound he had sustained; he had, when shooting, hurt his thumb by the accidental discharge of his gun, and for some days, having nothing but water with which to bathe it, he was in considerable pain, and the thumb became much inflamed. Lighting, in the course of his march, one day on a camp of Sioux Indians, one of the women observed his hurt; she came to him, and gave him a milk-like liquid, and told him to apply this when he felt pain; he did so, and from the first application the pain ceased, and in a few days a very complete cure was effected. A sergeant in the Mounted Police was an eye-witness of the effects of an opiate given to a man for whom the ordinary remedies of opium, laudanum, and chlorodyne had proved useless. It was evident that the medicine man had some good stuff, although it was equally certain that he employed a great deal of what is known as *hocus pocus* in applying it. He asked for a vessel, and after a time poured into it a white liquid he had concocted. He then covered this vessel over with a skin, pierced holes in the covering, rolled up some pellets of buffalo hair in his hand, muttered some pretended incantations, and dropped these balls of hair through the skin into the liquid. After a while, the covering was removed, and it was seen that the vessel held no longer a white but a red liquor. This, with an amount of faith which one does not often find in a sick patient, was drained by the invalid, and a sound sleep, which was the beginning of a perfect recovery from the illness, appeared to be the result. There may be something worth discovering in the application made by the Indians of certain herbs, but it is to be noticed that the roots and plants hitherto found in the medicine-man's lodge have, as a rule, been plants whose properties are already well known to science. It is only as a matter of curiosity, and to vary the subject, that I have spoken at such length of the few savage tribes which yet remain in possession of their old customs and manners, for they do not form by any means a prominent feature of even the most unsettled portions of Canada. The talk is not of Indians but of engines, of the plough, of the self-binder, of the reaper, of the hay-cutter. It is of the price of timber for building, of the advantages of the long grass for thatching, of the utility of straw for burning, and of the great output of coal which is already assured from the newly-opened mines at Alberta. The expectations are not of a visit from the wild man, but whether the splendid crop in the ground shall be visited by any early frost, and of the facilities in the way of transport the railway already affords, or such and such a projected line may still further increase; or if a new steamer on some great river will be able to make her return trip in time to carry off some of the superabundant grain. And where you question the farmer, he will tell you that his roots were this year, and last year, and the year before, marvellous in size, and that, as a rule, his acre gives its thirty bushels of wheat.

As this is intended as a paper speaking only of the main features of the country which are of popular interest, and as drawing your attention only to the subject, which is treated in much fuller detail in the papers and pamphlets issued by railway companies and by local governments in connection with the country, I shall here say no more, but ask you to give your attention not only to the prospects of the recently opened land, but also to the very inviting districts which are to be found in many of the older provinces. Of course, the more complete a civilisation is, the more it invites those whose battle of life has been more than half fought; and in Ontario, Nova Scotia, and New Brunswick, excellent farms, complete in homestead, cowhouse, and orchard, can be had for prices which in England seem almost ridiculous. If a man prefers to become a tenant of a holding under new and more easy conditions than are attainable here, he can readily have such, for it is an entire mistake to suppose that every man possesses his own land in Canada; the vast majority do so, but some prefer to remain as tenants, at a light rent. Nothing can exceed the beauty and fertility of such valleys as those of Sussex and St. John, in New Brunswick, while in the same province, the regions about Miramichi and Bathurst, are excellent. No fairer land can be found than that which has been made so widely known by Longfellow, in his touching story of "Evangeline," where the old French dykes still show the acadian settlements of an earlier day. A more extended system of reclamation has won from the sea many tracts of rich red loam on the shores of the Bay of Fundy, and it is quite worth the while of anybody who wishes to change his abode, to recollect that it is not necessary to go as far as the north-west of Canada to find new land, and that within a ten days' journey by sea of where we are now assembled, farms can be secured, and all the comforts of civilisation enjoyed in the maritime provinces of the Dominion of Canada.

DISCUSSION.

Mr. Staveley Hill, Q.C., M.P., having been in Canada during the autumns of the last three years, said he was able to bear full testimony to the excellence of the work of the noble Marquis and of the illustrious Princess in that country. While they were sorry to lose him from Canada, they could not but realise that here in England he was doing as good work for Canada as he did out there. He could completely endorse all that had been said with regard to the intelligence and energy with which the Canadian Pacific line had been pressed forward. He first went out to Canada three years ago, during the bad times in the iron trade, to see for his constituents in West Staffordshire what sort a place it was as a field for colonisation. In 1881, he went up in the first train which took passengers to Brandon; and the following year drove along by the side of the line as far as Moose-Jaw Creek, and this year he went in the train up into the Rocky Mountains. To show the pace at which they went, he might say, that one day he was with them in the forenoon, and had left his buggy standing by the side of the rails, and at half-past 2 o'clock it was nearly a mile behind. Near the Rocky Mountains they had left the prairie country and got into the ranche land, where there was a belt of about 30 miles of the most wonderful grazing country. The hollows in the hills were so well sheltered, that even during the enormous cold of winter the cattle were able to stay out, and got quite fat and fit for the butcher, and were in excellent condition when the breeding season came round. This land was not very large, compared to other parts of the country, but it was a glorious country for cattle, whilst the other was more adapted to raising grain, so that both kinds of produce, requisite for a large population, could be obtained in the Dominion. The passes over the Rocky Mountains were the Crow's Nest, which he went through last year; the Kicking Horse, formerly called the Vermillion Pass, and close to that the Kananaskis Pass. Near the Crow's Nest there was another pass called the Kootenai; and as he stood at the door of a friend's ranche at the head of the Old Man River last year, and looked at the glorious line of snowy mountains, he thought it had no parallel in the world. The much-praised view of the Bernese Oberland, from the terrace at Berne, was certainly, by no means, equal to it. Having gone into the Crow's Nest Pass last year, he this year went up the valley between the rivers Belly and Kootenai, and hoped to get across into the Crow's Nest Pass, little thinking of the big hills between; he got, however, into the Boundary Pass, which took them about 160 miles through a most beautiful woodland track, with magnificent trees rising up 150 and 200 feet, until they come down on the Tobacco plains spreading out on the western side of the Selkirk range. This was a most easy pass; it was, perhaps, too close to the boundary line for the railway to take advantage of, but there was nothing to prevent the making of a wagon-road, and the construction of a railroad would be an easy task. You might really ride through it in two or three days. With regard to the Indians, there was a most marked difference between the Indians in Canada and those in the United States. In Canada he could sleep in the midst of eighty or ninety lodges and feel as safe as in that room; but as soon as you went across the frontier line, into Montana, Wyoming, or Washington, the whole state of things was different, and you could not trust the Indians to the same extent. The reason was told by the Americans themselves: good faith had ever been kept by Canada with the wild man, but in the States too often what the Government freely paid, the Indian agent pocketed; the whiskey trade was allowed to flourish in the States, whilst in Canada, following the example of the Hudson's Bay Company, it was rigidly prohibited, and thus the greatest curse in that part of the world was prevented. There was no necessity for any one to drink a drop of spirit there. Each time he had been in the north-west he had been eight or nine weeks in camp, and though he had his pocket pistol of whiskey in case of emergency, he had come home each year without unscrewing it. He had slept in camp with 61° of frost, 29 below zero, and never felt the need of a drop of alcohol. In that climate it was worse than unnecessary, for he believed that those who took it would be unable to stand the cold. In 1874, the mounted police came down, and the whiskey trade with the Indians was done away with, and instead of being swept away in a few years, they were now increasing in numbers. In return for their lands the Government undertook to give them so much beef and flour for each man, woman, and child, every two days, and a certain amount of money to buy blankets, and every single word of that promise had been kept. The Indians knew that justice was meted out equally to the white man and the red skin, and the one thing they loved was to be called King George men, or subjects of the Great White Mother, and looking with pleasure on Englishmen as their fellow subjects there was good feeling and friendship; at the same time they were an idle set of rascals, who would not do a stroke of work if they could help it. He had seen an Indian buck come up to his tent, with his unfortunate squaw following behind, bearing on her back his whole worldly goods, and perhaps one or two children besides. The Indians looked on hunting and fighting as the only proper thing for a man to do, and everything else, including the cultivation of the ground, was considered women's work. An Indian buck would be as much appalled at the idea of planting potatoes or wheat as an English agricultural labourer would at being asked to darn stockings. Until this nonsense was knocked out of their heads, the Indians would not be industrious. In conclusion, he would say that any person who had leisure, and wanted to spend a long vacation happily, he could not do better than go to Canada, and when he came home tell his friends what the country was like. He hoped the time would soon come when many of the idle people in England would be hard at work producing food in Canada.

The Hon. Donald A. Smith said the Canadians felt they were under a very deep obligation to the Marquis of Lorne for what he had done, and that the time during which he had administered the government would be marked in the history of Canada with a red letter, as being one of the most prosperous periods up to the present, and it was with the most sincere regret that they saw him and his illustrious consort leave their shores. The north-west had been indeed a great acquisition to Canada. Some fifteen or twenty years ago, there were some mutterings of annexation, or something of that kind, amongst a certain class, for you could never satisfy everybody, but the condition of things was very different then to what it was to-day. Then in the eastern provinces there was a long narrow line of country looking to the North Pole; but now in the north-west there was a magnificent country, equal to anything their friends in the South could show. True, the land was not all equally good, but there was abundance of land there to grow millions and millions of grains of wheat, and sufficient grazing land for millions of cattle. It was not all wheat-growing land, but that which was not, was excellent land for mixed farming, such as farmers generally delighted in, and this reached right up to the Rocky Mountains. In the neighbouring States of Dacota and Minnesota, only thirteen or fourteen years ago, when you got some sixty or eighty miles north of the present city of St. Paul, or within 400 miles of the international boundary, the country was an entire desert, not a single bushel of corn being grown there, but to-day a railway had been run through the district, and this last year that railway had carried upwards of 20,000,000 bushels of wheat. The climate there was certainly not better than it was in the north-west of Canada, because as you went northward the ground sloped downwards, and the altitude was less, and the country was not so exposed as the more exposed parts of the Northern States. He did not say a word against those States, which were now peopled with a thriving and industrious set of farmers; but he wished to show what might be expected in a country where, on the whole, the climate was better. The cold, as registered by the thermometer, was no criterion to go by, for he had suffered more from the cold, perhaps, in London — but certainly in Edinburgh in the spring—than he ever did in Canada, where the air was so dry nd bracing. He had been farther north than Winnipeg, and had known the thermometer to fall to 55° below zero; but even then you could walk out without discomfort, and ladies accustomed to the climate of England were not inconvenienced. He could also confirm what had been said about not requiring alcoholic drinks. They required no wine there, still less spirits, unless it might be on St. Andrew's Day, when, perhaps, a little might be excused. He did not say that spirits were not required anywhere; that was a question on which there were different opinions; but it was certainly required less in Canada than anywhere else he knew of. The atmosphere was so exhilarating, you did not want champagne to add to it. Apollinaris water was much drunk there, either "straight," which meant pure, or "with a stick in it." A good many persons near the sea coast might prefer it with a stick, but in the north-west they did not care for the addition, and preferred it "straight." With regard to the Indians, we were most fortunate in following the Hudson's Bay Company; they had no troops to support them, and did not want any, because they dealt kindly and honestly with the Indians, and the Indians returned their kindness. Mr. Staveley Hill said they were very lazy, but he had known them turn to work; and the Sioux did good service to some parts of their country. No doubt the women did the greatest part of the work, but that was the case in most semi-civilised countries. There was an old custom amongst them in some parts, though he was afraid it was fast dying out, that when a squaw lost her husband by death, she carried his bones on her back for a certain number of years. This probably pointed to an Eastern origin for those tribes which practised this custom. The railway was, he thought, doing a great work, not only for Canada, but for the whole Empire. He believed it would be completed by the spring of 1886, and, when finished, it would have the effect of shortening the distance from London or Liverpool to Japan by 1,000 miles, and it would also be the shortest route from the Atlantic to the Pacific by about 300 miles. The gradients in two or three places were, no doubt, rather heavy, but it was only for a short distance, and they were not so heavy as on other lines, and could easily be surmounted by the aid of an additional engine, while all the rest of the road was remarkably level.

Mr. Stephen Bourne said he had no personal knowledge of Canada, but he hoped to go there next year, on the occasion of the visit of the British Association; and he considered the colony of immense importance, having regard to the condition of affairs at home. Some years ago, in a paper read at the Colonial Institute, he pointed out the necessity for extended colonisation, a subject on which the Marquis had also spoken recently in the same place, saying the time might come when the mother country would cry out to her colonies for aid in defending our trade, and support in any contest with our enemies. It struck him that the time had already come when a loud and bitter cry had gone out from this country to those on the other side of the Atlantic to come over and help us. We had lately been horrified by disclosures of the poverty and misery which existed in our large cities; and people were beginning to realise how much many of the poor suffered from the taking of those intoxicating liquors which he was rejoiced to hear were not needed, and in some places could not be procured, in Canada. The great cry from our crowded cities was to furnish the means whereby those who were destitute and oppressed might find refuge on those fertile plains of which they had been hearing; so that they might settle there, and produce not only their own food, but food for those who were left behind. They wanted to transport the surplus labour of this country, where, in many cases, it was a drug in the market, to a place where it would be employed in feeding those who where now half-starved, and at the same time raise up a nation of consumers for our home manufactures. The effect of emigration would thus be twofold. He trusted the effect of this paper would be to stir up those who could not find means of support in this country, to seek for new homes, and so benefit not only themselves, but those who were left behind. Probably none knew better the benefits of this large railway than the constituents of Mr. Staveley Hill, who had experienced a reaction in the iron market by the demand from Canada for rails to be there laid down. The Canadian Government were bridging over the distance between one side of that vast continent and the other. If there were these vast fields only waiting to be tilled, surely it was a reproach to British statesmen, capitalists, and philanthropists, to allow those fields to remain uncultivated, whilst our own cities were so densely crowded. This was the great problem of the day, and though he did not underrate the difficulties in the way, he was convinced that the sooner statesmen endeavoured to solve it, the better. In conclusion, he desired to bear testimony to the endeavours of the Canadian Government to provide for the spiritual wants of the emigrants who went over.

Mr. Wm. Botly remarked that this paper afforded great encouragement to English farmers to emigrate to Canada. He would recommend all persons interested in agriculture to study the report which was now published of some gentlemen who went as a deputation from Scotland to inquire into the capabilities of Canada as a field for emigration.

The Chairman, having proposed a vote of thanks to the Marquis of Lorne for his paper, which was carried unanimously,

The Marquis of Lorne briefly acknowledged the compliment, and the meeting adjourned.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees, appointed by the Executive Council of the Exhibition, have met at the Society of Arts:—

Food.—Group I.

Monday, December 17th.—Present: Sir J. B. Lawes, Bart., LL.D., F.R.S., in the chair; Professor Church; Prof. George Fleming, LL.D.; Sir B. T. Brandreth Gibbs; Professor H. N. Moseley, F.R.S.; Dr. David S. Price; Mr. John M. Thomson; Dr. Voelcker, F.R.S.; Mr. H. Trueman Wood.

The Dwelling House.—Group III.

Friday, December 14th.—Present: Sir Robert Rawlinson, C.B., in the chair; Dr. Alfred Carpenter; Mr. H. H. Collins; Mr. C. N. Cresswell; Mr. T. W. Cutler; Mr. J. Bailey Denton; Mr. W. Eassie; Mr. R. E. Farrand; Mr. Rogers Field, M.Inst. C.E.; Captain Douglas Galton, C.B., F.R.S.; Mr. George Godwin, F.R.S.; Mr. E. Hoole; Mr. Baldwin Latham; Mr. Shirley F. Murphy; Dr. G. V. Poore; Mr. George Shaw; Dr. Thorne Thorne; Mr. E. Turner, F.R.I.B.A.; Mr. George Vigers; Mr. H. Trueman Wood.

Wednesday, December 19th.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Mr. A. T. Atchison; Mr. W. R. E. Coles; Mr. H. H. Collins; Dr. Corfield; Mr. Thomas W. Cutler; Mr. Heisch; Mr. Baldwin Latham; Professor T. Hayter Lewis; Professor Chandler Roberts, F.R.S.; Mr. Frederic Scott; Mr. George Shaw; Mr. George Vigers; Mr. Greville Williams, F.R.S.; Mr. H. Trueman Wood.

The School (Group IV.), and Education (Group VI.)

Tuesday, December 18th.—Present: Mr. E. N. Buxton, in the chair; Mr. B. St. John Ackers; Dr. T. R. Armitage,; Mr. J. G. Fitch; Dr. J. H. Gladstone, F.R.S.; Major-General Hammersley; Mr. T. C. Horsfall; Mr. A. C. King; Colonel W. R. Lewis; Deputy Inspector-General F. J. Mouat; Mr. E. R. Robson, F.R.I.B.A., F.S.A.; Mr. H. Trueman Wood.

The Workshop.—Group V.

Saturday, December 8th.—Present: Dr. G. Buchanan, F.R.S., in the chair; Dr. A. Dupré, F.R.S.; Mr. Alexander Redgrave; Mr. Gilbert Redgrave; Mr. H. Trueman Wood.

Saturday, December 15th.—Present: Dr. George Buchanan, F.R.S., in the chair; Dr. Edward Ballard; Mr. J. H. Bridges; Mr. A. Redgrave; Mr. G. Redgrave; Mr. H. Trueman Wood; Mr. W. Woodall.

Sick and Ambulance.

Tuesday, December 18th.—Present: Director General Crawford, in the chair; Deputy Surgeon-General Bostock, C.B.; Brigade-Surgeon W. G. Don; Surgeon-Major G. J. H. Evatt; Mr. John Furley; Deputy Inspector-General F. J. Mouat; Director General John W. Reid; Dr. J. C. Steele; Mr. H. Trueman Wood.

NEW GUINEA AND ITS INHABITANTS.

New Guinea, or Papua, lies wholly in the south of the Equator, between 0° 22′ and 10° 42′ south latitude, and 130° 50′ and 150° 50′ east longitude. Its extreme length is 1,530 miles, and its breadth varies from 30 to 410 miles. Consul Griffin, of Auckland, says that the island appears to have been discovered by the Portuguese as far back as 1526, and it is known that the Spanish navigator Ynigo Ortez de Retes visited it in 1546, and first gave it the name of New Guinea, on account of the resemblance of the inhabitants to the negro race. In 1606, Torres took possession of it in the name of the king of Spain, and Tasman landed on the north coast in 1643. New Guinea was also visited by a number of Dutch navigators, who claimed to be entitled to the honour of conducting nearly every important discovery on the island for a period of two hundred years. Its best known bays and rivers still have Dutch names. The native inhabitants appear to present several distinct types of race, the colour of their complexions varying from a deep sooty brown, or black, to a shade not much darker than that of the Malay. The blood of the tribes dwelling along the coast has been intermixed with that of the inhabitants of other islands in the Pacific. The typical Papuan has a peculiar black, rough woolly hair, the word *papua* being derived from the Malay *puapua*, meaning woolly or curly. In stature he is a little taller than the Australian blacks, who are invariably below the medium height. His frame is stouter, and his limbs are more symmetrical. He has a long face, projecting eyebrows, and a large nose, and in this respect he differs from the native New Zealander, whose face is round, and nose not at all prominent. The New Zealander, moreover, has straight black hair, and possesses a quieter and more dignified demeanour than the Papuan. The six principal tribes inhabiting the island of New Guinea are the Ilema tribe, inhabiting the coast from Muro, a little north of Freshwater Bay, as far as Diabu, situated about ten miles above Yule Island; the Maiva, living on the coast from Oiabu to Kapatri; the Motu, whose territory extends along the coast from Kapatski to Kapakapa; the Kaitapa living on eminences overlooking the sea, and occupying the country of the Motu; the Kairapunu, extending along the sea-coast from Kapakapa to Mura; and the mountain tribe called Koiari by the Motu, and Kuni by the Kirapuno, occupying a large area in the interior. A different language or dialect is spoken by each o these tribes, but these dialects greatly resemble one another, and can be traced to the same common origin. The language may be described as a soft and musical one. It is composed principally of vowels and liquids, and has no harsh-sounding consonants The natives, who reside near the Maikasa, or Pearl River, are believed to be cannibals. Their country is thinly populated, and during the rainy seasons exceedingly unhealthy, on account of the prevalence of malaria. The Papuans pierce their ears and nostrils, and wear in them as ornaments bamboo sticks and bright coloured feathers. Some of them file their teeth to a sharp point. Their faces are disfigured with huge dark welts, burnt in with red-hot coals, and rubbed with various kinds of dyes. They pass their time principally in hunting and fishing, dancing and fighting. Their weapons consist of bows and arrows, clubs and spears. At Astrolabe Bay they have knives and axes of flint, and a weapon made of hard wood, exquisitely carved. The food of the various tribes consists principally of pigs, dogs, fowls, kangaroos, lizards, fish, insects, yams, cocoanuts, bananas, melons, mangoes, bread fruit, and sugar cane. They possess a rude knowledge of agriculture, and cultivate extensive plantations, the soil everywhere being fertile, and they plough or break the ground with pointed sticks. Their houses are built of bamboo, and raised on piles, and some of their dwellings have very low roofs, slanting almost to the ground. They possess a vague sort of belief in a Supreme Being, and erect temples for worship. They practice polygamy, and entertain the belief that man has a right to as many wives as he can support. The inhabitants of the village of Dorey, and along the shores of Geebrink Bay, possess a much better intellect than the other tribes, and often have European features. It is believed that they have Hindoo blood in their veins, and it is stated that their religion may be traced to Oriental origin. In the interior of the island the inhabitants display great skill in carving clubs out of a substance closely resembling the *pœnamu*, or greenstone of New Zealand. The Kirapuno tribe are described as being very handsome. The hair of their children is of a light golden colour, which becomes darker as they grow older, turning first to a rich amber, and then black with a reddish tinge. All the tribes delight in painting their faces and bodies, the favourite colours being black, yellow, and red. They are addicted to murder, and their highest chiefs do not hesitate to beg and steal. The tattoo marks on the breasts of the chiefs indicate the number of men they have slain. They wear for ornaments head dresses made of the feathers of the bird of paradise, necklaces or boar tusks, and bracelets cut from a species of clear white shell. The men are noted for their slender waists, which approach almost to a deformity, produced by drawing tightly round their bodies a girdle made of native cloth. The women, on the contrary,

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FRIDAY, DECEMBER 28, 1883.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FOREIGN AND COLONIAL SECTION COMMITTEE.

A meeting of this Committee was held on Thursday, 20th inst., to arrange for the proceedings of the Section during the coming Session. Present:—Sir Rutherford Alcock, K.C.B. (in the chair), Mr. Hyde Clarke, Mr. B. Francis Cobb, Mr. Trelawney Saunders, Mr. P. L. Simmonds, with Mr. H. Trueman Wood, Secretary, and Dr. R. J. Mann, Secretary of the Section.

JUVENILE LECTURES.

The first lecture will be delivered on Wednesday next, January 2, at 7 p.m.

All the tickets having been disposed of, the issue has ceased. As all the available accommodation will be required for those members who have received tickets, it will be understood that no member can be admitted without a ticket.

The Secretary will feel greatly obliged if any member who is unable to use his ticket will kindly send it back.

Proceedings of the Society

CANTOR LECTURES.

THE SCIENTIFIC BASIS OF COOKERY.

By W. Mattieu Williams, F.C.S.

Lecture I.—Delivered Monday, Dec. 3, 1882.

Although by no means disposed to quibble about words, and having but small respect for etymologies, I am constrained to commence these lectures with an etymological protest. I refer to the now popular use of the term "technical education," which, in my opinion, is misapplied. If this was merely a question of derivations, I should not notice it, but, as now used, it is very inconvenient, and provokes confusion of ideas. It has prevented me from giving the proper title to these lectures, which should have been "The Technology of Cookery;" but, in the prevailing confusion between "technical" and "technological," such a title would not have been understood.

There are two distinct branches of all industrial education. The first is that which is conducted in the workshop, or, as regards cookery, in the kitchen. This is technical, and should be so named in accordance with the signification of the Greek word τέχνη, *i.e.*, art, trade, or profession, and also in accordance with the established usage of the English words, technical, technicality, &c.

The other branch of industrial education is that which teaches the philosophy or *rationale* of the technical processes. Established usage, and unquestionable convenience, has assigned, in other cases, the appending of the Greek word λόγος in English form to the Anglicised Greek name of the general subject, to express such special philosophy. Thus we have geology, the science of the earth; biology, the science of life; anthropology, the science of man, &c. In strict accordance with this, the science of trade, art, or profession, should be named technology, and its corresponding adjective technological, corresponding to geological, biological, anthropological, &c.

The distinction between the technical and the technological is specially and personally demanded for my present subject. I venture to present myself as a technological teacher of cookery, while I should be guilty of impertinent charlatanism if I came forward as a technical teacher of this important art. I am repeatedly compelled to make strong protests against the prevailing absence of intelligence respecting the distinction between the technical and the technological, on finding myself consulted on the technicalities of cookery, or challenged to display my skill by the concoction of a banquet or some of the elements thereof.

The technology of cookery is but a subdivision of general domestic technology, a very broad subject, about the broadest of all the technologies. In the majority of trades, only a limited range of material is handled, but the housewife has to deal with a multitude;

the house itself, with its sanitary arrangements and furniture, its adaptations to comfort and elegance; food and its preparation; clothing; the rearing of infants, and the general preservation of health during health, and nursing during sickness; these demand for every woman a wider range of technological education than is necessary for men, who follow only one or two of the modern sub-divisions of labour. The technology demanded for the technical specialist is usually more exhaustive in detail, but is rarely, if ever, so wide in its grasp of many subjects. This should always be remembered in connection with the education of women. They certainly cannot afford to devote the larger half of their youthful working life to the study of dead languages, or any other demands of scholastic pedantry.

The operations of cookery are mainly chemical, and the chief agent in affecting these is heat. Thus the cook is a practical chemist, and the kitchen is a chemical laboratory, whose practice demands for its regulation no small amount of chemical knowledge. I do not refer to the sort of chemical knowledge most valued by the chemical specialist, who is working in the hazy region which forms the outer boundaries of science, and lies between the known and unknown, becoming, therefore, obscure and difficult; but to the solid foundations of chemical science, those great laws, or general facts that are now so well established as to be clearly understood, and therefore easily explained. Divested of shallow pedantries they are intelligible to everybody.

The laws of heat stand first, that is, the actual facts concerning heat. These should be well understood by every cook and every housewife. They are extremely simple, provided they are not obscured by any envelopment in the mathematical complications of thermostatic and thermodynamic theories, which merely record the hard struggles of bold intellects in grappling with the unknown. These belong to the science of the university, not the simple, clearly understood, and easily taught, technology of the kitchen.

In this short course I can only touch very briefly on this subject,* just referring to the the modes by which heat can be communicated, or the conditions on which this powerful agent will consent to become a servant to the cook. It must be either by means of *conduction*, *convection*, or *radiation*, either direct or reflected.

The two first demand contact with the heating agent, the third is the name for the manner in which heat is communicated to bodies at a distance from its source.

Conduction will be practically understood by simply holding a pin by one end, and placing the other end in the flame of a candle. The thumb and finger of the experimenter will presently communicate the fact that some of the heat of the candle flame has travelled from one end of the pin to the other. This unostentatious travelling of heat through the substance of body is called *conduction*.

By substituting for the pin a piece of charcoal or of wood of the same length (a match, for example), it will be found that one end of this may be made red hot without the other being sensibly warmed. A filament or stick of glass will display intermediate properties in this respect. We thus prove that bodies differ in their conducting power.

Metals generally are the best conductors, organic substances and carbon the worst among solids. The metals vary considerably among themselves. Silver and copper are the best of conductors; iron is inferior to these.

An important and less generally understood fact connected with this, is that bodies which thus take or conduct heat into themselves most readily are just those which give it out most readily, *by contact* with other bodies.

This is well illustrated by the boy's trick of placing a kettle of boiling water on the palm of the hand, and holding it there without inconvenience. The success of this depends upon the kettle being incrusted with a tolerably thick coating of carbon, in the form of soot deposit. The hand would be badly burned if the experiment were made with a new kettle, the heated metal of which would at once communicate its heat to the hand. In taking a Turkish bath, I frequently sit in a chamber the air of which is raised to the boiling point of water or thereabouts, and do this without inconvenience, provided the seat is covered with a bad conductor, and the floor also. If I attempted to wear my spectacles in that chamber the result would be very painful.

Convection is very different from this, although it demands contact. The laws of convection of heat were first clearly expounded by the man that I profoundly respect as my great teacher of the technology of cookery, Benjamin Thompson, Count of Rumford, Knight of the Orders of the White Eagle and St.

* I have treated it more fully, but without the theoretical complications, in "A Simple Treatise on Heat," published by Messrs. Chatto & Windus.

Stanislaus, Chamberlain, and Privy Counsellor of State of His Most Serene Highness the Elector Palatine, Reigning Duke of Bavaria, and Commander-in-Chief of the general staff of his army, F.R.S., &c.

This remarkable man, who began life as a poor village schoolmaster in America, and afterwards earned, by genuine honest work, the above titles, and many others that I have not time to specify, happened to scald his mouth when eating some rice porridge. The consequences were momentous, for it led him to investigate and discover the mode in which heat is communicated through liquids and gases, and to devise a multitude of important inventions based upon this. I quote his own account of the accident. He tells us that :—"Being engaged in an experiment that I could not leave, in a room heated by an iron stove, my dinner, which consisted of a bowl of thick rice soup,* was brought into the room, and as I happened to be too much engaged at the time to eat it, in order that it might not grow cold, I ordered it to be set down on the top of the stove. About an hour afterwards, as near as I can remember, beginning to grow hungry, and seeing my dinner standing on the stove, I went up to it, and took a spoonful of the soup, which I found almost cold, and quite thick. Going, by accident, deeper with the spoon the second time, the second spoonful burnt my mouth." This was followed up by reflecting on the fact that tea or coffee or thin soup is never thus cool on the surface and hot below. Why not ?

Up to this time, it was supposed that when we boil water in a kettle, saucepan, &c., the whole becomes heated by contact with the metal, and by conduction through the water, similar to the conduction of the heat through the bottom of the pot from the outside to its inside. Count Rumford ultimately proved that water and most other liquids, that air, and all gases are very bad conductors of heat, absolute non-conductors, he supposed; and that when we make water hot in saucepans, boilers, &c., the heating is effected by continual movements of the liquid, a film of which, touching the bottom of the heated vessel, is heated by direct contact, expands, and thus becoming lighter, ascends, and gives place to another cold film, which does the same, and so on until the whole is heated; or, otherwise expressed, the heat is conveyed throughout by such motion, and hence the term convection. A device of Count Rumford's illustrates this very prettily. He placed in tall cylindrical jars of water small fragments of amber, having the same specific gravity as the water, and, therefore, neither predisposed to sink nor float. These, by their movements, displayed the movement of the water itself. When such a jar was placed before the window of a room, heated above the temperature of the outer air, the amber moved downwards on the side of the jar facing the window, and ascended on the side presented to the interior of the room, and *vice versa*; if inner and outer temperature were equal, the amber remained stationary. He thus learned a domestic lesson, but little understood even now, viz., when to open and when to shut windows in the summer time. His convection glasses proved that a house is often kept cooler by shutting doors and windows than by opening them.

It will be seen at once how largely we avail ourselves of convection in the application of heat in cookery. Boiling, stewing, and frying, are examples of this, a bath of water or of fat being the convection medium by which the heat is communicated to the viands to be cooked.

All heated bodies radiate their heat to those around them, and all bodies are receiving radiant heat from their neighbours. If the temperature of a body is equal to that of its surroundings, it receives just as much heat as it gives out, and, therefore, is neither warmed nor cooled. If it is cooler than its surroundings, it receives more than it emits, and thus is warmed; if warmer, it radiates more than it absorbs, and thus is cooled proportionally. But the amount of heat thus radiated or absorbed by a body, in a given time, is not exactly proportionate to these differences. Some have greater radiating and absorbing powers than others. Thus, if we have two teapots of the same size and shape, and fill each with hot water from the same kettle, the water within them may or may not cool down at equal rates when similarly exposed. If one is of bright metal, especially burnished metal, and the other is of the same metal, but with a rough or porous surface, the rough will radiate more heat than the polished, and the water in it will cool more rapidly. In solid bodies the surface is the chief determinent of what I may term specific radiating energy. Radiation and absorption are, in this respect, exactly

* I commend this *menu* of the Lord High Chamberlain and Commander-in-Chief to the consideration of citizens and others who are not ashamed to sit down to a meal that costs two or three guineas per feeder.

co-equal; the conditions which favour one equally favour the other. One of the best radiators and absorbers is a surface of soot. Thus, a teapot should be bright in order to keep the water as hot as possible, but a tea-kettle that is heated by radiation from glowing coal, should be thinly coated with smoke deposit, in order that it may absorb freely. The advantage of fire-clay as the backing of a grate depends upon this. It is an excellent absorber and radiator, far better than iron or any other metal. Therefore, it is readily heated by the coal, it absorbs much of the heat that would otherwise pass by convection up the chimney, and, while doing this, is also actively radiating it into the room, or towards any object placed before it for the reception of such heat.

Bright surfaces are good reflectors of heat, though bad radiators. The difference of this should be clearly understood by the cook. Radiation is the giving off of the heat possessed by the radiant body as its own temperature. Reflection is the rejection of the heat radiated against the surface of the reflector, some of which it does not choose to accept, but scornfully throws back again to the giver if received perpendicularly, or casts aside at an angle equal and opposite to that of its reception if received obliquely.

A radiating body gives out its heat equally in all directions. A necessary consequence of this is that the intensity of the heat is diminished in proportion to the outspread, that outspreading being proportionate to the square of the distance. The *rationale* of this may be understood by supposing it to be received on the inside of a spherical shell surrounding the radiant body; as the area of that shell increases with the square of its radius, or the distance from its centre, the quantity of heat received on a given measure of the surface of the shell must be inversely as the distance from the centre, *i.e.*, at double the distance the surface of the sphere will be four times greater, and outspread heat four times, or diluted to $\frac{1}{4}$, at three times $\frac{1}{9}$, and so on.

In roasting a joint before the fire without any screen, the radiant heat from the coal is only used; the meat is heated only on one side, that next to the fire, and, as it turns round, is radiating its heat away from the other side to the wall, &c., of the kitchen. If a meat screen of polished metal is placed behind the meat, the rays of heat not intercepted by the meat itself are received upon the screen, and reflected back towards the meat, and thus both sides are heated.

The Dutch oven is a device for utilising the otherwise wasted radiant heat, by reflecting some of it to the part of the meat not opposite to the fire. Other devices for this purpose are familiar to all, and, if time permitted, I could show you how a reflector might be made to concentrate the heat in such wise that one part of the meat turned away from the fire should be more heated than that exposed directly to the fire. I merely give these examples to show that a study of the laws of heat have a direct bearing on practical cookery.

The oven is an apparatus for cooking by radiation. In this case the meat or other object of cookery receives radiant heat from the heated walls of the oven. If this chamber, with radiant walls, be so arranged that the heat shall be radiated equally on all sides, and is capable of regulation, it becomes a roaster, which theoretically does its work more perfectly than an open fire, even when aided by a screen.

Rumford proved this by constructing such a roaster. It was a cylindrical chamber, with a surrounding flue, which heated the chamber about equally all round, excepting at the bottom, which stood directly over the fire, and therefore was the hottest. Over this stood a dish containing water, and above the water a sort of gridiron, upon which stood the meat, over a dripping pan above this water pan. It was thus heated by nearly equal radiations from all sides up to the ordinary cooking point (of which I shall presently speak), and in the midst of *its own* vapours plus some steam from the water in the dish. When this heat had penetrated to the centre of the meat, so as to effect the chemical changes presently to be described, and which constitute ordinary cookery, the special peculiatity of roasting, that is, the browning of the surface, was effected by means of what he called "blowpipes," *i.e.*, metal tubes under the roaster, which were made red hot by direct exposure to the fire, and were so arranged that, by opening suitable plugs and valves, a blast or current of hot air was made to pass through the roaster, and thus the meat was browned on the outside, while it remained delicately tender inside, from having been previously cooked there in its own juice, and surrounded by its own steam.

To test its merits, practically, he took two legs of mutton of equal weight, and from the same carcase, had one of them roasted by an expert cook in the usual manner before the fire, and the other cooked in the roaster. When cooked, both were weighed. That cooked in the roaster was 6 per cent. heavier than the one cooked before the fire. They were both brought on table at the same time, "and a large and unprejudiced company was assembled to eat them," a poor and hungry company, if I understand rightly. Both were found good, but a decided preference was given to that cooked in the closed roaster, "It was more juicy, and was thought better tasted." Both were fairly eaten up, nothing remaining of either that was eatable, and the fragments collected. "Of the leg of mutton which had been roasted in the roaster, hardly anything visible remained, excepting the bare bone, while a considerable heap was found of the scraps not eatable which remained of that roasted on a spit." The silent eloquence of these scraps is to my mind irresistible.

But why has the Rumford roaster so completely disappeared that I am unable to obtain a specimen from the exhibition of cooking utensils that we have below?

There are two reasons. First, that one of the primary conditions of Rumford's experiment with the two legs of mutton are generally unobtainable in England, viz., the "perfectly unprejudiced company," to test its merits. A prejudice against baked meat, or meat roasted in an oven, is hereditary in Englishmen. Not one in a hundred who denounce it has ever consciously tried the experiment of comparing such meat with that roasted in an oven, although every one of the hundred has again and again eaten and enjoyed baked meat, believing it to be roasted. If he has not done so at home, he has at hotel dinners, and other costly banquets.

I have fairly compared both, and have not the slightest hesitation in affirming that moderate-sized joints, properly roasted in a closed chamber, are far better than similar joints cooked with the utmost skill in front of a fire. The smaller the joint, the greater the advantage of the closed chamber. A baron of beef or a whole ox may possibly be as well cooked on a spit before a large fire as in an oven. I have tasted such from the spit, but never from an oven, and therefore suspend judgment in this exceptional case.

All prejudices, all traditions, however unreasonable now, have had some reasonable or semi-reasonable origin. Whence came this one against baked meat? Though far from being an archæologist, I claim to have discovered the origin of this tradition, this domestic superstition. My theory is this. Once upon a time, and within the memory of living men, the great middle class of Englishmen, such as now reside in suburban villas, and scorn to associate with the local shopkeepers, lived in London; in the back parlour, behind their own shops, on week days, and in the first-floor drawing room over the shop on Sundays. These now aristocratic and fastidious people kept but one servant in those days, and she of the type of Dick Swiveller's beloved marchioness. At certain times, the mistress could not herself superintend the cooking of the dinner. The joint was then placed on a triangular support, in an earthenware dish, with potatoes below, and sent to the nearest baker, to be cooked in his oven, for a fee of one penny, or thereabouts. In this oven was closely packed a variety of viands sent there by a variety of people, pork, or goose, stuffed with sage and onions, side by side with beef and mutton; high and gamey hare next to delicate lamb or chicken. The whole of the hermetically sealed chamber was thus filled with heterogeneous vapours and flavours, with a fair probability of one or two joints being of objectionable quality. But this was not all. An ordinary baker's oven is constructed for baking bread. The walls are heated to a maximum temperature, the fuel then removed, and the bread placed in it to "soak," as it is termed. The oven gradually cools down, and its contents are cooked at a gradually diminishing temperature. This is just the opposite of the action of Rumford's roaster, and certainly adapted to produce very unsatisfactory results when meat takes the place of bread

The second cause of the disuse of Rumford's roaster is, that it is not adapted to our fireplaces. He fitted it over a specially constructed fireplace, which offered the cook no opportunity of indulging in her favourite pastime of wasting coal. With our ordinary fireplaces or kitchen furnaces, the blowpipes of the Rumford roaster would be oxidised and burnt through in a week or two.

Roasting-ovens, however, do exist, and are attached to all the best forms of kitcheners; and I find at home, and in other domestic kitchens that I have visited, the double water-pan, the dripping-pan, and meat-stand of precisely the same model as contrived and pictured by Rumford as essential to his roaster.

On one point, however, in the philosophy of roasting, I differ from my teacher. He begins at a low temperature, or the mean temperature. I think it desirable—and have tested this theory experimentally—to begin at a temperature above that which is to be maintained throughout the roasting. The object of this is to produce a crust on the surface of the meat that shall partially seal it, and keep in the juices as much as possible. Then the temperature may fall to the average, which should be well kept up, and rather raised towards the last. This comes about automatically in the ordinary course of cooking with a roasting-oven. When empty and closed, it is receiving heat, and only radiating to its own opposite sides, from which the same amount of heat is mutually received. When the cold joint goes in, these radiations are obstructed, and each side is giving to the joint far more than it receives from it; therefore, according to the simple law already stated, the sides must fall in temperature. As the meat becomes cooked, it takes less from the oven walls, and thus they become hotter.

I may add that the sealing is more demanded by a joint of beef than by one of mutton of given size, because in the beef there is more of cut surface, exposing the ends of the fibres of the meat. In a leg of mutton, for example, this exposure is only at one end, the rest is partially protected by the skin of the leg.

The *rationale* of basting appears to be that it assists in the sealing, and diminishes the evaporation of the juices of the meat, the chief difference between well roasted and ill-roasted meat depending upon this. I have defined the roasting and grilling of meat as processes of cookery by means of which the meat is stewed in its own juices. The flavour depends on this: no water being used, these juices are not diluted—they are, on the contrary, more or less concentrated by evaporation; but if this evaporation be carried too far, a drying-up occurs, and this desiccation, for reasons that will be explained presently, is accompanied with toughness and indigestibility, as well as sacrifice of flavour.

The smaller the joint, the greater the risk of such desiccation. This principle brings us at once to grilling, which is another kind of roasting, *i.e.*, of cooking by radiation. A beef steak or mutton chop is not roasted by turning it round and round in front of the fire, because so large a surface is exposed in proportion to the mass, and such treatment would evaporate from that large surface too much of the juices. Rapidity is the primary condition of success in grilling. When a large and specially-constructed grill, placed over a large coke or charcoal fire, is available, the heat radiated on the exposed surface of the meat rapidly browns or carbonises the exposed surface, and partially seals its pores.

If flesh were as good a conductor of heat as silver or copper, two or three minutes would be sufficient for a chop or steak, and ten or fifteen for a sirloin of beef; but as the heat has to pass through very slowly, the time is proportionately extended. If we attempted to grill a baron of beef or a whole ox, it would be actually burned to a cinder on the outside before the centre became warmed. Hence the necessity of the continuous basting of these great masses of meat.

Chops and steaks are commonly spoiled in domestic cookery from want of understanding these principles, and from mistaken notions concerning different kinds of flames. Every cook knows that if the flame of a coal fire comes in contact with a steak, a villainous flavour of tar is the result. This arises from an actual deposition of tarry soot on the meat. Hence she scrupulously avoids contact with any kind of flame. This is quite unnecessary; the flame caused by combustion of the fat of the meat itself makes no such tarry deposit, however much it may blacken the meat. I said that I am not a practical cook, but I make exception in the matter of grilling. When a bachelor, living in lodgings or an institute, I found such difficulty in obtaining a decently cooked steak or chop, that I frequently cooked my own, and my mode of proceeding may be described, as it illustrates these principles.

First I removed all the flaming coal, even though in so doing the fire was reduced to very poor dimensions. Then I cut off a piece of the fat, cast this in the middle of the fire, and as soon as it made a good flame recklessly plunged my dinner into the midst of it. It spluttered and frizzled, dropped more fat, made a bigger flame, but, still I refused to raise the gridiron, and thus cooked it throughout in its own flame. A few minutes sufficed. The outside edges were black, certainly, but the violent expansion of the juices within, when so suddenly heated, plumped up the lean almost to bursting; the inside was juicy red meat, fully cooked, though apparently raw, and the outside a crust that was by no means objectionable, though it might arouse the prejudice of the uninitiated. I do not recommend the exact following of this in detail where a good fire is available, but refer to it as illustrating the effect of rapid grilling.

Before going into the subject of boiling and stewing, I must say something about the boiling of water, as this is curiously misunderstood in most kitchens. When water is heated in a glass vessel over a flame where the action may be watched, bubbles are first seen growing on the sides of the glass, gradually detaching themselves, and rising to the surface. These are merely bubbles of air that was dissolved in the water. After this, other and larger bubbles form on the bottom just above the flame. At first they are flat, and continually collapsing. Presently they become hemispherical, but still they collapse; then they become more and more nearly spherical, and afterwards quite spherical; afterwards they detach themselves, and start upwards, but perish in the attempt, by collapsing somewhere on the way. At last they reach the surface, and break there, ejecting themselves as steam into the air. Now the water boils, and a thermometer dipped into it registers 212°. After this, it matters not whether the boiling is very violent or only the gentlest simmering, no further rise of the thermometer is perceptible, showing that the simmering temperature and the "galloping" temperature are the same.

It is most difficult to make a cook understand this. If something is to be kept below the boiling point, she puts the saucepan where the water will only simmer, firmly believing that thereby she is maintaining a temperature considerably below the boiling point, and, on the other hand, she believes that by making the water boil violently she is raising its temperature above the ordinary boiling point. This single, and almost universal, kitchen fallacy, prevailing as widely among the mistresses as the cooks, wastes a serious amount of fuel, and spoils tons and tons of good food every day, proving most strikingly the demand for a knowledge of the laws of heat by all concerned in cookery.

The temperature of water cannot be raised above a fixed boiling point, because every ounce of steam carries off nearly 1,000° of heat, *i.e.*, it requires so much to expand it as steam. Time will not permit me to go further into this subject of latent heat; all housewives and cooks should carefully study it.

The actual cooking temperature for animal food is considerably below the boiling point of water, and is regulated by the coagulation of albumen, which commences at rather below 160°, *i.e.*, more than 50° below the boiling point of water. The further elucidation of this belongs to the subject of my next lecture, but I may illustrate it in the meantime by what occurs in the cooking of the white of an egg, which is nearly pure albumen.

If this be gradually heated in a suitable glass vessel, with an immersed thermometer, the clear viscous liquid shows signs of change at about 134°, when white fibres commence forming within it. These go on increasing, until at about 160° the whole mass becomes gelid and semi-opaque. It is now delicately cooked, and best fitted for easy digestion without any of the disagreeable rawness of the uncooked slimy liquid. If the heat is continued up to 212°, the opacity and hardness increases; if this temperature is maintained, the albumen becomes of horny hardness; if exceeded, it becomes so tough that a powerful cement may be made, and is made by smearing the edges to be cemented with white of egg, and then heating them. Thus hardened it is unfit for food.

Now, apply this practically to the boiling of an egg for breakfast. By the ordinary method of the three minutes' immersion in continually boiling water, the white becomes hard and indigestible before the yolk is fairly warmed, and half-a-minute too much, or half a minute too little, will nearly ruin the operation. Cockney cooks know very little concerning new-laid eggs, but farmhouse cooks are well aware that a new-laid egg demands nearly a minute more of that sort of cookery than one of full London flavour.

The proper mode, as I pointed out years ago, in my first book on Norway, is to place the egg in boiling water, and then remove the saucepan from the fire altogether, and leave the egg in the water from ten minutes to a quarter of an hour. About half a pint for one egg, three-quarters of a pint for two eggs, or a pint for four eggs, is the quantity demanded if the saucepan is well covered.

The cold egg, or eggs, speedily reduce the temperature from 212°, to near the cooking temperature, and before the egg is warmed throughout, it is quite down to 160°, so that it matters little whether it now remains five or ten minutes longer in the water. In making experiments with eggs, I have discovered that the temperature of coagulation of the yolk is lower than that of the white, and thus, if the egg is kept in water at 160° for a long time, the yolk may become harder than the white, the centre having time to become nearly as warm as the outside. But for this, the egg might be kept in the water at about 160° for an hour or two.

I have here exhibited, by Mr. Burton, an apparatus specially constructed for the cooking of eggs. It is called an "egg coddler."

Being made of bright metal, and well covered, the heat of the water is retained, and a smaller quantity than I have named is sufficient. The eggs are supported in a moveable frame, which can be taken out, carrying the eggs with it; nothing more is necessary than to place these on the breakfast table duly charged with eggs, fill it with boiling water about ten minutes before the attack on the breakfast is anticipated, and if this should be delayed ten minutes later, no serious mischief is done; the eggs are not hard, and are still hot. Coddle your eggs, never boil them.

In my next I shall show the bearing of these principles of albumen coagulation upon the cooking of all kinds of animal food.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committee, appointed by the Executive Council of the Exhibition, has met at the Society of Arts since the meetings of the other sub-committees recorded in the last number of the *Journal*:—

INDIA.

Thursday, December 20th.—Present: Sir Joseph Fayrer, M.D., LL.D., K.C.S.I., F.R.S., in the chair; Sir Rutherford Alcock, K.C.B.; Sir George Birdwood, C.S.I., M.D.; Col. Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Mr. Andrew Cassels; Deputy Surgeon General N. Chevers, M.D., C.I.E.; Mr. Robert A. Dalzell; Surgeon-General Gordon; Col. J. Michael, C.S.I.; Mr. W. G. Pedder; Mr. Harold Arthur Perry; Mr. J. R. Royle; Dr. George Thin; Deputy Surgeon-General Townsend, C.B.; Mr. Frederick Young.

WINE-MAKING IN SICILY.

Consul Churchill, writing on the trade and commerce of Palermo and Sicily, says that the English were the first to establish factories in Sicily for the making of the wine known by the name of Marsala. This description of wine was previously made in the country, but it was not appreciated in foreign countries until it began to be prepared by the English, who chose the best grapes for the purpose, which are those known under the names of *cateratti* and *trebianno*, and which grow principally in the districts of Castelvetrano, Campobello, and Mazzara, situated in the south-western part of the island. These qualities of grapes, and more particularly the first, are rich in saccharine matter, tender skinned, and juicy. To secure the choicest fruit, the manufacturers make contracts with growers, and advance them money, to be returned in fruit or must of a superior quality. They reserve to themselves the right of inspecting th vines, and seeing that they are properly attended to, and they fix the date of the vintage, which usually takes place towards the end of September. If the crop is an abundant one, the manufacturers accept whatever may have been produced over and above the contracted quantity at the market price. If the crop is a poor one, they do not insist upon getting the full amount of fruit they ought to receive, which would force the growers to procure the deficit at ruinous prices from other sources, but they agree to receive their due the following year. As the quality of the crop cannot be ascertained in advance, the growers accept the rates fixed by the manufacturers, and it is in the interest of the latter to act loyally towards the growers. Under no circumstances is bad fruit allowed to be pressed, nor is must accepted that does not contain the required quantity of alcohol-producing matter. The labours of the vintage having been brought to a close, those of the factory begin—that is the choice and trial of the wine. When the new wine is brought in, it is placed in casks of about twelve hectolitres, or two hundred and sixty-two gallons. For the English market, Marsala wine requires to be highly alcoholised, in order to stand the voyage and to keep. This, however, is not necessary for the Italian market, hence the necessity of choosing the strong wines for the former. Alcohol is added to wine made for exportation, both after racking and at the time of exportation increasing its volume by seven per cent. The strength of the Italian wines is from 16° to 18°, while that for the English market comes to 20° and 22°. The alcohol is produced from the superior qualities of wine; but latterly, owing to the heavy taxes levied upon spirits manufactured in Italy, other means have been resorted to, to replace alcohol or to produce it naturally. With this object in view, the must is boiled until its volume is reduced by two-thirds, and it is then added to new wine in lieu of alcohol. At first, this cooked wine was added at the first racking, but it was found that the results were not good, so the practice was altered, and it is now added to the new wine as it is being casked, in the proportion of from five to ten per cent. The cooked wine is generally added before the must begins to ferment, as then the whole mixes up well and produces a stronger wine; after this it is allowed to clarify. Two months before casking a preliminary trial is made, which consists in examining each cask, to see if the wine has the required qualities of the well known Marsala; those that have not are marked, and put aside for distilling; those of doubtful quality are set apart for further trial. Great experience is required to appreciate the quality of the wine contained in each cask by sight, smell, and taste. Towards the end of March and the beginning of April, a further trial is made on the wines put aside as doubttul. Then the racking commences, the wine being put into casks containing about twelve hectolitres. If any wine is found in imperfect condition it is alcoholised, and is put by for the rest of the season. In the English manufactories, pumps and tubes are not used, as the wine is usually poured into cans, so that it may be seen when it begins to run thick. During the ensuing year, before the time of the vintage, a fresh trial is made, after which those wines that require it are cleared. This is done by dissolving a certain quantity of isinglass, so as to produce enough froth to cover the surface of the wine contained in the cask. This froth is poured in through the bung-holes, and with a short stick, flattened at the end, the surface of the wine is moved to and fro, so as to spread the froth over the entire surface. It is then left alone, and the isinglass gradually finds its way to the bottom, carrying with it every foreign substance, and leaving the wine clear. The English manufacturers used formerly white of egg and blood to clarify their wines, but it is now found more advantageous to employ isinglass. The wine once clarified is drawn and put into casks, care being taken to add alcohol to those that require it. Two months after this operation, the wine is subjected to a further trial, when all that is not condemned to be distilled is poured into large vats, containing as much as seventeen thousand six hundred gallons each. Smaller vats, from two thousand eight hundred to three thousand nine hundred gallons, are also used, and in order to obtain an unvarying type of wine, care is taken never to empty these vats except when absolutely necessary for repairs, but to add the new wine to the old. These vats are in the shape of two truncated cones set one against the other at the large ends. Those of average capacity are laid down on their sides, and by never emptying them, they get so impregnated with alcohol that for repairs it is not only necessary to empty them completely, but to leave them open for some time, in order to get rid of the alcoholic vapours, which would be sufficient to kill the coopers employed if sent in too soon. In these large vats the wine gets matured, and previous to exportation it is alcoholised according to its being for the English or the Italian market. Great care is exercised in making the casks for Marsala, and when made, they are filled with boiling water, in order to close up all pores of the wood, and after a month they are emptied and filled with a poor wine for two or three months, after which a better description of wine is poured into them for the same period. When required for exportation, they are emptied and cleaned by the use of chains. When filled, they are put into an outer cask for better protection.

FORESTS IN CEYLON.

A report upon the conservation and administration of the Crown forests in Ceylon has lately been published by Mr. F. D. A. Vincent, of the Madras Forest Service. The author notices the past history of the island, and arrives at the conclusion that a large proportion of the existing forests, usually spoken of as virgin or original, are but a secondary growth, which sprang up on the disappearance of a large population some time between the eighth and thirteenth centuries. On clearing the better timber out of this secondary forest, these species threaten to disappear, leaving a forest, entirely different in economic value. There is no material difference in the forest vegetation throughout Ceylon, for "where certain forests grow, we can ascertain from history and from the ancient remains that there were once cities and cultivated fields, but in other places without any remains there is precisely the same forest vegetation." Calculations are made with the object of deciding what area of forest there is in Ceylon. Roughly, speaking it appears that the area of private lands is $3\frac{3}{4}$ million acres, or about one-fourth of the island. Of the remaining three-fourths, the greater part belongs to the Crown. It is to be noted that, of the areas sold, 750,000 acres are estimated to belong to Europeans, 500,000 acres having been bought in the hill country for coffee, tea, cinchona &c., and 250,000 acres in the low-country for the cultivation of tea, Liberian coffee, cocoa, cocoanuts, and cinnamon. There are nearly sixteen million acres of land in the colony, of which only 2,500,000 are cultivated. Mr. Vincent allows four million acres for the large areas of natural scrub forest, for open bush country, for village tanks, roads, rivers, &c., and then half the total area is left on which the absence of forest is not explained by any natural causes; he believes that, with the exceptions mentioned, the whole of Ceylon was at one time covered with forest. He attributes this state of things to one cause—chena cultivation. This destructive form of cultivation has always enjoyed special advantages, as regards taxation over paddy, the permanent food grain cultivation. The range of rainfall is very varied in different parts of the island, as is seen from the fact that at Mannar, in the north, the amount is set down at 33 inches, while at Ratnapura, in the centre of the island, it is 149 inches.

There are many species of trees grown in Ceylon, but the species which are saleable at present are few. Mr. Vincent says that in the dry zone the small proportion of the valuable timber to the valueless is still more remarkable. "The general condition of the forests is that the trees of one or more of the saleable kinds are mixed with a very large variety of the valueless woods. The former never exists as a pure forest by themselves, and collectively, even in the most favourable situations, never form more than one-tenth of the whole. Looked at from a professional standpoint, the forests are most disappointing. They exhibit very poor growth, and the great mixture of species suggests at once great difficulties of management, and comparatively high working expenses. Throughout the same, great difficulty of treatment presents itself. The valuable trees are far apart, and are much in the minority." The reproduction of most of the best species has been very bad, the seedlings being, as a rule, overgrown by the valueless kinds before they can obtain a proper footing. Continual attention will, therefore, be required in the future to aid the natural reproduction. In the arid zone, including the Northern Province chiefly, there has for many years been a considerable trade in timber, and nearly all the mature ebony and satinwood has been cleared out; "pale and yavarani appear to be the only trees of which there should be any regular fellings for some time. But there is much hope that, at least from some parts of the Province, the commoner woods may in future be utilised, and that in connection with reproductive measures it may be possible to get firewood exported to India." In the moist zone the forests assume quite a different character to those in the dry and arid zones; there is to be found a luxurious tropical growth, the trees growing rapidly to a large size, with a dense undergrowth of shrubs, herbaceous species, rattans, &c.; but the wood is generally inferior to the slow-grown timbers in the dry zone. Here the area of the forests has been much reduced by chena cultivation and by land sales.

CULTIVATION OF THE ORANGE TREE IN SPAIN.

The United States Consular Agent, at Gras, writing on the propagation and cultivation of the orange tree in Spain, says that it does not thrive in the open air, except above 43° latitude, and then only in sheltered spots. When the average temperature reaches from 15° to 16° Réaumur, the apparent vegetation of the orange tree commences, which, as a rule, takes place in the month of March. The blossoming requires a mean temperature of 18°, the first flowers appearing in April, and frequently continuing throughout the whole of May. The blossoms are found on the secondary branches, but principally on the tertiary ones, or, in general, those formed during the previous year; but this is not an invariable rule. The soils in which the orange tree thrives well are of very distinct compositions, as there are as many orangeries in Spain on sandy as on clayey soils. Great attention is generally paid by the cultivators not only to the surface but also to the subsoil, as there are frequently parts where the soil is loose and of good quality on the surface, but very compact and bad beneath, or *vice versa*. Orange trees may be propagated either from seed or from cuttings; the former system perpetuates the species and creates new descriptions, afterwards improved by cultivation. The second method, either from shoots, cuttings, or grafting, continues the race, and, at the same time accelerates the fruitage, which is always later with the trees produced by the first-named system; but, in exchange, the trees raised from seed are more robust, and live to a much greater age. in cultivatin plants from the seed, attention must be paid to the soil, in order that it may be of good quality, and free from creeping herbs or seed, and it must be in a good situation so as to receive the sun in all parts, besides which it must have an abundance of water for irrigation. All seeds are sown in flat plots, and if delicate, the soil is lightly manured, and at the same time excavated and loosened, so as to give the plant greater freedom for growing. The plots, when prepared, are opened out in parallel rows of about four inches deep, and about one foot apart from each other. To obtain the quantity of seed required for sowing, when the proper times arrives, the general method is to divide the orange with a knife, taking care not to cut it so deeply as to touch the seeds, or to in any way injure them. These are then picked out, and placed in the shade to dry, after which they are preserved either in paper packets or earthenware pots in a dry place. When the seed is once obtained, and not required for use for a certain time, it is placed in layers of sand, to prevent it becoming too dry or opening. When the time has arrived for the seed to be sown, the soil is carefully prepared, being well watered and dug up. If the earth is compact and formed of hard lumps, these are broken up and smoked, and made up in *hormigueros*, which are heaps of dry vegetable refuse, covered over with earth, having a small opening near the ground, in which is introduced a wisp of straw. On setting fire to the straw, the whole mass gradually consumes itself, forming a small heap of vegetable ashes and earth. These ashes are equally distributed over the surface of the soil, and this is immediately afterwards manured. The ground has to be divided in long and narrow plots, having small irrigating canals between each, which must be sufficiently deep so as not to allow the water to reach the superficies of the rows. The seed is soaked in water for two days, and afterwards thickly sown. The young plants are from four to six weeks before appearing above the surface, and, as soon as they have acquired a certain development, which occurs at the end of a year, the plantation is commenced. This generally takes place from the middle of February to the beginning of March, according to the condition of the plants. The trees are planted in the plantation at a distance of from forty to fifty centimetres apart, and on transplanting the young trees a series of light beds are made. The trees are planted in regular files, but on the opposite side of the beds to that where they are irrigated, thus preventing the water from reaching the young shoots. The top soil is frequently loosened with a weeding hook, and thus the beds gradually get lower, until they become level with the surrounding earth, at the time when the plants have taken firm root, and are flourishing. The plantation is irrigated once in every three weeks in ordinary weather, but oftener when it is very dry. At the expiration of a year in the plantation, the young plants are sufficiently advanced for grafting, this being one of the most important means for the propagation of the orange tree. The system of grafting generally adopted is that of the grafting of a bud. These buds are selected from those of the previous year, and of the June shooting; and according to the size of the parent stem, one, two, or even four are placed, for should the parent stem be thick, and have only one bud grafted on it, the excess of sap would suffocate it. On placing the buds, the parent stem is probed, and they are applied to the most salient parts which the stems may present, as it is considered that it is here where the greatest quantity of sap is found, and it is done, when possible, in the part facing the north. The grafts are tied with esparto grass, and allowed to remain in this state for twenty-one days; if at the end of this time the bud continues green, the grafting is correct, in which case the shoot is cut off about four inches above, and it at once moves if it has dried. Sometimes it commences moving before the grafting has thoroughly taken place, in which case it is immediately cut. Great care is taken in transplanting the roots; they are dug out with a large spade, with a quantity of earth adhering to them, and this earth is surrounded with rotten or dried leaves, and tied round with cords. When the orange trees are taken to the spot for planting, the bottom of the holes is first lined with the earth which has adhered to the roots, until it is estimated that on planting the young tree it will be, after irrigating the soil, at about the same depth as when in the nursery, and as soon as the tree is placed in position, the virgin earth remaining round the sides of the hole is thrown in. Before closing up the hole, about twenty quarts of water is thrown in, if there is a probability of irrigating within a few days; if not, a small quantity of water is added. The orange may be submitted to two systems of cultivation, planting the trees at a considerable distance from each other, or planting them close to one another. The latter system is the most costly, but is productive of better results. In the first year of transplanting, ridges are formed at the sides of the rows of orange trees, at about the distance of about seventy centimetres from the trees, and in the month of April the trees are manured, at the distance of about fifty centimetres from the trunk, and a trench dug round it, in which the manure is placed and covered over. In February of the second year, about two or three pounds of manure are placed at the edge of the ridges, and manure is again deposited in April round each tree. In the third year the young roots have reached as far as the ridges, and the trees commence bearing fruit. The ridges are now broken down, the whole surface irrigated, and *hormigueros* are made. At the distance of about a yard from the trunk of each tree, small holes are dug, and two or three pounds of guano deposited in each, after which they are covered up. In the fourth year the fruit is plucked, and the pruning of the trees is commenced, this operation being generally effected between February and May, and repeated every year. All dry branches are cut off, as are also all ricketty shoots, and the crooked branches which cross one another, and as soon as the pruning is completed the working of the soil is commenced. Consular Agent Loewenstein says that the orange cultivator must be always on the watch, both as regards the weather and the condition of the soil, the utmost care and vigilance being required to ensure the successful cultivation of the tree, and the production of a good supply of fruit.

MINERAL WEALTH OF COLORADO.

An American author speaks of Colorado as a country lined with gold and silver, surrounded with iron, and scattered with lead. It contains the mining district of Leadville, 75 miles N.W. of Denver, the production of which has, in four years' time, attained a value of £10,000,000. This country has scarcely been worked six years, and yet it produces more gold, silver, lead. and iron than any other of the same size. A correspondent of the *Bulletin des Mines*, at the beginning of the present year, gives an account of the mineral production, from which the following particulars are taken:—

Mining industry is pursued with an activity not to be met with elsewhere; and the production of last year exceeded £3,400,000 in value, which is £300,000 more than that of 1881. Twenty mines give employment to from 75 to 400 hands each, the yearly wages amounting to £100,000. The ore extracted embraces silver, gold, lead, iron, and other substances which are utilised in the reduction of the metals, all the substances necessary for smelting and refining, except salt, being found on the spot.

Coke is indeed imported at present; but it can be made in the district in sufficient quantity, if a new method of treating the ores, invented by Professor Stamm, gives practically the results expected from it. Besides effecting a diminution of 75 per cent. in the expense of smelting, it will permit of the reduction of ores that are now considered too poor to pay for treatment. For reducing a ton of ore, the cost of fuel now amounts to nearly £1; but this will be reduced to 5s. 6d. by the new process. The economy consists in utilising the highly bituminous coal, which is converted into coke and gas in retorts. The coke is mixed with the ore; and the gas is injected into the middle of the incandescent mass, thus developing a higher degree of heat, and at lower cost than can be effected by any other means. Among the numerous mines worked to a profit in the district of Leadville, those of the La Plata Company, whose capital is £400,000, are among the richest. They are La Plata, Montgomery, and Gnesen, and employ 100 miners and 110 men in the smelting works. The wages amount to £30,000 yearly, and the monthly deliveries of metal reach 800 tons. The Leadville mines produced more during the last three months of 1882 than at any other similar period, and the works are encumbered with ore, notwithstanding the fact that many have been enlarged. The production of the different metals during the three months was as follows:—Copper, 9,734 tons; lead, 9,687 tons; silver, 50 tons; and gold 225 Troy lbs., amounting in value to £900,000.

Notes on Books.

Hand-books issued in connection with the Great International Fisheries Exhibition.

LITERATURE OF SEA AND RIVER FISHING. By J. J. Manley, M.A. London, 1883.

Mr. Manley deals with something more than the titles of the books he notices, and in this hand-book he has analysed the contents of the chief English books on fishing, from 1486, when the "Book of St. Alban's" was published, to the present time. He has divided his subject into eight chapters, the first of these treating of bibliographies and the last of periodical literature of sea and river fishing.

SEA FABLES EXPLAINED. By Henry Lee, F.R.S. London, 1883.

In this hand-book, Mr. Lee has followed up the subject treated by him in a previous volume, viz., "Sea Monsters Unmasked," and here he treats of the Mermaid, the Lernæan Hydra, Scylla and Charybdis, the "Spouting" of Whales, the "Sailing" of the Nautilus, and Barnacle Geese.

Papers of the Conferences held in connection with the Great International Fisheries Exhibition.

A SKETCH OF THE FISHERIES OF JAPAN. By Narinori Okoshi.

WEST AFRICAN FISHERIES, with particular reference to the Gold Coast Colony. By Captain C. A. Moloney.

THE FISHERIES OF SPAIN. By Lieut.-Col. Francisco Garcia Sola.

NOTES ON THE SUPPLY OF NORWAY. By Fredrik M. Wallem.

THE SWEDISH FISHERIES. By Prof. F. A. Smitt.

These five papers, read at the several Conferences, contain information respecting the fisheries of some of the countries represented at the Exhibition, and are fully supplied with the latest statistics from official sources.

ALL ABOUT PAINTING ON CHINA, with twelve descriptive lessons. By Mrs. Conyers Morrell. London: Kennedy and Brown. 1883.

In this little manual, the authoress has given a list of the materials required for painting in enamel colours, with a list of the colours themselves, some general directions, and a series of practical lessons, intended to teach amateurs who wish to paint upon china.

Correspondence.

WOODEN WATER PIPES.

At the present moment, not far from the Society of Arts' House, is a curious exemplification of the progress of our manufactures in our own time. On the embankment, next the City of London School, there are now some of the old wooden pipes of the New River Company, such as living members of the Society have seen laid; these are logs bored. They show the creation and expansion of branches of the iron trade in mains and pipes, which have superseded timber.

HYDE CLARKE.

General Notes

CANAL FROM ST. PETERSBURG TO CRONSTADT.—Communication between St. Petersburg and Cronstadt, says *Engineering*, is at present carried on by means of a narrow and sinuous canal, which crosses the vast delta of the Neva. Its depth is variable, the minimum being 6 feet 6 inches, and it is, of course, injuriously affected by the floods to which the basin of the Neva is so liable when the river is full, and a strong westerly or north-westerly wind blows back its waters. It was, therefore, decided to construct another and larger canal, in a new line, instead of attempting to enlarge the old one; and in the year 1876 the works were commenced, and are now about two-thirds complete. The canal starts from the mouth of the Neva, where it will open into a large basin, and proceeds southwards for nearly two miles. In this part of its course it will have a navigable width of 207 feet, and will be carefully embanked. Taking a wide curve, it will then join the canal which goes direct to Cronstadt; and from the same point a branch will proceed to meet the Neva above St. Petersburg. It will have a uniform depth of 22 feet. The soil is easy to work, consisting almost entirely of clay, sand, and gravel, and a total quantity of 47,737,000 cubic yards of ballast has been extracted, being about two-thirds of the whole. The remainder will be excavated by the end of next year. The dredgers employed were all English, except two small ones made at St. Petersburg, and one in Belgium; they number altogether ten, and are capable of excavating a total of 188,354 cubic yards in ten hours' work. Eighty-six barges and lighters are also in use, capable of transporting 153,038 cubic yards; twelve tugs, of a total force of 600 horse-power; one steamboat and two steam launches, for purposes of inspection; two floating dredgers, one Gabert excavator, and seven locomotives with a centrifugal Neut and Dumont exhausting pump. Any deficiencies in this plant are supplied by hiring.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first of these lectures, on "Crystals and Crystallisation," was delivered by Mr. J. Millar Thomson, F.R.S.E., Sec. C.S., on Wednesday evening, the 2nd inst. The lecture was illustrated by a large number of specimens, and by a series of crystals thrown on the screen by means of the electric light, which were shown by Mr. Cottrell. The lecturer commenced with an explanation of crystalline structure, and pointed out that the difference between crystalline and amorphous bodies was well exemplified in sugar-candy and in fat. The same difference is seen in nature in the structure of rocks, where will be found a gradual passage from one state to the other, as in limestone, marble, feldspar, and fluor spar. A crystal was described as a solid body exhibiting an original and not artificial regular form. Of these original forms there are six large groups or systems, viz.:—1. Tesseral; 2. Tetragonal; 3. Hexagonal; 4. Rhombic; 5. Monoclinic; 6. Triclinic. In order to obtain bodies in a crystalline form, the particles must have freedom to move, and this is given them by solution, "volatilisation" and "melting," or "fusion." These processes were then practically shown in operation. The general characters of solution were explained, and the difference between solution and mixture was shown. The solution of a salt in water produced cold, and this fact was taken advantage of for the purpose of artificial cooling, but, on the other hand, a combination with water produced heat.

In conclusion, the phenomena of sympathetic inks were explained, and change of colour was obtained in several experiments on specially prepared drawings, by the application of heat.

The second lecture will be delivered Wednesday, January 9th, at seven p.m. As previously announced, all tickets are disposed of.

Proceedings of the Society.

CANTOR LECTURES.

THE SCIENTIFIC BASIS OF COOKERY

By W. Mattieu Williams, F.C S.

Lecture II.—Delivered December 10th, 1883.

In order to understand the changes which cookery effects upon food, it is, of course, necessary to know something of the chemical composition of the food, and, as we shall presently see, something also of its mechanical structure.

Reduced to its primary elements by what has been called "ultimate analysis," all our food is very similar in composition. Its bulk is made up of carbon, hydrogen, oxygen, and nitrogen, with very small additions of such elements as phosphorus, sulphur, chlorine, and minute quantities of certain metals. Such ultimate analysis is, however, but of little concern in the *rationale* of cookery, for when the materials of food are reduced to these, they are food no longer—they have returned to their original place in the mineral world, and may be food for plants, but not for animals.

The growing vegetable is a synthetic laboratory, wherein the mineral compounds of the soil and the atmosphere are wrought into new combinations, which have been named the "proximate elements" of organic matter, those of which the tissues of the plant are built up, and which also exist in a state of solution in some of its juices. Upon these the animal feeds, and they are found slightly modified as the material of which the animal organs are constructed.

One general distinctive characteristic of these proximate organic elements, is the looseness or the chemical bonds which unite their ultimate elements.

They are easily dissociated by heat, or decomposed by the agency of the rival affinities of other substances. As an example of such chemical rivalry, I place in this glass vessel some white sugar, composed of carbon and water, or of carbon and the elements of water. I now add to it some concentrated solution of sulphuric acid, which has a strong affinity for water. On stirring them together, the sugar blackens and forms a sort of pitch; the union of the water with the sulphuric acid is attended, as in all cases of chemical combination, with an evolution of heat which is now sufficient to boil the water separated from the carbon of the sugar, as you see by the outburst of steam, and the curious expansion of the piece of coke to which the sugar is reduced.

Another and familiar example of the looseness of the chemical bonds by which the elements of organic compounds are held together, is supplied by putrefactive decomposition, which, as we all know, occurs spontaneously when such substances are exposed to the air. This putrefaction is a more or less complete return of the elements to their original mineral and more stable combinations. This facility of decomposition, or re-arrangement of elements, is an indispensable condition of nutriment. Such loosely bound elements may be easily converted into the materials demanded for the building up of the structure of the animal that feeds upon them, by the action of the saliva, gastric juice, bile, &c. They are also easy of oxidation in the moist state, *i.e.*, of slow combustion, by means of which the animal heat is maintained.

Water, which is so large a constituent of the animal structure, is an exception to this. It is a mineral rather than an organic compound. It differs from the organic constituents of food in the fact that it enters the body as water, remains there as water, is water always, subject to no decomposition whatever. The same is the case with a few soluble salts, of which common table salt may be regarded as an example.

In the last lecture, I described albumen as typically represented by the white of egg, selecting this because the changes effected on it by cookery are the most decided and best understood, and are practically the most important that occur in the cookery of animal food. You will remember the action of different degrees of heat upon it, and the great change of properties which the heat effects. The position held by this albumen in the structure of meat demands further explanation. It is the universal lubricant of the animal machinery. It is, as shown by the peculiar slimy properties of raw white of egg, remarkably well adapted for this purpose. The so-called "joint oil," or *synovia*, is albumen secreted (*i.e.*, concocted from the blood) by a special membrane lining the joints—the synovial membrane.

The contractile fibres of the muscles are bathed in it, and thus it constitutes one of the juices of lean meat, the lean meat being the muscular substance. Time will not permit me to discuss the other physiological functions of this unctuous liquid, so universally diffused throughout the animal body. I may merely mention that it probably acts as a nutrient fluid, not only diminishing the mechanical wear and tear of the working tissues, but supplying them with building material, by means of which their inevitable wear and waste is compensated.

The nutritive value of albumen from our present point of view, *i.e.*, as cookable food, is unquestionable. It not only contains the materials demanded for nutrition, but holds them in a most easily digestible form, provided always the cook does not verify a certain irreverent adage, by converting it into the indigestible, shrunken, leathery substance already described as the result of overheating.

Gelatine is another and very important constituent of animal food. As far as regards quantity, it is more so than albumen, as it is the chief material of the animal tissues. Haller says that half of the animal body is gelatine. The walls of the cells of which the animal is built up are of gelatine; the membranes enveloping the fibres of the muscles, the same; the ligaments and tendons are fundamentally composed of it. It is the chief constituent of the skin. The bones are built by means of cells composed of gelatine, in which the hard mineral matter, the phosphate of lime, is deposited. These facts justify the labour of the Bone-soup Commission of the French Academy, already referred to.

Its familiar form is that of the prepared gelatine of the shops, the jelly of stock, calves'-foot jelly, &c. Carpenters' glue is the same, but dirty. These, however, are not exactly the same as the material of the membranes as they exist in the flesh. The membranes are raw gelatine, these preparations are cooked gelatine. The gelatine, as it exists in the tissues, is not readily soluble in water. This is easily shown by immersing in water a piece of any animal membrane, or of tendon, or, better still, that structure of exceptionally pure gelatine known as isinglass, which is the shredded swim-bladder of a fish—of the sturgeon, or of some substitute for the sturgeon. It resists cold water, but yields to the continued action of boiling water. After having been thus treated, it becomes readily soluble. In this primary cooking it combines with a certain quantity of water. I venture to call it hydrated gelatine.

Here, then, we have a curious contradiction in the cookery of animal food. The cooking of albumen is the conversion of a viscous liquid into a solid, that of the gelatine, the conversion of a solid to a viscous liquid. The proper cooking of albumen demands a temperature of about thirty degrees below the boiling point of water, that of gelatine may be conducted at the full boiling point, but, fortunately, this is not necessary. If time is allowed, the gelatine may be quite as well cooked at 180° as at 212°. Even gelatine is spoiled if kept at 212°, when not under water, as the carpenter knows full well, and, therefore, he uses for the solution of his gelatine a vessel immersed in water—a *bain-marie*, or water-bath, rendering it impossible for the glue itself to reach the boiling point.

There are varieties of gelatine, or the tissue that produces gelatine when cooked, which time will not permit me to describe. *Chondrin* is that obtained by digesting the cartilages of the ribs, the larynx, or of the joints, for eighteen or twenty hours in hot water. *Fibroin*, obtained by a similar cooking of spiders' web, or the silk of silkworms and other caterpillars. The material of these fibres originally existed in the animals as a liquid, which has solidified on exposure to the air. The fibres of sponge yield a kind of gelatine. Another kind constitutes the basis of the structure of insects, and has been named *chitin*. *Chitin* soup may be made by boiling down grasshoppers, locusts, or the shells of lobsters, crabs, shrimps, and other creeping things that I need not specify. Neither will I here discuss the merits of this crustacean soup, as compared with the more popular preparation obtained from the callipash and callipee of marine reptiles.

I have eaten fried shrimps at Naples, where they are cooked, as we cook whitebait, shells and all, without any previous boiling. They are excellent, and I understand that locusts similarly cooked are not distinguishable from them, but have not yet had an opportunity of practically testing this delicacy. That large tracts of country should be periodically desolated by locusts, is a striking proof of the neglected condition of the science of cookery. If the locusts devour the crops, why not cook, preserve, and eat the locusts? As regards any inherent repulsiveness in the idea of eating them, they are far less objectionable than pigs, and not worse than oysters and periwinkles.

I have already referred to the Bone-soup Commission of the French Academy. Its object was to determine whether or not the vast quantities of gelatine contained in bones, and which is commonly wasted, might be used in making soup in hospitals and other public institutions. The academicians arrived at a negative conclusion on the main question of the nutritive value of gelatine. They found that dogs, fed upon it exclusively, at first appeared satisfied with it, then ate it with difficulty, and finally rejected it, and died of starvation when supplied with no other food. Some of the academicians experimented on themselves, but did not carry their researches so far as with the dogs. They reached the loathing stage, and then retired from the investigation, and dined as usual.

A multitude of such experiments led to the conclusion that gelatine is not nutritious—a conclusion curiously at variance with ordinary experience. Liebig stated it very broadly and positively. Further investigation has, however, refuted this conclusion, and the experiments of the academicians are explained by understanding that gelatine alone does not contain certain materials that are absolutely necessary for building up the body, and that starvation may ensue from the want of these. It is worthy of note that this later conclusion of science is but a confirmation of the intuitions of our natural instinct—our sense of taste. The gelatine obtained from bones is nearly tasteless—pure gelatine quite so; the addition of a little table salt improves it, but not satisfactorily. If, however, we add to insipid gelatine the juices of fruit, as when jellies are made for evening parties, or to tasteless broth the saline juices of flesh—of which I shall speak presently—then we obtain a mixture that men, or dogs, or other animals, eat with satisfaction. It has also been found that the addition of a very small quantity of meat juices is all that is required to render gelatine nutritious.

What, then, are these juices of meat? As we have already seen, albumen exists in a liquid state between the fibres of lean meat, and, therefore, is one of them; but when the juices of meat are particularly specified, reference is usually made to the juices that are not coagulable—to juices that are saline, and which partake of the general properties of mineral salts rather than organic compounds. Some of them may be regarded as standing between the organic and inorganic.

This is especially the case with two of the most characteristic of these juices, kreatine and kreatinine, which have been described by some physiologists as products of the wear and tear of the used-up tissues that are about to be removed from the body. Besides these, we find in the meat lactic acid and certain salts of potash, such as the phosphate of potash and minute quantities of other salts.

Time will not permit me to enter upon the details of the composition of these. I must need lump them all together, as the saline and sapid juices of flesh. When tasted alone, in concentrated form, their flavouring energies are strikingly manifested; they are painfully acrid to the tongue and palate.

There is one characteristic of these that is very little understood, but is very important. Although they are constituents of food, *they are not digested.* They are not converted into chyme by the gastric and mucous secretions of the stomach, then further changed into chyle by the secretions of the liver and pancreas, and afterwards passed along the alimentary canal, gradually taken up by the lacteals, and further changed by the mesenteric glands, before reaching the blood. Instead of all this, they pass directly through the walls of the wondrously delicate miles and miles of blood vessels which form a velvet on the inner coat of the stomach. These juices thus enter the general current of the blood directly, as water does.

That any liquid should pass through a water-tight membrane seems impossible, but it is nevertheless a fact that it can and does. If a wide-mouthed bottle be filled with salt water, or with a solution of sugar, and a piece of air-tight and water-tight bladder be tied firmly over the neck, so that no mechanical leakage can take place, the solution of salt or sugar will pass out through the bladder, if the bottle thus filled be immersed in water deep enough to cover the bladder. Or if a bladder itself be filled with brine, tied firmly, and then immersed in distilled water, the same occurs, as may be shown by adding a few drops of a solution of nitrate of silver to the outside water, after the bladder has been immersed in it for a short time. A white precipitate will be thrown down, the same as would be seen if a little of the salt water had been poured out of the bladder into the distilled water.

This is called endosmosis, when the passage is from without to within a vessel, or exosmosis when from within to without. They usually occur simultaneously, though not in equal degrees.

As the saline juices of meat are contained, for the most part, within the cell walls of the muscular fibre, or the sheaths of the bundles of fibres, we may avail ourselves of this mysterious action, and extract these saline juices by exosmosis. In spite of its unfamiliar name, it is one of the most familiar of kitchen operations, both useful and mischievous. When meat is rendered tasteless in the course of boiling or steaming, it is due to the exosmosis of its juices. On the other hand, in making meat broth, or soup, or beef tea, exosmosis is usefully applied to produce an intended result.

The making of beef tea is a good example of this, especially when made by simple maceration, *i.e.*, by using cold water only. To work out the *rationale* of this, the distinction between colloids and crystalloids must be understood.

Certain solutions perform the endosmosis and exosmosis I have just described, while others do not. On comparing them, it has been found that those which do thus pass through animal membranes are solutions of crystallisable salts, while those which do not are solutions that, when evaporated down, form jellies, mucilage, or amorphous, formless masses; hence the terms colloid and crystalloid. This being the case, it is evident that if we immerse a piece of gravy beef in cold water, only one class of its juices will pass through the enveloping membranes; this class will include the saline juices of which I have spoken, and will not include the albumen, nor any gelatine that may be dissolved. If the beef is minced, as in ordinary practice, a little of the albumen will be washed off the surface exposed by the cutting, and a modicum of gelatine may be dissolved from these surfaces. If, on the other hand, we stew beef in water heated just below the temperature at which albumen coagulates, more of this albumen will be washed out, and much more gelatine will be dissolved.

Thus we shall obtain two kinds of beef tea, the first containing only those juices which are directly absorbed by the capillaries of the stomach, and thus pass directly into the blood; and the second containing these same, *plus* some gelatine which has to be digested after the manner of solid food. In both cases the albumen is separated from the liquid, by heating it to the boiling point of water. It then rises to the top as a "scum."

I have been asked which is the proper method of making beef tea, by cold maceration, by moderate stewing, by or boiling. The boiling may be at once dismissed, for reasons that will be understood by all who have listened to what I have said concerning the coagulation of albumen.

The relative merits of the other two processes demand further consideration. If the beef tea is required for a very delicate invalid the "cold drawn" may be the best, but this conclusion pre-supposes a condition of the body demanding a supply of these particular saline juices which perform certain parts of the work of nutrition, and appear to have a kind of stimulating influence. A skilful physician is required to decide whether this is or is not the case.

If the beef tea is made for a convalescent regaining digestive power, and demanding full nutrition, there can be little or no doubt that the liquid prepared by digesting minced beef in warm water (which I prefer to call beef broth, or beef soup, restricting the name of beef tea to the cold drawn) is the best. In this there is a little gelatine, together with abundance of the saline juices, which render the gelatine digestible and nutritious.

Liebig's extract of meat, when properly prepared, is what I have called beef tea proper, in a concentrated form. When it was first introduced, great expectations were formed, based on the theory that it is concentrated nutriment. Further investigation has proved that it has many great merits, but it is not a complete nutriment, and that, after being used for a while, it becomes nauseous. Hence the preparations that are offered to supersede it, meat essences, &c., which are merely equivalent to Liebig's extract *plus* gelatine, and may be made by stewing beef in warm water, or by adding Liebig's extract to calf's-foot jelly, or to its equivalent, the jelly made from isinglass, or the prepared gelatine sold by grocers. I am not aware whether jelly for invalids is ever prepared thus, by adding a little dissolved Liebig before consolidating; but I believe that it would form a very good and easily prepared form of delicate food, always remembering that it is still but a partial diet, as it lacks the carbon-food supplied by sugar, and the farinaceous compounds, of which I shall have to speak in the next lecture.

I have yet to describe another constituent of flesh, viz., the actual fibre of the muscle itself; that which in life possesses the wonderful property of contractility—of shortening itself when commanded to do so by the mysterious agency of the nerves.

This has been named *syntonin*, also *fibrin*, the first name being given to distinguish it from the fibrin of the blood, which it resembles, but with which it is not quite identical. I can only describe it in relation to cookery. In this aspect it stands between albumen and gelatine, rather nearer to albumen. It is coagulable, like albumen; and soluble, like gelatine, but in a less degree. Like gelatine, it is tasteless and non-nutritious alone. This has been proved by separating the albumen and juices, and giving it to dogs. The washed fibrin of the blood, which closely resembles the washed-out muscular fibres, is similarly worthless alone.

I now come to stewing, and venture to describe this, an almost unknown art in England so far as ordinary domestic cookery is concerned. This is curious, because among our neighbours across the Channel it is the primary process of ordinary domestic cookery, and is well understood by the wife of every peasant.

The prevailing idea in England is that stewed meat only differs from boiled meat by being kept in the water for a longer time—that stewing is simply protracted boiling. I venture, nevertheless, to declare the total fallacy of this, and to assert that, so far as flesh food is concerned, boiling and stewing are diametrically opposite, as regards the special objects to be attained. In boiling a joint—say, a leg of mutton—the best efforts of the cook should be directed to retaining the juices within the meat, and allowing the smallest possible quantity to come out into the water. In stewing, the business is to get as much as possible out of the meat, to separate the juices from the meat and convey them to the water. This is the case, whether the French practice of serving the liquid *potage*, or *bouillon* as a separate dish, and the stewed meat or *bouilli* as another, or the English and Irish fashion of serving the stewed meat in its own juices or gravy, as in the case of stewed steak, Irish stew, &c. The cruel murder that is commonly perpetrated upon good mutton chops, in preparing Irish stews, is very deplorable. The chops are put into a saucepan in water, and the water is *boiled* or "*simmered*," *i.e.*, kept at 212°. whereby the albumen is at once coagulated, thus hindering the ready exosmosis of the juices. This is continued until both albumen and fibrin are so much hardened that they contract (as the white of egg does when used as a cement). The meat curls up curiously in consequence of this contraction, the albumen is made to resemble gutta-percha, and the fibrin to resemble cotton wool, before the extraction of the juices is completed.

Not so with the frugal stew of the poor French peasant, who does more with one pound of meat, in the way of stewing, than the English cook with three or four. The little bit of meat, and the large supply of vegetables are placed in a pot, and this in another vessel containing water—the *bain marie*. This stands on the embers of a poor little wood fire, and is left there till dinner time, under conditions that render boiling impossible, and demand little or no further attention from the cook; consequently, the meat, when removed, has parted with its juices to the *potage*, but is not curled up by the contraction of the hardened albumen, nor reduced to stringy fibres. It is tender, eatable, and enjoyable, that is, when the proper supply of saline juices of the meat, *plus* the saline juices of the vegetables, have been taken into the system.

Eaten alone, like our roast beef, it would be like the bone soup offered to the dogs by the academicians; but eaten with these juices, it is wholesome, and sufficiently savoury. Whether the *potage* and the meat should thus be separated, or whether they should be stewed together, as in an Irish stew, &c., is merely a matter of taste and custom; but that a stew should never be boiled, nor placed in a position on the fire where boiling or "simmering" is possible, should be regarded as a primary axiom in cooking where stewing is concerned.

The subject of frying, properly belonging to the programme of this lecture, must be postponed to the next; and also that of casein, another very important constituent of animal food.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the two meetings recorded in the last numbers of the *Journal*:—

THE DWELLING HOUSE.—GROUP III.—SUB-COMMITTEE A.

Friday, December 28th.—Present: Capt. Douglas Galton, C.B., F.R.S., in the chair; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. Rogers Field; Mr. Charles Heisch; Mr. Baldwin Latham; Mr. George Shaw; Mr. H. Trueman Wood.

THE DWELLING HOUSE.—SUB-COMMITTEE B.

Friday, December 28th.—Present: Mr. George Godwin, F.R.S., in the chair; Mr. C. N. Cresswell; Mr. T. W. Cutler; Mr. R. W. Edis; Mr. R. E. Farrant; Mr. E. Hoole; Mr. Malcolm Morris; Mr. George Shaw; Dr. R. Thorne Thorne; Mr. Ernest Turner; Mr. George Vigers; Mr. H. T. Wood.

THE WORKSHOP.—GROUP V.

Saturday, December 29th.—Mr. Gilbert R. Redgrave, in the chair; Mr. J. H. Bridges; Dr. A. Dupré, F.R.S.; Mr. Warington W. Smyth, F.R.S.; Mr. H. T. Wood.

DRESS.—GROUP II.

Monday, December 31st.—Present: Mr. Frederick Treves, F.R.C.S., in the chair; Mr. T. W. Cutler; Mr. J. D. Linton; Deputy Surgeon-General Jeffery Marston; Surgeon-General Townsend, C.B.; Hon. Lewis Wingfield; Mr. W. H. Weldon; Mr. H. T. Wood.

THE DWELLING HOUSE.—SUB-COMMITTEE C.

Tuesday, January 1st, 1884.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Sir Frederick Abel, C.B., F.R.S.; Mr. A. T. Atchison; Mr. W. R. E. Coles; Prof. T. Hayter Lewis; Mr. W. H. Preece, F.R.S.; Professor W. Chandler Roberts; Mr. Greville Williams; Mr. H. T. Wood.

THE SCHOOL (GROUP IV.) AND EDUCATION (GROUP VI.)

Tuesday, January 1st.—Present: Lord Reay, in the chair; Mr. B. St. John Ackers; Dr. T. R. Armitage; Mr. E. N. Buxton; Mr. J. G. Fitch; Dr. J. H. Gladstone, F.R.S.; Major-General Hammersley; Colonel W. Nassau Lees; Mr. Philip Magnus; Deputy Inspector-General F. J. Monat; Mr. T. Nordenfelt; Sir Francis R. Sandford, K.C.B.; Mr. H. T. Wood.

FRUIT FARMING.

An article on this subject, the particulars of which were drawn from a paper by Mr. Charles Whitehead, of Maidstone, in the *Journal of the Royal Agricultural Society*, and from some books published in America, appeared lately in the *Times*. The following facts are selected from that article:—

It appears that in England, between the years 1872 and 1882, fruit-growing land increased no less than 26,696 acres, while an analysis shows that this increase is apparent in twenty-six counties, all the others showing a decrease. The most important increase is shown in the five fruit-growing counties of Hereford (with 5,944 acres), Kent (5,362 acres), Somerset (with 4,324 acres), Worcester (4,290 acres), and Gloucester (with 3,251 acres increase); while Devonshire—in which county apples were cultivated so long ago as 1520—shows only an increase of 358 acres.

An important proportion of the increased fruit consumption is due to the demand for jam for home and foreign consumption. Jam is becoming a common article of food throughout the country. It may seem strange that fruit should be so dear as it was in 1882, for example, when it is seen that the amount of raw fruit sent into this country during this year was 4,045,691 bushels, of the value of £1,718,909, independently of the large quantities of fruit in the form of pulp, or dried by the sun or artificial processes. The annexed return will show the amount of raw fruit sent into England in 1871 and 1882 respectively, and the various countries from which it was sent:—

Name of country.	1871.		1882.	
	No. of bushels.	Value.	No. of bushels.	Value.
		£		£
Germany	62,519	22,104	515,604	151,096
Holland	160,392	59,542	444,886	182,876
Belgium	276,286	95,822	593,158	669,164
France	354,606	214,542	524,683	335,543
Portugal, Azores, and Madeira	73,979	57,081	133,124	81,245
Spain and Canary Islands	59,712	48,795	462,082	277,757
United States	56,441	40,604	1,065,076	387,190
British North America	55,150	37,004	222,128	90,077
British West India Islands	10,063	10,750	20,168	15,810
Other countries	12,520	9,863	14,197	7,581
Channel Islands	...	...	50,584	20,574
Total	1,218,668	596,107	4,045,690	2,218,913

Not only are the French, the Belgians, and the Germans increasing their area of fruit land, and improving their methods of cultivation, but the Americans are also planting fruit, and are adopting, with characteristic zeal, new and improved systems of packing and preserving it. In the report of the American Commissioner of Agriculture for 1878, it is stated that there were more than two millions of acres under cultivation as apple orchards, and that in twenty years the value of the products had increased from £1,320,000 to over £10,000,000. Besides apples and many other small fruits, the peach crop of the United States is estimated at the annual value of £11,500,000; so that it is not surprising that there is occasionally a superabundance of fruit, especially of peaches and apples, upon which pigs are fed. This waste has been in a great degree obviated by the ingenuity of the Americans in preserving the fruits and drying them. At Baltimore particularly, as well as in other cities which are centres for the accumulation of fruit, large establishments have been built and furnished with the most improved machinery and appliances for the rapid drying and evaporation of the watery parts of fruits. By an ingenious process the water is slowly separated from the solid parts, which at the same time undergo a chemical change, the acid and the starch being converted into grape-sugar. The Commissioner of Agriculture, in the report alluded to, says of this:—"The proof of the pudding is in the eating, and it is said that an apple-pie made from fruit evaporated by these processes cannot be distinguished from one made of fresh fruit; and yet only one half of the quantity of sugar is required to sweeten it; and the same fact is true in regard to tomatoes, and all fruits and vegetables." Iron stoves, and machines constructed on the principles described above for drying fruit, but portable, and costing only about £15, are used in many districts in the country far from towns. These will, it is said, thoroughly and perfectly dry as much fruit as a family can peel and slice in a day. All kinds of salad and delicate vegetables—such as onions, peas, asparagus, celery, Lima beans—are preserved by these new processes, fresh and "dehydrated," like the fruits of all seasons of the year, for all the markets of the world, returning, placed in water, at any time when desired for use, to their original fulness, colour, flavour, and other properties.

Much fruit is produced in Canada. The acreage of fruit land has been extended largely in the last fifteen years, and the greatest interest is taken by the Government and by the farmers themselves, in the promotion of this industry. The main part of the fruit-land is in Ontario, or Western Canada, in which it is said that any fruits can be grown that are produced in the temperate zone. There is a large fruit-growers' association in Ontario, devoted to the improvement of the cultivation, packing, and preserving of fruits. In 1880, a Commission was appointed by the Lieutenant-Governor, to inquire into the progress of agriculture, and in the report of the Commissioners valuable information as to fruit is contained, which is not only most useful and interesting to Canadian cultivators, but also to all other fruit-producers. Very fine apples are grown in Ontario, better, it is alleged by the Canadians, than those that are grown in the United States. It is said that when Canadian apples are good the Americans buy them and brand them "Americans," and when they have indifferent samples of their own growth, they brand these "Canadians." Canadian apples have undoubtedly a great reputation in the English markets. A large fruit-grower in Ontario, in his evidence before the Commissioners, says:—"There is nothing to prevent our apples from competing successfully with the English apples in England, if they are properly sent. We have beaten them in their own market with the Ribston-pippin. It sells in England at £3 per barrel." Not only do the Canadians exercise the greatest skill in the cultivation of apples, but they understand the art of storing them.

In England, however, Lord Sudeley is the only landowner who has taken up the question in a thorough and businesslike manner. He has already planted 500 acres, and is intending to plant 200 acres more at once. The land is a fairly free working moderately good soil on the Lias formation. It was deeply steam-ploughed and well manured, and standard trees of apples, pears, cherries, plums, and damsons were put in 16 feet apart; 3,000 apple trees were planted of the best sorts, including Lord Suffield, Keswick, Codlin, Grenadier, Cox's Orange Pippin, Cellini, and Warner's King; 812 pear trees have already been put in—Beurré de Capiaumont, Easter Beurré, Louise Bonne, Jargonelle, Beurré d'Amanlis, Doyenné d'Ete, and other choice varieties. There are 32,000 plum trees of forty-four different kinds, such as Diamond, Pond's Sneedling, Early Orleans, greengage, Victoria, and Autumn Compote. Of damson trees there are 9,000, nearly half of which are known as Brittenden's, so largely grown in Kent, and the remainder are the Shropshire prune, Cheshire, common prune, and black.

Only 522 cherry trees have been hitherto put in, as Lord Sudeley is not quite certain as to whether they will flourish at Toddington. These are of the best kinds, such as the late and early Bigarreau, Black Heart, Kentish, and Flemish, and at present are looking very well. Gooseberry or currant bushes and strawberry plants are set between the standards, and in some cases raspberry canes are put between the gooseberry and currant bushes. There are over fifty acres of black currants, raspberries, and strawberries by themselves, without standards. There are 100 acres of strawberry plants in all, and sixty acres of raspberry canes. Some of the apple trees are pyramids, which do very well. Gooseberry bushes number 130,000, and consist of no less than forty-five varieties. No less than 228,000 black currant bushes have been put in of the leading kinds, such as Lee's Prolific, Baldwin's Black, Black Naples, and Prince of Wales. Belts of poplars, Scotch firs, and other quick-growing trees, have been placed round the plantation, to shelter it from the prevailing winds. Beds of osiers have been formed on the banks of the little stream Isbourne, which have taken so well that all the baskets required for the fruit are now made on the estate. Ten acres more are to be planted at once with osiers. A nursery for raising trees and bushes has been formed in a convenient and well-sheltered spot, where standards, pyramids, and bush-trees of all sorts and sizes are seen, well grown, well trained, and worked upon the most approved stocks, as well as all descriptions of fruit bushes. About 100 tons of fruit will be grown on the estate this year, which is a capital quantity, considering that no fruit trees were planted until the autumn of 1880.

The Orange Judd Company of New York (London: Trübner) have just issued a volume by Dr. Oemler, in which we have clear evidence of how far vegetable and fruit culture has taken root in that country. The tomato is grown very largely in New York State, one farmer growing no less than fifty acres annually. They sell at about three dollars (12s.) per bushel crate, and as the average yield is 150 of such crates to the acre—the return for several years has been 450 dollars, or £112 per acre. In Florida, 400 bushels per acre are easily obtained, but as the fruit does not get to New York in quite so fresh a condition, only about two dollars per crate can be obtained. This is just 800 dollars (or £200) per acre, out of which must be deducted, however, cost of transit and a middle profit, so that probably the grower gets no more than the grower in New York State with his smaller yield. The cost of cultivation is not large, the labour being the chief item. It is put down at 100 dollars (£25) per acre, and from this it will be seen that a good rent for the land and profit for the cultivator is made. In a catalogue of a Rochester (New York) firm of lithographers, who specially issued coloured plates for nurserymen's lists, there is a list of no less than 664 plates of different varieties of apples, 150 of pears, 203 of peaches, 84 of new plums, 12 of apricots, 111 of cherries, 124 of grapes, 20 of blackberries, 96 of strawberries, 62 of raspberries, 24 of gooseberries, and 36 of currants. When we come to mere ornament, we find but 400 plates of roses, flowers of all descriptions and evergreens—less than two-thirds of the plates of apples alone. This is but characteristic of American farming.

Mr. J. C. R. Okes wrote subsequently to *The Times*, to point out that Cambridgeshire was not mentioned in this article, among the fruit-growing counties of England, and added the following particulars:—

"It is, I believe, not generally known that very large quantities of gooseberries and other fruits are grown in the neighbourhood of Wisbeach, where the soil seems admirably adapted to the production of fruit and vegetables. The local papers state that large sums are obtained from the sale of this crop. If my memory is correct, the gooseberry crop last year (1882) sold for nearly £100 per acre, and this year (1883) for £75 per acre. The chief markets are Birmingham and Manchester, to which places there is good rail accommodation. Possibly this is the nearest approach as regards prices to those obtainable in Canada and America."

NEW PATENT ACT.

Unusual activity prevailed at the Patent-office, on the 1st inst., when the new Patent Act came into operation. One enthusiastic inventor, hailing from north of the Tweed, took up his station outside the door soon after midnight, and his patience was rewarded by the honour of appearing as "No. 1" under the new law. Towards 4 o'clock, he was joined by two others, and when the hour for opening had arrived, a small crowd of about fifty eager appli-

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FRIDAY, JANUARY 11, 1884.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SWINEY PRIZE.

The adjudicators under the will of the late Dr. Swiney are summoned to meet on Monday, the 21st January, 1884, at the Rooms of the Society, at 3.30 p.m., to make the award in conformity with the terms of the bequest contained in the will of the testator.

By order,
H. Trueman Wood, Secretary.

16th January, 1884.

MULREADY PRIZE COMPETITION.

The Council of the Society of Arts, acting on the report of the Judges appointed by them, have awarded the Society's Gold Medal to Charles J. Adams, of the School of Art, Leicester, for his drawing from the nude figure, submitted in competition for the prize offered by the Society "to that student in a School of Art in the United Kingdom who exhibits the best drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready."

PRIZES FOR ESSAYS.

The Council have to announce that they have accepted a very liberal offer made by Mr. William Westgarth, a member of the Society, to provide a sum of £1,200 for prizes for essays upon the construction of Dwellings for the Poor of the Metropolis, and on plans for reconstructing Central London. The prize for the former essay will amount to £250; for the latter there will be one prize of £500, and three prizes of £150 each. Full particulars of the conditions will be published immediately.

JUVENILE LECTURES.

The second of these lectures, on "Crystals and Crystallisation," was delivered by Mr. J. Millar Thomson, F.R.S.E., Sec. C.S., on Wednesday evening, the 9th inst. The lecturer first described the solution of substances in solvents other than water, such as alcohol, and pointed out that, in these cases, as in the case of solution in water, crystalline salts may be obtained termed alcoholates. He next dwelt upon the union of water with salts at low temperatures, and described the formation of those crystalline bodies which Dr. Guthrie terms cryohydrates. The next portion of the lecture dealt with the passage of light through certain crystals, as in the case of Iceland spar, where the pencil of light becomes divided, giving rise to the phenomenon of double refraction. After showing this phenomenon on the screen, Mr. Thomson drew attention to the action of polarised light when passing through films of crystals of different thickness, and exhibited in the beam of the lantern patterns made from different thicknesses of the crystals. He then passed to the consideration of abnormal cases of solution and crystallisation, alluding to the phenomena of supersaturation. He first showed that a flask containing such a supersaturated solution, when opened to the air of the room, suddenly became solid. Minute solid particles, derived from the air, appear to be instrumental in causing the crystallisation of such solutions, and Mr. Thomson showed that if such a solution be placed in a flask furnished with two tubes closed with plugs of cotton wool, it was found that on withdrawing the plugs, and blowing air through one of the tubes dipping into the solution, crystallisation does not take place, apparently from the air having been deprived of the particles causing it; for if the air be blown through the same solution with bellows, it solidifies almost instantaneously. After explaining the conditions of isomorphism between certain groups of crystals, Mr. Thomson pointed out that crystals of different bodies may be dropped through supersaturated solutions, provided such crystals were of a different form from that of the body in solution. He also showed that a solution may be stirred with a glass rod provided it be thoroughly clean, but the moment it is withdrawn and touches some other body, it takes up some nucleus which starts the crystallisation. After alluding to the separation of substances by this means, if they are of different forms, Mr. Thomson concluded his lecture by showing two supersaturated solutions in a tall cylinder, one above the other. A crystal of the body in the lower one was dropped in, when it passed through the upper solution, solidifying only the lower layer; on touching the upper layer, however, with a crystal of itself, the top layer then became solid.

Proceedings of the Society.

CANTOR LECTURES.

THE SCIENTIFIC BASIS OF COOKERY.

By W. Mattieu Williams, F.C S.

Lecture III.—Delivered December 17, 1883.

According to the classification adopted in the first lecture, frying ranks with boiling and stewing, rather than with grilling. When properly conducted, it is one of the processes in which the heat is communicated by convection, the medium being hot fat instead of the hot water used in the so-called, and miscalled, "boiling" of meat.

I say "when properly conducted," because it is too often very improperly conducted in domestic kitchens. This is the case whenever fish, cutlets, &c., are fried on a merely greased plate of metal, such as a common frying-pan. Pancakes or omelettes may be thus fried, but no kind of fish or meat. These should be immersed in a bath of fat sufficiently deep to cover them completely. To those who have not reasoned out the subject, such complete immersion in so large a quantity of fat may appear likely to produce a very greasy result. The contrary is the case.

Let us take, as an example, the frying of a sole. On immersing this in a bath of fat raised to a temperature above that of boiling water, a violent hissing and crackling noise ("frizzling") is heard. This is caused by a series of small explosions due to the sudden conversion of water into steam. The water was originally on the surface and between and within the fibres of the flesh of the sole. The continual expansion of this water into vapour, and its outbursting, prevents the fat from penetrating the fish, so long as the temperature is maintained above 212°, and thus the substance of the sole is cooked by the steam of its own juices, and its outside browned by the superheated fat.

Now, let us suppose that a merely greased plate, like the bottom of a frying-pan, is used. Only one side of the sole is cooked at first—the side in contact with the pan—therefore it must be turned to cook the other side. When thus turned, the side first cooked with its adhering fat is cooling; its steam is condensing between its fibres, and the fat gradually entering to supply the place of steam, while the other side is cooking. Thus it is more greasy than if rapidly withdrawn from the bath of hot fat, and then allowed to drain before the steam commences to condense.

Here is a frying-kettle, exhibited by Mr. Burton, with a wire frame or grill, fitting the bottom. On this the fish is laid, and by this it is raised immediately it is cooked, and the fat drained away. A stew-pan, or any other suitable kind of kettle, may be used, if provided with the wire basket for lifting; or a frying-pan of the ordinary kind, if deep enough.

Although the quantity of fat required for starting this kind of frying is considerable, the consumption at each operation is less than when the greased plate is used; the material of the fat bath can be used again and again with occasional clarifying by methods well understood in the kitchen, but the fat used for smearing the frying-pan is nearly all wasted by the overheating and carbonizing of a portion of it. Of course, two or more supplies of fat are required, one for fish, another for cutlets, &c., and another for such delicacies as apple fritters, which especially require the fat bath.

There is yet to be described a constituent of animal food that is not contained in any kind of flesh, nor even in the blood, and yet is of the highest nutritive value, This is *casein*, the substantial basis of milk. It is separated as curd in the familiar operation of making curds and whey, and in the first stage of the manufacture of cheese. When thus separated from whole milk, it is by no means pure casein, as it carries with it nearly all the oil globules, *i.e.*, the cream contained in the milk.

Pure casein, as prepared in the laboratory for the study of its special properties, is obtained by first skimming the cream from the milk, then precipitating the curd from this, and washing it with ether, to remove the small quantity of cream still adhering to it.

Before describing its properties, I must say a few words concerning the precipitation of the curd. Rennet is commonly used. This is the inner or mucous membrane of the stomach of a calf, a little salted piece of which, or a solution from it in hot water, will precipitate all the casein from many thousand times its own weight of milk. The precipitation may also be effected by acids, and it is probable that the rennet sets up a sort of fermentation, or incipient putrefaction, which liberates lactic acid (the acid of sour milk), and that this souring of the milk goes on until all the curd is separated. What, then, is the nature of the change that induces this precipitation? It is a coagulation nearly resembling that of albumen, excepting that casein is not coagulable by simple heating.

There is one lesson here that I am particularly anxious to impress, viz., that casein may exist in two forms, the insoluble casein of the precipated curd, or of cheese, which is simply pressed curd more or less salted; and the soluble casein, which exists in milk. The practical application I make of this will be seen presently.

If skim milk from which all the fat has been removed be carefully boiled down, we may obtain soluble casein in a solid form and dry. It is an amber-coloured translucent substance, tasteless and inodorous, when pure. If added to a small quantity of water, a yellowish viscous liquid is obtained. Condensed milk is this, *plus* cream and sugar, and its solubility is familiar to all.

Casein that has been coagulated by rennet or acids is insoluble. This is the condition of the casein of cheese, and I think sufficiently explains the difference between the digestibility of cheese and that of milk. An infant that feeds on milk would be killed by a raw cheese diet.

This indigestibility of insoluble casein is very serious, as dry casein has about the same composition as dry albumen, fibrin, or gelatine, and, if as easily digested, would have equal nutritive value. But this is not all. We do not use either our albumen, fibrin, or gelatine, or casein, in the dry form as obtained in the laboratory, but the first three in the form of flesh meat, and the latter in that of cheese. In both cases we have an addition of fatty matter, either the fat of the animal tissue, or that of the cream. But in both the meat and the cheese there is another constituent, viz., water. In the best part of lean beef an average of 72½ per cent. of water is found; in mutton, 73½; in veal, 74½; in pork, 69½; in fowl, 73½; while in Cheshire cheese the average only amounts to 30½ per cent. Other cheeses about the same.

Taking the composition of a whole skinned and prepared sheep, or ox, as it hangs in a butcher's shop, the amount of nutriment it contains is about equal to one-third of its weight of cheese. The fat is about the same in both, but the difference is due to the bones and excess of water. Thus, 20 lbs. of cheese contains as much nutritious material as a sheep of 60 lbs. weight, and would have the same value as practical nutriment, if it could be as easily digested.

To us, in this densely populated country, so largely dependent on imported food, this is of vast importance, cheese being the most portable of all food—even more so than wheat—on account of the greater value in given bulk. We may obtain it from nearly all parts of the world, and it can be used as ballast, if obtainable where ballast is required.

I, therefore, claim to have done the State some service in having worked out the problem of restoring the casein of cheese to its original soluble form, as it existed in the milk, and thereby rendering it easy of digestion. My method is very simple, and, after what I have just explained, so obvious, that I am surprised at being unable to find any record of its having been done before.

As everybody now knows, acids are neutralised by alkalis. If then, the casein was rendered insoluble by acid—say lactic acid—it is probable that it may have its solubility restored by adding as much alkali as will neutralise that acid. I have tried this with complete success, have thus dissolved cheese both in milk and in water.

But you will say that this is bringing too much of the laboratory into the kitchen—this neutralisation by alkali, and will very properly ask, what alkali? and how this alkali will act in the body; whether as food, or as medicine, or as poison?

The alkali I use is potash, in the form of bicarbonate, which readily gives up its alkali to any fixed acid when hot; a little explanation will show that it not only renders the cheese digestible, but supplies just that which cheese requires in order to render it a complete food

Salts of potash exist in milk, but they are all so soluble that when the curd is precipitated in the cheese-making they are left behind in the whey, causing the cheese to be in a condition somewhat analogous to that of the gelatine of the academicians, or still more nearly to that of salt junk, from which the juices have passed by exosmosis into the brine.

In the course of my youthful wanderings, I had a very instructive experience of this. With a fellow tourist (the late C. M. Clayton, son of the diplomatist concerned in the "Clayton-Bulwer treaty"), I took passage in a small schooner from Malta to Athens. We were both pedestrians, had walked together, "roughing it," in Italy and Sicily, and proud of our powers of enduring hardships. Consequently, in providing our food for the voyage, we took nothing but a lump of cheese and some loaves of bread. A gale of wind blew us far out of our proper course, and made the journey a long one. We ate our cheese heartily enough for about three days, then it became hard work to go on with it. It grew worse and worse, until at last we gladly exchanged the remainder for some of the vile broth made by the dirty sailors, in the still dirtier forecastle, and composed of horse beans and stale cabbage leaves, boiled in water. On landing at the Pireaus, we devoured cucumbers, fruit, and lettuces with strange avidity. We were evidently on the road to scurvy, and should have reached some of its uglier symptoms had we continued the cheese diet much longer.

We were craving for the potash salts wanting in the cheese, and which the raw vegetables supplied, just as sailors crave for the like after a long course of salt junk and biscuits.

This is my recipe for restoring the casein of cheese to its original soluble condition. Grate the cheese, or cut it into shreds, then add bicarbonate of potash at the rate of a quarter of an ounce to one pound of cheese (this proportion I have calculated as about supplying the amount of potash which originally existed in the quantity of milk from which the cheese was made). Put these in three or four times their own bulk of water or milk, slowly raise o the boiling point, and keep hot, stirring until all the cheese is dissolved. The solution thus obtained, thickens into a custard-like mass on cooling. Any larger quantity of water or milk may be used if a more liquid result is required.

I use common English or American cheese, in spite of the cookery books, which prescribe Parmesan whenever grated cheese is demanded. Parmesan grates readily, because, as they say in the Midlands, "its butter has gone to market." It is similar to what is there called "skim Dick," the hard dry cheese given to farm labourers, or sold at about 4½d. per lb. It is made from skimmed milk. Parmesan is but glorified skim Dick, glorified by its peculiar and fine flavour. The solution of cheese may be used in many different ways. Stirred into oatmeal porridge, boiled rice, bread crumbs, mashed potatoes, hasty pudding, or other similar farinaceous preparations, it supplies a highly nutritious, economical, and digestible dish, a meal in itself equivalent in composition and nutritive value to beef and potatoes.

I have given these concoctions the general name of "cheese porridge." They are not likely to be acceptable to pampered epicures, to whose requirements I give no attention, but those who work hard with brain or muscle will, I think, appreciate them. Their preparation may be simplified, and, I think, rather improved, by adding the bicarbonate of potash to the water in which the meal, rice, &c., is boiled, and, throwing in the grated cheese, well mixing it, just before turning the porridge out of the pot.

The following is an excellent dish—cheese custard, or improved digestible *fondu*. Dissolve grated cheese in milk with bicarbonate of potash in the proportions already given, flavour with mustard and pepper, &c.; then beat up eggs, yolk and white together, at the rate of two or three to every ¼ lb. of cheese. Add these to the cheese solution. Now take a shallow dish that will bear heating, put a little butter on it, and heat the butter till it frizzles; then pour the mixture into this, and bake or fry until it is nearly solidified, and very lightly browned. This is a rich dish, requiring bread. It is best cooked in little dishes, one portion in each, and eaten from the same.

By using a larger quantity of milk to dilute this cheese custard, a very wholesome and delicious cheese pudding may be made. Bread cut in slices, with or without butter, is laid in a pie dish one slice above the other, and the diluted cheese custard poured upon it cold, and allowed to stand an hour or more until the bread is fully saturated. It is then baked until the surface is lightly browned.

The cooking of milk is very simple. The only notable change which occurs is the coagulation of the small quantity of albumen it contains. This is shown by the scum formed on the surface of boiled milk. There is, however, a special reason why the milk supplied to

London and other large towns, from sources unknown, should all be boiled before using it. There is now no further reason to doubt that certain disease germs, or species of microbia that disseminate disease, are nourished by milk, increase and multiply therein, and may thus be introduced into the blood, and produce very serious consequences. As these microbia are killed by subjecting them to a temperature of 212° (the boiling point of milk is a little above this), there is little, if any danger, in milk that has been boiled. The loss of albumen as scum is very trivial.

Butter may possibly convey these germs, and I think this subject worthy of further investigation than it has received.

A great revolution is in progress as regards butter. I greatly amused some of my friends, about twelve years ago, by predicting that such a revolution would occur—that dairy butter would, to a great extent, be superseded by butter manufactured from the waste fat of slaughtered animals. This is now the case. I have obtained samples of this product, technically named "bosch," at various times, and from various sources, since I wrote about it in 1871, and have observed a steady improvement from the early attempts, which resulted in a yellow, granular fat-like dripping, to a very recent sample, which neither myself nor the wholesale butter factor who showed it to me could distinguish from first-class fresh butter. It was offered, and largely sold, at 8½d. per lb., done up very neatly in rolls, wrapped in linen, and packed in boxes. I know one family, very particular in the matter of butter, who ate 24 lbs. of it, believing it to be superior cream butter. Many others do so, but pay more than double the price I have named, and are thereby assured that it must be real Devonshire.

Most of the other samples I have recently tried were slightly tainted with a resinous flavour, due, I suspect, to careless preparation with apparatus or utensils, made of resinous pine, or deal wood. More carefully prepared, and sold honestly for what it is, there is no good reason why it should not take the place of butter very largely. It does so now, by dishonest admixture, and by being sold under false pretences.

I must now pass to the cookery of vegetable food. Its ultimate elements are the same as those of animal food. This is at once obvious, seeing that beef and mutton are made from grass.

The proximate elements differ but slightly. The fat of the animal is represented by the starch, sugar, oils, and resins of vegetables. We do not eat the latter, and only a selected few of the oils, but starch and sugar, composed of carbon and the elements of water, constitute the greater part of the bulk of vegetable food generally.

Arrowroot is nearly pure starch, tapioca and sago are similar, rice and potatoes are chiefly composed of starch, and in a less degree it contributes to the bulk of wheat, barley, oats, and maize. In all these it exists as minute granules enveloped in a special membrane. Arrowroot, as sold in the shops, consists of granules that may be felt between the fingers, or seen distinctly by the aid of a microscope of very moderate power. Such raw starch does not dissolve in cold water. The granules merely fall to the bottom, and rest there as granules.

The cookery of starch resembles the cookery of gelatine; it is a conversion from an insoluble to a soluble or hydrated form, when heated in water. The change takes place very readily; at 140° the granules absorb water, swell and burst; the result being the formation of the well-known mucilaginous material used by laundresses for stiffening linen. Here we have a case of endosmosis through the envelope of the granule.

A dry heat of 320° converts the starch into *dextrin*, or "British gum," which has the same composition as starch, but is freely soluble in cold water. This conversion of starch into dextrin is also affected by a curious substance called *diastase*, or *mucin*, which is formed during the germination of grain and seeds generally. Like albumen, casein, gelatine, &c., this diastase is a nitrogenous substance, but is not very well understood. Very minute quantities act. It is estimated that one part of diastase will change above a thousand times its own weight of starch into dextrin.

The vegetable germ, lying dormant in the dry seed, is surrounded by the material of its food, the starch; but this insoluble uncooked starch is not food for the germ. When the conditions of germ growth are fulfilled, the germ mysteriously produces a modicum of diastase; this cooks or renders soluble the starch, which now becomes dextrin; and after this, by further change, is converted into sugar, upon which the germ feeds freely.

The malster uses this action by starting the germination, and carrying it forward until the sugar is formed; then, by heating the malt, he kills the germ, and appropriates its food.

The saliva of man and other animals converts starch into dextrin, and then into sugar, by a similar action, that has been ascribed to a rather hypothetical compound called animal diastase, or salivary diastase.

The chemist can easily imitate this in his laboratory, and convert any quantity of starch into sugar. I have not time to describe the process, but may add that he can do more than this, he can convert cellulose or woody fibre into sugar. Sugar may be made from linen and cotton rags, or from paper pulp, or even from sawdust, but, at present, it does not pay to carry this out commercially. Nature does it for us very cheaply.

The ripening of fruit is an example of this. The best pears are those which, when gathered in autumn, are woody, sour, and uneatable. By simply storing them for a month or two, they become deliciously soft and sweet. The woody fibre is converted into sugar, the process being probably aided by the acid, as the chemist uses an acid in effecting the metamorphosis I have just described.

This leads me to a subject on which I have been pondering lately, viz., the possibility of applying the principle of ensilage, which is a sort of slow cookery, in the preparation of human food. You have heard, of course, of the ensilage of cattle fodder, how by storing very coarse fibrous vegetable matter, such as pea-stalks, the stem and flags of maize, &c., and leaving it in a humid condition, but covered from the air and well pressed together, it becomes digestible and nutritious fodder, well appreciated by cattle.

If I mistake not, the change which takes place in the silo is similar to that which occurs in the ripening pear, a partial conversion of woody fibre or cellulose into sugar. Standing faithfully to my own subject, I may describe it as slow cookery, very gentle and deliberate stewing.

I must now briefly refer to the nitrogenous constituents of vegetable food, those which correspond to albumen, gelatine, fibrin and casein, and have been classed together as albuminoids. Gluten is one of these, and being the flesh-forming constituent of bread, claims first rank. If some wheat flour, moistened to form a dough, be wrapped in a piece of loosely woven linen, and held and kneaded in running water, the starch granules may be washed out, until there remains a tenacious gluey substance. This is the gluten, having a composition almost identical with albumen, casein, fibrin, and gelatine, and a corresponding value as food It is rendered less tenacious, and more soluble by cooking.

Peas, beans, lentils, and other seeds of leguminous plants yield a somewhat different albuminoid, legumin, so nearly resembling casein, that it has been named vegetable casein.

Like animal casein it is highly nutritious, and is difficult of digestion. Peas, beans, &c., contain far more nutriment than any kind of grain, and would be practically more nutritious, weight for weight, than either grain or flesh, if this casein could be rendered easy of digestion. I am experimenting upon it with growing prospects of success. These experiments have thrown a new light upon the old doggrel—

> "Peas pudding hot, peas pudding cold,
> Peas pudding in the pot, nine days old."

Why "nine days old?" In these words I see a deep prophetic meaning, the foreshadowing of a great vegetarian future, when by the ensilage or slow stewing of the cellulose, and similar treatment of the casein of some of the most abundant of vegetables, we shall obtain many new varieties of food that will supersede altogether our present barbaric dependence upon the digestive and assimilating organs of sheep, cows, pigs, &c., for the preparation of our food from its primary source, the vegetable world.

I find that oatmeal porridge "nine days old" is more digestible, and I believe more assimilable or nutritious, than freshly made porridge. My studies of peas-pudding are at present limited, but are sufficient to indicate that this and pease brose may be rendered easily digestible by means of a sort of ensilage, when duly mixed with farinaceous or even fibrous vegetables, and aided by a little bicarbonate of potash. My difficulty hitherto has been mouldiness, but this is merely incidental, and may be prevented by better arrangements for the exclusion of air, and a more capacious silo.

The advantages possessed by flesh food do not depend upon its composition, but upon its condition. This is shown by the following comparative statement of the chemical composition of the nitrogenous constituents of animal and vegetable food:—

	Animal Casein	Vegetable Casein.
Carbon	53·83	53·46
Hydrogen	7·15	7·13
Nitrogen	15·65	16·04
Oxygen, Sulphur, Phosphorus	23·37	23·37

	Albumen.	Gluten.
Carbon	53·5	53·27
Hydrogen	7·0	7·17
Nitrogen	15·5	15·94
Oxygen, Sulphur, Phosphorus	24·0	23·62

	Animal Fibrin.	Vegetable Fibrin.
Carbon	52·7	53·23
Hydrogen	6·9	7·01
Nitrogen	15·4	16·41
Oxygen, Sulphur, Phosphorus	25·0	23·35

Remembering that vegetable oils, and sugar, and starch, have a similar food value to fat, nothing is easier than to select a purely vegetable *menu* that shall contain, in the same weight and bulk, exactly the same constituents as any given *menu* including animal food; but at present we cannot supply it in a condition so easy of assimilation. There is more work to be done after swallowing the vegetable meal, in order to convert it into blood, than is demanded by the flesh food of corresponding composition, and consequently some of it escapes, or the demand on our vital energy made to assimilate the vegetable food takes too much away from our other working powers.

Nothing is wanted here but more science applied to cookery, the problem is clearly definable and defined, and is obviously less difficult than many others that science has already solved.

I must conclude by simply naming some of the other nutritive constituents of vegetables, such as *pecten*, the jelly of fruits; and the saline juices of vegetables that contain all that is contained in the saline juices of flesh, and are of similar value as completing the dietary. They are subject to little or no change in cookery, are quite as good when raw as after being cooked.

In connection with this, I must again be egotistical, by proclaiming another result of my own researches, viz., the determination of the difference between baked potatoes, and boiled or steamed potatoes, and between potatoes boiled in their jackets, and potatoes peeled before boiling. I find potash in the water in which potatoes have been boiled. It is evident that some of the soluble potash salts of the juice of the potato passes out by exosmosis into the water. By baking them, or frying them, this is entirely prevented. We all know that there is a difference between a baked and a boiled potato. I attribute it mainly to this.

As regards the great question of jackets or no jackets, I can only speak theoretically at present. I suppose that the natural envelope does resist the out-going of some of these saline juices, but have not yet proved it analytically. The highest of all practical authorities on this subject, the Irish peasant, has very firmly decided for himself. I have never seen raw potatoes in a state of nakedness in Ireland, and suspect that natural appetite has discovered that there is something in the full-dressed potato that is demanded in the system, just as it teaches the sailor to crave for potash food, as I and my fellow cheese eater did in in Greece.

For the same reason raw salads are better than boiled vegetables of similar composition, unless the water in which they are boiled is used as a *potage* or *soupe maigre*. The Irish demand for "a stone in the middle" of his potato may be due to the better retention of the potash by the under-cooked tuber.

I must now conclude with apology for the necessary imperfections of this very short sketch of a large subject, which can only be treated in barest outline in three lectures. But the time you have spent in listening to them will have been well spent, if they have only awakened an interest in the subject, and induced you to prosecute it further, by proving that there really is a "scientific basis of cookery."

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

Sick and Ambulance.

Thursday, January 3rd.—Present: Director-General Crawford, A.M.D., in the chair; Deputy Surgeon-General Bostock, C.B.; Brigade-Surgeon W. G. Don, A.M.G.; Surgeon-Major G. J. H. Evatt, M.D., A.M.D.; Mr. John Furley; Deputy Inspector-General F. J. Mouat; Dr. J. C. Steele; Mr. H. T. Wood.

METEOROLOGICAL.

Friday, January 4th.—Present: Professor F. De Chaumont, M.D., F.R.S., in the chair; Mr. W. B. Bryan; Captain Douglas Galton, C.B., F.R.S.; Mr. T. Hawksley; Mr. Robert H. Scott; Mr. G. J. Symons; Dr. J. W. Tribe; Mr. H. T. Wood.

FOOD.

Friday, January 4th.—Present: Dr. J. H. Gilbert, F.R.S., in the chair; Mr. J. Bell; Dr. T. Lander Bruton, F.R.S.; Mr. C. A. Buckmaster, M.A.; Mr. W. Carruthers, F.R.S.; Professor F. De Chaumont, M.D., F.R.S.; Professor A. H. Church; Dr. Spencer Cobbold; Director-General Crawford, A.M.D.; Dr. A. Dupré, F.R.S.; Prof. Charles Graham, D.Sc.; Dr. Wilson Hake; Professor H. N. Moseley, F.R.S.; Dr. F. W. Pavy, F.R.S.; Sir Henry Thompson; Dr. C. M. Tidy; Mr. T. Twining; Mr. G. W. Wigner; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III.—SUB-COMMITTEE A.

Tuesday, January 8th.—Present: Dr. Frankland, F.R.S., in the chair; Mr. H. H. Collins; Mr. J. Bailey Denton, C.E.; Mr. Rogers Field, M.Inst.C.E.; Mr. Shirley F. Murphy; Mr. George Shaw; Mr. H. T. Wood.

The various Committees are preparing memoranda upon the classes which come under their direction. The following have been issued by the "Workshop" Committee, and by the Committee on Heating, &c.

"THE WORKSHOP."—GROUP V.

It is desired to illustrate, in as practical a manner as possible, the relation of Industrial Conditions and Processes to Health; and to the Sub-Committee charged with advising on this department of the Exhibition the name of "The Workshop Sub-Committee" has been given. The place of production of all articles used by man is for the present purpose spoken of as "The Workshop."

In this department the following classes of the Exhibition are comprised:—

Class 41.—Designs and models for improvements in the arrangements and construction of workshops, especially those in which dangerous or unwholesome processes are conducted.

Class 42.—Apparatus and fittings for preventing or minimising the danger to health or life from carrying on certain trades. Guards, screens, fans, air-jets, preservative solutions, washes, &c.

Class 43.—Objects for personal use. Mouth-pieces, spectacles, dresses, hoods, &c., for use in certain unhealthy and poisonous trades.

Class 44.—Illustrations of diseases and deformities caused by unwholesome trades and professions. Methods of combating these diseases. Preservative measures, &c.

Class 45.—Sanitary construction and inspection of workshops, factories, and mines. (*a*) New inventions or improvements for ameliorating the condition of life of those engaged in unhealthy occupations. (*b*) Means of economising human labour in various industrial operations.

Class 46.—Literature, statistics, diagrams, &c., relating to this Group.

The following heads show the principal subjects which the Sub-Committee are anxious should be illustrated in the several classes of this department, the illustrations being expected to include alike the conditions of injury to health and the means proposed for improvement.

Besides apparatus used, or proposed for use, with a view to minimise danger to life and health, the exhibits may comprise models, drawings, specimens, both of harmful products and improved products, &c., and the Committee will be specially glad to receive collections of specimens, models, diagrams, photographs, &c., showing existing evils or noxious conditions which have been modified by recent improvements.

(a.) Ventilation of the workshop—By simple discharge of internal air; by destroying offensive or injurious quality of discharged air.

(b.) Effluvium nuisances — By condensing and utilising vapours; by consuming vapours; by other means, as in gas works.

(c.) Dust nuisances, *e.g.*—In needle grinding, mother-o'-pearl working, in weaving sheds.

(d.) Danger from mineral poisons, *e.g.*—In arsenic works, white-lead works, playing-card making, card-bronzing; phosphorus and match manufacture.

(e.) Danger from animal poisons, *e.g.*—In wool-sorting, rag-picking.

(f.) Prevention of accidents in the workshop, *e.g.*—Protection against heat, injury to eyes; against explosions in the mine and elsewhere.

THE DWELLING HOUSE.—GROUP III.

Classes 24, 25, 26, *Heating, Lighting, Ventilating, and Smoke Abatement.*

The portion of Group 3, the Dwelling, with which this Committee proposes to deal, is that comprised within Classes 24, 25, and 26, the following being the official classification:—

Class 24. — Grates, stoves, kitcheners, ranges, boilers, &c., for domestic use. Apparatus for heating and warming, smoke abatement, &c.

Class 25.—Ventilators, air-inlets and outlets, cubic space of rooms, cowls, air straining and cleansing.

Class 26.—Lighting apparatus—(*a*) Electrical apparatus for illumination and domestic use, secondary batteries, electroliers, accumulators, &c.; (*b*) apparatus for lighting by gas, gas producers, gas meters, gas fittings, chandeliers, &c.; (*c*) oil and other lamps, and stoves; mineral oil, wax and other candles, vegetable and animal oils.

In Class 24, will be included methods of warming:—(1) by open and closed grates and stoves; (2) by water, air, steam, and gas apparatus, designed to heat only; (3) by similar appliances, but combining provision for ventilation and the heating of more than one apartment; (4) by similar appliances for domestic use, specially designed for the economical consumption of fuel, and intended to minimise the production of smoke or other noxious products of combustion.

Domestic kitcheners will be included in this class. but appliances for cookery on a large scale will more properly be arranged under Class 6 (Cookery, &c.)

Furnaces and steam boilers for manufacturing operations are not considered to be within the scope of the present Exhibition.

In Class 25 will be included special appliances for ventilation, other than those which may be considered more suitable for Class 24; these will include means for cooling air supplied to rooms, means for improving the condition of the air in rooms, methods for testing air, the results of experimental researches into the state of air vitiated by combustion or by respiration; results of experiments on ventilation, and any other means of effecting improvement in matters relating to this class, or of diffusing knowledge about them.

The official classification sufficiently indicates the class of exhibits which are desired for Class 26. It may be added that electric lighting is to be limited to illustrations of its application to domestic lighting. Its use on a large scale will be practically illustrated by the arrangements made for lighting the Exhibition itself. In the same way, the commercial manufacture of gas is not included, though its production on a small scale for private use is. Exhibits showing the progress of domestic lighting, and affording means of comparison between old and new systems are specially desired. Photometric and other tests for illuminating materials may be added to the list contained in the classification, and it is desirable that methods of gas-lighting should be shown, which either assist, or do not interfere with, the ventilation.

TIMBER TRADE OF CHILI.

Timber, according to the *North-Western Lumberman* (Chicago), is somewhat abundant in all the provinces south of Santiago. There are said to be over one hundred kinds of indigenous trees, of which not more than thirteen ever shed their leaves, and these are mainly utilised in shipbuilding and house carpentering. There are a few ornamental woods but such trees are scarce. The Araucanian pine grows on the mountains south from the Biobio, the trees looking from a distance like gigantic umbrellas The Chilian cedar is regarded as the most important tree. The most abundant timber is the Lombardy poplar, and silver-leaf poplar or aspen. The Jesuits began planting these trees two to three centuries ago for fencing purposes, and miles of poplars in line are found following the courses of ditches, or marking out areas. When sufficiently large, these great hedgerows are attacked with the axe, the trees being cut down so as to leave the stumps about 8 ft. high. The Lombardy variety is principally used for making brake-blocks, and the aspen makes good timber.

Facilities for receiving and getting out lumber have always been meagre and miserable. There is no harbour at Valparaiso, and the vessels arriving are obliged to lie at anchor within easy reach of the shore, while the cargo is unloaded by swarthy and muscular natives who station themselves at intervals of about two rods out in the surf, on a line reaching from boat to beach. They pass the lumber from one to another along the queer line of transportation. The natives go on a jog trot through the shallow surf, and often keep up the action all day with little cessation.

Up to a recent period there has been no means of manufacturing the domestic timber. It was simply formed by hand, and made up into boards of certain dimensions, which were regarded as standard, but never figured in feet, being sold by the piece. In some of the less progressive sections, boards have passed as a medium of exchange. To the lumber that is received into Chili from foreign ports, the Government applies the metric system of measurement, on which its duty collections are based. In addition to lumber, considerable wood is cut in the tan-bark business. Red-wood is being raised in the coast region 1,000 miles from Valparaiso. The timber country is generally mountainous, while the rivers abound with bars. In addition to the woods that have been mentioned, there is a fine variety which resembles beech, while another has a fine grain, and there is a third variety of a reddish colour which polishes nearly as finely as cedar.

Latterly, however, several portable saw-mills have been brought to Chili from the manufactories of the United States, and other improved means are being employed, while the imports of lumber are increasing. Very little manufacturing of goods from wood has been carried on, but enterprises in this direction are contemplated, and, in fact, in course of establishment. Furniture and similar articles have been imported somewhat extensively, but the duties have been made very heavy on such goods, and are reckoned by the weight instead of the exact value in each case. The inhabitants have found importing to be a very expensive business, and it is proposed to build factories for the manufacture of boxes, the importation of which has been heavy, sash, doors and blinds, furniture, &c. Men of capital are now engaged in investigating the details in connection with such enterprises.

From fifty to seventy-five vessels are engaged in trade between Valparaiso, which is the most important west shore port except San Francisco, and other points. Lumber and common freight are combined.

The wages of peons are from 40 to 50 cents. per day, two pieces of bread and one meal of beans being conceded in addition. General unskilled labour commands 1·25 dols. per day among the natives, and artisans obtain 2·50 dols. per day and find themselves. Intelligent foreigners can get from 3 to 6 dols. per day. In the case of the surf-packmen, they obtain large pay, sometimes making as high as 10 dols. per day.

PHYSICAL FEATURES OF COCHIN CHINA.

The following details are taken from a communication by M. Fuchs, engineer-in-chief of mines to the French Geographical Society, made last year with M. Saladin :—

The populations are concentrated in the three large valleys of the Yellow River, the Mekong, and the Meinam, the estuaries of which are rapidly increasing. Two principal races occupy the country, viz., the pro-Malays, including the Siamese, the Laotians, the Khmers, and the Cambogians, on the west; and the yellow race, chiefly represented by the Annamites, on the East. The former attained a high degree of civilisation towards the eighth or ninth century, while the latter are characterised by a predominance of the civil over the military element, and by the accessibility of all offices through public examination.

The vast chain, detached from the Mountains of Thibet, and running south, nearly touches the east coast of the great peninsula. It is composed of granitic rocks, which have, in places, upheaved and penetrated thick strata of ancient shales belonging to the Devonian period. At the bottom of the basins thus formed are large deposits of coal, which appear of slightly later date than those of Europe. Sometimes enormous masses of metamorphic limestone are met with; and above the coal measures are thick strata of sandstone, like that of the Vosges and Thuringia. But there is no trace of either secondary or tertiary formations, so that Cochin China must have emerged since the end of the carboniferous era, and has subsequently been invaded only by diluvial waters.

The coal deposits equal those of France in extent, one of them having been traced for a length of over 100 kilometres, or 62 miles. Three groups of seams have been proved, the actual thickness of coal exceeding 10 metres, or 33 feet. The most accessible deposit, near the Bay of Honggâa, might be connected with the coast by a series of small-guage tramways, and serve for coaling vessels, which are now dependent on Japan and Australia for their supply in the extreme East.

Analyses made at the Ecole des Mines show that the coals may be divided into two classes:—(1) Semi-bituminous (so-called) leaving after combustion a very pure ash; and (2) poor coals burning with a long flame, containing 38 per cent. of volatile matters, and kindling with great facilities.

There is a great abundance of iron ore, both present with the coal and underlying it, but at present worked only in the most primitive manner. There exist deposits of copper, lead, and tin, the extent of which could not, however, be ascertained. There is also an auriferous deposit in the delta of the Tonquin river, formed by the sand washed down by streams from quartzose veins, and containing 30 grammes, or 463 Troy grains, to the ton of sand; but difficulties were encountered from the Government in an attempt to obtain the right of working.

THE GEODETIC CONGRESS AT ROME.

At the Congress recently held at Rome, twenty-eight States were represented, and resolutions embodying the following principles were adopted by the delegates present :—

1. The unification of longitude and of time is recommended to all Governments, as forming a suitable basis for international treaties; the scientific and practical advantages resulting from such an arrangement more than compensating for any inconvenience attending its introduction. This arrangement would be carried out in all astronomical and nautical almanacks, except as regards any data in which a local meridian and local time are indispensable.

2. That information should be diffused as to the decimal subdivision of the quadrant, and that this system should be partially introduced as regards calculations, &c., although the present system can hardly be superseded with respect to navigation, &c.

3. The meridian of Greenwich being the most generally accepted, it is recommended for adoption in the proposed international arrangements.

4. It is suggested to reckon longitude only from west to east, starting from the meridian of Greenwich.

5. For purposes of railway, steamboat, post and telegraphic services, the adoption of a universal time is recommended; local time being still used for ordinary purposes.

6. The foundation of this international time would be noon according to Greenwich time; the hours being reckoned from 0 to 24.

7. States which accept the new system of unification should adopt measures for its introduction as soon as possible.

8. The adoption of the English meridian will, it is

hoped, urge England to take steps as to the question of uniformity of weights and measures.

9. The proposal of the United States Government for a special Conference is approved; and wishes for the holding of an international convention for the ratification of the proposed uniformity of longitude and time are also expressed. The only important case of absence from the voting was that of the representatives of Holland, the Government of that country preferring to await the result of the Congress to be held in 1884 at Washington.

General Notes.

Import of Jute into Germany.—According to the *Central-Blatt für Textil Industrie*, six full cargoes of jute were discharged at Bremen during the first nine months of 1883. Four of these were imported from Calcutta by one large German manufacturing establishment. The total quantity of jute thus received was about 60,000 bales, worth £175,000.

Artificial Mineral Waters.—Messrs. Struve and Co., the manufacturers of the "original Brighton Seltzer," write to contradict a statement in Mr. Bruce-Warren's paper on "Mineral Waters," to the effect that there are at present no scientific mineral-water manufacturers in the kingdom. Messrs. Struve refer to reports in the *British Medical Journal*, and in the *Lancet*, showing that their mineral waters strictly follow the composition of the natural waters they are intended to resemble; and refer also to several eminent physicians as being ready to testify that their manufactures are produced on scientific principles.

Silk Waste.—An article on this subject lately appeared in a German contemporary. From the facts which it contains, it would seem that the modern idea of the treatment of silk waste in this manner is, to a certain extent, the following out of the system of treatment applied to flax for centuries past. England and Switzerland, it is remarked, are entitled to recognition as having perfected, the processes of combing, &c., by means of which silk waste has been utilised. The employment of the waste in the velvet manufactures of the Rhenish districts, dates from the year 1861. For a time the English spinners of the article had the exclusive command of the trade, but in 1867 Switzerland arrived at the requisite degree of perfection to allow of successful rivalry, in the German market, with the products of English industry. Austria, Italy, and Alsace have since entered the field of competition. In 1870, a process was introduced in Crefeld, by means of which the yarn was gassed after being dyed, the result being that its brightness was increased. A progressive increase in the employment of silk waste has taken place in the Crefeld district, the quantity used in 1882 having been about 270 tons.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

Dates Fixed.

January 16.—"Electric Launches." By A. Reckenzaun. W. H. Preece, F.R.S., Vice-President of the Society, will preside.

January 23.—"Science Teaching in Elementary Schools." By William Lant Carpenter, B.A., B.Sc. Sir John Lubbock, Bart., M.P., F.R.S., Vice-President of the Society, will preside.

January 30.—"Coal Gas as a Labour-saving Agent in Mechanical Trades." By Thomas Fletcher, F.C.S.

Dates to be Hereafter Announced.

"Sanitary Progress." By B. W. Richardson, M.D., F.R.S.

"The Progress of Electric Lighting." By W. H. Preece, F.R.S.

"Forest Administration in India." By Dr. Brandis, F.R.S.

"Reclamation of Land on the North-Western Coast of England." By Hyde Clarke.

"Water Regulation in England." By General Rundall.

"Telpherage." By Professor Fleeming Jenkin, F.R.S.

"New Process of Permanent Mural Painting," invented by Adolph Keim, of Munich. By Rev. J. A. Rivington.

"Slate Quarrying." By W. A. Darbishire.

Foreign and Colonial Section.

Tuesday evenings:—

January 29.—"Canada as it will appear to the British Association in 1884." By Joseph G. Colmer, Secretary to the High Commissioner for Canada. The Marquis of Lorne, K.T., will preside.

February 12.—"The Portuguese Colonies of West Africa." By H. H. Johnston.

February 26.—"Reflections on Chinese History, with reference to the present situation of affairs." By Demetrius G. Boulger.

March 18.—"Borneo and its Products." By B. Francis Cobb, Vice-President of the Society.

April 1.—"The Rivers Congo and Niger entrances to Mid-Africa." By Robert Capper.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

JANUARY 24.—"Manufacture of Gas from Limed Coal." By Professor WANKLYN. DAVID HOWARD, F.C.S., will preside.

FEBRUARY 21.—"The Upper Thames as a Source of Water Supply." By Dr. PERCY F. FRANKLAND.

MARCH 27.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc.

APRIL 24.—"Economic Applications of Seaweed." By EDWARD C. STANFORD, F.C.S.

MAY 8.—

MAY 29.—

INDIAN SECTION.

Friday evenings :—

FEBRUARY 15.—"State Monopoly of Railways in India." By J. M. MACLEAN.

MARCH 7.—"The New Bengal Rent Bill." By W. SETON-KARR.

MARCH 28.—"Trade Routes in Afghanistan." By GRIFFIN W. VYSE.

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

MAY 9.—

MAY 30.—

*** The dates given above are subject to alteration.

CANTOR LECTURES.

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By THOMAS BOLAS, F.C.S.

LECTURE I. Jan. 28.—New Developments of the Woodbury Type Process.

LECTURE II. Feb. 4.—Type Blocks from Line Drawings and Half Tone subjects.

LECTURE III. Feb. 11.—Intaglio Plates. Collotypes. Photo-Mechanical Methods, as applied to the Decoration of Pottery. Miscellaneous Processes.

The Third Course will be on "The Building of London Houses." By ROBERT W. EDIS, F.S.A. *Dates*—February 18, 25; March 3.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint. *Dates*—March 17, 24, 31; April 7.

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. NORMAN LOCKYER, F.R.S., F.R.A.S. *Dates*—April 28; May 5.

The Sixth Course will be on "Fermentation and Distillation." By Professor W. NOEL HARTLEY, F.C.S. *Dates*—May 12, 19, 26.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 14...Surveyors, 12, Great George-street, S.W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Henry Blackburn, "The Art Season of 1883."

TUESDAY, JAN. 15...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. S. Poole, "The Interest and Usefulness of the Study of Coins and Medals." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.

Pathological, 53, Berners-st., Oxford-st., W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. W. F. R. Weldon, "The Placenta of *Tetraceros quadricornis*." 2. Mr. E. J. Miles, "Some Crustaceans from the Mauritius." 3. "Varieties and Hybrids among the Salmonidæ."

WEDNESDAY, JAN. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. Reckenzaun, "Electric Launches."

Meteorological, 25, Great George-street, S.W., 7 p.m. Annual Meeting and Presidential Address.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Dr. Joseph Stevens, "The Remains found in the Anglo-Saxon Tumulus, at Taplow, Bucks."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. G. Simonds, "The Science of Mechanics as applied to the Fine Arts."

THURSDAY, JAN. 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. G. Baker, "Revision of the Tuber-bearing Species, *Solanum*." 2. Mr. A. D. Michael, "The Hypopus Question, or Life History of certain Acarina." 3. Mr. W. Joshua, "Burmese Desmidicæ."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. C. T. Kingzett, "Camphoric Peroxide and Camphorate of Barium." 2. Dr. Edward Divers and Mr. Michisada Kawakita, "Decomposition of Silver Fulminate by Hydrochloric Acid;" "Supplementary Note on Liebig's Production of Fulminating Silver without the Use of Nitric Acid." 3. Dr. Edward Divers and Mr. Tamemasa Haga, "Hyponitrites."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. H. Dixon, "The Nature of Explosions."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. T. Pridgin Teale, "Economy of Coal in Private Houses."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Pauer, "The History and Development of the Music for the Pianoforte, &c." (Lecture I.)

Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

FRIDAY, JAN. 18...Froebel Society (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Annual Meeting.

United Service Inst., Whitehall-yard, 3 p.m. Surgeon Major G. J. Evatt, "Army Medical Organisation in War, with suggestions as to Militia and Volunteer Aid."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Prof. Tyndall, "Rainbows."

Philological, University College, W.C., 8 p.m. A Dictionary Evening, by Dr. J. A. H. Murray, President.

Medical Officers of Health, 1, Adam-street, Adelphi, W.C., 7½ p.m.

SATURDAY, JAN. 19...Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Morley, "Life and Literature under Charles I." (Lecture I.)

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FRIDAY, JANUARY 18, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SWINEY PRIZE.

The adjudicators under the will of the late Dr. Swiney are summoned to meet on Monday, the 21st January, 1884, at the Rooms of the Society, at 3.30 p.m., to make the award in conformity with the terms of the bequest contained in the will of the testator.

By order,
H. Trueman Wood, Secretary.
16th January, 1884.

Proceedings of the Society.

SIXTH ORDINARY MEETING.

Wednesday, January 16th, 1884: William Henry Preece, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bentley, Richard, Upton, Slough, Bucks.
Cameron, Lieut.-Colonel Donald Roderick, R.A., Sheerness.
Clapp, William John, Nantyglo, Monmouthshire.
Glover, James, B.A., 30, Crosby-road, Birkdale, Southport.
Godwin, John, 19, St. Mary Abbotts-terrace, Kensington, W.
Graham, Mrs., 40, Woodstock-road, Bedford-park, Chiswick.
Head, John Merrick, London-road, Reigate, Surrey.
Phelips, Richard Charles Hungerford, Cucklington, Somerset.
Huntington, Charles P., Astley Bank, Darwen, Lancashire.
Leeming, Thomas Henry, 2, Lee-terrace, Barking-road, Plaistow, E.
Mackenzie, Colin, Junior Athenæum Club, 116, Piccadilly, W.
Morris, Malcolm, 63, Montagu-square, W.
Newton, Henry Charles, Belsize-court, Hampstead, N.W.
Pike, Luke Owen, 201, Maida-vale, W.
Renouf, Philip Louis, Grove-lodge, Thistle-grove, S.W.
Shearer, John Ronald, 10, Basinghall-street, E.C.
Siemens, Lady, Sherwood, Tunbridge Wells.
Traill, William A., Giant's Causeway, Portrush and Bush Valley Railway, Portrush, Ireland.
Trenchard, Edward Penny, junior, 63, Granville-park, Blackheath, S.E.
Van Praagh, W., 17, Fitzroy-square, W.
Waymouth, George, Angleside, Crouch-hill, N., and 23, Moorgate-street, E.C.
Williams, Rowland, Birch Vale, Derbyshire.
Willink, Henry George, 29, Albion-street, Hyde-park, W.
Wilson, Albert Edward, Redbourn Hill Iron Company, Frodingham, Brigg, Lincolnshire, and Scunthorpe, Lincolnshire.

The following candidates were balloted for and duly elected members of the Society:—

Bennett, John Wheeler, Carisbrooke, Bromley-common, Kent.
Chaytor, Rev. Edward Clerevaux, Elstree School, Herts.
Coleman, Thomas Henry, Regent-street, Wrexham.
Ellis, George Henry, Knighton Hayes, Leicester.
Fielden, John Ashton, Centre-vale, Todmorden.
Lovelock, James Frederick, Rokeby-house, Bishop's-road, Highgate, N.
Smith, William, Sundon-house, Clifton-down, Bristol.
Willis, William H., Ockham-house, Culverden-road, Balham, S.W.

The paper read was—

ELECTRIC LAUNCHES.

By A. Reckenzaun.

It is not my intention to treat this subject from a shipwright's point of view. The title of this paper is supposed to indicate a mode of propelling boats by means of electrical energy, and it is to this motive power that I shall have the honour of drawing your attention.

The primary object of a launch, in the modern sense of the word, lies in the conveyance of passengers on rivers and lakes, less than for the transport of heavy goods; therefore it may not be out of place to consider the conveniences arising from the employment of a motive power which promises to become valuable as time and experience advance. In a recent paper before the British Association at Southport, I referred to numerous experiments made with electric launches; now it is proposed to treat the subject in a wider sense, touching upon the points of convenience in the first place; secondly, upon the cost and method of producing the current of electricity; and thirdly, upon the construction and efficiency of the propelling power and its accessories.

Whether it is for business, pleasure, or war purposes, a launch should be in readiness at all times, without requiring much preparation or attention. The distances to be traversed are seldom very great, fifty to sixty miles being the average.

Nearly the whole space of a launch should be available for the accommodation of passengers, and this is the case with an electrically-propelled launch. We have it on good authority, that an electric launch will accommodate nearly double the number of passengers that a steam launch of the same dimensions would; therefore, for any given accommodation we should require a much smaller vessel, demanding less power to propel it at a given rate of speed, costing less, and affording easier management.

A further convenience arising from electromotive power is the absence of combustibles, and the absence of the products of combustion—matters of great importance; and for the milder seasons, when inland navigation is principally enjoyed, the absence of heat, smell, and noise, and, finally, the dispensing with one attendant on board, whose wages, in most cases, amount to as much or more than the cost of fuel, besides the inconvenience of carrying an additional individual.

I do not know whether the cost of motive power is a serious consideration with proprietors of launches, but it is evident that if there be a choice between two methods of equal qualities, the most economical method will gain favour. The motive power on the electric launch is the electric current; we must decide upon the mode of procuring the current. The mode which first suggested itself to Professor Jacobi, in the year 1838, was the primary battery, or the purely chemical process of generating electricity.

Jacobi employed, in the first instance, a Daniell's battery, and in later experiments with his boat on the river Neva, a Grove's battery. The Daniell's battery consisted of 320 cells containing plates of copper and zinc; the speed attained by the boat with this battery did not reach one mile and a quarter per hour; when 64 Grove's cells were substituted, the speed came to two and a quarter miles per hour; the boat was 28 ft. long, 7½ beam, and 3 ft. deep. The electro-motor was invented by Professor Jacobi; it virtually consisted of two discs, one of which was stationary, and carried a number of electro-magnets, while the other disc was provided with pieces of iron serving as armatures to the pole pieces of the electro-magnets, which were attracted whilst the electric current was alternately conveyed through the bobbins by means of a commutator, producing continuous rotation.

We are not informed as to the length of time the batteries were enabled to supply the motor with sufficient current, but we may infer, from the surface of the acting materials in the battery, that the run was rather short; the power of the motor was evidently very small judging by the limited speed obtained, but the originality of Jacobi deserves comment, and for this, as well as for numerous other researches, his name will be remembered at all times.

It may not be generally known that an electric launch was tried for experimental purposes, on a lake at Penllegaer, near Swansea. Mr. Robert Hunt, in the discussion of his paper on electro-magnetism before the Institution of Civil Engineers in 1858, mentioned that he carried on an extended series of experiments at Falmouth, and at the instigation of Benkhausen, Russian Consul-General, he communicated with Jacobi upon the subject. In the year 1848, at a meeting of the British Association at Swansea, Mr. Hunt was applied to by some gentlemen connected with the copper trade of that part, to make some experiments on the electrical propulsion of vessels; they stated, that although electricity might cost thirty times as much as the power obtained from coal, it would, nevertheless, be sufficiently economical to induce its employment for the auxiliary screw ships employed in the copper trade with South America.

The boat at Swansea was partly made under Mr. (now Sir William) Grove's directions, and the engine was worked on the principle of the old toys of Ritchie, which consisted of six radiating poles projecting from a spindle, and rotating between a large electro-magnet. Three persons travelled in Hunt's boat, at the rate of three miles per hour. Eight large Grove's cells were employed, but the expense put it out of question as a practical application.

Had the Gramme or Siemens machine existed at that time, no doubt the subject would have been further advanced, for it was not merely the cost of the battery which stood in the way, but the inefficient motor, which returned only a small fraction of the power furnished by the zinc.

Professor Silvanus Thompson informs us, that an electric boat was constructed by Mr. G. E. Dering, in the year 1856, at Messrs. Searle's yard, on the River Thames; it was worked by a motor in which rotation was effected by magnets arranged within coils, like galvanometer needles, and acted on successively by currents from a battery.

From a recent number of the *Annales de L'Electricitè*, we learn that Count de Moulins experimented on the lake in the Bois de Boulogne, in the year 1866, with an iron flat-bottomed boat, carrying twelve persons. Twenty Bunsen cells furnished the current to a motor on Froment's principle turning a pair of paddle wheels.

In all these reports there is a lack of data. We are interested to know what power the motors developed, the time and speed, as well as dimensions and weights.

Until Trouvé's trip on the Seine, in 1881, and the launch of the *Electricity* on the Thames, in 1882, very little was known concerning the history of electric navigation.

M. Trouvé originally employed Planté's secondary battery, but afterwards reverted to a bichromate battery of his own invention. In all the primary batteries hitherto applied with advantage, zinc has been used as the acting material. Where much power is required, the consumption of zinc amounts to a formidable item; it costs, in quantity, about 3d. per pound, and in a well-arranged battery a definite quantity of zinc is transformed. The final effect of this transformation manifests itself in electrical energy, amounting to about 746 watts, or one electrical horse-power for every two pounds of this metal consumed per hour. The cost of the exciting fluid varies, however, considerably; it may be a solution of salts, or it may be dilute acid. Considering the zinc by itself, the expense for five electrical or four mechanical horse-power through an efficient motor, in a small launch, would be 2s. 6d. per hour. Many persons would willingly sacrifice 2s. 6d. per hour for the convenience, but a great item connected with the employment of zinc batteries is in the exciting fluid, and the trouble of preparing the zinc plates frequently. The process of cleaning, amalgamating and re-filling is so tedious, that the use of primary batteries for locomotive purposes is extremely limited. To re-charge a Bunsen, Grove, or bichromate battery, capable of giving six or seven hours' work at the rate of five electrical horse-power, would involve a good day's work for one man; no doubt he would consider himself entitled to a full day's wages, with the best appliances to assist him in the operation.

Several improved primary batteries have recently been brought out, which promise economical results. If the residual compound of zinc can be utilised, and sold at a good price, then the cost of such motive-power may be reduced in proportion to the value of those by-products.

For the purpose of comparison, let us now employ the man who would otherwise clean and prepare the primary cells, at engine-driving. We let him attend to a 6 horse-power steam-engine, boiler, and dynamo machine for charging 50 accumulators, each of a capacity of 370 ampère hours, or one horse-power hour. The consumption of fuel will probably amount to 40 lbs. per hour, which, at the rate of 18s. a ton, will give an expenditure of nearly 4d. per hour. The energy derived from coal in the accumulator costs, in the case of a supply of 5 electrical horse-power for 7 hours, 2s. 9d.; the energy derived from the zinc in a primary battery, supplying 5 electrical horse-power for 7 hours, would cost 17s. 3d.

It is hardly probable that anyone would lay down a complete plant, consisting of a steam or gas-engine and dynamo, for the sole purpose of charging the boat cells, unless such a boat were in almost daily use, or unless several boats were to be supplied with electrical power from one station. In order that electric launches may prove useful, it will be desirable that charging stations should be established, and on many of the British and Irish rivers and lakes there is abundance of motive power, in the shape of steam or gas-engines, or even waterwheels.

A system of hiring accumulators ready for use may, perhaps, best satisfy the conditions imposed in the case of pleasure launches.

It is difficult to compile comparative tables showing the relative expenses for running steam launches, electric launches with secondary batteries, and electric launches with primary zinc batteries; but I have roughly calculated that, for a launch having accommodation for a definite number of passengers, the total costs are as 1, 2·5, and 12 respectively, steam being lowest and zinc batteries highest.

The accumulators are, in this case, charged by a small high-pressure steam-engine, and a very large margin for depreciation and interest on plant is added. The launch taken for this comparison must run during 2,000 hours in the year, and be principally employed in a regular passenger service, police and harbour duties, postal service on the lakes and rivers of foreign countries, and the like.

The subject of secondary batteries has been so ably treated by Professor Silvanus Thompson and Dr. Oliver Lodge, in this room, that I should vainly attempt to give you a more complete idea of their nature. The improvements which are being made from time to time, mostly concern mechanical details, and, although important, a description will scarcely prove interesting.

A complete Faure-Sellon-Volckmar cell, such as is used in the existing electric launches, is here on the table; this box weighs, when ready for use, 56 lbs.; and it stores energy equal to 1 horse-power for 1 hour = 1,980,000 foot-pounds, or about 1 horse-power per minute for each pound weight of material. It is not advantageous to withdraw the whole amount of energy put in; although its charging capacity is as much as 370 ampère hours, we do not use more than 80 per cent., or 300 ampère hours; hence, if we discharge these accumulators at the rate of 40 ampères, we obtain an almost constant current for 7½ hours; one cell gives an E.M.F. of 2 volts. In order to have a constant power of 1 horse for 7½ hours, at the rate of 40 ampères discharge, we must have more than 9 cells per electrical horse-power; and 47 such cells will supply 5 electrical horse-power for the time stated, and these 47 cells will weigh 2,632 lbs.

We could employ half the number of cells by using them at the rate of 80 ampères, but then they will supply the power for less than half the time. The fact, however, that the cells will give so high a rate of discharge for a few hours, is, in itself, important, since we are enabled to apply great power if desirable; the 47 cells above referred to can be made to give 10 or 12 electrical horse-power for over two hours, and thus propel the boat at a very high speed, provided that the motor is adapted to utilise such powerful currents.

The above-mentioned weight of battery power—viz., 2,632 lbs., to which has to be added the weight of the motor and the various fittings—represents, in the case of a steam launch, the weight of coals, steam-boiler, engine, and fittings. The electro-motor capable of giving 4 horse-power on the screw shaft need not weigh 400 lbs. if economically designed; this, added to the weight of the accumulators, and allowing a margin for switches and leads, brings the whole apparatus up to about 28 cwt.

An equally powerful launch engine and boiler, together with a maximum stowage of fuel, will weigh about the same. There is, however, this disadvantage about the steam power, that it occupies the most valuable part of the vessel, taking away some eight or nine feet of the widest and most convenient part, and in a launch of twenty-four feet length, requiring such a power as we have been discussing, this is actually one-third of the total length of the vessel, and one-half of the passenger accommodation; therefore, I may safely assert that an electric launch will carry about twice as many people as a steam launch of similar dimensions.

The diagram on the wall represents sections of an electric launch built by Messrs. Yarrow and Company, and fitted up by the Electrical Power Storage Company, for the recent Electrical Exhibition in Vienna. She has made a great number of successful voyages on the River Danube during the autumn. Her hull is of steel, 40 ft. long and 6 ft. beam, and there are seats to accommodate forty adults comfortably. Her accumulators are stowed away under the floor, so is the motor, but owing to the lines of the boat, the floor just above the motor is raised a few inches. This motor is a Siemens D_2 machine, capable of working up to 7 horse-power with eighty accumulators.

In speaking of the horse-power of an electro-motor, I always mean the actual power developed on the shaft, and not the electrical horse-power; this, therefore, should not be compared to the indicated horse-power of a steam-engine.

I am indebted to Messrs. Yarrow for the principal dimensions and other particulars of a high-pressure launch engine and boiler, such as would be suitable for this boat. From these dimensions I prepared a second diagram representing the steam-power, and when placed in position it will show at a glance how much space this apparatus will occupy. The total length lost in this way amounts to 12 feet, leaving for seating capacity only 15 feet, while that of the electric launch is 27 feet on each side of the boat; thus the accommodation is as fifteen to twenty-seven, or as twenty-two passengers to forty, in favour of the electric launch.

Comparing the relative weights of the steam-power and the electric-power for this launch, we find that they are nearly equal, each approaches 50 cwt.; but in the case of the steam launch we include 10 cwt. of coals, which can be stowed into the bunkers, and which allow fifteen hours' continuous steaming, whereas the electric energy stored up will only give us seven and a-half hours with perfect safety.

I have here allowed 8 lbs. of coal per indicated horse-power per hour, and 10 horse-power giving off 7 mechanical horse-power on the screw shaft; this is an example of an average launch engine. There are launch engines in existence which do not consume one-half that amount of fuel, but these are so few, so rare, and so expensive, that I have neglected them in this account.

Not many years ago, a steam launch carrying a seven hours' supply of fuel was considered marvellous.

Our present accumulator supplies 33,000 foot-pounds of work per pound of lead, but theoretically one pound of lead manifests an energy equal to 360,000 foot-pounds in the separation from its oxide; and in the case of iron, Prof. Osborne Reynolds told us in this place, the energy evolved by its oxidation is equivalent to 1,900,000 foot-pounds per pound of metal. How nearly these limits may be approached will be the problem of the chemist; to prophesy is dangerous, whilst science and its applications are advancing at this rapid rate.

Theoretically then, with our weight of fully oxidised lead, we should be able to travel for 82 hours; with the same weight of iron for 430 hours, or 18 days and nights continually, at the rate of 8 miles per hour, with one charge. Of course, these feats are quite impossible. We might as well dream of getting 5 horse-power out of a steam-engine for one pound of coal per hour.

Whilst the chemist is busy with his researches for substances and combinations which will yield great power with small quantities of material, the engineer assiduously endeavours to reconvert the chemical or electrical energy into mechanical work suitable to the various needs.

To get the maximum amount of work with a minimum amount of weight, and least dimensions combined with the necessary strength, is the province of the mechanical engineer; it is a grand and interesting study; it involves many factors; it is not, as in the steam-engine and the hydraulic machine, a matter of pressures, tension and compression, centrifugal and static forces, but it comprises a still larger number of factors, all bearing a definite relation to each other.

With dynamo machines the aim has been to obtain as nearly as possible as much electrical energy out of the machine as has been put in by the prime mover, irrespective of the quantity of material employed in its construction. Dr. J. Hopkinson has not only improved upon the Edison dynamo, and obtained 94 per cent. of the powers applied in the form of electrical energy, but he got 50 horse-power out of the same quantity of iron and copper where Edison could only get 20 horse-power—and, though the efficiency of this generator is perfect, it could not be called an efficient motor, suitable for locomotion by land or water, because it is still too heavy. An efficient motor for locomotion purposes must not only give out in mechanical work as nearly as possible as much as the electrical energy put in, but it must be of small weight, because it has to propel itself along with the vehicle, and every pound weight of the motor represents so many foot-pounds of energy used in its own propulsion; thus, if a motor weighed 660 pounds, and were travelling at the rate of 50 feet per minute, against gravitation, it would expend 33,000 foot-pounds per minute in moving itself, and although this machine may give 2 horse-power, with an efficiency of 90 per cent., it would, in the case of a boat or a tram-car, be termed a wasteful machine. Here we have an all important factor which can be neglected, to a certain extent, in the dynamo as a generator, although from an economical point of view, excessive weight in the dynamo must also be carefully avoided.

The proper test for an electro-motor, therefore, is not merely its efficiency, or the quotient of the mechanical power given out, divided by the electrical energy put in, but also the number of feet it could raise its own weight in a given space of time, with a given current, or, in other words, the number of foot-pounds of work each pound weight of the motor would give out.

The Siemens' D_2 machine, as used in the launch shown in the diagram on the wall is one of the lightest and best motors, it gives 7 horse-power on the shaft, with an expenditure of 9 electrical horse-power, and it weighs 658 lbs.; its efficiency, therefore, is 7-9ths, or nearly 78 per cent.; but its "co-efficient" as an engine of locomotion is 351—that is to say, each pound weight of the motor will yield 351 foot-pounds on the shaft. We could get even more than 7 horse-power out of this machine, by either running it at an excessive speed, or by using excessive currents; in both cases, however, we should shorten the life of the apparatus.

An electro-motor consists, generally, of two or more electro-magnets so arranged that they continually attract each other, and thereby convey power. As already stated, there are numerous factors, all bearing a certain relationship to each other, and particular rules which hold good in one type of machine will not always answer in another, but the general laws of electricity and magnetism must be observed in all cases. With a given energy expressed in watts, we can arrange a quantity of wire and iron to produce a certain quantity of work; the smaller the quantity of material employed, and the larger the return for the energy put in, the greater is the total efficiency of the machine.

Powerful electro-magnets, judiciously arranged, must make powerful motors. The ease with which powerful electro-magnets can be constructed, has led many to believe that the power of an electro-motor can be increased almost infinitely, without a corresponding increase of energy spent. The strongest magnet can be produced with an exceedingly small current, if we only wind sufficient wire upon an iron core. An electro-magnet excited by a tiny battery of 10 volts, and, say, one ampere of current, may be able to hold a tremendous weight in suspension, although the energy consumed amounts to only 10 watts, or less than 1-75th of a horse-power; but the suspended weight produces no mechanical work. Mechanical work would only be done if we discontinued the flow of the current, in which case the said weight would drop; if the distance is sufficiently small, the magnet could, by the application of the current from the battery, raise the weight again, and if that operation is repeated many times in a minute, then we could determine the mechanical work performed. Assuming that the weight raised is 1,000 lbs., and that we could make and break the current two hundred times a-minute, then the work done by the falling mass could, under no circumstances, equal 1-75th of a horse-power, or 440 foot-pounds; that is, 1,000 lbs. lifted 2·27 feet high in a minute, or about one-eighth of an inch for each operation; hence the mere statical pull, or power of the magnet, does in no way tend to increase the energy furnished by the battery or generator, for the instant we wish to do work we must have motion—work being the product of mass and distance.

Large sums of money have virtually been thrown away in the endeavour to produce energy, and there are intelligent persons who to this day imagine that, by indefinitely increasing the strength of a magnet, more power may be got out of it than is put in.

Large field-magnets are advantageous, and the tendency in the manufacture of dynamo machines has been to increase the mass of iron, because with long and heavy cores and pole pieces there is a steady magnetism ensured, and therefore a steady current, since large masses of iron take a long time to magnetise and demagnetise; thus very slight irregularities in the speed of an armature are not so easily perceived. In the case of electro-motors these conditions are changed. In the first place, we assume that the current put through the coils of the magnets is continuous; and secondly, we can count upon the momentum of the armature, as well as the momentum of the driven object, to assist us over slight irregularities. With electric launches we are bound to employ a battery current, and battery currents are perfectly continuous—there are no sudden changes; it is consequently a question as to how small a mass of iron we may employ in our dynamo as a motor without sacrificing efficiency. The intensity of the magnetic field must be got by saturating the iron, and the energy being fixed, this saturation determines the limit of the weight of iron. Soft wrought iron, divided into the largest possible number of pieces, will serve our purpose best. The question of strength of materials plays also an important part. We cannot reduce the quantity and division to such a point that the rigidity and equilibrium of the whole structure is in any way endangered.

The armature, for instance, must not give way to the centrifugal forces imposed upon it, nor should the field magnets be so flexible as to yield to the statical pull of the magnetic poles. The compass of this paper does not permit of a detailed discussion of the essential points to be observed in the construction of electro-motors; a reference to the main points, may, however, be useful. The designer has, first of all, to determine the most effective positions of the purely electrical and magnetic parts; secondly, compactness and simplicity in details; thirdly, easy access to such parts as are subject to wear and adjustment; and, fourthly, the cost of materials and labour. The internal resistance of the motor should be proportioned to the resistances of the generator, and the conductors leading from the generator to the receiver.

The insulation resistances must be as high as possible; the insulation can never be too good. The motor should be made to run at that speed at which it gives the greatest power with a high efficiency, without heating to a degree which would damage the insulating material.

Before fixing a motor in its final position, it should also be tested for power with a dynamometer, and for this purpose a Prony brake answers very well.

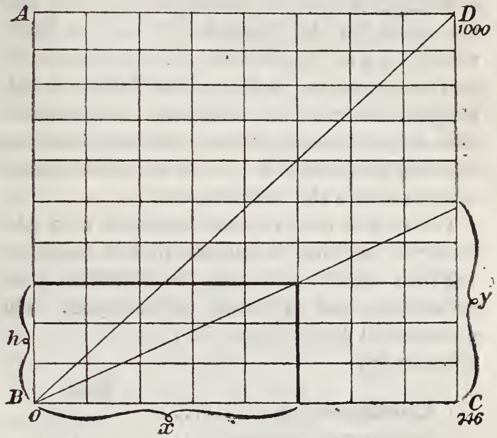
An ammeter inserted in the circuit will show at a glance what current is passing at any particular speed, and volt-meter readings are taken at the terminals of the machine, when the same is standing still as well as when the armature is running, because the E.M.F. indicated when the armature is at rest alone determines the commercial efficiency of the motor, whereas the E.M.F. developed during motion varies with the speed until it nearly reaches the E.M.F. in the leads; at that point the theoretical efficiency will be highest.

Calculations are greatly facilitated, and the value of tests can be ascertained quickly, if the constant of the brake is ascertained; then it will be simply necessary to multiply the number of revolutions and the weight at the end of the lever by such a constant, and the product gives the horse-power, because, with a given Prony brake, the only variable quantities are the weight and the speed. All the observations, electrical and mechanical, are made simultaneously. The electrical horse-power put into the motor is found by the well-known formulæ $C \times E \div 746$; this simple multiplication and division becomes very tedious and even laborious if many tests have to be made in quick succession, and to obviate this trouble, and prevent errors, I have constructed a horse-power diagram, the principle of which is shown in the diagram. (Fig. 1.)

Graphic representations are of the greatest value in all comparative tests. Mr. Gisbert Kapp has recently published a useful curve in the *Electrician*, by means of which one can easily compare the power and efficiency at a glance. (Fig. 2.)

The speeds are plotted as abscissæ, and the electrical work absorbed in watts divided by 746 as ordinates; then with a series-wound motor we obtain the curve E E. The shape of this curve depends on the type of the motor. Variation of speed is obtained by loading the brake with different weights. We begin with an excess of weight which holds the motor fast, and then a maximum current will flow through it without producing any external

Fig. 1.—Reckenzaun's Electrical Horse-power Diagram.

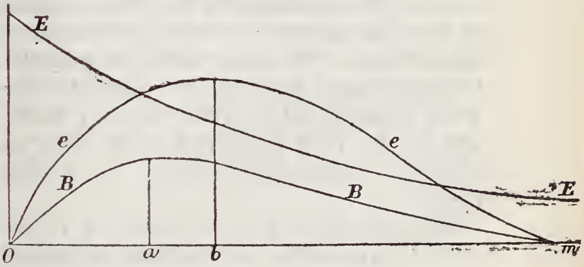


Draw a square A B C D—divide B C into 746 parts, and C D into 1,000 parts, or, generally, let a division on C D be ·746 of a division on B C, so that we can use the horizontal lines cutting A B as a horse-power scale. A B, in the above diagram, gives 1,000 horse-power, if the line B C represents 746 volts, and C D 1,000 ampères. Let $x =$ any number of volts, y the ampères, and h the horse-power, then

$$\frac{h}{x} = \frac{y}{746} \therefore h = \frac{xy}{746}.$$

A fine wire or thread stretched from o as a centre to the required division on C D, will facilitate references.

Fig. 2.—Kapp's Diagram.



work. When we remove the brake altogether, the motor will run with a maximum speed, and again produce no external work, but in this case very little current will pass; this maximum speed is $o\ m$ on the diagram. Between these two extremes external work will be done, and there is a speed at which this is a maximum. To find these speeds we load the brake to different weights, and plot the resulting speeds and horse-powers as abscissæ and ordinates producing the curve BB. Another curve $e = \frac{B}{E}$, made with an arbitrary scale, gives the commercial efficiency; the speed for a maximum external horse-power is *o a*, and the speed for the highest efficiency is represented by *o b*. In practice it is not necessary to test a motor to the whole limits of this diagram, it will be sufficient to commence with a speed at which the efficiency becomes appreciable, and to leave off with that speed which renders the desired power.

I have now to draw your attention to a new motor of my own invention, of the weight of 124 lbs., which, at 1,550 revolutions, gives 31 ampères and 61·5 volts at terminals. The mechanical horse-power is 1·37, and the coefficient 373.

	Ohms.
Armature resistance	·4*w*.
Field-magnet resistance......	·17*w*.
Insulation resistance	1,500,000*w*.

This motor was only completed on the morning before reading the paper; it could not, therefore, be tested as to its various capacities.

We have next to consider the principle of applying the motive power to the propulsion of a launch. The propellers hitherto practically applied in steam navigation are the paddle-wheel and the screw. The experience of modern steam navigation points to the exclusive use and advantage of the screw propeller where great speed of shaft is obtainable, and the electric engine is pre-eminently a high-speed engine, consequently the screw appears to be most suitable to the requirements of electric boats. By simply fixing the propeller to the prolonged motor shaft, we complete the whole system, which, when correctly made, will do its duty in perfect order, with an efficiency approaching theory to a high degree.

Whatever force may be imparted to the water by a propeller, such force can be resolved into two elements, one of which is parallel, and the other in a plane at right angles to the keel. The parallel force alone has the propelling effect; the screw, therefore, should always be so constructed that its surfaces shall be chiefly employed in driving the water in a direction parallel to the keel from stem to stern.

It is evident that a finely-pitched screw, running at a high velocity, will supply these conditions best. With that beautiful screw lying on this table, and made by Messrs. Yarrow, 95 per cent. of efficiency have been obtained when running at a speed of over 800 revolutions per minute, that is to say, only 5 per cent. was lost in slip.

Reviewing the various points of advantage, it appears that electricity will, in times to come, be largely used for propelling launches, and, perhaps, something more than launches.

In conclusion, quoting Dr. Lardner's remarks on the subject of steam navigation of nearly fifty years ago, he said:—

"Some, who, being conversant with the actual conditions of steam engineering as applied to navigation, and aware of various commercial conditions which must affect the problem, were enabled to estimate calmly and dispassionately the difficulties and drawbacks, as well as the disadvantages, of the undertaking, entertained doubts which clouded the brightness of their hopes, and warned the commercial world against the indulgence of too sanguine anticipations, of the immediate and unqualified realisation of the project. They counselled caution and reserve against an improvident investment of extensive capital, in schemes which still be only regarded as experimental, and which might prove its grave. But the voice of remonstrance was drowned amid the enthusiasm excited by the promise of an immediate practical realisation of a scheme so grand.

"It cannot," he continues, "be seriously imagined that anyone who had been conversant with the past history of steam navigation could entertain the least doubt of the abstract practicability of a steam vessel making the voyage between Bristol and New York. A steam vessel, having as cargo a couple of hundred tons of coals would, *cæteris paribus*, be as capable of crossing the Atlantic as a vessel transporting the same weight of any other cargo."

Dr. Lardner is generally credited with having asserted that a steam voyage across the Atlantic was "a physical impossibility," but in the work from which I took the liberty of copying his words he denies the charge, and says that what he did affirm was, that long sea voyages could not at that time be maintained with that regularity and certainty which are indispensable to commercial success, by any revenue which could be expected from traffic alone.

The practical results are well-known to us. History repeats itself, and the next generation may put on record our weak attempts, our doubts and fears of this day. Whether electricity will ever rival steam, remains yet to be proved; we may be on the threshold of great things. The premature enthusiasm has subsided, and we enter upon the road of steady progress.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said that no doubt those present would like to know something about the cost of such a boat as Mr. Reckenzaun described, and he hoped that gentleman would give them some information on that point.

Admiral SELWYN suggested that electrical propulsion would be specially applicable to lifeboats. A lifeboat must be expected at times to capsize, and very often to be full of water, which rendered steam-boiler an impossibility, but perhaps something might be done with electricity. His attention was drawn to this matter by a coastguard officer in Ireland, who wrote to him asking a variety of questions about motive power, which he was obliged to tell him savoured too much of perpetual motion. He told him then that there was but one answer to the question, and that was an electrical answer, provided they could abandon the ideas now prevalent about particular metals. Chemists would agree with him that iron and several other metals could be used for this purpose, some of which combined lightness with the capacity for complete oxidation, and some of which would probably be used in future. But with all that possibility he thought Mr. Reckenzaun was a little below the mark when he talked about the dream of getting 5 horse-power for one pound, he would not say of coal, but of fuel. For some months he had seen 1-6th lb. of fuel produce 1 horse-power, and he knew it could be done. That fuel was condensed concentrated fuel in the shape of oil. When this could be done, electrical energy also could be obtained much cheaper, but if it were extended to yachts, he thought that would be as far as anyone now present could be expected to see it go. Still he thought there was a future for it, and that future would be best advanced by considering the question on which he had touched. Firstly, the mployment of a cheaper mode of getting the power n the steam-engine; and, secondly, a cheaper and ighter secondary battery. In a railway train weight was a formidable affair, but in a floating vessel it was still more important. He did not think, however, that a light secondary battery was by any means an impossibility. Mr. Loftus Perkins had actually produced by improvements in the boiler and steam-engine two great things; first, one indicated horse-power for a pound of fuel per hour, and next he had devised a steam-engine of 100 horse-power, of a weight of only 84 lbs. per horse-power, instead of 304 lbs., which was about the average. Those were two enormous steps in advance, and under a still more improved Patent-law he had no doubt things would be brought forward which would show a still greater progress. Within the last fifteen days, nearly 2,000 patents had been taken out, as against 5,000 in the whole of the previous year, which showed how operative a very small and illusory inducement had been to encourage invention. He had long been known as an advocate of Patent-law reform, and, therefore, felt bound to lose no opportunity of calling attention to its importance. Invention was in the hands of the inventor, the creator of trade. If, without robbing anybody one wished to produce property, it must be done by improving manufactures as a consequence of inventions. In one instance alone it had been proved that a single invention had been the means of introducing twenty millions annually, upon which income-tax was paid.

Lord SUDELEY thought they were much indebted to Mr. Reckenzaun for the very clear way in which he had explained the subject. There were considerable delays before this launch arrived at Vienna, and when at last the boat got there, some part of the machinery had been left behind at Antwerp, which caused additional delay, and, perhaps, added to the interest with which it was regarded. When at last it was all in order, and set to work on the Danube, it excited great admiration. It went along silently, without vibration, and was able to stem a rather swift current, and showed that England had made a very great step, at any rate, in one particular direction. On one occasion he had the honour of being on board with Sir William Thomson, Sir William Siemens, and Sir Frederick Abel, and one or two Austrian electricians, whose opinions were all highly favourable; for they one and all said it was a very great success, and did the designer and builders very great credit. There was no doubt that in the future there would be a very great opening for such boats, depending, no doubt, in great measure on what could be done with secondary batteries, in which there was, as yet, great room for improvement. Then, again, there was the question how far they could be used, unless there were conveniences at different places for charging, or re-charging them. Another important question was, how far these boats could be used in harbour defences, or in torpedo warfare, which would be a great boon, on account of the large amount of space at disposal. Whether it would be safe to take them in a rough or chopping sea, he was not prepared to say; but no doubt their adaptability to such uses was only a question of time.

Mr. CROHNE (Messrs. Yarrow) said he had the highest opinion of this launch, having carried through the experiments. It was very convenient and pleasant; there was no noise, dirt, or vibration, and in every respect he considered it with great respect.

One very important point in connection with this boat was that the weight was so low down as to ballast her in the most perfect manner, such as could not be attained in any steamer. He had had as many as fourteen men in the boat, sitting on the rail and gunwale, and she was so staunch that there was not the slightest danger; but in a similar boat propelled by steam, this would have entailed the greatest risk; in fact, he could not have got the same number of men into a steam launch at all. The accommodation was very great, and the stability enormous. In the case of a life-boat, the weight being so low down would be of the greatest service; in fact, it would be almost impossible to capsize the boat. He was afraid there was no chance of using such boats for torpedo warfare, torpedo boats being cram-full of steam power; one of that size, for instance, would be about 100 indicated horse-power; and he did not know how 70 actual horse-power was to be got from electricity in the weight such a boat would carry. He was not an electrician, but he had not heard of any means by which it could be done. For ordinary speeds, however, he considered such boats a great success.

Mr. LIGGINS said he had studied the subject of steam launches for a long time—in fact, since the first one was built at Cowes, about sixteen years ago, for the *Pantomime*, which was 24 ft. long. She turned out so satisfactory that it was thought at first that every yacht over 100 tons would have a steam launch, in order to tow her in calm weather. He was, at that time, cruising in Mr. Ashbury's yacht, the *Cambria*, and that gentleman at once gave an order for a steam launch, and he (Mr. Liggins) was so enthusiastic in its favour from the delight he took in cruising about the Isle of Wight in her, that he thought every yacht owner in England would have one. It was found, however, that, owing to the dirt and smoke, and the annoyance from the steam, &c., they did not meet with very much favour. But he suggested to Mr. Yarrow the desirability of fitting up such launches. He took the hint, and having the first boats built by Messrs. Forrest, they turned out a very great success, and were very popular; though, at that time, eight or nine miles an hour was thought a great speed, as showing the wonderful improvement that had been made in them, he had just read that one of their torpedo boats had shown a speed of twenty miles an hour. That led him to believe that the speed of these electric launches would, in like manner, be increased, and that they would become the pleasure boats of the future. Of course they could not be used generally, unless gentlemen had small steam-engines with which to charge the batteries. It was not so many years ago since Dr. Lardner was reported to have said that a steam vessel could never cross the Atlantic, though, in fact, at that very time the voyage had been made by the *Sirius*, a steamer built to ply between London and Dublin. They all knew the immense strides which had been made in steam navigation since then, a large vessel of 5,000 tons and 5,000 horse-power having just left the Clyde, which had a speed of nearly 20 miles an hour; and he had, no doubt, that similar advances would be made in electricity. He would ask if there was not a necessity to keep the accumulators constantly at work, because it had been stated that otherwise a film formed over the lead plates, which materially interfered with their efficiency. He did not think the question of cost was of very much importance, as it would, no doubt, be lessened as the demand increased.

Lieut-Colonel WEBBER thought the allusion made by Lord Sudeley to the use of this sort of launch for torpedo purposes was not intended to refer to the so-called torpedo boats mentioned by Mr. Crohne, having a very high speed, but rather to the advantage of having a boat with the large space, such as was here afforded, for the purpose of laying out torpedoes for the defence of harbours. Besides the advantage of a large space, it would allow of a smaller boat being used, which was of great importance, as all would recognise who had been engaged in this service. Again, when torpedoes had to be laid out at night in the neighbourhood of an enemy, the silence, and the absence of glare and reflection from the funnel, would be of the highest advantage.

Mr. CRAMPTON said he did not think steam could ever compete with electricity, under certain circumstances; but, at the same time, it would be a long time before it was superseded. He should like very much to see the compressed oil, one-sixth of a pound of which would give 1 horse-power per hour.

Admiral SELWYN said he had seen a common Cornish boiler doing it years ago.

Mr. CRAMPTON said it had never come under his notice, and he had no hesitation in saying that no such duty ever was performed by any oil, because he never heard of any oil which evaporated more than eighteen to twenty-two pounds of water per pound. However he was delighted to hear of such progress being made, and though he had been for so many years connected with steam, he never expected it would last for ever. He was now making experiments for some large shipowners, for the purpose of facilitating feeding and doing away with dust, but let him succeed to to what extent he might, steam would never compete with electricity for such small vessels as these launches.

The CHAIRMAN asked if he rightly understood Admiral Selwyn that he had recently seen an invention in which one-sixth of a pound of condensed fuel would give 1 horse-power per hour.

Admiral SELWYN said it was now some years ago since he saw this going on, but the persons who did it did not know how or why it was done. He had studied the question for the last ten years, and now knew the *rationale* of it, and would be prepared shortly to publish it. He knew that 22 was the theoretical calorific value of the pound of oil, and never supposed that oil alone would give 46 lbs., which he saw it doing. He had found out that by means of the oil forming carbon constantly in the furnace, the hydrogen of the steam was burned, and that it was a fallacy to suppose that an equal quantity of heat was used in raising steam, at a pressure of, say, 120 lbs. to the square inch, as the hydrogen was capable of developing when properly burned. There were, however, conditions under which alone that combustion could take place—one being that the heat of the chamber must be 3,700°, and that carbon must be constantly formed.

Mr. Gumpel said it was not so much the present position of the electric launch, as its promise for the future, which was of interest and importance, for as yet it might be looked upon almost in the light of a plaything; but, at a future time, the records of that meeting and the opinions now expressed would be referred to as they now looked back to the supposed utterances of Dr. Lardner with regard to steam. The whole weight in the vessel being placed so low, giving great stability, and the small space occupied, were both points of great importance; but one point to which he would call attention was the great speed of the propeller. It had about 9 inches pitch, and worked at 800 revolutions a minute. Now some experiments he made in 1859 and 1860, and the discussions on the subject, which had taken place in the Society of Naval Architects and elsewhere, had shown that there was a certain limit to the pitch of a screw, and that you might lose too much power by friction. He believed that if Mr. Reckenzaun could construct a motor which would give a less number of revolutions, but develop the same amount of propelling power, there would be greater efficiency. With regard to the use of electricity by means of the secondary battery, when the vessel had run seven and a-half hours, and the electricity had been discharged, the question arose as to recharging the cells, for which purpose the boat must be laid up somewhere where there was the means of charging the batteries, or they must be replaced. With regard to the general application of electricity to the propulsion of vessels as well as to railway trains, he believed that many of those present would live to see electricity applied to that purpose, because there were so many minds now applied to the problem, that before long he had no doubt we should see coal burned in batteries, as it was now burned in steam boilers. The utmost they could do, then, would be about 50 per cent. less than Admiral Selwyn said could be accomplished with condensed fuel. He could not but wonder where Admiral Selwyn obtained his information, knowing that a theoretically perfect heat-engine would only give 23 per cent. of the absolute heat used, and that a pound of the best coal would give but 8,000 and hydrocarbon 13,000 heat units, whilst hydrogen would give 34,000, and calculating it out, how was it possible to get out of one-sixth of a pound of carbon, or any hydrocarbon, the amount of power stated. No doubt, when Admiral Selwyn applied the knowledge which physicists would give him of the amount of power which could be got out of a certain amount of carbon and hydrogen, he would find that there was a mistake made somewhere. He greatly admired the manner in which Mr. Reckenzaun had brought forward the subject, which formed a pleasant contrast to some papers they had heard from inventors of particular motors; and he thought it would be very useful if he would prepare another paper on the different forms of motors, and the conditions necessary for their efficiency. It was a most important subject, which he hoped would be further discussed there, and in which much progress might be made.

Mr. Reckenzaun, in reply, said it would be very difficult to answer the question put by the Chairman, as to the cost of an electric launch—quite as difficult as to say what would be the cost of a steam launch. It depended on the fittings, the ornamental part, the power required, and the time it was required to run. If such a launch were to run constantly, two sets of accumulators would be required, one to replace the other when discharged. This could be easily done, the floor being made to take up, and the cells could be changed in a few minutes with proper appliances. As to Admiral Selwyn's remarks about one-sixth of a pound of fuel per horse-power, he had never heard of such a thing before, and should like to know more about it. Mr. Loftus Perkins's new steam-engine was a wonderful example of modern engineering. A comparatively small engine, occupying no more space than that of a steam launch of considerable dimensions, developed 800 horse-power indicated. From a mechanical point of view, this engine was extremely interesting; it had four cylinders, but only one crank and one connecting rod; and there were no dead centres. The mechanism was very beautiful, but would require elaborate diagrams to explain. Mr. Perkins deserved the greatest praise for it, for in it he had reduced both the weight of the engine and the consumption of fuel to a minimum. He believed he used coke, and took one pound per horse-power. He should not like to cross the Channel in the electric launch, if there was a heavy sea on, for shaking certainly did not increase the efficiency of the accumulators, but a fair amount of motion they could stand, and they had run on the Thames, by the side of heavy tug-boats causing a considerable amount of swell, without any mishap. Of course each box was provided with a lid, and the plates were so closely packed that a fair amount of shaking would not affect them; the only danger was the spilling of the acid. Mr. Crohne had remarked that a torpedo boat of that size would have 100 indicated horse-power, but then the whole boat would be filled with machinery. What might be done with electricity they had, as yet, no idea of. At present, they could only get 33,000 foot-pounds from 1 lb. of lead and acid, though, theoretically, they ought to get 360,000 foot-pounds. Iron, in its oxidation, would manifest theoretically 1,900,000 foot-pounds per lb. of material. As yet they had not succeeded in making an iron accumulator; if they could, they would get about six or seven times the energy for the same weight of material, or could reduce the weight proportionately for the same power, and in that way they might eventually get 70 horse-power in a boat of that size, because the weight of the motor was not great. With regard to the formation of a film on the surface, no doubt a film of sulphate of lead was formed if the battery stood idle, but it did not considerably reduce its efficiency; as soon as it was broken through by the energy being evolved from it, it would give off its maximum current. They knew by experience that, with properly constructed accumulators, 80 per cent. of the energy put into them was returned in work. It was quite certain, as Mr. Crampton said, that it would be a long time before steam was superseded; he did not prophecy at all; and he entitled his paper "Electric Launches," because it would be presumptuous to speak of anything more until larger vessels had been made and tried. With regard to Mr. Gumpel's remark on the friction of the propeller, he would say that it was constructed to run 900 revolutions; if it were driven by a steam-engine, and the speed reduced to 300, not only would the pitch have to be altered, but the surface would have to be larger, which would entail more friction. Mr. Crohne would bear him out that they lost only 5 per cent. by slip and friction combined, on an average of a great number of trials, both with and against the current.

Mr. GUMPEL remarked that Sir E. J. Reed had pointed out in that room that it was a fallacy to suppose that slip in itself was a loss. You must have slip for the purpose of propelling the vessel. The 5 per cent. loss would not give any idea of the efficiency of the propeller in itself.

Mr. CROHNE said he had always been of opinion that such a fine pitch would not do at all, and they had an electric launch made with gear to reduce the speed of the propeller; but, practically, he found he was mistaken. He had expected that negative slip and the friction of the propeller would be a serious impediment, but he found he was entirely mistaken. This wonderfully fine pitch of about 10 inches, and a diameter of 20 inches, was quite unknown before, as far as he was aware, but it gave very good results indeed.

The CHAIRMAN, in proposing a vote of thanks to Mr. Reckenzaun, said he rejoiced to find that that gentleman had proved, to one practical man at least, that his views had been mistaken. He found in these days of the practical applications of electricity, that the ideas of most practical men were gradually being proved to be mistaken, and every day new facts were being discovered, which led them to imagine that as yet they were only on the shore of an enormous ocean of knowledge. It was quite impossible to say what these electric launches would lead to. Certain points of great importance had been pointed out; they gave great room, and they were always ready. For lifeboat and fire-engine purposes, as Captain Shaw pointed out at Vienna, this was of great consequence. At first, they were led to believe that there was great stability, but that idea had been a little shaken, not as to the boat itself, but as to the influence of the motion of the water upon the constancy of the cells. But these boats were only intended for smooth water, and if they could not be adapted for rough water, he feared Admiral Selwyn's suggestion of the application of this principle to lifeboats would fall to the ground; but if secondary batteries were not calculated as yet to stand rough usage, it only required probably some thought on Mr. Reckenzaun's part to make them available even in a gale. Enormous strides were being made with regard to these batteries. No one present had been a greater sceptic with regard to them at first than he himself; but after constant experiments—employing them, as he had done for many months, for telegraphic purposes—he was gradually coming to view them with a much more favourable eye. The same steps which had rendered all scientific notions practicable, had gradually eliminated the faults which originally existed, and they were now becoming good, sound, available instruments. At present, he could only regard this electric launch as a luxury. He had hoped that Mr. Reckenzaun would have been able to say something which would have enabled poor men to look forward to the time when they might enjoy themselves in them on the river; but he was told at Vienna, when he enjoyed two or three trips in this boat on the Danube, that her cost would be about £800, which was a little too much for most people. They wanted something more within their reach, so that at various points on the river they might see small engines constantly at work supplying energy to secondary batteries, and so that they might start on a Friday evening, and go up as far as Oxford, or higher, and come down again on Monday morning. He must congratulate Mr. Reckenzaun on the excellent diagrams he had constructed. The trouble of calculating figures of this sort was very great when making experiments; and the use of diagrams and curves expedited the labour very much. At present they were passing through a stage of electrical depression; robbery had been committed on a large scale; the earnings of the poor had been filched out of their pockets by sanguine company promoters; an enormous amount of money had been lost, and the result had been that confidence was, to a great extent, destroyed. But those who had been wise enough to keep their money in their pockets, and to read the papers read in that room, must have seen that there was a constant steady advance in scientific knowledge of the laws of electricity and in their practical applications, and as soon as some of these rotten mushroom companies had been wiped out of existence, they might hope that real practical progress would be made, and that the day was not far distant when the public would again acquire confidence in electrical enterprise. They would then enable inventors and practical men to carry out their experiments, and to put electrical matters on a proper footing.

The vote of thanks having been carried unanimously, the meeting separated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

INDIA.

Wednesday, January 9th.—Present: Sir Joseph Fayrer, M.D., F.R.S., in the chair; Sir George Birdwood, M.D., C.S.I.; Colonel Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Deputy Surgeon-General N. Chevers, M.D., C.I.E.; Surgeon-General Gordon; Mr. P. Macfadyen; Colonel J. Michael, C.S.I.; Mr. Harold A. Perry; Surgeon-General Townsend, C.B.; Mr. Frederick Young; Mr. A. Stirling; Mr. H. Trueman Wood.

SCHOOL (GROUP IV.) AND EDUCATION (GROUP VI.)

Thursday, January 10th.—Present: Lord Reay, in the chair; Mr. B. St. John Ackers; the Venerable Archdeacon Emery; Mr. J. G. Fitch; Mr. Arnold Graves; Mr. T. C. Horsfall; Mr. T. E. Heller; Mr. A. C. King; Mr. Philip Magnus; Mr. T. Nordenfelt; Mr. H. T. Wood.

METEOROLOGICAL.

Friday, January 11th.—Present: Professor F. De Chaumont, M.D., F.R.S., in the chair; Mr. Robert H. Scott, F.R.S.; Mr. G. J. Symons, F.R.S.; Dr. J. W. Tripe; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III.—
SUB-COMMITTEE A.

Saturday, January 12th.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. Rogers Field, C.E.; Mr. Shirley F. Murphy; Mr. George Shaw; Mr. H. T. Wood.

THE WORKSHOP.—GROUP V.

Saturday, January 12th.—Present: Dr. George Buchanan, in the chair; Mr. Joseph Dickinson; Mr. Alexander Redgrave; Mr. Gilbert R. Redgrave; Mr. Warington W. Smith, F.R.S.; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III.—SUB-COMMITTEE ON SANITARY AND UNSANITARY HOUSES.

Monday, January 14th.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. Rogers Field; Mr. Ernest Turner; Mr. H. T. Wood.

DRESS.

Tuesday, January 15th.—Present: Mr. Frederick Treves, F.R.C.S., in the chair; Mr. George Erskine; Prof. W. H. Flower, LL.D., F.R.S.; Deputy Surgeon-General Jeffery Marston; Mr. George D. Ramsay, C.B.; Mr. George Scharf; Mr. Thorn; Surgeon-General Townsend, C.B.; Hon. Lewis Wingfield; Mr. H. T. Wood.

SCHOOL AND EDUCATION.—GROUPS IV & VI.

The following is the classification of these two Groups:—

GROUP 4.—THE SCHOOL.

Class 34.—Designs and models of improved buildings for elementary schools, infant schools and crèches.

Class 35.—Apparatus and fittings for warming, ventilating, and lighting schools; school latrines, closets, &c.

Class 36.—Special school fittings for storing and drying clothing.

Class 37.—School kitchens and arrangements for school canteens; methods of warming children's meals, &c.

Class 38.—Precaution in schools for preventing the spread of infectious diseases, school sanitaria, infirmaries, &c.

Class 39.—Special apparatus for physical training in schools, gymnasia, apparatus for exercise, drill, &c.

Class 40.—Literature, statistics, diagrams, &c., relating to Group 4.

GROUP 6.—EDUCATIONAL WORKS AND APPLIANCES.

Class 47.—Crèches and infant schools—(*a*) Apparatus and fittings for crèches and infant schools; (*b*) games, toys, and kindergarten amusements; (*c*) models and appliances for teaching; (*d*) examples of school work.

Class 48.—Primary schools—(*a*) Apparatus and fittings; (*b*) models and appliances for teaching; text-books, diagrams and examples; (*c*) specimens of work done in elementary schools.

Class 49.—Domestic economy in schools for girls—

(*a*) Models and apparatus for the teaching of cookery, housework, washing, and ironing, needlework, and embroidery, dressmaking, artificial flower-making, painting on silk, pottery, &c.; (*b*) specimens of school work.

Class 50.—Handicraft teaching in schools for boys—(*a*) Apparatus and fittings for elementary trade teaching in schools; (*b*) specimens of school work.

Class 51.—Science teaching—(*a*) Apparatus, and models for elementary science instruction in schools; apparatus for chemistry, physics, mechanics, &c.; (*b*) diagrams, copies, text-books, &c.; (*c*) specimens of the school work in these subjects.

Class 52.—Art teaching—(*a*) Apparatus, models, and fittings for elementary art instruction in schools; (*b*) diagrams, copies, text-books, &c.; (*c*) specimens of art work, modelling, &c., in schools.

Class 53.—Technical and apprenticeship schools—(*a*) Apparatus and examples used in primary and secondary schools for teaching handicrafts; (*b*) models, plans, and designs for the fitting up of workshop and industrial schools; (*c*) results of industrial work done in such schools.

Class 54.—Schools for the blind and for the deaf and dumb—(*a*) Apparatus and examples for teaching; (*b*) specimens of school work.

Class 55.—Literature, statistics, and diagrams relating to Group 6, and to the effects of "cramming" and overwork on the young, &c.

Class 56.—Collective displays of school work and appliances.

It will be seen that in Group 4 are comprised all the exhibits relating to school construction, to the improvement of the sanitary condition of school buildings, and to means for promoting the health of the scholars by physical exercises and otherwise.

The classification sufficiently shows the character of the exhibits the Committee would wish to see provided. They would, however, lay special stress on those included in Class 39, and relating to physical education. They would be glad to see included as many models as may be convenient of typical elementary schools, and they would appeal for this purpose to school authorities and managers in this and other countries, and to architects who have given special attention to school construction, for the loan of such models, as well as of plans and diagrams. The admission of the latter, however, must be to a certain extent limited by considerations of space.

As regards Class 40 of this Group—and the same remark will apply to Class 55 in Group 6—the Committee are anxious that this Class should be limited, with a view to preventing the Exhibition being overburdened with literature. Books stowed away in glazed cases, the backs only being visible, as is the usual custom in exhibitions, are of little practical value or interest; and if available for examination a constant watch is necessary.

Group 6, which forms the second division of the Exhibition within the province of this Committee, relates entirely to educational works and appliances, these being restricted to such in the first instance, as attach to primary schools, and secondly, to scientific, artistic, and technical education in secondary and higher grade schools, it being understood that Class 49 comprises what may be considered as technical education for women. Regarding this Group, it will be noted that in every Class where they can come in, examples or specimens of school work are included. In the case of primary and infant schools, the Committee would be glad to see this part of the Exhibition strictly limited to what is important or characteristic, and the same remark to a great extent applies to Class 49.

The Committee would wish to arrange for as large a display of maps and diagrams as the wall space available will permit.

Of the specimens of work of a handicraft or technical character, the Committee would be glad to see as full a collection as possible, especially of the higher class of work done in certain foreign schools.

The Committee do not consider it at all necessary that extensive collections of apparatus and fittings for infant and elementary schools in use in this country should be shown, especially when it is remembered that the educational collection of the South Kensington Museum is in the close neighbourhood of the Exhibition.

Among other points, on the importance of which the Committee would lay stress, may be mentioned the artistic decoration of school-rooms, the exhibition of works of art suitable for use in schools, and the exhibition of objects suitable for school museums, or possibly of a typical school museum.

As regards the instruction of the blind and of the deaf and dumb—as in all other departments—the Committee would like the various systems to be fully represented, and it should be understood that no preference would be given to one system above another on account of any individual views which members of the Committee might entertain.

It will be noticed that in Class 55 are included the effects of cramming and overwork on the young. The Committee understand that this subject is mentioned in the classification merely in order that it might be included amongst the subjects for conferences, and they do not understand that any exhibits intended to illustrate it will be sought for.

As regards collective displays (Class 56), the Committee will endeavour to organise displays of this character, which are likely to have a higher educational value than the exhibition of separate articles.

Memorandum from "The Indian" Sub-Committee.

The object which this Sub-Committee think should be kept in view in considering the arrangements for the Indian Section of the Exhibition, is the illustration, in as vivid a manner as possible, of the actual life of the masses of the people of India, as regards the three especial objects of the Exhibition, their

Food, their Dress, and their Dwellings, also, but to a less extent, their Education.

The Committee feel that they must not rely solely on contributions from India, but that they must also expect the aid both of traders and of private individuals in England in securing an effective Indian display. They are, therefore, anxious that it should be distinctly understood that applications for space from Indian traders in England will be readily considered, provided of course, that the proposed exhibits are of a character suitable for the Exhibition.

As regards Group 1, Food, it will be desirable that there should be complete collections of the ordinary food of the people in some selected districts of each principal province. Where possible, it would be desirable to have the prepared food itself; when this cannot be done, the raw materials and models might be shown. Thus, for a Deccan district, samples of Bajra and jowar, the chief grain foods, of wheat, dhal, and pulses, and of the flour as prepared by the natives for use; models of the chowpattis or loaves; then the condiments, salt, pepper, pickles, &c., as actually used; ghi, gur, and sweetmeats, with the grindstones; models of "chulas," or cooking stoves and the like; cooking pots, dishes, &c., as used. For a coast district, rice in its various preparations, salt and dried fish, &c.

Specimens also of Indian food-stuffs imported in this country are desired, as well as specimens of the various condiments, pickles, preserves, &c., manufactured either for European or local use. Models of edible fruits, especially those known in this country in a dried state, would be useful. Also representations or stuffed specimens of animals and fish used as food.

Any illustration of the processes of preparing rice, tea, coffee, &c., would be welcomed. It would certainly create great interest here if a few native cooks could be brought over, with plenty of materials, who would cook daily, for sale, say a good Mussulman dinner, and a good Hindu dinner, with accompaniments such as are used at caste feasts, weddings, &c.

As regards Group 2, Dress, the most important thing will be to show the clothing, &c., of representative classes in representative districts of each province; thus, from Bombay, there might be a Gujerat Patidar, a Deccan Banya, a Konkan fisherman, a Borah trader, a Parsee merchant—with their women; from Bengal and Madras similar typical examples. The dresses should be shown on lay figures, and should be the ordinary habiliments of the people with their ordinary ornaments, also with Charpais, Kamlis, rasais, &c.

Exhibits illustrating the construction of Indian fabrics, and specimens of any fabrics of special interest are desirable, also illustrations of silk culture (especially tussur).

In Group 3, the Dwelling, possibly there might be exact models of the better classes of houses in representative districts (say of a cultivator of the better class, a banker, a shop keeper), of the cottages of the lower class, the huts of weavers, fishermen, &c., of European up-country bungalows, and of a bit of a bazaar in an up-country town. With these models should be shown small figures, dressed to represent the people at their usual avocations; models of their furniture and of their domestic animals might be put into their houses.

Models of native schools, and any matters connected with the education of the people would be acceptable.

Punkas, Tattis and Thermantidotes should be admitted, and other means of cooling air, drinks, &c.; also means for carrying and preserving water.

If, besides the cooks above mentioned, other Indian workmen could be brought over, potters, blacksmiths, weavers, clothworkers, embroiderers, silversmiths, &c., it would form a most interesting feature in this Exhibition, and, as illustrating the life of the people of India, possibly not a unsuitable feature.

GUTTA-PERCHA.

By James Collins.

The earliest notice concerning gutta-percha I have come across, is contained in John Tradescant's catalogue of his "Rarities preserved at South Lambeth."* In this is mentioned "plyable mazer wood, being warmed in water, will work to any form." It is also by no means impossible that some of the historical "mazer cups" may have been made from this material,† the mottled appearance of gutta-percha answering to the descriptions given, and its lightness, strength, and non-liability to fracture, would render it a good substitute for the true maple. "Mazer-wood tree" is also one of the vernacular names of the gutta-percha tree.

To Dr. William Montgomerie, a surgeon in the East India Company's service, belongs the honour of first bringing this substance before the commercial world. He first noticed it in Singapore in 1822, and experimented on it; and in 1842, whilst again in Singapore, he recommended it to the Medical Board of Calcutta as a substance useful in the making of surgical splints. He also sent samples to London to the Society of Arts, who warmly took up the subject, and, in 1844, awarded Dr. Montgomerie their gold medal. In 1843, Dr. (afterwards Sir) José d'Almeida sent a sample to the Royal Asiatic Society, and some persons have confounded these two circumstances. Dr. d'Almeida, it should be remembered, sent gutta-percha as a curiosity, whilst Dr. Montgomerie, long before this date, experimented on the substance, and recommended it as likely to prove of great utility in the arts and manufactures.

In 1847, Sir W. J. Hooker‡ named the plant *Ison-*

* "Museum Tradescantium."—London, MDCLVI.

† *Vide* Spenser's "Shephearde's Calendar," and "Faerie Queene."

‡ "Lond. Jour. Botany," Sept. 1847, p. 404.

andra gutta, from specimens supplied by Mr. Lobb, who was at that time collecting plants for the Messrs. Veitch, the eminent nurserymen; and Mr. Motley, whilst in Borneo, added materially to our information. Dr. de Vriese, on the part of the Dutch Government, did good work in this direction, he giving descriptions of eighteen plants yielding this substance.*

Gutta-percha, as it appears in commerce, is of a reddish or yellowish hue, nearly as hard as wood, and of a porous structure. When cast or rolled, it assumes a fibrous structure, and acquires a tenacity in a determinate direction. At a temperature of 32° to 77° Fahr., it has as much tenacity as thick leather, but not at all elastic, and less flexible. In water, towards 120° Fahr., it softens and becomes doughy, although still tough; at 145° to 150° it becomes soft and pliant, assuming the elasticity of caoutchouc, becoming again hard and rigid on cooling. It is highly inflammable, burning with a bright flame, and its electrical properties are well known.

Gutta-percha, like many other milky juices, is found stored up in an irregular network of tubes (*Cinenchyma*, or lactiferous tissue), in the middle layer of the bark; the outer layer, largely developed in the cork oak, is known as the corky layer, or *epiphleum*, and the inner, largely developed in fibre-plants, is known as liber-layer, or *endophleum*. Thus the bark has to be cut into to free the milky juice.

Gutta-percha trees are confined to the natural order Sapotaceæ, an order yielding succulent fruits, such as the sapodilla plum (*Achras sapota*), vegetable butters as from the seeds of various species of *Bassia*, whilst from species of *Dichopsis* (*Isonandra*), and other genera, we have the peculiar gum-resin, or hydrocarbon, known as gutta-percha. A short description of the better known tree will be sufficient for the present purpose.

Dichopsis gutta (Isonandra gutta) is known uuder various names, such as gutta-percha, gutta tabán (the more correct), gutta durian, gutta niato, and many others. The word gutta, gutah, gatta, gittáh, as it is variously spelt, signifies in Malay, gum or juice. The second name is the name of the tree producing this gum, the same tree having a different name in different localities. The tree is found in the Malay Peninsula, Sumatra, Borneo, and throughout the Malayan Archipelago generally. It grows to a height of 60 to 80 feet, with a diameter of 2 to 5 feet. The leaves are inversely egg-shaped and entire, pale green on the upper side, and covered beneath with a reddish-brown shining down. The flowers are arranged in clusters of three or four in the axils of the leaves. The fruit is a small oval berry. The gutta, as it flows from the tree, is of a greyish colour, at times somewhat roseate in hue, possibly arising from the colour of the bark. There is also an oblong leaved variety of this species. Of other kinds mention may be made of the following:—

* De Vriese, Plantæ Batavæ Orientalis, Lug. Bat. 1856; De Handel in Getah-Pertja, 1856.

Dichopsis macrophylla, the Ngiato putih or white gutta-percha of Borneo, the gutta of which, according to Motley, is of a second-rate quality.

Dichopsis Motleyana, yielding a very low kind, known as gutta kotian (Motley).

Payena dasyphylla, yielding a second-rate quality, known as gutta benton, in Borneo (Motley).

Payena Leeri, yielding gutta balem-tandoek, &c., in Sumatra and Java.

Beside these there are species of *Chrysophyllum*, *Sideroxylon*, *Bassia*, *and Mimusops*, also said to yield gutta-percha.

The names of varieties of gutta-percha are exceedingly numerous, and many are no doubt synonymous, and a bare mention of a few of these will suffice. In all, the words gutta-percha may be used as a prefix to these names.

Waringen.—Borneo. Well spoken of.

Nettu.—Borneo. Said to be of a second quality.

Ploot.—Borneo. A third quality.

This is a Dyak term, and seems to be applied to varieties all alike.

Papua.—Borneo. Fourth class.

Rana.—Borneo. Very low quality.

Katella, Jankar and Kladi guttas are only used for adulterating better qualities.

Daging.—In the Malay Peninsula, gutta daging is well known, the term daging meaning "flesh," the gutta having a very gristly character. It is much like Balata, and is a capital gutta.

Muntah.—Under the name gutta muntah, or white Borneo, this kind made its appearance in the English market some years ago. Muntah means "raw," and is applied to all guttas which have not been cooked or prepared. Hence the term is applied to the lowest as well as the best varieties. If not speedily used up, it loses all its value by becoming resinified.

In the Brow and Boolongan districts, on the east coast of Borneo, Captain Lingard informed me that there are three kinds of gutta-percha recognised by the natives.

(1.) Kalapeieh, or Lota lanyut, or "tough gutta," is the first and best quality. It is known in the English market as Lingard's "Nina" brand.

(2.) Kalapeieh, or Lota mooka, or "spongy gutta" yields about 10 per cent. less gutta, and the tree is more difficult to cut down.

(3.) Kalapeieh, or Lota kapur, yields about 20 per cent. less than No. 1, and in the wet season even 30 per cent less.*

(*To be continued.*)

INDUSTRIAL PROGRESS IN RUSSIA.

Russia at present displays in the provinces of Livonia, Esthonia, and Kourland, as well as in Poland, great industrial activity. The *Central-Blatt*

* See also some remarks on Malayan varieties by the late Mr. Murton, "Journal of the Society of Arts," Oct. 11, 1878.

Journal of the Society of Arts.

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FRIDAY, JANUARY 25, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SWINEY PRIZE.

A meeting of the adjudicators of this prize, appointed by the will of the late Dr. Swiney, was held on January 21st, 1884, at the Rooms of the Society of Arts. R. E. Webster, Q.C., Member of Council, in the chair.

The Secretary read the advertisement convening the meeting.

The Secretary read a report from the joint Committee of the Society of Arts and the College of Physicians, recommending that the prize should be awarded to Professor Sheldon Amos, M.A., for his work entitled "A Systematic View of the Science of Jurisprudence."

It was thereupon moved by Mr. B. Francis Cobb, Vice-President of the Society of Arts, and seconded by Sir Henry Pitman, M.D., Registrar of the College of Physicians, and carried, "That the prize, a silver goblet value £100, containing gold coin to the same amount, be adjudged, and the same is hereby presented to Professor Sheldon Amos, M.A., the author of a published work on jurisprudence entitled 'A Systematic View of the Science of Jurisprudence.'"

The cup has been executed by Messrs. Garrard, from a design made expressly for the Society by the late Daniel Maclise, R.A.

PRIZES FOR ESSAYS ON DWELLINGS FOR THE POOR, AND ON THE RECONSTRUCTION OF CENTRAL LONDON.

The Council of the Society of Arts have had placed at their disposal by Mr. William Westgarth, a member of the Society, a sum of £1,200, to be awarded in prizes for essays on the above subjects.

The first prize will be a sum of £250, for the best practical essay upon the re-housing of the poorer classes, and especially of the very poorest classes, of the metropolis.

The second prize will be a sum of £500, for the best practical essay upon the whole subject of the sanitation, street re-alignment, and reconstruction of the central part of London.

The essays should include the following points:—

I. Reconstruction of the central part of London with regard to the plan of the streets.

II. Removal of the old and poisoned soil.

III. Re-arrangement of the levels, and provision of subterranean ways for the accommodation of electric wires, pipes for water supply, sewage, &c.; also provision for warehousing.

In addition to the above, there will be three further prizes of £150 each:—

1. For the best treatment of the engineering considerations.
2. For the best treatment of the architectural considerations.
3. For the best treatment of the sanitary considerations. Any or all of these

last-named prizes may be awarded to the same essay as that to which the £500 prize may be awarded, or they may be awarded separately.

The essays must be sent in to the Secretary of the Society of Arts, John-street, Adelphi, not later than December 31, 1884. No essays can be received in manuscript. Two printed copies of each essay must be submitted, and it will be convenient that they should be printed in pages, with wide margins. The essays should be accompanied with such maps, plans, drawings, &c., as may be necessary, and these need not be in duplicate.

The Council reserve the right of withholding any of the prizes, or of awarding the amounts, or parts of the amounts, in any manner which may seem to them desirable. They also reserve the right of publishing any essay to which a prize may be awarded.

The name of the writer must not appear on the essay, but each essay must have written or printed thereon a motto, and be accompanied by a sealed envelope containing on the outside the same motto, and within the name and address of the writer.

The awards will be made by the Council upon the recommendation of judges, to be appointed by them, and will be final.

H. TRUEMAN WOOD,
Secretary.

John-street, Adelphi.
January. 1884.

*** Mr. Westgarth's own views are embodied in a memorandum prepared by him, copies of which can be obtained on application at the Society's offices.

A paper entitled "Suggestions on the Rehousing of the Poor, and on the Reconstruction of Central London" will be read by Mr. Westgarth, before the Society of Arts, on Wednesday, February 6th.

Proceedings of the Society.

SEVENTH ORDINARY MEETING.

Wednesday, January 23rd, 1884: Sir JOHN LUBBOCK, Bart., M.P., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Blyth, Alexander Wynter, M.R.C.S., The Court House, Marylebone, W.
Bond, Henry Charles, Brasenose, Bromley, Kent.
Campbell, F. J., Royal Normal College and Academy of Music for the Blind, Westow-street, Upper Norwood, S.E.
Johnston, Archibald, 6, Paternoster-buildings, E.C.
Lascelles, Brian Piers, 9 Holywell-street, Oxford.
Palmer, Walter, B.Sc., F.C.S., Westfield, Reading.
Ruscoe, John, Albion Works, Hyde, Manchester, and Prospect-house, Hyde, Manchester.
Stopes, Henry, 24A, Southwark-street, S.E., and Kenwyn, Cintra-park, Upper Norwood, S.E.
Van Gelder, Pieter, Sowerby-bridge, Yorkshire.

The following candidates were balloted for and duly elected members of the Society:—

Appleton, R. H., Woodside-hall, Eaglescliff Junction, by Darlington.
Houston, Frederick H., Carlisle-terrace, Belfast.
Pott, Henry, 81, Cornwall-gardens, S.W.
Prosser, William Owen, 5, Trinity-place, Swansea.
Rea, Russell, 19, Primrose-hill-road, N.W.
Tomkins, Daniel, The College, Great Yarmouth.
Wildsmith, James H. S., 131, Upper Kennington-lane, S.E.

The CHAIRMAN said he was glad that the Society of Arts was about to take up the subject of science teaching, which was one of very great importance. The Duke of Devonshire's Commission had reported that the neglect of science—and, he might add, of modern languages—in our schools, was a national misfortune; and though, no doubt, there was some improvement since that time, almost the same might be said now. Considering how much science had done and was doing for us, the general, though happily not now universal, neglect of it in our schools was astonishing. If we did not avail ourselves to the utmost of the resources of nature, our great and growing population would become more and more miserable, and we should be distanced in the race of competition by foreign nations. He believed the public did not realise the present state of affairs. He had recently made some statements on the subject at Bristol, and was told that they were simply incredible, and that he was speaking of schools as they existed thirty or forty years ago. He adhered, however, to all he then said. Though almost incredible, it was quite true. Of course he did not say that there were not schools in which science and modern languages received due attention, no doubt there were some bright examples, but he was speaking of schools generally. A Parliamentary return, published in 1879, gave the number of hours devoted to different subjects in all schools with an endowment of more than £500 a year. Of course there would be some change since then, but probably not much. The return comprised 233 schools, but there were three or four in which the figures were unintelligible. As regards the other 230 schools, there were 30 in which neither science or modern languages were taught, 64 in which less than one hour a week was given to science, 33 in which an hour a week was devoted to science. The time occupied in "preparation" was not included in the return. Allowing an hour a week for this, he found that out of the whole 230 schools, 168 devoted less than three hours a week to science, 38 from three to four hours, and only 24 more than four hours. As regards modern languages, 87 schools devoted less than three hours, 44 from three to four hours, and 93 more than four hours. According to their last report, the Oxford and Cambridge School Examination Board examined 60 schools. Less than half of these schools presented any boys at all for examination in science, and out of the whole 60 schools only 200 boys altogether were presented for examination in science, and under 400 in modern languages. The loss inflicted on the nation by the present system was incalculable. No doubt the system pursued at the Universities of Oxford and Cambridge made it difficult for schools to alter their arrangements. He wished that all our universities, would insist on some science not on a smattering, but on a good groundwork being laid. Passing on to the elementary schools, we also found the same discouragement of science. There were four class subjects, as they were technically called, namely, history, geography, English, and elementary science. Schools were only allowed to present children in two of them, and one of the two must be English. History and geography were excluded. Of course, as often happened in England, our practice is better than our system. In spite of the Code, some of the stronger School Boards do teach science. In one part of Birmingham the science lesson was given on washing-day. As the science lesson was so popular, the mothers could not keep their girls at home, and they were obliged to change the washing-day. He thought the Code required alteration in this respect, on several grounds. Some schoolmasters could not teach grammar in an interesting manner. Secondly, it was a mistake to insist on the same system all over the country, without any reference to the condition or requirements of the district. Again, we ought not to dictate to School Boards on such a point; and lastly, he must protest against an arrangement which tended to exclude the book of Nature from our elementary schools.

The paper read was—

SCIENCE TEACHING IN ELEMENTARY SCHOOLS.

By William Lant Carpenter, B.A., B.Sc.

The object of the present paper is not merely to draw attention to the crying need for elementary scientific instruction in our primary schools, but also to point out how such instruction can best be given, and to show that this can be, and has been, done on a large scale with extraordinarily beneficial results to the children thus taught, without any more expenditure of time than at present. I shall, in fact, give reasons for believing that science, properly taught, may excite such an interest in children's minds as to prove actually a relief from that overstrain in education of which we have heard so much during the past few months, and I shall adduce many instances of a very large increase in the per-centage of passes in the three R's, in schools which have devoted an hour or two weekly to science demonstrations of the kind to be described, such time being taken from that previously devoted to the ordinary routine, and in too many cases mechanical, instruction which is so much in vogue.

It may perhaps be well to define at this point the sense in which the terms science, and scientific instruction, will be used in this paper. That orderly arrangement of facts to which, in a broad sense, we give the name of science, or the scientific method, may be, often is, and still more ought to be, applied to the treatment of all subjects of instruction; a lesson on an air-pump may be thoroughly unscientific, while a lesson on the infinitive mood may be scientific in a high degree. For my present purpose, however, I wish to be understood as meaning by science that knowledge of the facts and phenomena of that universe around us, with which every one of us is in daily relation (though we too seldom realise the fact), to which the phrase natural science is sometimes applied, including both physics and biology (using those terms in the widest sense), the sciences essentially of experiment and observation.

During the first year or two of the life of an ordinary child, the amount of positive information obtained by him regarding the external world is indeed remarkable. The late Dr. Whewell, in congratulating a friend, famous for his knowledge and ability, on the birth of a son, remarked, "Young as he is, he will learn more than you in the next twelve months." And, in the words of Professor Tyndall:—

"As the child grows he is still an experimenter; he grasps at the moon, and his failure teaches him to respect distance. At length his little fingers acquire sufficient mechanical tact to lay hold of a spoon; he thrusts the instrument into his mouth, hurts his gums, and thus learns the impenetrability of matter. He lets the spoon fall, and jumps with delight to hear it rattle against the table. The experiment made by accident is repeated with intention, and thus the young student receives his first lessons upon sound and gravitation. There are pains and penalties, however, in the path of the inquirer; he is sure to go wrong, and Nature is just as sure to inform him of the fact. He falls downstairs, burns his fingers, cuts his hand, scalds his tongue, and in this way learns the conditions of his physical well-being. This is Nature's way of proceeding, and it is wonderful what progress her pupil makes."

In October, 1869, the Pedagogical Society of Berlin issued a circular, requesting the managers of the eighty-four established schools of that city to put a series of questions to their pupils, the avowed object of which was "to determine the individuality of the children, so far as conditioned by the concepts arising from their immediate environment." More than 2,000 children were thus questioned, and an abstract of the results will be found in the Berlin *Statisches Jahrbuch*, Jahrgang 4, s 59. With the advantages of many suggestions, and not a few warnings, from this experiment, Mr. G. Stanley Hall, of Boston, U.S.A., made out a list of questions "suitable for obtaining an inventory of the contents of the minds of children of ordinary intelligence, on entering the primary schools of that city," which are attended, as I can testify from personal experience, by children of all social grades. In order that they might not suggest answers to each other, the children were questioned three at a time, in a small room, by four of the best trained and experienced Kindergarten teachers, and the results were tabulated. Many most amusing details are to be found in the article in the *Princeton Review*, where Mr. Hall gives an account of the work.

"Tables are given showing the per-centage of children of various kinds, and with different previous training, ignorant of several common objects or concepts. For example, 55 per cent. did not know that wooden things came from trees; 69 per cent. were ignorant of the origin of woollen things; 75·5 per cent. did not know what season it was; to 61 per cent. the words 'growing potatoes,' 'a snail,' or 'a spade' conveyed no idea. Of 48 children questioned, 20 believed sun, moon, or stars to live; 15 thought a doll, and 16 thought flowers, would suffer pain if burned. Of all the children questioned, 48 per cent. thought that at night the sun 'goes, or rolls, or flies, is blown, or walks, or God pulls it up higher out of sight. He takes it to heaven, and perhaps puts it to bed; or even takes off its clothes and puts them on in the morning; or, again, it lies under the trees, where the angels mind it. It may stay where it is, only we cannot see it, for it is dark, or the dark rains down so, and it comes out when it gets light so it can see.' So also the moon comes around when people forget to light lamps; sometimes a piece is cut off, and it is only half stuck or buttoned into the sky. 'God lights the stars with matches, and blows them out, and opens the door and calls them in, in the morning. Lightning is when God strikes many matches at once; He makes rain up in Heaven out of nothing, keeps it in a big tub, and lets it down with a water-hose through a sieve. Thunder was due to God rolling barrels about, or grinding snow, having coal run in, hitting the clouds, or, in some cases, merely to ice sliding off lots of houses, or to piles of boards falling down.'"

Most of us probably can, or could if we took the pains to ask such questions, give similar results from our own knowledge. The four-year old child of a friend of my own, having attentively watched an upholsterer nailing leather on bookshelves with brass-headed nails, pointed to the stars, on the evening of that day, with the question, "Mama, are those the nails that keep Heaven up?" A member of the Glasgow School Board, having listened to a lesson on a robin, given to nearly 120 children, asked "how many had seen a robin." Six or eight hands were held up, and selecting the brightest-looking owner, he said, "Well, my boy, as you have seen a robin, tell me anything whatever you like about it." "Please sir, it's a bird with a red spot on its tail!" was the result of a good deal of deliberation.

There is, I am told, good foundation for the remark that the best elementary schools of twenty years ago were nearly, if not quite, equal to those of to-day; and that the improvement in the intervening period, of which so much has been said, has been rather in the direction of the quantity of the work (by a multiplication of good schools of one pattern) than in its quality. It is to this latter that I am about to ask your attention.

It will, I think, be acknowledged by all those whose experience enables them to judge, that one of the great shortcomings of the present system is the mechanical nature of the work done, which reduces the children to the state of machines rather than of thinking individuals. The Government inspectors complain unceasingly of the monotony, want of ease and power, and lack of "general intelligence" exhibited by the children. They read correctly, but the words represent or convey no ideas to their minds. "They can" (to quote an official utterance) "usually work 'straightforward' sums with quickness and precision, but they rarely succeed in solving the easiest problem." I have read various statements by teachers of large experience as to the evil effects of the "payment by results," and of the individual examination system; I will only trouble you with two—"There is not time to train children to think," and "What will pass, not what will educate, is the incentive." In fact, of the two great mistakes which, according to some writers, vitiate the whole organisation of English education, from the elementary schools upwards, the one with which we are concerned now is, the conception of intellectual training as the acquisition of information, rather than as the development of faculty.

That this deficiency in the present system has been lately, to some extent, practically recognised by Mr. Mundella, all true friends of education—using this word in the etymological sense of "drawing out the faculties"—will greatly rejoice. Although the individual examination is to remain the same (not for many years longer, let us hope), an entirely new element is introduced in the shape of a "Merit Grant," and henceforward the instructions to inspectors are explicit, that they shall in future take due account of, and give full credit for, the general intelligence of the children, as indicative of the manner in which they have been taught.

I desire now to point out the enormous—I had almost said the superlative—value of science teaching in thus quickening this general intelligence, as well as the very great practical value of the knowledge imparted, provided that the teaching is conducted in a proper manner. For this it is absolutely essential that the children should be so taught as to attach definite ideas to the words used by their instructors and by themselves. That great danger exists of their not doing so in their ordinary reading lessons, I have already tried to show; and this to a great extent disposes of the argument used by many opponents of reform who nevertheless admit, to a certain degree, the utility of science teaching, but who assert that science can be properly taught, and reading improved at the same time, simply by reading short extracts upon scientific subjects in the ordinary school lesson books. To scientific men such a statemeut carries its own refutation on the face of it, but it is extremely difficult to convince many people of the fact; and it is hoped that the education of the public mind upon this point may be, to some extent, improved—to however small an extent—by these remarks, and more particularly by the expressions of opinion on the same subject, from men far more qualified to address you on the general question than I am, which I trust we may hear in the discussion that will follow this paper. In the most recently published "science readers" for elementary schools, viz., Messrs. Gill's excellent *Albany Series*, attention is drawn in the preface to the necessity for illustrating the reading lessons by experiments, specimens, &c.

It may, perhaps, not be undesirable to call attention here, very briefly, to the main features of an ordinary public elementary school. In towns, each school is ordinarily divided into three departments—(1) the infant school, with children of both sexes from four to seven years old; (2) a girls' school; (3) a boys' school; each of the two last containing children from seven to fourteen years of age, classified, according to the Government requirements, into seven standards. In addition to the three R's, any child above Standard I. may be taught any two of the so-called "class subjects," one of which must be English, the others being geography, elementary science, and history; and for evidence of successful teaching in these, an extra payment of from 1s. to 2s. is made. Lastly, and this is the special point with which we are now concerned, children in the 4th and higher standards may, in addition, take up any two of ten named "specific subjects of secular instruction"—viz., algebra, Euclid and mensuration, mechanics, chemistry, physics, animal physiology, botany, principles of agriculture, Latin, French, domestic economy. Any other subject may be taken under this head, subject to the approval of the inspector. For each individual pass in these, an additional grant of 4s. per head is made.

The origin of the system of scientific instruction to which I now invite your attention is thus described in a paper by Mr. E. M. Hance, clerk to the Liverpool School Board, published in the *School Board Chronicle* for November 1st, 1879:—

"However important, I might say essential, may have been the system of payment by results introduced by the Revised Code, I think that there can be little doubt that the effects of it as first applied—and, to a modified extent, the same still holds good—was to reduce education in, I might say, the majority of Government-aided schools to a monotonous 'grind' at reading, writing, and arithmetic, of which the ultimate aim appeared to be the attainment of mechanical accuracy. This not only did very little, if anything, to develop the intelligence of the children, but was directly calculated to defeat that object by generating in a large proportion of cases a positive distaste for intellectual attainments. The Liverpool School Board, as soon as they had any schools to manage, were, like most other School Boards, greatly impressed with the necessity of providing a somewhat more varied curriculum. They also felt strongly the importance of introducing some subject specially calculated to awaken and exercise the observing faculties of the children, and, by making this subject common to all their schools, to render it a distinctive feature in their educational system. With this object, they sought and obtained the valuable advice of Professor Huxley, Colonel Donnelly, and other gentlemen of eminence in the world of science. The result would, if they had felt themselves entirely free, have probably been the adoption of "elementary physics" for both boys and girls; but, in view of the provisions of the New Code as to Government grants, and of the importance of having the work tested by independent examination, it was decided not to go outside of the subjects provided for by the Code. Under these circumstances, the Board, at the suggestion of the gentlemen before mentioned, ultimately selected 'mechanics' for boys, and 'domestic economy' for girls, as the subjects most suitable for their purpose —the definition of these subjects given in the New Code being of such a nature as to allow of the instruction being considerably expanded in the one case in the direction of elementary physics, and in the other in that of elementary chemistry, physics, and physiology. In reference to the system of instruction, it was, by the same advice, decided to absolutely abandon the use of text-books by the scholars, and to rely upon oral instruction, accompanied by, or rather explaining, appropriate illustrations and experiments."

The general idea of the scheme thus suggested was first worked out in detail in Liverpool, but was speedily adopted by the Birmingham School Board, and by it still further developed. I have had considerable opportunities of studying its working in both towns, and consider the results obtained to be so extremely valuable, that I am devoting a good deal of time to making them known, and am now in correspondence with several School Boards on the subject. As recently as Friday last, January 18th, I addressed a large meeting of teachers in Bristol on this subject, and I have the permission of the chairman of the Glasgow Board to say that a meeting of that Board was specially summoned last month, to hear a statement from me upon the subject, at the close of which I was requested to come again, to confer not only with them but with some of their teachers.

The special feature of the scheme, and one which is rightly regarded as of the very highest importance in connection with it, is that these science demonstrations are given not by the ordinary staff of the school but by a specially appointed expert, whose sole duty it is to go round from school to school, giving practically the same lesson in each one, until all have been visited. The apparatus necessary is kept, and the experiments are prepared, at a central laboratory at one of the schools, and whatever is needed for a given lesson is carefully packed in neatly partitioned boxes, and is taken from school to school in a hand-cart, drawn by a boy employed for the purpose. In this way the Birmingham demonstrator, Mr. W. Jerome Harrison, F.G.S., is able to give four lessons per day, of about forty-five minutes each, in as many different schools; and at present all the thirty Board schools, or sixty departments, are thus receiving such instruction, which is given to about 2,800 boys and 1,600 girls, from among the 17,944 who were presented for examination in 1883. Mr. Harrison has two assistants in this teaching, and one laboratory assistant; and it occasionally happens, as was the case at the time of my "surprise" visit, that he may be teaching mechanics to boys, and one of his assistants expounding domestic economy to girls, in different rooms of the school at the same time. Carriage of apparatus is thus saved. In addition to these, 485 boys are being taught magnetism and electricity, and 95 boys and 90 girls are similarly learning animal physiology, the instruction being in every case given by one of the special demonstrators.

In the eighteen Board schools of Liverpool last year, 10,512 children were presented for examination, 7,203 of these were examined in some of the class subjects; moreover, every boy in Standards IV. to VI. was examined in "mechanics" and every girl in the same standards in "domestic economy," the numbers being 1,868 boys, and 1,334 girls. The previous years' returns of this board afforded very clear testimony to the fact that elementary instruction in science so quickens a child's mental life, as to render him more generally intelligent. The "passes," as compared with the numbers presented for examination in ordinary subjects, were:—

In 1873-4	74·4 per cent.	
" 1874-5	74·5 "	
" 1875-6	74·4 "	
" 1876-6	79·1 "	Year in which "class subjects" were first examined.
" 1877-8	85·6 "	Year in which the system of science demonstrations was introduced.
" 1878-9	87·1 "	
" 1879-80 ..	88·4 "	
" 1880-1	89·7 "	
" 1881-2	88·5 "	

From this it appears that, while the average per-centage of passes in ordinary subjects for the three years prior to the introduction of this particular form of science teaching was 74·4, the average per-centage in the same subjects in the five years succeeding its introduction was 87·8, an actual increase of $13\frac{1}{2}$ per cent., and an increase on the quantity under consideration of 18 per cent, or nearly one-fifth.

It is a somewhat remarkable point, and one that has only been recently noticed, that whereas the figure of merit in the Liverpool Board schools is only slightly above that of the whole country in reading and writing, these schools are very decidedly superior in arithmetic, their per-centage of passes being 87·13, as against 77·27 per cent. for the average of schools in the country. This result is considered by the Board as due in a great degree to their system of science teaching. The clerk to the Birmingham School Board writes as follows:—

"Our head teachers unite in saying that the science lessons do the children so much good, that although they have to afford time for them which used to be devoted to the ordinary work for the Government examinations, they, nevertheless, gain in results, and they would feel it to be a loss if they were to be deprived of such lessons. This is even the case in the girls' schools, where they were so heavily handicapped by the time that has to be devoted to needlework, that they can ill afford time for any extra lessons whatever."

In Birmingham, the lessons are given fortnightly. One of the regular staff of the school is always present, and it is his duty in the intervening week to go over the lesson again to the class, and drive it home. After this, each child writes out notes of the lesson, often in reply to questions set, and these notes are revised by the demonstrator himself, before he next visits the school. I looked over several of these notes, selected at hazard, and was much surprised at the ability displayed in some of the answers. I also conversed on the subject with my friend Dr. Poynting, Professor of Physics, &c., in the Mason College, Birmingham, who, at the request of the Board, had examined a number of boy candidates for a scholarship offered in connection with the system, and he spoke in very strong terms to me of the excellent results noticeable throughout the examination, as well as of the individual excellence of the successful candidates. The boys showed that they had seen and understood the experiments which they described—that they had been taught to reason for themselves upon them—and that they were not merely using forms of words which they had learnt without attaching physical ideas to them.

The practice of having one or more of the ordinary teachers present at the demonstration, is fraught with more important consequences than at first sight appears. Their attention is thus drawn to science, and to science well taught, as the following quotation from a teacher's letter to Mr. Harrison will show. The writer is one of the hardest-working assistant teachers in Birmingham, and his testimony was spontaneous:—

"I have attended eight or ten science classes, and gained several certificates, but from them all I have not gained so much knowledge as by listening to your lessons."

I venture to hope that this system of science teaching in elementary schools, by specially appointed demonstrators, will obtain authoritative endorsement as the the right one. Dr. Crosskey, the chairman of the School Management Committee in Birmingham, tells me that he has had to fight for it against objections of the following kind:—

I. "The regular teachers can do all the science which is needed." Those, however, who know how completely their time is occupied under the present system, can see at once that there is really no time available for the necessary experimental preparations.

II. "Only a few elementary principles can be taught, and this special supply of apparatus and demonstrators is beyond the mark." To this it is sufficient to reply, that the careful scientific demonstration of the simplest principles is a necessity for their apprehension. As my father, Dr. Carpenter, said to me once, "I hold that every child should have his hand on an air-pump receiver, while the air is exhausted from beneath it, and should see for himself the circulation of the blood in the frog's foot." As his son, I can testify to the vividness of the impression made upon my boyish mind at about eight years old, by these very things.

III. "It will interfere with the ordinary school work," was frequently urged. The best answer to this is the results, which show that the schools in which the Birmingham Board passes most in science, are also the best in the ordinary school work, since the general intelligence is so much quickened. Moreover, the past year has shown an "advance all along the line" in these schools, which never before contained so many children in the upper standards.

This special instruction is given to *every child* in the Liverpool and Birmingham Board schools who remains at the school after having passed the fourth standard. As this is usually done at eleven years of age, most of the children get from two to three years of this teaching.

The general scheme of instruction is as follows:—

Boys. 1st stage.—Matter in three states, solids, liquids, and gases. Mechanical properties peculiar to each state. Matter is porous, compressible, elastic. Measurement as practised by mechanics. Production of a plane surface. Measures of length, time, and velocity.

In Birmingham this is given in twenty-one lessons, in Liverpool in thirty-four. Both courses include such practical subjects as the spirit-level, air-pump, thermometer, clocks, hydrometers, filters, &c.

Boys. 2nd stage.—The meaning of force, and work done; gravitation and the three laws of motion; the idea of energy, both kinetic and potential, and of its conversation.

Boys. 3rd stage.—The principles of the six simple mechanical powers, the hydrostatic press, and the parallelograms of forces and of velocities.

As arranged for the girls, the instruction in the so-called "domestic economy" is as follows:—

Girls. 1st stage.—Functions of food, and its distribution by the blood; the chemistry of oxygen, hydrogen, carbon, and nitrogen; the proximate composition of various kinds of food; clothing and its uses, and the mechanics and chemistry of washing, both as regards the person and the clothes.

Girls. 2nd stage.—Food, its functions and composition, treated more in detail than in the first stage; and the physical and chemical principles involved in warming, cleaning, and ventilating a dwelling.

Girls. 3rd stage.—Rules for health; the management of a sick room; the preparation and culinary treatment of food; and lessons on expenditure and savings.

As regards the expense of the scheme, the cost to the Liverpool School Board was about £100 for the stock of apparatus, and £470 yearly for the instructor and his assistants. In Birmingham more than £200 has been spent upon apparatus, and the present annual expenditure is—chief demonstrator, £300; two assistants, £255; two juniors, 10s. and 12s. per week, say £55; or a total of £610, or about £10 per year, per school department. It is obvious that, under this plan, a maximum of highly efficient teaching is obtained at a minimum of cost; since the same demonstrators and the same apparatus are available for a large number of schools—in Birmingham, at present, for sixty school departments.

It may be objected that, although feasible in large towns, such a scheme is not practically useful in the number of smaller towns scattered over the country. I venture to think, however, that the objection is more apparent than real, and that a little concerted action on the part of neighbouring towns would soon remove the difficulty, in all but very outlying places in agricultural districts. In such thickly populated counties as Lancashire and Yorkshire, for example, four or five towns might unite in securing the services of one demonstrator. I know of several small towns where such joint action is ardently desired; and during a recent lecturing tour in the Border counties, in the course of which I advocated this scheme, the inhabitants of some of those Border burghs which are accustomed to such co-operation for political purposes, expressed a strong hope that some of their organising energy might be turned into some such educational channel as I have indicated. Moreover, the whole subject of this present paper was favourably discussed from various points of view, about three weeks ago, at the annual Congress of the Educational Institute of Scotland.

The duties of the Birmingham demonstrators, however, are by no means confined to the day-lessons, for ten evening science classes (under South Kensington) are conducted by them for teachers, and for children holding scholarships. The numbers under instruction at present are—physiography, 166; magnetism and electricity, 252; inorganic chemistry, 24; analytical chemistry, 24. The discovery of the manufactory of dynamite in Birmingham was due, in the first instance, to a youth who passed through these classes. He had, I believe, been taught the relation of glycerine to explosive compounds, and, living near Whitehead's premises, and seeing what he recognised as cans of glycerine and carboys and bottles of acid go in there, he communicated his suspicions to a friend who happened to be a detective policeman!

Further, Mr. Harrison, the chief demonstrator, devotes at least one evening per week in the winter months to giving elementary popular lectures at the various schools, illustrated with photographs and transparencies projected by a very good bi-unial lantern, presented to the Board for such purposes by Mr. Tangye, of Tangye Brothers, who also gave £250 to found scholarships. Of this work Mr. Harrison says, "The effect in improving the general intelligence of the children, in attracting them to school, and in improving the regularity of the attendance is, I believe, unquestioned." I may add that, for such purposes, the series of lantern photographs illustrating physics, already published by York and Son, and the series illustrating biology, at present in course of publication, are especially suited.

In this connection, also, I ought to mention that, acting upon a deficiency in their system pointed out by H.M. Inspector for the Birmingham district, the Board have just issued "Suggestions regarding the preparation of progressive schemes of object-lessons, in boys', girls', and infants' schools," in order to help the teachers to prepare the scholars of the first four standards systematically for the science courses which they enter upon when the 4th Standard is passed. The number of new lessons in any one year is fixed at thirty-six; and their aim is "to place the child in intelligent connection with the phenomena by which it is surrounded." The lessons, however, are confined to "objects," *i.e.*, matter; those which need reference to force being left until the 5th Standard is passed. It is true that in many of our schools, lessons, called by courtesy "object lessons," are already given; and the unsatisfactory results often attributed to them are due, chiefly, to the disconnected and "scrappy" choice of subjects, so that we find a lesson on flint succeeded by one on a pin, and this, again, by one on an oyster, and so on. Moreover, they are seldom prepared with sufficient care, and are often altogether deficient in the all-important point of illustration by tangible objects. One of H.M. Inspectors of London told me, for example, that he was present once at a lesson upon honey, the only illustration of which was a hermetically sealed specimen tube, containing a few grains of that substance!

A very important suggestion for the better illustration of object lessons, is at present under discussion in Liverpool, between the School Board and the museum authorities. It is due to the Rev. H. H. Higgins, the chairman of the museum sub-committee, and proposes the utilisation of duplicate specimens of the museum for the establishment of a circulating museum. The frequent failure hitherto of small school museums has arisen mainly from the insignificant individuality of the specimens, and the familiarity of the children with them. A specimen of considerable excellence, say a mineral, fossil, stuffed animal, or shell, will not only assist the teacher in more firmly imparting the knowledge he wishes to convey, but the beautiful and uncommon thing itself, if carefully handled, &c., by the children, will exercise a good moral and refining influence upon them, by calling out the faculties of observation and admiration.

The results of the system here advocated, which have been incidentally alluded to, are thus summed up by those who have watched it from the commencement:—

(1.) The general quickening of the intellectual life of the school.

(2.) The sending of a large number of lads to science classes after leaving school.

(3.) The finding out of lads of exceptional scientific ability, and setting them on their road.

(4.) The attracting the attention of the ordinary teachers to science, and to the results of teaching it.

Much might be said, did time permit, of the good effects of a variation in the monotonous routine of the school, afforded to the pupils by the science lesson; and, paradoxical as it at first appears, there is ample evidence to justify the conclusion that this mode of teaching really affords a relief from the overstrain in education, of which so much has lately been said and written. "The interest displayed by the children," writes one, "is in the highest degree pleasurable to witness. It is pleasant, too, sometimes to see a half-timer, who has stolen in from his work for this one lesson, standing by the side of the class, with grimy arms and rolled-up apron; or a little knot of girls released temporarily from 'minding the baby,' and waiting outside the locked door in order to obtain admission to the science lesson." Dr. Crosskey writes—"It is a wonderful thing to see the power of experimental science over the roughest lads. My own belief is that in our young blackguards we have a most amazing reserve power of scientific research; they are alive in every sense, and I have watched them at the science lessons as keenly interested as if they were up to mischief in the streets." Another man of very wide experience writes, "I have not the smallest doubt that there is a large class of minds whose activity is more easily promoted, and whose imagination is more readily fired, by physical science than by literature, especially of the class most met with in elementary schools."

It will have been observed that, in the system of instruction which has been described, there are two essential features which distinguish it from other systems of elementary science teaching. In the first place, the instruction is given orally, and with demonstrations, by a specially-appointed "expert." The next and more important point is that it forms an essential part of the teaching of every child who has passed the 4th Standard in every Board school in Liverpool and Birmingham. Let me now ask your attention very briefly to what is being done in the same general direction in the Board schools of some other provincial towns, and I may take this opportunity of thanking the clerks of the respective Boards, and other correspondents, for much information courteously furnished to me. I have purposely omitted London in my inquiries, since I hope we may hear during the discussion some account of what is actually done in London Board schools, and of what some members, at any rate, of the Board hope eventually to see accomplished.

In the Leeds Board schools, a somewhat similar scheme has been in operation since 1877, but the instruction is confined to elementary physiology and domestic economy, and is only given by an experienced and specially-trained female teacher, who, in the course of a fortnight, gives one lesson in each of thirty-five girls' and mixed schools. The class consists of the upper standards, but only scholars in the 5th and 6th Standards are required to answer the questions, which, as a rule, are written as a composition school lesson. These lessons are illustrated by models, diagrams, and simple experiments, the apparatus being carried round in a hand-cart. The course lasts for the school year, and the lessons are selected from Mrs. C. M. Buckton's excellent little work, "Health in the House." This lady not only gave the instruction herself in the first instance, but subsequently reduced it to a system, and personally superintended it for many years. It is much appreciated both by parents and scholars, and though it is a valuable aid in preparing girls for passing intelligently the Government examination in the two "specific subjects" of animal physiology and domestic economy, it is of the greatest value in thus early awakening an idea of paramount importance of the laws of health amongst those who are specially concerned in its maintenance. Five hundred and thirty-nine children passed in domestic economy, and 547 in physiology, in 1883, the total passes in 71 schools being 19,182.

It should also be mentioned, in connection with the work of the Leeds School Board, that a very excellent scheme of practical instruction in cookery is now carried out in twenty girls' schools, in both day and evening classes, under specially qualified instructors. This also was worked out by Mrs. C. M. Buckton, and I need scarcely say that it is founded on the same principles as that "Scientific Basis of Cookery" which was so well brought before this Society by Mr. W. Mattieu Williams, in his recent course of Cantor lectures; the particulars of it are to be found in a little volume, "Food and Home Cookery," written by Mrs. Buckton, and published by Messrs. Longmans and Co. The arrangements of the Glasgow School Board are such that every girl in Standard IV., or upwards, receives instruction in cookery during one or two courses. Over 1,500 girls attended these classes last year.

In the forty-seven schools of the Glasgow School Board, the average attendance is 30,600 children. Of these, 7,381 are studying two of the specific subjects, something less than half taking the scientific ones; physical geography and domestic economy, however, absorb more than 75 per cent. of these pupils. Only three out of the forty-seven schools teach any physics at all, and these are devoted to light and heat, and to magnetism and electricity. Mechanics, in the sense understood in Liverpool and Birmingham, appear to find no place in the Glasgow scheme. It will be noticed that here, as elsewhere, elementary science is taught in a few upper grade schools, the subjects selected being very much according to the idiosyncrasies of the masters thereof; but that science teaching, *per se*, does not form a part of the mental training of every child above Standard IV., which is the particular point I am now urging, as well as that it should be given by a specially appointed expert, and be of a particular character. I may say that this distinction is clearly apprehended by the Glasgow Board, who, as I have before hinted, are disposed to value very highly, for its own sake, the practical value of the information thus given.

This brings me to another point, viz., the great value to boys of such elementary training in the principles of mechanics as is given in Liverpool and Birmingham, as a preparation for the technical training which is now so strongly desired, and for which such ample provision is at last being made. There is a scheme at present under discussion in Birmingham for making another link in this chain, by providing workshops and a young skilled mechanic, where, Mr. Harrison thinks, probably one-third of his class in each school having learnt the principles by day, would carry them out practically in evening classes. At present, however, the best development of this idea is to be found at Sheffield, where a class in the Central Higher Board School "aims to give a systematic course of practical instruction in the science of mechanics." The majority of the scholars there are drafted into it from the public elementary schools of the town, and the majority leave it between fourteen and fifteen years of age. The class in mechanics has about two hours' workshop practice per day, in which considerable manipulative skill is acquired, as well as correctness in applying geometrical principles. The results of this school have been tested in machine construction and drawing, in mathematics, and in chemistry, by the examinations of the Science and Art Department, with remarkably good results. Here again, however, I would remark that in Sheffield the teaching is given to a selected few, and not to every child.

In Manchester, science is taught in only four Board schools by day, 650 children being under instruction, which is given in mathematics, chemistry, physics, physiology, and hygiene. These classes, however, are organised with a view to the May examinations of the Science and Art Department, and they are largely supplemented by the science and art classes, held in the Board schools in the evenings, when 2,500 pupils are at present in attendance. In Manchester, the nearest approach to the Liverpool and Birmingham system, is in the employment of a peripatetic teacher, who gives instruction in the elements of botany, and in the "class subject" known as elementary science. In this city, the School Board awards annually fifty elementary school scholarships of the value of £10 each, and "science and art" scholarships of £15 each, open to both sexes, and tenable at the Central Board school, where special attention is given to the scholars. This system, therefore, much resembles that in Sheffield, and is open to the same objection, viz., that it is the selected few to whom science is taught, and that it is not made a part of the mental training of every child who remains in Board schools over eleven years of age.

In drawing this paper to a conclusion, I desire briefly to ask your attention to the way in which the teaching of science in elementary schools is handicapped under the present regulations of the Revised Code, including the system of "payments by results."

Under Art. 16, of the New Code, the subjects of instruction for which grants may be made are the following:—

(*a*) Obligatory subjects—Reading, writing, arithmetic; and needlework for girls in day-schools.

(*b*) Optional subjects (i.) taken by classes throughout the school:—Singing, English, geography, elementary science, history, called "class subjects"; (ii.) taken by individual children in the upper classes of the school, the ten "specific subjects" before detailed.

Under Art. 109, a grant of 1s. or 2s. on examination in class subjects is made, and no more than two class subjects may be taken, one of which must always be English. Hence, of the remaining subjects, elementary science has only one chance in three, Moreover, it does not earn a higher grant than geography or history, either of which can be much more readily taught, both as regards the usual acquirements of the average teacher, and the absence of any further provision for teaching than books and maps. Elementary science, as defined in Schedule II. of the New Code for the first three standards, comprises "a progressive course of simple lessons on some of the following topics, adapted to cultivate habits of exact observation, statement, and reasoning—common objects, such as familiar animals, plants, and substances employed in ordinary life;" and for Standard IV., "a more advanced knowledge of special groups of common objects, such as (*a*) animals or plants, with particular reference to agriculture; (*b*) substances employed in arts and manufactures; (*c*) the simpler kinds of physical and mechanical appliances, *e.g.*, the thermometer, barometer, lever, pulley, wheel and axle, spirit level." It is obvious that, to give a series of lessons to children in the first four standards on these lines, special collections of objects and of apparatus are necessary, as well as an amount of knowledge not usual on the part of the schoolmaster. It is evident therefore, since the grant is the same for all class subjects, that not only is there no inducement to the ordinary teacher to teach elementary science as one of them, but that a premium is actually put upon instruction in one of the other optional class subjects by the facility with which they can be taught. Hence, as long as human nature remains what it is, and as long as the regulations of the Code are unaltered, we must expect to see that elementary science is but little taught as a class subject. The case of the Glasgow schools may be cited as an example:—The geography and history grant in the year ended June 30, 1883, was paid for 27,498 children, or 89·8 per cent. of the number in average attendances; the grammar and intelligence grant for the same period was paid for 27,634, or 90·3 per cent. of the average attendance. The elementary science grant was paid for—not a single child! In giving these figures, however, on the hard and fast definitions and classifications of the New Code, I ought to point out that geography for the first four standards, as defined in Schedule II., includes the physical and political geography of the British Isles, British North America, and Australia, with knowledge of their productions, and to refer to what I said in an earlier part of the paper, as to the scientific method of teaching any subject.

What I have said about the "class subjects" applies with even greater force to the "specific subjects," since the instruction in science is more specialised, and requires more perfect illustration. To quote again from the returns of the Glasgow School Board for the year ending June 30th, 1883 (the permission of the Inspector had been given for the introduction of subjects other than the ten named in the Code), the numbers studying were:—

English Literature	5,176	in	45	schools.
Latin....................	687	,,	18	,,
Greek	27	,,	3	,,
French	884	,,	21	,,
German	39	,,	2	,,
Domestic Economy	3,194	,,	46	,,
Physical Geography	1,803	,,	28	,,
Mathematics	323	,,	19	,,
Chemistry.............	104	,,	2	,,
Physiology	872	,,	14	,,
Light and Heat	59	,,	1	,,
Magnetism and Electricity	239	,,	2	,,

It thus appears that the number studying English literature was thrice the total number of those studying physiology, chemistry, physics, and mathematics—and that mechanics was not taught to any one of these 30,000 children. Moreover, if physical geography be omitted from both sides of the calculation, the number studying English literature alone, considerably exceeded the total numbers of those studying science, including in that term domestic economy as taught in Glasgow, not as taught in Birmingham or Liverpool.

The following are the numbers presented for examination in the ten named specific subjects in the year 1881-82, over the whole country.

			Per cent. of the whole.
English Literature	127,313	....	49·25
Latin................	1,006	....	0·40
French	3,360	....	1·30
German..............	34	....	—
Physical Geography ..	34,382	....	13·30
Mathematics..........	6,174	....	2·39
Mechanics............	2,458	....	0·96
Animal Physiology....	25,886	....	10·00
Botany	1,903	....	0·74
Domestic Economy....	55,993	....	21·66
	258,509		100·00

Here we see that the study of English literature alone absorbs as many children in the upper standards as all the other nine "specific subjects" together—a subject taught by the reading of books alone, and which, however excellent and refining in itself, gives a child little or no knowledge of its relations to the outside world, and of the facts and phenomena by which it is surrounded, and upon which its very life depends.

The points, then, which I would most strongly urge are—

(1.) That instruction in some branch of elementary science, preferably mechanics or physics for boys, and domestic economy for girls, should form a necessary part of the education of every child who remains in a public elementary school above Standard IV.

(2.) That such instruction should be oral, accompanied by demonstrations and experiments, and given by an "expert" in such teaching, whose services may be best utilised by his being employed at many schools in succession.

(3.) That such teaching can be given during the ordinary school hours, not only without detriment to the instruction of the three R's, but with an actual increase of efficiency, as judged by that standard as well as by the general intelligence of the scholars.

(4.) That such alterations should be made in the scale of grants under the New Code as should encourage the teaching of elementary science, and especially the employment of specially appointed teachers, as at Liverpool, Birmingham, and Leeds.

In this age, most educated persons are keenly—in some cases perhaps too keenly—alive to solecisms and other errors of grammar, considered from the literary point of view. Let us hope that the day is not far distant when ignorance of the grammar of Nature will be held in equal aversion. In that good time to come, such a picture as one in the last Royal Academy Exhibition in which a rainbow was represented with the violet streak in the centre of the spectrum, will be as sternly rejected for contravening the laws of physical science as other pictures now are for disregard of the canons of art; such answers, too, as that of the Eton boy, who assigned as a reason for the greater length of the day in summer, the expansion of all bodies by heat, will be considered as disgraceful as a false quantity in a Latin quotation, or a slight error in syntax is now. The attainment of such a result is a noble object to strive for, and I trust that the reading of this paper, and the discussion thereon, may have some influence in drawing attention to this essentially practical scheme for science demonstrations in Board schools—a scheme suggested by the matured experience of most eminent men of science, worked out in practical detail by Boards controlling two of our largest centres of population (would that it were adopted in London also!), and proved to have given, under their management, such admirable results. I will conclude by simply recording my very firm conviction that, if this work can be set moving, it will end in a moral and intellectual revolution for the mass of our people, and that the national results of it will be great.

DISCUSSION.

Dr. GLADSTONE, F.R.S., said he agreed with nearly all the views expressed by Mr. Carpenter, and did not think he had gone at all beyond the truth in his description of the results of the experiments carried on in Birmingham and Liverpool. He had not had the pleasure of visiting the schools at Liverpool, but he spent a very pleasant morning in Birmingham a short time ago, and saw the work Mr. Harrison was doing there. He heard him give a lesson on the different states of matter in a superior class; and afterwards, in another school in one of the lowest parts of the town, he saw his two assistants giving lessons, one to the boys on the inclined plane, and the other to the girls on domestic economy, coal being the special subject of the day. It was very pleasing to see the delight with which the girls listened to the explanation given them, and examined through a hand microscope the structure of the coal, and to hear the inquiries they made. He He was sorry that he could not give quite so good an account of the teaching of science in the London Board Schools, but still it was advancing, he hoped surely, although slowly. In the infant schools, object lessons had been given from the commencement, perhaps not very systematically, but it was made a condition that they should be given on the objects themselves, and, as a rule, the teachers had fair specimens from which to teach. The formation of museums was also encouraged, in which the children themselves assisted by bringing specimens which interested them. Of course all kinds of rubbish was brought, but this soon got eliminated, and what was of any value remained. A cabinet was furnished in which the specimens might be kept, and in many cases more than one was asked for. In the boys' and girls' department, it was laid down from the commencement that object lessons should be given systematically. This, he feared, to some extent, had been rather a rule on paper than in practice, but since the New Code had been in force, it had been more rigidly insisted on. In order that experiments might be made, a little box of apparatus had been got up, and he frequently saw it in use when visiting the schools. In October, 1882, a circular was issued, saying "The School Management Committee have decided that elementary science shall be taught throughout the boys' and girls' departments, in place of the present object lessons, and the instructions to teachers on object lessons have been modified according." This meant that elementary science was to be taught more or less in all the boys' and girls' schools, and it was finding its way into them all, but they could not always ensure its being well taught. They did not insist upon its being taken up as a second-class subject, and many teachers preferred geography, or history, or needlework; but they did require that some elementary science should be taught, either as a class subject or not; and in some schools it was being very well taught. The favourite specific subject was animal physiology. He was not altogether prepared to defend this choice, as it was mainly taught by text-books and diagrams, and did not give the same amount of mental training as some other subjects. From a return he had lately procured of what was being done in the schools which had been first examined under the Mundella Code, he found there were 61 schools, with about 2,000 boys and 310 girls, in which animal physiology was being taken. The next favourite subject was magnetism and electricity, which was being taught in 8 schools, with 400 scholars. Botany, chemistry, mechanics, and even agriculture, were also being taught. The position of pupil-teachers was a very important question; they had several centres where pupil-teachers were taught, and care was taken that these had instruction in science. It was laid down in the Code that pupil-teachers, before entering the training school, should be examined in certain things, but natural science was not amongst them, and yet these pupil-teachers were expected to teach object lessons, and in future years they would, no doubt, be expected to teach science. They were able, certainly, to gain marks by presenting a South Kensington certificate, and they went in for those examinations to a great extent; but these examinations were very special, and the pupil generally crammed up for them, instead of really studying the subject. They were now endeavouring to introduce into pupil-teachers' centres such a syllabus of education in natural science as would give them primary notions of nature, which they might afterwards develop into chemistry, mechanics, physiology, or any other science. If they went through this course, they would have studied all which South Kensington understood by physiography, and would also be able to acquire chemical or biological certificates, with a little more study. The important point was to insist on training for the mind, not merely the acquisition of information, and nothing so tended to develop the powers of perception and comparison as natural science subjects studied experimentally, and this would also lead on to technical education, which was absolutely essential. Our artisans and domestic servants were being trained in the elementary schools—the men and women who had to do the hard work of the world—and the educational appliances must be adapted to their needs. It seemed to him that there was great danger in thinking that, in order to educate the lower classes, they had only to adopt the methods which were considered to be the best for educating the middle and upper classes in the Middle Ages. The lower classes did not want a scholastic education. Let them have a knowledge of poetry, and everything else which would cultivate the mind; but what they specially wanted was a knowledge of the natural forces and materials with which they would have constantly to deal and contend, and which would become their masters if they did not learn how to make them their slaves.

Dr. W. B. Carpenter, F.R.S., said the facts and conclusions stated in the paper entirely accorded with his own experience; and he also agreed with what Dr. Gladstone had said on the importance of what might be called living knowledge of these subjects, in opposition to dead knowledge. For instance, the use of an air-pump had been referred to; nobody could teach a child the action of a pump or the use of a barometer without explaining the pressure of the air, but that was merely a form of words unless the child had the air exhausted from under his hand, and felt that a considerable force was required to withdraw it. From a long experience of examinations, he could entirely endorse what had been said of the cramming system of getting up subjects from books. He had examined in science for the Indian Civil Service, and had often found candidates giving the most excellent descriptions, entirely from memory, out of books of objects which they did not even know by sight when put before them. That was not scientific knowledge at all, it was merely something committed to memory; the only use of which was that it exercised the memory, but it did not exercise the capacity for observation and reasoning upon observation, which was the special value of scientific teaching. The results shown in the general improvement of the pupils entirely corresponded with what he had heard from various experienced teachers in higher class schools. Many years ago, Dr. Greenwood, principal of Owen's College, now Vice-Chancellor of Victoria University, told him that when he found a lad stupid and taking no interest in his language lessons, he recommended him to attend a course of chemistry, and he generally found that he would come back with a much quickened intelligence, and disposed to take more interest in his classical work. Mr. Percival also, formerly Principal of Clifton College, and now President of Trinity College, Oxford, told him exactly the same thing. It was his wish that every boy in the school should go through a course of elementary chemistry, and also have laboratory instruction. All who had attended to the subject came to the same conclusion, but of course it required attention, because the obvious objections were just what Dr. Crosskey has pointed out, and which he had met with over and over again. The first was that it was occupying time which might be more usefully spent. But when the large amount of time spent in giving instruction of a very vague kind, which excited little definite apprehension in the mind of the pupil, was considered, it would be seen that lopping off some of that, and substituting for it science teaching, would have a most beneficial effect. A daughter of the late Robert Chambers, some years ago, took much interest in introducing the teaching of animal physiology in primary schools, and she used to go into one of the schools in the Cowgate, Edinburgh, twice a week, and give lessons in it, and no doubt her teaching was of the most attractive kind; at any rate, the children were so much interested in it, that some of the clerical managers of the school were annoyed that the children cared so much more for this subject than for their ordinary lessons. No doubt there was a great deal of teaching about the dimensions of the Tabernacle, and the number of fringes on the high priest's garments, and so on, which the children did not appreciate so much as the animal physiology, and the result was that Miss Chambers was asked to discontinue; but the children held a meeting, and passed resolutions that they would not come to school at all if she were not allowed to go on, and as she described, the clergy came and requested her to continue her teaching. This was a good illustration of the fact, which all who attended to the subject knew, that science well taught was apprehended by children in a remarkable degree. A very young child apprehended what was put before it intelligently; and, in an older child, reasoning went on concurrently with observation.

Miss DAVENPORT HILL said the London School Board was by no means behind hand with regard to the teaching of cooking; though it was not carried on quite in the same way as at Leeds. Small kitchens were built in certain schools, where an instructor was appointed, who taught the girls from the schools all round. Roughly speaking, about one-fifth of the girls at school were taught, and as they hoped that all the girls would remain five years at school, there was an opportunity for all to learn in their turn. The instruction given was thoroughly practical. The instructor having given the pupils the ingredients and method, which the children wrote down, cooked the dish before them, and then, having well washed their hands, the children did it themselves under her supervision, and succeeded very well. There were twenty-eight cooking centres, and having visited many of them she could speak with much satisfaction of the results. Of course, at all these centres, a good deal of food was cooked, which had to be sold, or else a great expense would be incurred, and she was happy to say that in November last, when the accounts were made up, there was only a difference of 6s. between what they had bought and sold in that month. It was not very expensive, therefore, so far as materials went; of course there were the salaries and other expenses, but she was quite satisfied that whatever was spent in teaching cookery was well spent, and did not think there was much chance of the ratepayers grumbling about it. They were always adding to these centres, and in the case of isolated schools, too far from any centre to take advantage of it, they adopted the same plan as Mrs. Buckton did at Leeds.

Mr. E. C. ROBINS said when he last read a paper in that room on the subject of technical education, he made some remarks which he thought were novel, but he began to find they were not, and that the importance of science teaching, even to the lowest stratum of society, was beginning to be widely acknowledged. He was delighted to find this system growing so extensively in Birmingham, Manchester, and Liverpool, and that the representatives of the London School Board were also able to say that they had overcome former prejudices, so much as to be able to introduce some kind of science teaching. From his connection with the City Guilds Technical Institute he had learned some facts which were of great importance; for instance, it was found that some of the scholars who presented themselves had not received sufficient preliminary education to enable them to commence at once with the technical curriculum, and, therefore, special provision had to be made for them. He hoped before long this subject would take such a hold of the public mind that, both from primary and secondary schools, they would have scholars coming forward able to take advantage of the facilities offered by the City Guilds, for until this was done, technical education itself could never be put on a satisfactory basis, such as would enable England to compete on fair terms with other countries.

Mr. T. E. HELLER (Secretary of the Teachers' Association) said this subject was one which commanded the sympathy of every educationist, but yet, as the representative of a large body of teachers, he found himself in some difficulty with regard to it. He believed the diagrams were somewhat fallacious, but, at the same time, the paper would do much good in drawing attention to a most important subject. Twenty years ago he had charge of an elementary school, in which he ventured to say that the intellectual scientific teaching, properly so-called, was infinitely better done —and the same might be said of a large nnmber of elementary schools in the country—than was possible at the present day. Mr. Carpenter had hinted at some of the chief causes which led to that result. The Revised Code had been, in some respects, advantageous, but it had practically killed intellectual education; not only by making it worse than it was, but by retarding the natural progress which might have been fairly expected had an intelligent system of inspection and of grants been then established. With regard to the tables, Mr. Carpenter seemed to assume that the improvement in per-centages in elementary subjects was due to one specific cause only; but he thought he could show another School Board of equal importance with Liverpool, where no definite attempt had been made to introduce general scientific teaching over the whole school, in which a corresponding improvement had taken place in the same period. There were several circumstances which might produce that result. He believed that about 1876 or 1877, there was an important change in the inspector of the district, and it might be that a different standard was adopted, or it might be that the arrangements of the staff had been changed. But with all this, he did not mean in any way to disagree with the proposition, that if you could introduce intelligent teaching of a scientific character, based on actual observation, it must re-act on the general intelligence of the scholars. He gave up school-keeping about the time the New Code came in, but during the previous ten years, he never gave up systematic object lessons, or the addition of some scientific subject, such as mechanics, for the higher boys, and he was not prepared to say that the results in reading, writing, and arithmetic in any way suffered; on the contrary, he believed there was an improvement. But at the present time, they were met with the fact that the system of examination and inspection was dead against the adoption of anything like an intelligent system of scientific teaching; and until that could be altered, teachers would be afraid to crowd in any fresh subject. Those interested in this question, therefore, should look to a change of the system, at any rate simultaneously with the introduction of any new subjects; the time-table did not suffer from want of variety; there was plenty of that, but there was a dull mechanical striving after accuracy without knowledge. He did not in the least oppose science teaching, but you could not force more subjects into the curriculum, if they were to be examined in the same mechanical way as most subjects now were by the representatives of the Education Department. With regard to the teaching of cooking by the London School Board, they were not at all behind any provincial work in the solid work which was done, and he might add to what had already been said, that it was laid down as part of the scheme that the practical lessons should be preceded in the school by theoretical teaching on the nature and chemical properties of food.

Dr. ARMSTRONG, F.R.S., said the paper was not only very important in itself, but it raised several important points for discussion. Mr. Carpenter not only told them what had been done, but recommended a particular system, that adopted at Birmingham, for general use. It appeared to him, however, as a teacher of science, that that was not the best system. He did not see why science should be treated as a peripatetic subject, and wheeled about in a cart. No doubt everything which was done for the teaching of science was of value, but it was another question whether they were to accept this system as final. There were also certain recommendations as to the subjects which should be taught, viz., mechanics or physics for boys, and domestic economy for girls. He could not help thinking that they did not want any specific subject chosen, but a new subject got up specifically for the purpose; what was wanted was to teach boys and girls to go about with their eyes and minds open; to understand what was going on about them; to have a fair knowledge of natural materials, forces, and laws; and so to teach these things in the schools as not to kill the spirit of inquiry which was so pregnant in children. At present, they were not in a position to do anything of the kind. The Chairman had alluded to the difficulty which masters of higher schools were under with regard to the Universities; but beyond that, schoolmasters might say to men of science—"You are no doubt right in the main in urging us to teach science, but you have not yet put before us a proper method of teaching science; it is not yet sufficiently developed; there are too few teachers." And when a schoolmaster asked what book you would recommend him for teaching any particular science, they were obliged to confess that they could not honestly recommend any, for most text-books were tainted, more or less, with the vice which had been alluded to, that they tended rather to teach bare facts, than to develop the intellectual faculties. What was wanted, was more co-operation on the part of those who understood the subject, not a few people here and there introducing systems of their own. They also wanted instruction as to the meaning of science; the public generally did not know what science meant; and had no idea that the intention was to teach boys and girls to use their eyes and their minds.

Mr. LIGGINS objected to science being universally taught, though he was delighted to hear that the London School Board was teaching girls cookery. The first diagram he thought most unfair, because it compared the whole of England, including the agricultural districts, with one of the most civilised towns in the country. They were about on a par in reading, but in writing Liverpool was far ahead, and naturally so; they saw much more of it, while country children scarcely ever saw pen and ink except at school. And the same with regard to arithmetic; country children scarcely ever saw anything to make them acquainted with figures. Again, one of the most useful sciences or arts, drawing, was left out altogether. All children should be taught to draw, because all would find it useful, but what was the use of physical geography to a man who was to be a carpenter or bricklayer all his life? Chemistry again, or mathematics, would be no advantage to a navvy. To attempt to teach all these sciences universally would be a great waste of strength; because each child would only have the aptitude for studying one out of the number, and trying to make him learn the others would be only a waste of time. Science was all very well for employers, but it would be of no use to those who had to get their bread by the sweat of their brow.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first of the Second Course of Cantor Lectures on "Recent Improvements in Photo-Mechanical Printing Methods," was delivered by Mr. Thomas Bolas, F.C.S., on Monday, the 28th inst. The special subject of the lecture was new developments of the Woodbury-Type process.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, January 24th, 1884; David Howard, F.C.S., in the chair.

The paper read was—

THE MANUFACTURE OF GAS FROM LIMED COAL.

By J. Alfred Wanklyn.

Although the distillation of coal in the process of gas-making forms the chief source of the ammonia of commerce, it is a well ascertained fact that only a small fraction of the total nitrogen of coal is made to assume the form of ammonia in the process of gas-making, as commonly carried out. From the great importance of an abundant supply of ammoniacal salts in agriculture, the economising of a larger proportion of the nitrgoen of coal becomes a matter of national concern; and the introduction into the gas industry of a process which renders useful a larger fraction of the nitrogen in coal, ought to meet with a hearty welcome at the hands of all who are interested in the prosperity of agriculture.

Such a process is Cooper's plan of liming coal, as a preliminary to distillation in the gas retorts. The following quotation from the specification, which is dated June 2nd, 1882, will serve to indicate the nature of the process:—

"To the coal, either in a lumpy condition (such as that in which coal is used in gas-making), or, by preference, in a state of fine division, I add lime in the condition of hydrate of lime, or slaked lime, and I cause the mixture to be well incorporated. When I employ the mixture in gas retorts in gas works, I find it convenient to employ about half a hundredweight of quicklime to every ton of coal, and I slake the lime with about its own weight of water (*i.e.*, five gallons of water), whereby it is brought into such condition as to be readily mixed with the coal."

From this quotation it will be seen that Cooper proposes to make gas from a new gas-generating material, which may be appropriately designated "limed coal."

The products which arise in the distillation of "limed coal" differ materially from those given in the ordinary course of gas manufacture by distilling coal pure and simple.

Limed coal yields a larger fraction of its nitrogen in the form of ammonia; a slightly larger fraction of its carbon in the form of volatile compounds (*i.e.*, there is an increase in the tar and gas taken conjointly); a smaller fraction of its sulphur in volatile forms; and it yields limed coke instead of common coke.

Here is a specimen of limed coke from the Tunbridge Wells Gas Works, where the new process has been in operation for the last three months. As you will perceive, there are hardly any physical differences between limed coke and common gas-coke; an occasional white speck, where the lime has failed to mix perfectly with the coal, being the only apparent distinguishing feature. The differences show themselves when the coke is burnt.

Common coke, as most persons know by experience, gives off very abundantly the pungent fumes of sulphurous acid when it is burnt. Limed coke, on the other hand, evolves very little sulphurous acid on combustion, and, granting that the original admixture of lime and coal were absolutely perfect, would evolve absolutely no sulphurous acid.

The limed coke has another advantage, and that advantage was quite unexpected, when the investigation of Cooper's process was begun in the laboratory before the filing of the specification. Inasmuch as lime, and calcium compounds generally, are pre-eminently non-volatile, the addition of lime to the coal before distillation must be equivalent to the addition of so much mineral matters to the ash of the coke given by the coal. Limed coke, manufactured from a given quality of coal, must necessarily contain more fixed matter or ash than common coke from the same quality of coal. We dislike fuel which leaves much ash; and, indeed, ash in fuel is recognised as not only unprofitable but "profligate"—to borrow a term from agricultural chemistry. It was anticipated, therefore, that limed coke would not burn so well as common coke. This anticipation has been negatived. A very large quantity of limed coke has been produced and burned under a great variety of circumstances, and it has been observed that the limed coke burns brighter, and quicker, and readier than common coke. And when we seek for an explanation, we are led to see a potent oxygen-carrier in the thin film of calcium compound, which coats the coke as it is gradually burnt away in the fire. Especially is limed coke adapted for domestic consumption in dwelling-houses.

Limed coal yields a larger fraction of its nitrogen in the form of ammonia. In order to gain a proper idea of the actual production of ammonia in the gas industry, the records of the London gas works may be consulted with advantage. In the aggregate, the London gas works carbonise upwards of two million tons of coal annually, and obtain from 5 to 6 lbs. of ammonia from each ton of coal.

If all the nitrogen in the coal were got into the form of ammonia, the yield of ammonia would be from 25 to 50 lbs. of ammonia per ton of coal carbonised. The production of coke appears to be incompatible with the complete transformation of the nitrogen into ammonia, for coke contains a solid carburet of nitrogen, endowed with great stability, and resolvable into ammonia only when the coke is made to assume the gaseous form, by combination with oxygen and hydrogen.

Cooper's process increases the yield of ammonia very considerably, without making a sacrifice of the coke. Experiments made in my laboratory on the yield of ammonia by Cooper's process, shows that the ton of coal may be made to give from 12 to 15 lbs. of ammonia, when it is limed, upon being distilled. And I look for a similar result in practice on the large scale, not immediately, but in course of time.

A substantial gain in ammonia, due to the liming process, has been shown by the following engineers:—Mr. Trewby, at Beckton; Mr. Jones, at the Commercial Gas Works; Mr. Paterson, at Cheltenham,; Mr. Wilton, at Silvertown; Mr. Eastwood, at Batley; Mr. Botley, at Wormwood Scrubbs; and Mr. Dougall, at Tunbridge Wells. The highest comparative yield, *i.e.*, the greatest difference between the same sample of coal in its limed and its unlimed condition, has been shown by Mr. Botley, at Wormwood Scrubbs. Mr. Botley showed that, in his experiment, the yield of ammonia was doubled when the coal was limed. The highest absolute yield of ammonia has been shown by Mr. Dougall, at Tunbridge Wells.

In the course of these trials, which have been going on during the last eighteen months, I have been strongly impressed with the inadequacy of the arrangements for the collection and storage of the gas liquor in most gas works, and especially in old gas works. At the old Bankside Works, belonging to the South Metropolitan Gas Company, no gain of ammonia was registered. At the Vauxhall Works, another branch of the South Metropolitan Gas Company, there was no gain of ammonia, and yet some 30,000 tons of coal had been limed. I entertain no doubt whatsoever that the failure to get the gain of ammonia depended on the bad arrangements which prevail at those works.

(2.) The slight increase in the fraction of the carbon which assumes the volatile condition when limed coal is distilled has been dealt with on a recent occasion, and I will pass it over without further mention.

(3.) The great diminution of the fraction of the sulphur which assumes the volatile condition when "limed coal" is distilled will now engage our attention.

Chemists are quite familiar with the fact that sulphur present in organic compounds can be caused to attach itself firmly to calcium, by simply heating the organic compound in contact with lime; and, in accordance with general chemical principles, a perfect mixture of coal with excess of lime cannot possibly evolve sulphur compounds when it is heated strongly. It will, therefore, be intelligible that limed coal should yield little or no volatile sulphur compounds when it is employed in gas-making.

In a preliminary experiment, in which gas was made from limed coal in the laboratory, so striking was the absence of sulphur compounds from the gas, that the patentee recognised the gas as being fragrant rather than fœtid, as is the case with common crude gas. Sulphur, as is well known, occurs in crude-coal gas partly and mainly in the form of sulphuretted hydrogen, and partly in the form of what is by gas managers termed "sulphur," or "sulphur compounds other than sulphuretted hydrogen." These sulphur compounds consist of bisulphuret of carbon and a variety of other volatile sulphur compounds which are little understood.

As has been said, the main portion of the sulphur exists as sulphuretted hydrogen. I have found from 0·8 to 1·5 vols. of sulphuretted hydrogen in different samples of common crude-coal gas. The "sulphur other than sulphuretted hydrogen" in common crude-coal gas, as far as I have been able to ascertain, is less than 0·3 vols. per 100 vols. of gas.

Both the sulphuretted hydrogen and the "sulphur compounds other than sulphuretted hydrogen" are diminished by the application of Cooper's process. Even when Cooper's process is very imperfectly carried out, that is to say, when the mixing of the lime with the coal is very imperfect, the diminution of the sulphur in the crude gas has been observed. Thus, for instance, at the Vauxhall Gas Works, where the coal has been very imperfectly limed, the following observations were recorded in January, 1883:—Vols. of sulphuretted hydrogen in 100 vols. of crude-gas from

		Limed coal.	Unlimed coal.
Experiment	I.	0·42	0·61
,,	II.	0·45	0·61
,,	III.	0·42	0·58
	Mean	0·43	0·60

In addition to the evidence of the diminution of H_2S afforded by examination of the gas itself, there is other and equally conclusive evidence afforded by the prolongation of the time during which purifiers retain their activity. Thus, at Tunbridge Wells, the duration of the active life of an oxide of iron purifier has extended so that a life of ten days has been prolonged to much more than fifty days. In fine, this diminution of the sulphuretted hydrogen by Cooper's process is so palpable that it cannot be overlooked. Equally certain is the diminution of the "sulphur compounds other than sulphuretted hydrogen," and the diminution is palpable, even in cases when the mixing of lime and coal has been very imperfect.

At the Vauxhall Gas Works there were, in the early part of last year, supplies of crude gas from limed coal in one retort house, and of crude gas from unlimed coal in another retort house. Comparative testings of the gas were made with the following results:—

1883.		Limed.	Unlimed.
30th January	I.	14·4	26·3
,,	II.	17·1	26·3
,,	III.	15·9	—
31st ,,	I.	16·4	26·3
,,	II.	17·2	27·9
,,	III.	16·8	—
1st February	I.	16·8	25·6
,,	II.	11·2	18·0
2nd ,,	I.	16·1	26·3
,,	II.	16·4	27·0
3rd ,,	I.	15·6	25·4
,,	II.	15·4	25·0
5th ,,	I.	14·1	27·1
,,	II.	17·3	—
6th ,,	—	15·3	27·8
7th ,,	I.	19·7	29·5
,,	II.	17·4	29·4
8th ,,	I.	16·4	28·2
,,	II.	17·6	26·1
,,	III.	20·5	—
9th ,,	—	16·7	24·1
10th ,,	I.	13·6	23·5
,,	II.	15·3	—
12th ,,	I.	12·8	16·7
,,	II.	15·0	11·2
,,	III.	11·8	15·2
,,	IV.	18·0	15·2
,,	V.	—	21·7
13th ,,	I.	13·7	18·9
,,	II.	12·8	21·2
,,	III.	13·0	21·0
,,	IV.	10·3	19·4
,,	V.	10·6	—

On the 14th February, 1883, all three retort houses at Vauxhall were placed under Cooper's system, and there was no gas from unlimed coal at the Vauxhall Works, and the comparative testing came naturally to an end. In the above investigation the circumstances of the case precluded the employment of the Referee's method, and Harcourt's method had to be resorted to. Each figure in the above statement is the mean of some four or five readings.

After 15th February, when all the gas at the works was made from Cooper's limed coal, a pipe from the main in one of the retort houses was caused to convey a portion of the crude gas to a small condenser, and then the gas went through a scrubber, and then through three boxes charged only with oxide of iron, and then it was collected in a small holder which was filled every day. The gas was tested by the Referee's method, and gave the following results:—

1883.	Grains of S. per 100 cubic feet of gas.
20th February	11·8
21st "	13·5
22nd "	12·2
23rd "	13·2
24th "	13·6

On 26th February very little lime was added to the coal, next day no lime was mixed with the coal, and Cooper's process was stopped till 5th March, when it was recommenced, and continued for many weeks.

Continuing the tabular statement, the figures were as follows:—

28th February	24·5
1st March	31·0
3rd "	18·2
6th "	24·4
7th "	12·4
8th "	8·0
10th "	3·3

The amount of coal carbonised at that time at Vauxhall amounted to about 3,000 tons a week; and the success of the process was so manifest, that even the officials of the South Metropolitan Gas Company were moved; and on March 9th, on the occasion of the emptying of one of the large lime purifiers at the Vauxhall Works, the opportunity was seized to substitute oxide of iron for the lime. About a week later, a second lime purifier was refilled with oxide of iron, and on March 24th, a third lime purifier was charged with oxide of iron; and from that time forward, for a considerable period, no lime other than that employed in the Cooper process was used at Vauxhall.

As I have already mentioned, the liming of coal, as carried out at Vauxhall, was very irregular and imperfect. Since that time, Cooper's process has been put in operation under less unfavourable conditions. By the aid of the admirable machine which the gas industry owes to Mr. West, a good and regular admixture of the lime with the coal has become practicable; and at the Tunbridge Wells Gas Works—notwithstanding that the coal is rather highly sulphurous, containing 1·7 per cent. of sulphur—an average of 3·0 grains of sulphur per 100 cubic feet of gas has been maintained for three weeks. Not only has the lime purifier been abolished at Tunbridge Wells, but so altered is the function of the oxide of iron, that the manufacture of gas in Tunbridge Wells has been correctly designated by Mr. Spice as an operation in closed vessels.

With the sulphur reduced to 3 grains per 100 cubic feet of coal gas, and with purifiers which require changing only once or twice a year, the gas industry enters upon a new era.

In dealing with the financial side of the liming process, I have first to direct attention to an almost unique feature which distinguishes this process from what is usually brought before the gas industry. No new plant is required, but on the contrary, plant is diminished. Neither is any new material brought into the gas works, for lime has been there ever since the gas manufacture began. Computing on the one ton of coal carbonised, as is customary among gas-makers, the cost of the lime itself, and the slaking of it, and its application to the coal, is about 6d. per ton of coal carbonised. A small allowance for extra retort room has to be made, for a ton of coal without lime gives practically, about the same quantity of gas as a ton of coal with lime. This allowance is 2d. The debit side of the account is therefore 8d.

On the credit side there are a variety of items. First of all, the cost of the lime is, to a great extent, recovered when the coke is sold. The presence of the lime in the coke, as has been explained, is useful. And buyers of coke have already acknowledged the utility of the lime in the coke by paying for it. The saving in the cost of gas purification is a most important item. There is a saving of 90 per cent. in labour, and almost an entire saving of the purifying material. The saving in purification may be set down at 7d. Then there is the gain in ammonia, 9d., and the gain in tar 2d. On these items alone, there is a balance of one shilling per ton of coal carbonised. This is a very moderate estimate, and at Tunbridge Wells Gas Works has been greatly exceeded.

Besides the above advantages, which are immediate, and on the surface, there are other advantages. The saving in purifying plant is a very great advantage. Many gas works are in great straits, by reason of the inadequacy of the purifying plant to meet the requirements of the winter make of gas. In these instances, the adoption of the liming process is a vital matter. The question of the abatement of nuisance has a financial aspect, and the possibility of doing away with the lime-purifier will enable many a gas works to continue in existence in the midst of a dense population.

I have, at the Southport meeting of the British Association, called attention to the sanitary aspect of this subject. To stop the pollution of the general atmosphere with sulphurous acid is, briefly, that which the adoption of the liming process will achieve. To accomplish that, is to bring back vegetation into our towns, and to remove one of those general agencies which tend to depress the vital energy of the population.

By the production of an illuminating gas of unprecedented freedom from sulphur, the liming process will greatly benefit the gas consumer in his home. Gas, as hitherto known, has been one of the most destructive agents which has ever entered our houses. Gas practically free from sulphur, that is to say, gas such as the liming process furnishes, will cease to be destructive, and will become as harmless as the electric light itself.

DISCUSSION.

Mr. KING (Liverpool) said this subject first came under his attention nine or ten months ago, when Mr. Cooper called on him and explained the process. Finding that there was a probability that this would meet what the gas-makers felt was a matter of difficulty and expense, viz., the removal of the sulphur compounds, he was glad to have the opportunity of at once putting it into practice; and he must say, at the outset, that the matter appeared so simple, and, as he was led to believe, that there was every prospect of accomplishing the special object they had in view, he was throughout the whole process strongly prejudiced in favour of the patent. Therefore, if in any respect the results obtained did not come up to his expectations, it certainly did not proceed from any unfavourable bias. The process was at once adopted at two of the Liverpool gas works, 6,300 tons of coal being limed at one works, and 5,700 tons at the other, making a total of 12,000 tons. The recommended quantity of 2½ per cent. of lime was used, the slaked lime being mixed with the coal and cannel as efficiently as possible by hand labour. The object had been simply to carry out the patentee's views as thoroughly as possible, without having regard to how the mixture might be most economically conducted. The results might be summarised thus:—In the first instance, there was no increase of gas obtained per ton of coal; the mixture gave practically the same quantity of gas as the unlimed coal did. The illuminating power also remained the same; there was no difference beyond the merest fraction of a candle. Then, coming to what was the object mainly in view, the removal of the sulphur compounds, in that respect also they failed to obtain the fulfilment of their hopes. Had they been under the Referee's clauses, which were in force in London, with regard to the quantity of sulphur, other than sulphuretted hydrogen, allowed, which he believed was 22 grains in winter and 17 in summer, with the exception of one day, he believed the quantity would have been exceeded. Certainly some of the sulphur was removed; but using the oxide of iron purifier simply, and carrying on the process in the ordinary way in that respect, the mixture of lime and coal would not have enabled them to comply with the requirements of the London Gas Referees. He had been very much disappointed in this, as it was the point of all others to which he had specially looked forward. There was certainly an increase in the quantity of ammonia, but he could not give the exact figures, as their arrangements hardly admitted of exact measurement. They had had no difficulty in selling the thousands of tons of coke produced, except in a few instances, where the parties said it did not suit their purposes. They had no difficulty, generally speaking, in selling it for domestic purposes, such as to workhouses and prisons, where the coke was required for heating purposes, but in their own works they experienced great difficulty from this limed coke, from the very rapid destruction or deterioration of the furnaces, and the choking of the flues of the retort settings. This appeared to him to be a great difficulty in carrying out the process. It was somewhat extraordinary to see the different results obtained from this process in different places. Mr. Eastwood, of Batley, had published results which certainly, to a large extent, seemed to confirm his own experience; he spoke not of the gain in money, but taking the debit and credit side of the account, the words he used were that the process would not pay. Such discussions as that in which he took part were very valuable, for it was only by comparing different results that the truth could be arrived at. They did not meet either to depreciate or laud any particular process, but to get, if possible, at the truth of the matter. He thought generally speaking, gas engineers would be only too glad to accept a process so simple, if the results hoped for really could be obtained. Possibly one difference in the results obtained in the north and in the south might arise from the very different nature of the material used. The softer coal used in the south might permit of a more intimate mixture with the lime; whereas in the north of England, particularly in Liverpool, where a large proportion of cannel was used, the gas being 21½ candles, the lime might be differently affected.

Mr. HARRIS said he should propose to give a short statement of the experience he had with regard to the process, though it was a very remote one, and consequently he was perhaps not in so fair a position to judge of the merits of the case as those who had tried it more recently. Professor Wanklyn drew his attention to the matter some eighteen months ago; he had then no opportunity of trying the process on a large scale, but he had the opportunity of mixing some lime with the coal, and did so under his directions to the extent of 3 per cent. His principal object was to see what effect the lime would have upon the coke, and he must say that, from what he saw, he came to the conclusion that it would have a very deteriorating effect, because the particles of lime were apparent in the coke, and he came to the conclusion that it would be prejudicial. In the first place he presumed the effect would be produced which Mr. King had explained was produced on their furnaces, and as for domestic use, he thought the white appearance would be considered detrimental. He did not make sufficient coke to try it practically, and it was not so serious a defect as to utterly deter him from using it, and therefore he introduced it at the works at Silvertown, where it was tried for some time. He had not statistics with him of the result, but the general effect was that there was no great advantage derived from the use of this lime process on the coke. Undoubtedly there was an increase in ammonia, but at that time the question had not arisen as to the effect on the sulphur compounds, which appeared to have arisen from subsequent experiments, and, therefore, his attention was not directed to it. One thing occurred to him with regard to the commercial value of the process, supposing it were a commercial success, from the statistics given him at the time, it appeared that the expense would be 6d. per ton for the lime added to the coal, and then came the question how that 6d. was to be paid for. He could not see that it would be paid for by any subsequent purification, because he did not consider the use of lime in the retorts would obviate the necessity of using lime in the subsequent process of purification. The great bulk of lime used at the present time was neutralised by the carbonic acid in the gas, and he could not see that the addition of lime to the coal would prevent that production of carbonic acid, though possibly it might be so. He, therefore, considered that the subsequent process would be partially the same as at present. Then came the question whether the extra ammonia produced would be of more value than the lime added to the coal, and, at the then price of ammonia, the conclusion he came to was that it would be about equal. If the ammonia ordinarily produced was worth 2s. per ton, a 30 per cent. increase would be about 8d., which would have to be placed against the 6d., and the extra labour required. Since then, however, as he had said, the question of the sulphur compounds had cropped up, which might put a different complexion on the subject.

Mr. BROADBERRY said, something like fifteen or sixteen years ago, the idea of using limed coal occurred to him, and he tried some experiments with it, using about two bushels of lime to the ton, and mixing it as had been described. He did not carry the experiment out to the end, for the simple reason that he found the coke fluxed the furnaces so much that he abandoned it before coming to any definite conclusion on the question of sulphur. At the time they did not think anything about ammonia, the only trouble being how to get rid of it. He should certainly be very careful how he introduced limed coal into his furnaces, or how he used the resulting coke, for he found in three days it thoroughly destroyed the furnace, and he could easily run out two sets of furnace bars every day. He should like to ask Professor Wanklyn what apparatus was used for testing for ammonia, the ordinary method, or Mr. Harcourt's. It was stated that you might get an increase of 30 to 40 lbs. of ammonia per ton, but was it to be understood that there was that quantity of ammonia in the coal which, in this way, could be got from it. Again, 2d. extra was put down for one ton, and he did not understand how that was arrived at.

Mr. WILLIAM FOX remarked that this question was not entirely one of monetary gain, but, if the purification could be carried on in closed vessels, it was of immense importance as a matter affecting public health and vegetation. It had been stated to him by workmen that they had no trouble whatever in ascension pipes, which was a matter of great importance, and that the coke certainly gave out more heat than ordinary coke, which could be well understood if the lime could be used as a carrier of oxygen. This would account for the damage done to the furnace bars. It was not simply a question of the gain per ton in tar or ammonia, but rather of the advantage which it would be to the public health, which was of importance. It was a pity that they had not more information as to the quality of the tar produced.

Prof. REDWOOD said this question was one of considerable interest to him, as having had some experience in connection with gas manufacture, and certainly one great difficulty, which had presented itself more than any other when he had been called in to advise, was that occasioned by the offensive smell arising from the charging of the lime purifiers. If this process enabled the use of lime purifiers to be dispensed with, it would be an immense advantage. He had heard with considerable interest the remarks of Mr. Harris, with whom he had been engaged in gas experiments in former years, and knew that full reliance could be placed upon whatever he said. It did not appear, however, that he was able to offer a very definite opinion with regard to the effect of the process upon the sulphur compounds. There appeared to be strong evidence to indicate that an increase of ammonia took place, and, theoretically, such a result might be expected, and that was so far satisfactory as regarded the economy of the process. Still, he looked to the improvement in the quality of the gas by the reduction of the sulphur—not only that which first came over in the crude gas, but that which would ultimately remain in the purified state—

as the most important object in many respects—both in a sanitary sense and in an economic sense, as related to the consumers—because, undoubtedly, the sulphur in gas was the cause of great destruction to furniture and apparatus. He knew of some towns—Exeter, for instance—where, for a long series of years, great difficulties had been experienced on account of the offensive odour constantly emitted from the process of gas-making, much of which would, no doubt, be done away with if the sulphur could be fixed in the gas retort, instead of having to be taken out in a volatile condition subsequently. One point that occurred to many was, why was not this done before? because it appeared so very natural that gas manufacturers who, from the first, had been using lime for purifying the product of distillation, should have thought of putting lime in with the coal itself. He might recall Mr. Harris's recollection to an experiment which he saw him make a great many years ago upon a small scale, of a similar description—mixing the lime with the coal before carbonising—and if he recollected rightly, the conclusion then arrived at was, that it diminished the sulphur, but at the same time diminished the illuminating power.

Dr. SAUNDERS thought the author of the paper had not taken sufficient credit to himself for this process, because, when they came to think that gas giving off sulphurous acid caused headaches, and injured furniture and works of art, it would be seen that if they could do away with the sulphurous acid in gas an immense service would be done; even if there were no increase in the ammonia, if they could do away with the lime purifiers, it would be a great thing. He had unusual opportunities of seeing and smelling a large number of provincial gas works, being a medical officer of health for a large combined district, and he found one of the principal sources of nuisance was the lime purifiers, not only when they were emptied, but when they were redisturbed by the farmers to carry away the stuff. This was a continual nuisance to those who lived near the works.

Mr. MACKINNON said he understood Professor Wanklyn to say that heat would not drive away the sulphur from the sulphur compounds, but that did not quite agree with the process now carried on at the South Metropolitan Gas Works. There they took the lime from the purifiers and submitted it to a process in an oven specially constructed for driving off and burning away those sulphur compounds. He could not see why the same result would not follow the burning of coke in houses, because he thought the heat would be quite sufficient, and he presumed the sulphur was in the form of sulphide of calcium, the decomposition of which would drive off the sulphur. He should imagine that a great portion of the sulphur would form a sulphide, and would therefore spoil the lime for building purposes.

Mr. COOPER desired to say a word or two on the statements made by Mr. King, of Liverpool. That gentlemen had not told them the cost of the damage to his furnace per ton of coal, which he complained of, but when he was at Liverpool, he informed him that it amounted to a fraction of a penny per ton. If that were so, he thought he had made rather more of it than the matter deserved, especially as the profit which was evident from the process in other ways, namely, the gain in ammonia and in tar, might come up to 2s. or 3s. per ton. Mr. Harris had referred to the question of sulphur compounds as if it were an afterthought, and had only been found out since the process was used on a large scale, but he might say that within a few days of the filing of the provisional specification, he issued a circular in which he put forward the fact that the sulphur compounds would be reduced without the use of lime purifiers, and with a reduction in the quantity of oxide employed.

The CHAIRMAN said the discussion had shown, even more clearly than the paper itself, the importance of this process being thoroughly worked out, and the advantages and disadvantages—and every new process had to be fairly and carefully weighed, before any decision was come to. The advantages promised were by no means trifling. The increased yield of ammonia was in itself no light matter to a chemist, or to an agriculturist either. No doubt the recent drop in price might have discouraged some people from saving ammonia, but from what he had seen himself of the effect on increased consumption from drops in price, he thought there was no fear of the extinction of the manufacture of the sulphate of ammonia from the present small reduction in price. An increased yield of ammonia, even to the extent of 30 per cent., especially considering the much larger per-centage of the ammonia in the coal which was now lost, was a step in the right direction. No doubt the object in making gas had hitherto been to make pure gas of high illuminating power, and it was only recently that the bye-products had been considered of importance. He could remember when ammonia liquor was thrown away; in the country it was to be had by simply sending a tank barge for it; and when the dead oils could be had for the fetching, large quantities being what was politely called burned—run into gravel pits—until everybody who had the misfortune to live on the same gravel bed, within a considerable distance, found it out; when, in fact, everything except gas and coke was considered worthless. They were only on the threshold of the possibilities of the distillation of coal viewed from the side of the bye-products, vast as were the steps which had already been made. If, therefore, this process fulfilled its promise, as shown in more than one experiment, of increasing the quantity of ammonia, and also of tar, and especially of light naphthas, it would be very valuable. He had had some experience of burning coke both in large and small furnaces, and it appeared to him that the difficulty experienced in furnaces was no proof that it was unfit for domestic use. In small fires, even under boilers, the evil of coke was undoubtedly the dust which it made, there not being lime enough in it to make it into a clinker; and the very fact of the coherence of the dust which would be produced by a certain quantity of lime in a moderate heat, would make it a potent flux if put into a strong furnace; and in such circumstances he could well understand that the limed coke would be exceedingly injurious to the furnace bars. But that did not prove that in small furnaces, and especially in domestic fireplaces, the presence of lime would be injurious. He thought a case had been made out for saying that, in the presence of an excess of lime and oxygen, sulphurous acid was not given off in the process of burning, which, from a sanitary point of view, was most important of all. Great complaints were made of fogs, and very unpleasant they were, but the worst part of them was not the carbon which, though it was nasty, did no particular harm, but the presence of sulphurous acid and sulphuretted hydrogen. The use of gas fires, coke, and improved fire-places might do something to reduce the amount of smoke; but so long as the sulphurous acid was sent up into the air, they would never have a pure atmosphere. If any one wanted to see the effect of burning coke, let them go into a freshly plastered room, where coke was being burned in an open fire-place. It seemed to be established that the addition of lime to coke prevented it giving off sulphurous acid in burning, and there would be an immense improvement in sanitation. Another point to be remembered was that one great evil of smoke was that it acted as a nucleus for fog; therefore, if coke were more largely used, it would diminish the vesicular state of the atmosphere, which caused fog. Undoubtedly the question of £ s. d. was a most important one, and if the process did not pay, he feared they would go on poisoning one another, sending sulphurous acid into the air by thousands of tons, and grumbling at the result. The figures wanted careful looking into, and the process should be tried on a large scale, and under favourable circumstances, before any conclusion could be arrived at. It might possibly be that, in Liverpool, special difficulties had occurred from the character of the coal, and a process offering so many advantages was not to be dismissed lightly. He could not look upon it as the final possibility in coal distillation, but it was certainly a step in the right direction—a step which he could thoroughly appreciate, living, as he did, in a district where the impurities in the gas seemed to be what was charged for. Those who enjoyed the benefit of the high degree of purification attained by the great London gas companies, did not know so well as those who lived in the outskirts, or in the country, what impure gas was. There was one advantage, that it never leaked without your knowing it. He could speak from experience of the terrible nuisance which gasworks sometimes were to those who lived near them, or who burned the gas. There was always a difficulty in carrying out a new process, and one of the greatest misfortunes of manufacturing chemists, amongst whom gas managers must be included, was that they never had any rest. As soon as they thought they had made things all right, something new turned up; but there were very few new processes which entailed less trouble in the shape of new apparatus than this one.

Prof. WANKLYN, in reply, said it was a marvel to him, from what he saw of the liming which took place at Liverpool, how any result whatever could be obtained. The coal, instead of being the usual mixture of lumpy and small coal, was in large blocks, 40 per cent. to 60 per cent. being cannel. The mixing performed was of the most rudimentary kind, and it spoke very highly for the process that, under those conditions, the gain in ammonia was so marked that Mr. King could not fail to recognise it. The lowering of the sulphur compounds was also very marked, and, as he had been informed, Mr. King wrote to Mr. Livesey, saying that they had solved the sulphur problem. That occurred soon after the introduction of the process. With regard to the destruction of the furnace bars when the process first came out, no one could possibly have felt more keenly than he did that they would have to contend with almost insuperable prejudices, that it would be said that the coke was spoilt and everything destroyed. Now, at Vauxhall, the process was put on to one of the retort houses in January, and continued up to June, about 1,000 tons of coal being carbonised weekly, and no damage had occurred to the furnaces that he had heard of. If it damaged the furnaces in one place it should in another. No damage either was done at Tunbridge Wells; but this immense damage was done in Liverpool. No doubt this depended upon the peculiarities in the way the work was carried on. Mr. Harris had asked what they did with the carbonic acid? Now, the use of lime in the retort did not diminish the proportion of carbonic acid which came out with the gas, but the extra ammonia which was formed absorbed some of it, and practically, in the gas as it left the purifiers, there was a smaller amount of carbonic acid. In the ordinary process, as conducted in London, the carbonic acid was taken out, not because it did no direct harm, but because it must be removed before you could use lime so as to lower the sulphur compounds. When carbonic acid occurred in considerable quantity, it was worth taking out, but traces of it were not, as there was no process by which you could take them out which would not itself lower the illuminating power of the gas to as great an extent as the carbonic acid itself. He was afraid he had not made himself quite clear with regard to the improvements claimed for this process. It was claimed that they, in one sense, abolished all purifiers whatever; that only the oxide of iron required to be used, and that the purifier need only be opened once or twice a year, just as a scrubber had to be opened occasionally; the lime purifiers disappeared altogether, and the oxide of iron lasted so long, that the process became one of work in closed vessels. There was a very beautiful theoretical explanation of the fact. The gas, as it left the retort, contained ·4 of sulphuretted hydrogen, and one per cent. of air entering the gas would give sufficient oxygen to consume that sulphuretted hydrogen. What was really done in this process, when properly carried out, was to make use of the traces of air which entered, and practically, to do all the purification by means of that trace of air. The oxide of iron purifier became a sulphuret of iron sponge, the function of which was to transfer oxygen from the traces of air to the sulphuretted hydrogen. That was why the process was one of operating in closed vessels. A question had been asked about the adhesion of sulphur to calcium. One of the prejudices he knew they would have to deal with arose from the well-known fact that the contents of the lime purifiers, when taken out and exposed to the air, evolved sulphuretted hydrogen. That sulphuretted hydrogen did not come from sulphate of calcium, but from a compound of sulphuret of calcium with sulphuretted hydrogen. That sulphuret of calcium adhered to the sulphuretted hydrogen, but when the compound became heated by oxidation the sulphuretted hydrogen parted company with the sulphuret of calcium; but really sulphuret of calcium in the presence of an excess of lime did not part with its sulphur. So certain was this adhesion of sulphur to calcium, that you might actually measure the amount of sulphur in coal by taking powdered coal, weighing it, mixing it with about half its weight of slaked lime, and then igniting in a platinum crucible. In that way you got sulphate of lime, which you could wash off and convert into sulphate of baryta. He had determined the amount of sulphur in coal in that way, which seemed to him an absolute proof of the perfect manner in which sulphur and calcium held together.

Mr. KING asked permission to say a word in explanation. As he before remarked, he had been from the first strongly prejudiced in favour of the process, so much so that, when an opportunity again occurred next spring or summer, he intended to make further experiments. The gas works at Liverpool he had thrown open to these two gentlemen, whom he had the pleasure of showing over them, and requested the benefit of their advice, and he should have been only too glad if they could have spent a week or more at the works. The whole process of mixing was shown them, and they had not a single suggestion to make, except, that large quantities of Cannel being used, possibly the lime might slide off a smoother surface. Having investigated the matter day by day himself, and having gentlemen under him at the works who had every desire to make the process a success, he did not believe that any deterioration of the furnace was due to want of care on the part of the workmen. They had had to give it up in the autumn, on account of the destruction to the bars and the furnaces, and the stoppage of the flues, but they intended repeating the experiment in the spring.

The CHAIRMAN, in proposing a vote of thanks to Professor Wanklyn, said he was sure that gentleman did not mean to imply that there was any wilful inability on Mr. King's part to make the process work. He had no doubt there would be difficulties to be got over, especially when dealing with very different qualities of coal.

The vote of thanks having been carried unanimously, the proceedings terminated.

Mr. R. R. SPICE writes as follows:—"As the advantages of the process appeared to me to be considerable, I resolved to make an effort to secure such a critical examination of the method as would enable me to determine, for myself, whether the drawbacks which were said to hinder its use were such as really to counterbalance the benefits, admitted to be desirable; and having brought the question under the notice of the Tunbridge Wells Gas Company, I obtained the consent of the directors for such an experiment to be made at their works. Operations were accordingly commenced at the end of October last, and are still being continued—two months' working up to the end of December. The effects derivable from the use of the process are, an increase in the quantity of ammonia, the average value of which, from carbonising 10,000 tons of coals, may fairly be put at

fairly be put at	£450
The saving in cost of labour in purifying	80
And in cost of purifying materials	480
Value of advantages..........	£1,010
Less by additional cost of wear and tear, and the lime mixed with the coal	240
	£770

There is thus a difference between my first estimate, printed in the *Journal of Lighting, Water Supply, and Sanitary Improvement*, owing to my misconceiving Mr. Dougall's meaning, of £18, which may be regarded as important; and I am of opinion that a fair year's working with sulphate of ammonia, at an average price in the market, may result in my original estimate being fully realised. I have heard something about the destructive action of the limed coal in the retort furnaces at one of the Liverpool works; but as nothing of the kind has been felt at Tunbridge Wells, I am not prepared to admit that the injurious effects spoken of as having been experienced at Liverpool is rightly attributable to the cause which my friend Mr. King assigns it to. After three months' work at Tunbridge Wells, the only complaint reported to me concerning the objection felt at Liverpool, is that the furnace bars are quickly destroyed, which is easily understood; and this I have considered in making the allowance of 10 per cent. on the previous cost of wear and tear. That having been £1,400, I have added £140 to it. But above all questions of mere convenience or cost, I say, let the economy of the process be more or less than I have stated, the value of it will be found, in very many instances, to be beyond all such considerations; and I shall be greatly surprised if the invention be not generally appreciated by the gas manufacturers as a body, on account of the positive blessing it confers on all, in offering an opportunity of abolishing a cause of grievance and expense—which has led, in past years, to a vast amount of bitter controversy, and extensive and costly litigation —concerning the difficulty of dealing with impurities called sulphur compounds."

FOREIGN AND COLONIAL SECTION.

Tuesday, January 29th, 1884; The MARQUIS OF LORNE, K.T., in the chair.

The CHAIRMAN, in introducing Mr. Colmer, said that amongst his other duties, one was to watch and, if necessary, to contradict, the rumours sent from the other side of the Atlantic to this country, with regard to Canadian affairs. He (the Chairman) had been surprised to see a most extraordinary telegram, which emanated from New York, making out that the finances of the Dominion were generally bad, and that there was no hope for the country at all. He had, however, been relieved next day by receiving a letter from Mr. Colmer, pointing out that every single set of figures in that telegram was wholly and entirely erroneous, being, in many cases, wrong by several hundreds of thousands of dollars. This remarkable circumstance led him to the conclusion that, although there were many persons in America who were kindly affected towards things British, there were certain other persons who were by no means in the same state. For his own part, he could only speak most lovingly of the American people; but, at the same time, we must not let our love for our kinsmen across the Atlantic make us forget that we owe our first duty towards our flock on that continent. The reply to such rumours was in the almost unanimous experiences of the settlers in the North-West, who had succeeded on the farms in which they had been placed. On the subject of emigration, the Chairman read extracts from a pamphlet by Lady Hobart, the honorary secretary of the East London Family Emigration Fund, to show how successful those who had left this country for Canada had been in bettering their fortunes. He also mentioned that the Princess Louise had been working with the Ladies' Emigration Society, whose principle was that inquiry should be made in England as to persons to be sent out, intimation given to the Canadian Government of the result of this inquiry, and the sanction of the latter for their transmittal. He thought the action of the private individuals forming these societies might be seconded by the Government. He doubted whether lump sums should be devoted by Parliament to such objects, but it might be made a matter for Government consideration, on the recommendation of the local authority in congested districts like the East of London or the West of Ireland, whether they should not put down something like a pound a head for persons sent out to Canada, who were approved for emigration both on this and the other side. In conclusion, he said he believed Canada to be a country to which men might be sent, both for its own benefit and for that of England.

The paper read was—

CANADA AS IT WILL APPEAR TO THE BRITISH ASSOCIATION IN 1884.

By JOSEPH G. COLMER,
Secretary to the High Commissioner for Canada.

It is gratifying to see indications, on every side, that the development of the Colonies is attracting much greater attention now than was formerly the case. They are proud to be recognised as important sections of the British Empire, and to know that there is a strong feeling in this country in favour of drawing the bonds of union still more closely together. Much of the indifference shown, not so many years ago, arose, undoubtedly, from the want of knowledge that prevailed, and this is not difficult to explain. Communication was not easy, and correspondence not very frequent. In the schools, the rising generation were told that the sun never sets upon the Empire; but they were taught little or nothing respecting the importance and resources of the Colonies, and the position they were destined to occupy in the world in the near future. I am prepared to admit, as my opening sentences indicate, that this lack of interest does not exist at the present time to the same extent as previously; but a great deal still remains to be done. The Colonies of course owe their origin to the mother-country, but to many minds they occupy somewhat the same position as the little girl in the story, who insisted that she had "growed the rest herself." Lines of steamers now leave for Canada, Australasia, the Cape, and other British possessions at regular and frequent intervals; and it is becoming more and more the fashion—and a good one it is—to visit the Colonies. It is also significant that the emigration to their shores grows larger every year. I have spoken so far generally of the Colonies, but all that I have said applies with particular force to Canada. It can therefore be imagined with what pleasure the Canadians learned that the British Association for the Advancement of Science had departed from its usual custom, and had decided to hold its meeting in 1884 in the City of Montreal. I may add that the Marquis of Lorne (the late Governor-General) has from the first given the matter most hearty support.

I do not propose in this paper to say very much respecting the early history of Canada, or its progress in the first century after it was ceded to Great Britain. I shall take it for granted that an audience meeting in the rooms of the Society of Arts will be acquainted with these things, and rather treat of its development since the Confederation of the various provinces, which, as you will be aware, was inaugurated under the British North America Act of 1867. Neither do I intend to explain the detailed arrangements that have been made by the Montreal Committee for the conveyance of members of the British Association to the place of meeting, and for their comfort during their stay in that country. These particulars will be supplied in the circular about to be issued. My intention is to place before you some information respecting the social, commercial, and political aspects of the Dominion. Later on, I propose to say something of Montreal, and of the principal excursions to be undertaken; and in the meantime must ask you to consider yourselves for a short time in the Economic Section of one of the annual gatherings of the Association.

The rapidity with which Canada has progressed during the last four or five years has been remarkable, and has attracted much attention in Great Britain. The revenue has expanded, the trade has increased, immigration has been growing larger annually, and the rapid construction of the Canadian Pacific Railway has been watched with wonder and surprise in every part of the world.

Before entering upon these points in a somewhat more detailed manner, I must say just a few words as to the extent of Canada, for no paper on the subject would be complete in the absence of that information.

The Dominion, as at present constituted, is estimated to contain 3,470,392 square miles. It occupies about one-half of North America—in the opinion of Canadians not the least important half—and is as large as the United States, exclusive of Alaska. You will be able, perhaps, to form a better idea of its extent when I say that its area is nearly as great as that of Europe. The country is divided into eight provinces — Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island, British Columbia, Manitoba, and the North-West Territories. This latter district, about which I shall have something more to say presently, has recently been divided into four smaller territories, called Assiniboia, Saskatchewan, Alberta (after her Royal Highness the Princess Louise), and Athabaska. They each have an area of about 100,000 square miles, so that the word smaller can only properly be used in a relative sense. The older provinces, including Manitoba, but excluding the more recently formed territories, have local Legislatures, which have authority in matters affecting civil rights and property, the administration of justice, education, control of municipal institututions, and other local questions; while the Dominion or Federal Parliament controls public debt and property, trade and commerce, postal service, census statistics, militia and defence, navigation and shipping, quarantine, currency and coinage, banking, weights and measures, bankruptcy, patents, copyrights, naturalisation, marriage and divorce, &c. At the head of the Government, and representing her Most Gracious Majesty, is the Governor-General, holding the position which was recently occupied with so much distinction by our noble Chairman. It is hardly necessary for me to say that under this system of government the country has greatly prospered. I think I may safely add that the members of the Society of Arts, and of that most valuable association, the Royal Colonial Institute, are not without hope that the principles of its confederation may in the near future be extended—not only to Australasia and the Cape, but that they may have a still wider application.

At the last Dominion census, in 1881, the population numbered 4,324,810, the larger proportion being of English, Irish, and Scotch origin. The French Canadians number, however, more than a million, and there are also to be found natives of most of the other countries of Europe. But few, if any, national prejudices are at work. Settlers soon become thoroughly Canadian, and call themselves so; and, should they come from the United Kingdom, do not forfeit the right of being also Englishmen and Englishwomen. In fact, the population of the Dominion—heterogeneous though its origin may be—is thoroughly loyal to the Queen, and to the Empire. Visitors are generally surprised to find that there is no poor-law system in Canada. There are no general poor rates, and none of the workhouses so common in this country; consequently there is but little vagrancy or beggary. In most of the large cities and towns there are benevolent societies (named after the patron saints of England, Ireland, and Scotland—St. George, St. Patrick, and St. Andrew) which deal with any cases of real distress that may arise, according to nationality. The Germans and French have similar institutions. The question of the population leads me to state a fact which I do not believe is as well known as it ought to be, that, compared with the United States, the growth of Canada has been more rapid than is supposed. In 1776, the former contained about 3,900,000 inhabitants, and in 1881 about 50,000,000, an increase of about 1,250 per cent.; Canada, on the other hand, at the census in 1784, numbered less than 150,000, while in 1881 it had advanced to 4,324,810, an addition of 3,000 per cent. In other respects, the progress of the country has been equally satisfactory, and in no way justifies the stigma that, until a few years ago, it was the custom to cast upon the energy, intelligence, and enterprise of the Canadians. Considering the disadvantages under which they have laboured; that their growth has been accomplished without much direct assistance from the mother country, and in competition with the great nation, their neighbour; that the western prairies of the United States have been accessible since 1840, while those of Canada have only had railway communication for about five years, I think it must be admitted, apart from possible national prejudices, that the progress of Canada has been very creditable to its people; and that they have endeavoured, in the words of Sir Alexander Galt, spoken at the Colonial Institute, in 1881, to prove worthy of the great race from which they have sprung.

The revenue, which in 1869 was about fourteen millions of dollars, had increased in 1872 to twenty-three millions, and in 1883 to to nearly thirty-six millions. The expenditure, according to the custom of most civilised countries, advanced also, but not for the whole of the time in an equal ratio. During the last three years, the surplus has amounted in the aggregate to about seventeen millions of dollars, which, as a general rule, has been applied to the reduction of the taxation of the country, and to the cost of the great public works that are now in progress. This will be understood by a reference to the public debt of Canada. In 1880, this amounted to 152,451,588 dols., and in 1882 had advanced to 153,661,650 dols., an increase of 1,000,000 dols. only, although in the same period 24,000,000 dols. had been expended on capital account. The customs duties form the foundation of the revenues of the Dominion, out of which grants are made to the provinces, according to population, towards the expenses of the local governments. Taxes are also imposed by the provinces for educational and other purposes, and by the municipal authorities. These, however, will compare favourably with those levied in other countries. With the increase in the revenue, the prosperity of the people has also been advancing. In the chartered banks the deposits have been growing rapidly, and this is still more apparent in the Dominion and Post-office Savings Banks. The amount standing to the credit of depositors in the latter institutions, in 1879, was 9,207,683 dols., and in 1882, 21,768,661 dols. A still further increase is apparent in 1883, but I am not in possession of the actual figures.

Trade and commerce have advanced by leaps and bounds since the confederation, and I trust you will excuse me if I trouble you with a few more figures. In 1868, the total exports and imports were valued at 130,000,000 dols., while in 1882 the figures were 221,556,000 dols. —an increase of 70 per cent. for fourteen years. The exports are divided into seven heads—the mine, the forest, fisheries, animals and their produce, farm and agricultural produce, manufactures, and miscellaneous. Timber, agricultural produce, and animals are among the most valuable of the exports, but the manufacturing industry is yearly becoming more important. It will have been seen by those who visited the late International Fisheries Exhibition, that Canada has immense wealth along her coasts, and in her rivers aud lakes. The produce of the fisheries in 1882 was valued at 16,800,000 dols.; about one-half was exported to different parts of the world. The important maritime position of Canada is well known. The total number of vessels on the register books on the 31st December, 1882, was 7,312, measuring 1,260,777 tons. Assuming the average value to be 30 dols. per ton, the value of this shipping would be about £7,500,000 sterling. The imports include raw material and manufactured goods. The proportion of the aggregate trade with Great Britain is very nearly fifty per cent., the balance being divided between the United States and other countries. There seems to be no reason why the development to which I have referred should not be as great in the years to come as it has been in the past. I do not mean to say that periods of depression may not be experienced; they occur in every country and under every condition of things, no matter what the fiscal policy has been, and may be described as "national medicine." They are not pleasant experiences, but are not without good results. Still, I must say that in Canada, and in the other Colonies, there should, in my opinion, be less chance of any serious difficulties of this kind than in some of the European countries. In the older provinces of Canada the population is growing rapidly; the area of land under cultivation is annually becoming larger (although there is still an immense extent of territory unoccupied), and the investment of capital in manufactures is increasing. I notice in the census of 1871, that there were in that year only twenty-two cities and towns with populations of 5,000 and upwards, aggregating 494,699. In 1881, the number had increased to thirty-seven, with 641,703 inhabitants. Manitoba and the North-West Territories (which did not appear to advantage in the last census, having at that time only had railway communication for three years) must not be left out of any calculations of the kind. Villages and towns are springing into existence within their boundaries, particularly along the route of the Canadian Pacific Railway, as the British Association will be able to judge this summer. These districts are progressing at a wonderful rate, and there can be no doubt that the future of Canada is largely connected with their development, and that of the Pacific Province of British Columbia.

I regret that the time at my disposal will not permit me to make some extended remarks respecting the public debt of Canada. I may say, generally, however, that it has been applied to the useful work of developing the country; in subsidising railways; in constructing the system of canals connecting the St. Lawrence with the Great Lakes; for lighthouses; the improvement of navigation; and other public works. It is not a record of war and bloodshed, but of peaceful and rapid progress. Many particulars of an interesting nature could also be given respecting the postal and telegraphic system, the various useful purposes for which electricity is utilised, the patent laws for the encouragement of inventions, copyright regulations, the franchise, and many other matters. Anyone, however, who reads a paper on a subject so vast as Canada, and who is limited to one hour, is obliged to omit much that might with advantage be said. I desire, however, to say a few words respecting the educational system; the laws in operation for the regulation of the liquor traffic; the railway and canal systems of the country; and the question of the climate which the Marquis of Lorne has properly described as the bugbear of the Dominion.

Long before School Boards were established in England, Canada was in the enjoyment of a well organised educational system. Every township is divided into sections sufficiently large for one school, and trustees are elected to undertake the management of the affairs. This is also the case in the cities and towns. In districts where the inhabitants are divided in their religious opinions, and mixed schools are not possible, the law enables separate schools to be provided. The necessary funds are raised partly by tax upon the ratepayers, and partly by grants from the provincial treasuries. Teachers are prepared and trained at normal schools, supported and maintained at the public expense. As a rule, no fees are charged. Education, however, does not rest at this point; for those who can afford it—and the cost is comparatively small — there are schools of a higher grade. In all parts of the country grammar schools are to be found, managed, like the common schools, by trustees. At these, as well as many excellent private schools, the pupils receive a classical education, and are trained and prepared for the legal and other professions. There are also colleges, possessing university powers, endowed with scholarships of considerable value, open to youths prepared in the lower schools. Toronto, Montreal, and other places have schools of medicine; while the various leading religious denominations have institutions at which young men are prepared for the ministry. For the higher education of girls there are excellent schools, many of which are denominational in character. Some of the schools have libraries of judiciously chosen collections of books for the use of the pupils. In fact, means of education, both for the rich and the poor, abound in the Dominion. In very many cases the children of immigrants who have arrived in Canada in a state of poverty, very little removed from absolute pauperism, have received a thorough education, and have secured the highest prizes the country offers.

In all the universities scientific education forms a part of the course in arts, and in most of them there are honour courses in natural and physical science. McGill College, Montreal, has a faculty of applied science, including the subjects of civil, mechanical, and mining engineering, and practical chemistry; and in its honour course prepares for field work in geology. The University of Toronto has similar courses. These institutions, as well as some others, have good chemical laboratories. Elementary science, more especially chemistry, botany, and physiology, is taught in most of the higher, and, more or less, in the lower schools. The teachers are prepared for work of the kind in the provincial normal schools, in which, among other things, agricultural chemistry is taught. There are also several well appointed agricultural colleges in the provinces of Ontario and Quebec.

The following are the principal scientific societies in Canada, and they all publish their transactions :—The Royal Society of Canada; The Natural History Society of Montreal; The Canadian Institute of Toronto; The Nova Scotia Institute of Science; The Natural History Society of St. John, New Brunswick; and the Scientific and Historical Society of Winnipeg. Such, in a few words, is the educational system of the country. I trust that one of the many results sure to follow the visit of the British Association will be the formation of a similar institution in the Dominion, and that it will do as valuable work in Canada as the old Association has accomplished in the United Kingdom.

The Dominion occupies a prominent position in connection with the promotion of temperance. In the great North-West, that we hear so much of, spirituous liquors are not allowed to be sold under any circumstances, in consequence of which the Indians in that territory occupy the satisfactory position they do today. At first sight this prohibition might be considered as not likely to be favourably regarded by the European, Canadian, or American settler. But the principle has been so far accepted, and its benefits recognised, that on the recent extension of the western boundary of Manitoba, the population in that portion of the North-West Territories which it was desired to include, petitioned that the prohibition should be continued. I hope the existence of regulations of this kind will not deter members of the British Association from taking the excursion through the country to the Rocky Mountains. The Lieut.-Governor of the province has power to give a "permit," that is, to allow a small quantity of alcoholic liquor to be conveyed by travellers, but it is exercised only in cases of illness, as a medical necessity. I state this as a matter of fact, and disclaim any intention of another nature, to which unkind persons might perhaps attribute it.

A new Act was passed during the last Dominion Parliament (it came into operation on the 1st of January), which, I think, will be very interesting, as showing the rapid progress that is being made in social reforms in Canada. The measure provides that the country shall be divided into license districts, identical, so far as possible and convenient, with existing counties, electoral districts, or cities. A Board of Licensing Commissioners, consisting of three persons, will be appointed in each district. One member of the Board must be a county-court judge, or other judicial officer; another the mayor of a city, or warden of a county, as the case may be; and one is to be appointed by the Government for one year. I mention this to show that every care is taken to ensure the important work being in good hands. A Chief License Inspector, and one or more inspectors, will be nominated by the Board in each district. The feature of the Act is that it determines the number of hotel and saloon licenses to be granted. In cities, towns, and incorporated villages, one license may be issued for every 250 of the first 1,000 of the population, and one for each full 500 in excess of that figure, but there may be two hotels in any town or incorporated village where the inhabitants number less than 500. In county towns five licenses may be granted. Two hotels beyond the number the population may warrant may be licensed for a period of six months, commencing on May 1 in each year, in any locality largely resorted to in the summer by visitors. In incorporated villages, townships, or parishes, no saloon licenses will be granted. Shop licenses, which authorise the holders to sell and dispose of any liquors—not less than one pint in quantity—not to be drunk in and upon the premises, may be granted, one for each 400 up to 1,200 of the population, and one for each 1,000 beyond. Any person applying for a license who is not already a licensee under the Act, or under any previous Act, must be supported by a certificate signed by one-third of the electors of the district. Ten or more electors, and in an unorganised division five or more, out of twenty householders, may object to any application, and can be heard by the Board, and it will be refused if two-thirds of the electors petition against it. Before any license is granted, the applicant must enter into a bond in the sum of

500 dols., with two sureties for 150 dols. each, for the payment of all fines and penalties which they may, for infractions of the law, be condemned to pay. No license will be granted by the Board within the limits of any town, incorporated village, township, or other municipality, excepting counties and cities, if three-fifths of the qualified electors have declared themselves in favour of a prohibition. Hotels and saloons and shops are prohibited to sell liquors from seven on Saturday night, till six on Monday morning, and from eleven at night till six in the morning on other days, except for medical purposes, under proper restraint. Lodgers in hotels may, however, be provided on Sundays, during meals, between the hours of one and three, and five and seven in the afternoon. The hotels and public houses are closed on the polling days for Dominion, provincial, or municipal elections. A very important provision enables two Justices to forbid any licensees to sell drink to any person who "by excessive drinking mis-spends, wastes, or lessens his or her estate, or greatly injures his or her health, &c.," in any city, town, or district in which the drunkard may be likely to resort. Another clause provides that any husband or wife, whose wife or husband may have contracted the habit of drinking intoxicating liquor to excess; the father, mother, curator, tutor, or employer of any person under the age of twenty-one afflicted with the same weakness; and the manager or person in charge of an asylum in which any person resides or is kept, may require the chief inspector of the district to give notice in writing to any person licensed to sell liquors that he is not to supply them to such interdicted person. If I have dwelt at some length on this subject, I hope you will forgive me; but knowing the importance with which the question—particularly with reference to local option—is regarded in this country, I ventured to believe that the experience of Canada might be interesting to you. The measure, as you will observe, is a very drastic one, but its principle has been well received, and it is the natural consequence of previous legislation.

The construction of railways in the Dominion of Canada has been very rapid since the confederation; and efforts are being made at the present moment to extend and complete the system. In 1870, there were only 2,497 miles open for traffic; in June, 1882, this had increased to 8,069 miles, and in the last eighteen months another 1,000 miles, at least, have been added. There are now, therefore, over 9,000 miles in operation, affording means of communication from the province of Nova Scotia to Ontario, and again from the western shores of Lake Superior to Winnipeg, and through the North-West Territories to the Rocky Mountains. The total amount of capital invested in the construction and equipment of railways in Canada, to the end of the fiscal year, 1882, was 389,285,700 dols. The Canadian Pacific Railway—one of the greatest national undertakings of the age—is being rapidly constructed. It is nearly ready for operation from Montreal to Algoma Mills, on Georgian Bay, and is now being worked from Port Arthur, on Lake Superior, to the Rocky Mountains, a distance of nearly 1,400 miles; and from Winnipeg south to the international boundary, where it connects with the United States railway system. Large numbers of men are being employed on the other sections of the line, and it is confidently expected that in 1886 there will be direct communication from the Maritime Provinces to the Pacific coast entirely through Canadian territory, the importance of which, to Canada and to the British Empire, it is impossible to exaggerate. Many persons may remember that at the last meeting of the Association at Southport, Sir Charles Tupper, the High Commissioner for Canada, also Minister of Railways and Canals, gave a most interesting and graphic description of the railway; and there is no one better qualified to speak respecting it. Prior to 1881, the work was being carried out by the Government; but in that year it was transferred by Act of Parliament to the Canadian Pacific Railway Company. There are about 2,000 miles constructed at the present time, and the track has been laid during the past season at the rate of between three and four miles per day. The difficult work in British Columbia, and on the northern shore of Lake Superior, is being accelerated as much as possible. The line, when complete, will, including branches, be about 3,300 miles long. It has been largely subsidised by the Government, and the work would have been an onerous one for a country with a much larger population than that of Canada. The completion of the line must have a great effect upon British Columbia. That province has not yet been in the enjoyment of railway communication with the other parts of the Dominion, but as soon as this is accomplished, its natural resources and favourable climate will ensure its taking an important position, as it is the only British possession on the Pacific coast of the American continent.

The inland navigation of the Dominion has cost a large sum of money, but is a work of which the country may well be proud. The canals were constructed to overcome the obstructions of river and lake navigation. What is the result? Vessels of 600 tons can now proceed from the western end of Lake Superior, and from the United States ports of that vast inland sea, to Montreal, by way of Lakes Huron, Erie, and Ontario, and the River St. Lawrence—a distance of nearly 1,300 miles. The locks on the Welland Canal, connecting Lakes Erie and Ontario—rendered necessary by the Niagara Falls—have recently been enlarged, and are now 270 feet long, 45 feet wide, and 14 feet deep. The Canadian route, from the lakes to the ports of transhipment, compared with that to New York and other American ports, possesses some advantages. In the year 1882, abont 3,000,000 bushels of grain from the United States were, in consequence, shipped to Europe from Montreal. Take, for instance, the distance from Chicago, on Lake Michigan. It is nearer by some 150 miles to Montreal than it is to New York, *viâ* Buffalo and Erie Canal; and there are 16 more locks and 89½ feet more lockage by the American than by the Canadian route. In addition, Montreal is 300 miles nearer to England than New York. Atlantic steamers of 5,000 tons can now be moored alongside the wharves at Quebec and Montreal.

The question of the condition and progress of the Indians in the different parts of Canada is always an interesting one. They number about 100,000, and are, probably, in a more satisfactory position than the aboriginal inhabitants of many other portions of the empire. There is a special department of State, under the able administration of Sir John Macdonald, entrusted with Indian affairs. Efforts are being made for the elementary education of the children, and, according to the latest information, there is a regular attendance in such schools of about 4,000. In addition, there are farms and industrial schools for their tuition in agriculture and in industrial pursuits. The following is an extract from the Report of the Superintendent-General of Indian affairs, presented to the Canadian Parliament during its last session:—

"The increased desire among Indians of the older provinces for additional schools, on reserves on which none have as yet been established, or where those already in operation are deemed insufficient, may be regarded as an indication that the much to be desired demand for enfranchisement on the part of some, not of many, of the bands, may follow as the result of this inclination for further enlightenment, and every facility, compatible with reason, to enable them to become enfranchised, should be offered those anxious for the step. The law might possibly be, with advantage, amended in this respect, so as to give those desirous of enfranchisement increased facilities for accomplishing their object."

This must be regarded as a very satisfactory statement.

The condition of the Indians in the North-West Territory, considering that they have only been under the direct control of the Government for a few years, is also encouraging. Sir John Macdonald says:—

"I am glad to be able to report that the advanced condition of the Indians settled upon reserves in several localities in the territories admitted of the closing, during the past season, of the instructor's farms in those localities. The object for which they were established, namely, the practical exemplification to the Indians of the manner in which farms should be managed, has been attained. It is hoped that next autumn the Indians in several other localities will be sufficiently advanced to admit of a similar change being effected."

It is not to be supposed, however, that, although these farms have been closed, the Indians will be left without oversight in their agricultural operations, as they might, in such circumstances, rapidly relapse into their old habits. Competent and reliable men will be placed on each reserve to encourage and direct their efforts.

The judicious treatment of the Indians by the Government in all their dealings with them is sure to have its effect in the future. The Bishop of Saskatchewan, in a very interesting address delivered last year, said:—

"By-and-bye I have no doubt that we shall see a very grand result in the Dominion of Canada in reference to these Indians. I am one of those hopeful individuals who look forward to the day when we shall see the Indian population making their bread honestly side by side with the white men, who have come into the country as immigrants; and all this will be the direct result of that eminently wise and farseeing and thoroughly English policy which has been so consistently pursued by those who conduct the destinies of the Government of Canada."

It has often struck me as a significant fact that the complaints against the climate are made to refer, at the present time particularly, to Manitoba and the North-West Territories. It will be remembered, however, that the statements now being made respecting

Manitoba were formerly applied to Ontario, Quebec, Nova Scotia, and New Brunswick. These provinces, it is said, never grow fruit to any extent; it would be impossible that they should ever become famous for raising cattle; and the season is manifestly too short to permit of agricultural operations being carried on successfully and profitably. It is hardly necessary to state how completely these prophecies have been falsified. Canada has a reputation for fruit far beyond its boundaries. Canadian apples probably bring the highest price of any that are imported into the English markets. Those who have visited the country will know that it is famous for many other fruits besides apples, and that many species grown in England under glass, flourish there in the open air. An important portion of a recent article in the *Times* on "Fruit Culture" was devoted to Canada. As a cattle country it is taking an important position. Not only are there sufficient cattle and sheep and other animals to supply the demands of its own population, but on an average about 60,000 to 70,000 head of cattle, and 300,000 sheep are exported annually. The larger proportion of the cattle are sent to Great Britain, while the sheep principally go to the United States. There are many articles of Canadian farm produce which have attracted considerable notice in this country. The total value of the exports under the heading of "Animals and their Produce," in 1882, was 20,500,000 dols.; of this, the United States took about 6,500,000 dols., representing, chiefly, horses, horned cattle, sheep, butter, and eggs.

With regard to agriculture, a good deal of misapprehension seems to prevail; but that the climate is not in any way unsuited to that important pursuit, is proved by the increase of the population, the largely extending area of land brought under cultivation, and the rapidly increasing quantity of the produce that is grown and exported. In 1882, the value of the agricultural exports was 31,000,000 dols.; of this, 18,000,000 dols. represents barley, oats, rye, wheat, hay, potatoes, &c., sent to the United States. It is not generally understood that the farmer in Canada has to perform in the winter very much the same sort of work as the farmer in this country; after the harvest is over, he does as much ploughing as possible, and this is the case in England. Very little actual work is done on the land in either country during mid-winter, for equally obvious though different reasons. But cattle have to be fed, cereals threshed, machinery put in order, buildings repaired, and carting done, which latter, by the way, the Canadian farmer owing to the snow, is able to do very cheaply. Then again, snow in Canada is not considered a disadvantage; it destroys insects and pulverises the soil. It may be that the spring commences two or three weeks later than in England; yet the conditions for the rapid growth of all produce are so favourable that the crops of the two countries are about equally advanced by the middle of July. It is commonly stated, even now, that Canada has an eight-months winter. I feel that it is hardly complimentary to the intelligence of this audience to notice such a remark seriously, but I came across some very interesting statistics the other day which seem to me to refute, very clearly and forcibly, statements of this kind, I refer to the dates of the opening and closing of the navigation of the St. Lawrence during the last twenty years, and of the canals connecting the river with the great lakes. I find that, at Montreal, the river on an average, for the last ten years, was closed for navigation 141 days annually; at Toronto, 123 days; and on the Welland Canal about the same period. In considering these figures it must be remembered that, although navigation is reported as closing or opening on a particular day, the river or canals are properly navigable for several days in addition, as the steamers and other vessels have to leave before the frost commences, and they do not enter the river for some days after there is open water. The average winter may, therefore, be taken at about four and a-half months—sometimes it is longer or shorter by a few days. Between Manitoba and the North-West and Ontario, there are a few days' difference in favour of the latter. British Columbia probably posseses the finest climate in North America; it has all the advantages of that of England, without its disadvantages. Ask a Canadian, or an Englishman who has spent a winter in the Dominion, which he prefers, the climate of Canada or that of this country, and you will find that he will not hesitate in his answer.

The cold is not always to be estimated by the thermometer. The humidity of the atmosphere is the real criterion by which the effects of the temperature must be judged. I have worn in England clothing as warm as I have found necessary in Canada. If the climate were as humid as that of Great Britain, the low temperatures that prevail might be detrimental; but the dryness of the air prevents any such consequences, and the country is a very healthy one. Another thing, in Canada one is always prepared for the cold. Here it is not so. It is not usual there for ladies to put on shawls when passing from one room to another. In winter the houses are far warmer than in this country.

In the spring you will find wild flowers as prevalent as in England; and in August, wild fruits and delicate ferns abound. Besides, if the climate were the wretched one that has been described by persons who have but little knowledge of it, and so detrimental to the prosperity and progress of the country, so many people would not have gone there, and the population and the agricultural industry would not have increased with the rapidity that is now apparent.

Having endeavoured briefly to give an idea of Canada, as it will appear in several aspects to the members of the British Association, I will now make a few remarks respecting Montreal, and some of the excursions to be undertaken after the meetings are over.

The first thing that strikes the visitor to Montreal is the grandeur of the River St. Lawrence, and the splendid position the city occupies. It is situated on the left bank of the river, at the south-east corner of a triangular island formed by the mouths of the River Ottawa, where, after a course of 600 miles, it enters the St. Lawrence. The waters of the two rivers do not at once mingle; the line of junction is apparent for many miles—the clear blue water of the St. Lawrence washing the right hand, and the turbid stream of the Ottawa the left hand, bank. The city is built on a series of terraces rising towards Mount Royal, from which it takes its name. The summit of the mountain—as it is there called—is about 700 feet above the level of the river. I have seen no place of its size (its population numbers about 190,000) which contains so many fine buildings, both for business and residential purposes.

A whole paper could very easily be written about Montreal, and a very interesting one it would be. In the business portion one cannot but be impressed with the splendid piles of warehouses and premises, giving it an appearance of solidity not very common in colonial cities, while up towards the base of the mountain will be found street after street of handsome residences, hardly to be surpassed even in England. Then to climb up to the mountain and see the city stretching beneath you, with the river in the distance spanned by the Victoria-bridge, is a sight that once seen will not soon be forgotten. Montreal is known in America as the city of churches, and some of them are very fine specimens of architecture. Mark Twain, in a speech at the Windsor Hotel, not very long ago, said that "he never was in a city before where one could not throw a brick-bat without breaking a church window." I will not say that the churches are quite so numerous as the remark would imply. Whether the people are, however, better than their neighbours for their religious surroundings, I shall leave their visitors to judge.

Montreal is the chief commercial city of Canada, and although it is 900 miles from the ocean, the largest steamers crossing the Atlantic will be found moored along the wharves. Between Quebec and Montreal there is always a depth of 30 feet of water, excepting for a distance of thirty miles, chiefly in the lake St. Peter. In 1851, when the work of deepening the channel at this part of the river was commenced by the Harbour Commissioners of Montreal, there was not more that 11 feet of water on the flats of the lake. This, however, has now been increased to 26 feet, and the artificial channel is 300 feet wide at its narrowest part. This great engineering work has made Montreal. Had it not been accomplished it could not have occupied the position it does to-day. The total length of the wharf accommodation is $4\frac{3}{4}$ miles, of which two-thirds is available for vessels drawing 25 feet. It has every convenience for loading and dispatching ships, and I remember myself that on one occasion a large ocean-going vessel arrived one day and was unloaded, re-loaded, and despatched the next day. A walk along the river street will give an idea of the bustle and activity of the place. The wharves at which the ships discharge are several feet below the level of the road, so that the whole proceedings can be surveyed at a glance. Not only is Montreal the Liverpool of Canada, but it is a large and growing manufacturing centre. A fitting companion to the splendid wharves and shipping accommodation is the Victoria-bridge, designed by Robert Stephenson, which must be considered one of the finest structures of the kind in the world. It is 9,184 feet long—in fact, nearly 2 miles—and carries the Grand Trunk Railway over the St. Lawrence. The first stone was laid in July, 1854, and the first passenger train passed over it on the 19th December, 1859. The total cost amounted to £1,200,000.

The appearance of the city from the river is very attractive. Mr. W. D. Howells, the American writer, says of it:—

"For miles the water front of Montreal is superbly faced with quays and locks of solid stone masonry, and thus she is clean and beautiful to the very feet. Stately piles of architecture, instead of old tumble-down warehouses that dishonour the waterside in most cities, rise from the broad wharves, behind these spring the twin towers of Notre Dame, and the steeples of the other churches above the roofs."

Of the view from the tower of the Parish Church of Notre Dame, which is 220 feet high, he says in one of his works:—

"So far as the eye reaches it dwells upon what is magnificent. All the features of that landscape are grand. Below you spreads the city, which has less that is really mean in it than any other city of our continent, and which is everywhere ennobled by stately civic edifices, adorned by stately churches, and skirted by full-foliaged avenues of mansions and villas. Behind it rises the beautiful mountain, green with woods and gardens to its crest, and flanked on the east by an endless fertile plain, and on the west by another expanse, through which the Ottawa rushes, turbid and dark, to its confluence with the St. Lawrence. Then those two mighty streams commingled, flow past the city, lighting up the vast country to the south, while upon the utmost southern verge, as on the northern, rise the cloudy summits of far-off mountains."

The British Association will probably hold its sectional meetings in the buildings of the McGill University. This institution owes its origin to a Montreal citizen, James McGill, who died in 1813, leaving a fortune valued at that time at £30,000, for the purpose. The property of the college is now estimated at more than half a million dollars. The latest large benefaction which it has received is the Peter Redpath Museum, valued at more than 100,000 dols. This was opened in 1882, and was the gift of a gentleman of that name. Its forty professors and lecturers include some of the most eminent men in their department in the Dominion, and its students may be stated in round numbers at about 500. It has four faculties—arts, applied science, medicine, and law. Being non-denominational, it has no theological faculty, but it offers advantageous terms of affiliation to colleges where such degrees may be obtained. There are other excellent educational institutions in the city.

There are many objects of interest in and around Montreal well worth seeing, for which facilities will be provided. Means of conveyance are abundant, excellent, and moderate in cost. I would specially mention the Lachine Rapids; but there are others too numerous for me to mention. Further afield are Quebec, Ottawa, the capital of the Dominion (the residence of the Governor-General), with its splendid Parliament buildings, and its miniature Niagara; the eastern townships of Quebec, with their romantic lake and landscape scenery; and there are also excursions through the famous Thousand Islands of the St. Lawrence. Niagara Falls will certainly not be omitted. I have said a good deal of Montreal in this paper, but it is not the only city worth visiting by any means. In addition to Quebec and Ottawa, there are Toronto (known as the "Queen City of the West"), Hamilton, London, and many others; while the maritime provinces of Nova Scotia and New Brunswick will be very interesting to those who are able to visit them on the journey home, embarking at Halifax for England.

The principal excursion will be to Winnipeg and the Rocky Mountains. The present arrangement is for a special train to start from Montreal over the Canadian Pacific Railway to Algoma Mills on Georgian Bay. At this point passengers will embark on board the new large steel steamships of the Company, and proceed to Port Arthur, at the western end of Lake Superior, the voyage occupying about twenty-four hours. The scenery through the lake is grand and picturesque. From Port Arthur the party will be conveyed by rail to Winnipeg, where, I imagine, a short stay will be made. This city was formerly known as Fort Garry, one of the posts of the Hudson's Bay Company. In 1870, when the Territories were taken over by the Government, the population numbered a few hundreds. Now it is estimated to contain 30,000 people. The journey from Winnipeg to the Rocky Mountains will probably take about two or three days, according to the stoppages that are made on the way. The North-West Territories, *i.e.*, that portion of the country between the boundary of the Province of Manitoba and the Rocky Mountains, are estimated to contain about 250,000 people, while a few years ago the only inhabitants were the Indians. I must not, however, omit to mention the officers of the Hudson's Bay Company, and those devoted servants of the Church to whose fair treatment, careful management, and civilising influences, the satisfactory position which the Indians occupy to day is greatly due. The country is dotted with settlements here and there, formed by men from England, Ireland, Scotland, and different parts of Europe, besides Canadians and Americans, who have removed their homes to this region. The "illimitable wilderness" as the late Lord Beaconsfield described it, is gradually being cultivated; and golden fields of wheat, and other cereals, are taking the place of those vast seas of grass which formerly covered the prairies. It is truly said that he is a public benefactor who causes two blades of grass to grow where but one grew before, and in my opinion the same remark will apply to those who, in Manitoba and the great North-West, have made fields of wheat to grow where but wild grasses flourished before.

The visit will also be most important from ethnical and anthropological views, from the investigation by our scientific men of the vast extent of treeless prairie they will pass over, and in connection with the geological features of the country. For a time it was said that its settlement would never be possible owing to the absence of timber, both for building and fuel. Both these difficulties have been removed by the discovery that immense forests exist, and that beds of coal and lignite underlie the whole of the western portions of the territory. Those who were present when the Marquis of Lorne read his recent interesting paper at Exeter-hall, will remember having seen a specimen of the coal in the room. It has since been subjected to analysis, at the Royal School of Mines, with most satisfactory results, and it is stated to be suitable for both domestic and mechanical purposes. In this connection I call to mind a remark made by the Bishop of Saskatchewan on the occasion to which I have previously referred, to the effect that if the country had not been intended to provide homes for millions of our fellow men, Providence would never have placed the hidden treasure of an inexhaustible coal supply there for the use of man.

Emigration may not be a matter connected with abstract science, but I do not think my paper would be complete without some reference to it. It is an economical problem of immense importance both to Great Britain and to Canada. Here there are thousands upon thousands who are unable to procure a living, and the wonder is that they manage to exist at all. In Canada there are millions of acres of land practically unoccupied, capable of affording food and employment for any number of people. It is an admitted fact that some outlet must be found for the surplus population of this country, and it is equally necessary for Canada to add to its population. The annual increase in the number of its inhabitants is small compared with the extent of the land waiting to be occupied, and the rapid development of the country is therefore very much connected with the question of emigration.

Five millions of people have left Great Britain during the last thirty years, of whom 1,400,000 have gone to the Colonies, and 3,300,000 to the United States. If means could have been found, years ago, to direct this stream of wealth to our own possessions, they would have occupied a much greater position than they do to-day. The Empire would have been much stronger, and the stream would have continued to flow in that direction to the advantage of our trade and commerce. It would for ever have settled the question of the food supply of the country, besides many other subjects that are now troubling economists.

The Canadian Government has been endeavouring, and, considering all the circumstances, with some success, to encourage settlement in the Dominion. Not only are "assisted passages" offered to the different kinds of labour—particularly farm and general labourers, certain classes of mechanics, and domestic servants—which have been in great demand during the last few years, but free grants of land may be obtained by those who are able to command a small capital. In the older provinces, these are covered with bush, and are not, therefore, altogether suitable for European settlers; but in Manitoba and the North-West Territories there are millions of acres of fertile land available, ready for the plough, and any *boná-fide* settler may obtain 160 acres on payment of £2, to cover the cost of the survey and the preparation of the necessary documents; he has also the right to pre-empt a similar quantity at from 8s. to 10s. per acre. Before obtaining a title to the land, the settler is obliged to reside on the homestead at least six months, annually, for three years, and to perform certain minor conditions of a not very onerous nature, viz., to put a reasonable but undefined portion of the ground under cultivation, and to erect a house.

For those who are possessed of capital, and do not desire to brave the exigencies of pioneer life, improved farms—farms under partial cultivation, with the necessary buildings erected, &c.—can be purchased in every province at from £2 to £20 per acre, according to position, and the conveniences that are offered.

As a general rule, the emigration to Canada, during the last few years, of which I have personal knowledge, has been both satisfactory to the Dominion and to the people who have settled there. Thousands of persons have proceeded to the country during that period, through the offices of the Canadian Government, and I am able to say that hardly a complaint has been received from any such persons, that they were not satisfied with their reception, or with their prospects. This is a particularly gratifying fact. The conditions of successful settlement are very similar to those which will command success anywhere. If a man is prepared to work and adapt himself to circumstances, there is no reason whatever why he should not, with ordinary good fortune, do well in Canada. The Colonies are certainly not the places for what are known as "soft things," and I have no doubt that some of the failures of which we hear arise from unrealised expectations of the kind, or from the persons having proceeded without obtaining proper advice as to whether they are suitable, and as to what they should do on their arrival. There are agents of the Government in every important place, to whom new setlers of every class are directed to proceed, with the certainty of receiving proper advice and, almost invariably, where it is necessary, assistance in obtaining employment.

I have no doubt that when the members of the British Association see the enormous resources and capabilities of Canada, and its suitability for the absorption of an immense population, their thoughts will revert to the condition of things as they are now to be found, not only in this country but in other parts of Europe, and one good object will have been served if the visit should result in some well organised and systematic proposal for a remedy of the evils, resulting from the rapid increase of the population, and the competition in the labour market, which have recently been attracting so much attention.

In a few days a circular will be issued by the British Association, explaining in detail the arrangements that have been made in connection with the meeting in Montreal; but I have, in advance, endeavoured to place before you, briefly, some of the more prominent of the social, political, and commercial aspects of the country at the present time. If I have not succeeded as well as I should have liked, I have the satisfaction of knowing that among those present, there are many eminently qualified to supply any deficiencies of which I may have been guilty. There is every reason to believe that the gathering will be a success in every way, and I trust the Association will bring back with them very pleasant reminiscenses of the occasion — as warm and as cordial as the feelings of satisfaction and pleasure with which they will be received, not only in Montreal, but throughout the Dominion.

DISCUSSION.

The CHAIRMAN, in inviting remarks on the paper, said he believed there were many members of the British Association present, who would be glad to hear a few remarks from Sir Alexander Galt, who besides his many other claims to their attention, had long been a resident in Montreal.

Sir ALEXANDER GALT shared in the gratification they must all have felt at hearing the very excellent paper of Mr. Colmer. The Canadian Government were fortunate in being represented by that gentlemen on this occasion, and the members of the British Association were no doubt well aware that he had been one of the most active in bringing about the visit to which they all looked forward with so much pleasure this summer. Mr. Colmer, in his lucid statement, had touched upon many of the points which would certainly attract the attention of the members of the British Association, or indeed of any stranger who might visit the country. In Canada they looked forward to receiving the greatest advantage from that visit, when they would have in their midst gentlemen of the highest scientific ability, bringing with them the knowledge they had gained in Europe, and he ventured to think that the benefit would be reciprocal. Up to this time, the British Association had confined their meetings entirely to this country, and they had not "in the midst of our old civilisation" had placed before them, as they would have in Canada, the conditions under which the bonds of society were created. Many of the problems which had been of late receiving the attention of intelligent men here would be seen to have found a partial, if not a complete, solution in Canada. Mr. Colmer had referred to the educational and municipal systems there, and to the regulations to which the trade in intoxicating liquors was now subjected. Those were all questions which had been dealt with by a people who were freer, in the sense of having more votes, than the people of England. Those measures were the results of a very popular system indeed, and great advantage would be found in studying the application of such principles to this country. Canada certainly possessed a better municipal system than we have here, and by studying it they would be able to avoid many obstacles, and to take advantage of a system which was sound in principle. In fact, the visit of the British Association would be useful not only to the Colony, but to the whole empire. At the present time they had Mr. George among them here, giving them lessons on the nationalisation of the land; but it was strange that it had not occurred to that gentleman, an American himself, that within the last ten years there had been in Canada enormous tracts of land which had been absolutely in possession of the people, and without an owner, and what had they done with it? They had found that land without inhabitants was good for nothing, and that security of possession was what gave value to the land, as it gave value to everything else. Take away the security of possession, all the value was destroyed. They had not made their 200,000,000 acres of land in the North-West one great farm which anyone might go upon and cultivate, and which the stronger man might elbow his neighbour out of, but it was ready now to be taken up on payment of a small sum per acre. It was, in one sense, God's gift to man, and he was happy to say that man in Canada was not withholding it from his fellow creatures.

Mr. STAVELEY HILL, Q.C., M.P., in reference to Mr. Colmer's remarks upon Canada in the future, said it was often remarked that no man should prophesy unless he knows, but that qualification belonged pre-eminently to Mr. Colmer, because nobody knew better than he what were the existing conditions there. He envied the British Association their first view of Canada, and then, following the line suggested by Mr. Colmer up the St. Lawrence past Montreal, across the lakes to Winnipeg, and from Winnipeg over the boundless prairie up to the Rocky Mountains, they would have something to see the like of which they had never seen before, and much also to learn. But really from England to the Rocky Mountains was not now so far as people had been accustomed to consider it. It was often said what a pity it was that people should go so far from home, but after they had been five or six times across the Atlantic they would think no more of it than of crossing the Channel, and it was certainly far preferable to do so, on the score of comfort. They would have great pleasure not only in the scenery but in studying the Indians, the old inhabitants of the country, and they would find them, savages it might be, yet still rendered a happy people by the kind and just treatment they had ever received from the Government of Canada. They would come back impressed with the aspect of a country which had a great future before it, and in which poor people leaving England would find happy homes and plenty to give them enjoyment in life. Going there emigrants would none the less look upon England as their home because they were settled in Canada. It should be impressed upon all how necessary it was that Canada should be still more closely connected with this country, and that the time might come when our Parliament should be not the Parliament of the British Isles alone, but the Parliament of our federated Empire throughout the world.

The BISHOP OF SASKATCHEWAN said that for twenty-five years he had lived in Canada; for the first five in Ontario, and for the last seventeen in Manitoba and the North-West Territory. For ten years past he had been Bishop of Saskatchewan, and had travelled over the whole of that vast country. He could endorse every word Mr. Colmer had said. That gentleman had told them that of the 5,000,000 people who had left the shores of Great Britain within the last thirty years, some 3,400,000 had gone to the United States, and it was a grave question to ask what that meant commercially to England? How many of those emigrants were trained artisans? The exact money value of a trained mechanic to a country could be calculated, and it would easily be seen what the United States had gained, and what England had lost, by that one fact. And he would ask the same question politically—What did that fact mean? In the early days of Canada, emigrants wended their way to the plains of the Far West of the United States; but that was now changed, for it was found that Canada too had plains of her own inferior to none. How many of those 3,400,000 emigrants had taken the oath of allegiance as citizens of the United States? No emigrant could obtain the privileges of an American citizen without doing so; and that fact should come home to Englishmen, for by that oath they swore to discard all fealty to Queen Victoria and their native land. That was something terrible to contemplate in the event of a war between England and the United States Professionally, he was a man of peace, but he preferred peace with honour to peace at any price. The Canadian fisheries were mentioned also in the paper, and it should be known how important they were, and what an enormous stretch of coast Canada afforded for the promotion of that industry. But there was a great political question connected with that, too. It was of the highest importance to England that she should retain the coast which formed a nursery for hardy seamen, for the day had not yet gone by when the fleet must be considered the great safeguard of the liberties of England. It was necessary that England should have in the future a still larger naval reserve than she had in the past, and where, outside England, would she be able so well to obtain it as on that magnificent line of seaboard round the great Canadian Dominion. With reference to the climate of the great North-West, Manitoba was, no doubt, cold, but it was a healthy cold. He had been seventeen years in that territory, and had never suffered from it, though he had traversed the great snowfields for hundreds of miles north of the point where there were likely to be any settlements for the next fifty years, camping out, in the months of January and February, in the open with no covering but the sky. Mr. Colmer had mentioned, too, the way in which the Indians had been dealt with, both by the Hudson's Bay Company and the Government. In that respect the action of the Hudson's Bay Company had been beyond all praise, and their officers, who had had the management of the Indians during bygone years, had paved the way for the peaceable position of the Government in the magnificent North-West. Then Mr. Colmer had spoken of the educational interests of the country. The Chairman would remember that while he was Governor-General, the Dominion Parliament had passed a Bill for instituting a university in the Saskatchewan district, and the reason why he (the Bishop) was in England to-day, instead of in his diocese, was that he was trying to meet the requirements of the Bill for establishing that university on the banks of the Saskatchewan, where, a few years ago, there were no inhabitants but wild Indians and the buffaloes. That fact showed how well the Canadian Legislature were caring for the education of every man who came into the country.

Capt. J. C. R. Colomb wished to avoid taking a merely abstract view of the subject, while losing sight of the particular identity of the country under view. Remembering that the exports and imports of Canada were now in excess of the total exports and imports of France at the time the British Association was founded, they would obtain some idea of the progress of the country; and the tonnage entered and cleared last year from Canadian ports was double the aggregate tonnage entered and cleared in the ports of the United Kingdom, when the British Association held its first meeting at York. The completion of the Canadian Pacific Railway was but the carrying out of the policy which dated back to the days of Queen Elizabeth, to make for England a highway across the world. From the days of Drake down to the time of Franklin, efforts had been directed to the discovery of a short cut to the Pacific. He believed in the ability of the British Empire to stand firm and secure when the hour of danger came, but the real danger was not of invasion, it was the possible failure of the food supply. With the sea threatened, one-half of the population of England would find their food supply cut off; but that great railway would open up a country to them where they could grow their food on their own flank, and no longer be dependent on their present eighteen different sources of supply. Their command of the sea in the Pacific largely depended upon their ability to hold that valuable portion of the territory, British Columbia. From that point down to Cape Horn, there was no coal, and there alone could they obtain the coal necessary to enable the English fleet to keep the sea. Isolated, it could not be utilised, but now the whole of our naval force could be fed by that railway. It would also give greater facilities for populating and developing the territory. England last year voted £100,000 for a State-aided emigration scheme, and 16,000 people had been sent away from Ireland; but for one man who had been sent to Canada, ten had been sent to foreign countries. He did not think Englishmen realised what Parliament was doing in that respect. They were facilitating the transfer at the public expense of men who would be valuable producers under our own flag, to territory under a foreign flag. From the few families who had emigrated to Canada, he had not seen one single bad account, while he had heard very bad accounts from families who had gone to the States.

Captain Bedford Pim, R.N., said it was one of the happiest days in his life when he found the British Association intended to go over to Canada, and he was heartily glad to say he was himself partly responsible for it. He quite believed in temperance, and that temperance had made the Canadians what they were; but he hoped the British Association would not suffer any inconvenience from the strict carrying out of those principles. As to the great value of the Canada Pacific Railway, Captain Maury had told him, that when it was made, it would be the return route for the whole of the commerce from China and Japan, though outwardly this might go by San Francisco. That was an idea which was worth noting, and which, perhaps, had not yet presented itself to the statesmen of the Dominion. The Marquis of Lorne had alluded to the creation of an association there for the advancement of science, and he hoped that would be one of the results of the visit of the British Association, to whom he wished every possible enjoyment.

Mr. Cornelius Walford referred to the great advance made by Canada since 1851. For a long time the Dominion had stood still, and the States appeared to have made a very rapid march ahead of her; but at that time they had not the facilities which they now possessed since railway enterprise had set in. Toronto alone had fourteen lines of railway radiating away from it, and would become one of the great centres of Canadian commerce. It must be felt that the present policy of the Canadian Government, in opening railways, was the right policy, and the visitors would see that there was really room for everybody who wanted to go to the country. Doubtless, some of the emigrants who had started for Canada were not adapted for the life there, and people who went to Canada should be capable of earning their living out in the country. Even if there had been people to cultivate it before, it would have been of no use to the population of this country, because there were no facilities for bringing the produce down; but now that that they had them, the progress of Canada would be equal to that of the States. Canada was now in every way a flourishing country, and he hoped to live to see the day when the Dominion and all the Colonial possessions of Great Britain would form one United Empire.

The Chairman said they were all very much indebted to Mr. Colmer for his excellent paper. He could not express how glad he was that the British Association had decided to make the voyage to Canada. He did not think they would find it a very formidable one. It was but a short one after all—six days at sea was not a very great matter, and it must be remembered that they would have two days in the St. Lawrence before they reached Quebec. He would advise them not to land there, but to go straight on to Montreal. Quebec was well worth seeing, but it could be easily visited afterwards. The members of the Association would find awaiting them an organised society ready to provide them with every facility they could require. A Royal Society had been founded in Canada, and some of the most distinguished men had given their names as members of it. One other point he would refer to was the geology of Canada. As they were aware, Nova Scotia presented specimens of almost every measure, from the oldest to the newest. It was in the cretaceous measures that the excellent coal was found which was now being got by Sir Alexander Galt. It was similar to that which was found in Vancouver's Island, and no better coal existed. He asked the meeting to join in a cordial vote of thanks to Mr. Colmer for his very interesting paper.

Mr. COLMER briefly thanked the gentlemen who had taken part in the discussion for their assistance in elucidating the subject, and the meeting generally for the kind attention they had accorded to him.

EIGHTH ORDINARY MEETING.

Wednesday, January 30th, 1884: Prof. W. CHANDLER ROBERTS, F.R.S., F.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Chaimsonovitz, Elieson Prosper, 7, Drayton-terrace, Drayton-road, Leytonstone, E.
Colthurst, Sir George St. John, Bart., Blarney Castle, Co. Cork.
Dalton, William Henry, 118, Gower-street, W.C., and Melbourne, Australia.
Knowles, Thomas, Fir Tree-cottage, Turton, near Bolton.
Miller, John Ezra, 1, Tunstall-road, Sunderland.
Nicholson, Robert, J.P., Loanend-house, Norham, near Berwick-on-Tweed.
Pengelly, Thomas, Bodriggy-villas, Hayle, Cornwall.
Richardson, H. Cameron, 2, Carlton-villas, Elm-park-road, Finchley, N.
Sadler, Lieut.-Colonel, The Southlands, Preston-on-Tees, *viâ* Darlington.
Scott, Major-General Alexander de Courcy, Woodfield, Lytton-grove, Putney-hill, S.W.
Staples, Henry John, 87, Avenue-road, Regent's-park, N.W.
Thornton, Thomas Henry, C.S.I., D.C.L., Leigham Holme, Streatham, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Bentley, Richard, Upton, Slough, Bucks.
Cameron, Lieut.-Colonel Donald Roderick, R.A., 10, Hornton-street, Kensington, W.
Clapp, William John, Nantyglo, Monmouthshire.
Glover, James, B.A., 30, Crosby-road, Birkdale, Southport.
Godwin, John, 19, St. Mary Abbotts-terrace, Kensington, W.
Graham, Mrs., 40, Woodstock-road, Bedford-park, Chiswick.
Head, John Merrick, London-road, Reigate, Surrey.
Huntington, Charles P., Astley Bank, Darwen, Lancashire.
Leeming, Thomas Henry, 2, Lee-terrace, Barking-road, Plaistow, E.
Mackenzie, Colin, Junior Athenæum Club, 116, Piccadilly, W.
Morris, Malcolm, 63, Montagu-square, W.
Newton, Henry Charles, Belsize-court, Hampstead, N.W.
Phelips, Richard Charles Hungerford, Cucklington Somerset.
Pike, Luke Owen, 201, Maida-vale, W.
Renouf, Philip Louis, Grove-lodge, Thistle-grove, S.W.
Shearer, John Ronald, 10, Basinghall-street, E.C.
Siemens, Lady, Sherwood, Tunbridge Wells.
Traill, William A., Giant's Causeway, Portrush and Bush Valley Railway, Portrush, Ireland.
Trenchard, Edward Penny, junior, 63, Granville-park, Blackheath, S.E.
Van Praagh, W., 17, Fitzroy-square, W.
Waymouth, George, Angleside, Crouch-hill, N., and 23, Moorgate-street, E.C.
Williams, Rowland, Birch Vale, Derbyshire.
Willink, Henry George, 29, Albion-street, Hyde-park, W.
Wilson, Albert Edward, Redbourn Hill Iron Company, Frodingham, Brigg, Lincolnshire, and Scunthorpe, Lincolnshire.

The CHAIRMAN, in introducing Mr. Fletcher, said he had to express his regret that an accident which he had met with in the performance of his public duties, prevented the Chairman of the Council, Sir Frederick Abel, from being present. He was, however, glad to hear that he was progressing favourably, and would soon be again amongst them.

The paper read was—

COAL GAS AS A LABOUR-SAVING AGENT IN MECHANICAL TRADES.

By THOMAS FLETCHER, F.C.S.

Gas, as a fuel, is an absolute necessity to the economical carrying out of many commercial processes. It is often used in the crudest and most costly way; a burner may be perfect for one purpose, yet exceedingly wasteful for another, and however good it may be, an error of judgment in its application may lead to its total condemnation. An excess of chimney draught, in cases where a flue is necessary, may pull in sufficient excess of cold air to almost neutralise the whole power of the burner, unless a damper is used with judgment. With solid fuel, an excess of draught causes more fuel to be burnt, but with gas, the fuel is adjusted and limited; there is no margin or store of fuel ready to combine with the excess of air, which, therefore, lowers the amount of work done by its cooling power. The power of any burner, for any specified purpose, depends not only on its perfection, but to a far greater extent on the difference in the temperature of the flame, and of the object to be heated. For instance, if a bright red heat is required, it is not possible to obtain this temperature economically with any burner working without an artificial blast of air, the difference between the temperature of the flame, and that of the object heated, is too little to enable the heat to be taken up freely or quickly, and the result is a large loss of costly fuel. If we want to obtain high temperatures economically, an artificial blast of air is necessary, and the heavier the pressure of air, the greater the economy. On the contrary, low temperatures and diffused heat are obtained best by flames without any artificial air supply.

For such purposes as ovens, disinfecting chambers, japanners' stoves, founders' core drying, and similar requirements, the best results are obtained by a number of separate jets of flame at the lowest part of the enclosed space, and the use of either illuminating or blue flames is a matter of no importance, as the total amount of heated air from either character of flame is the same. If there is any preference, it may be given to illuminating flames, as the proportion of radiant heat is greater, and this makes the average temperature of the enclosed space more equal; but, on the other hand, may be considered the greater liability of the very fine holes, necessary for illuminating flames, to be choked with dust and dirt. This may, to a great extent, be obviated by using very small union jets, and setting them horizontally, so as to make a flat horizontal sheet of flame. Burners placed this way are practically safe from the interference of falling dust or dirt, but not from splashes. Falling dirt or splashes must always be considered in the arrangement of any burners, and the ventilation must be no greater than is absolutely necessary for the required work. In cooking, this limit of ventilation may be exceeded, as most things are better cooked with a free ventilation, the extra cost of fuel being well compensated for by the better quality of the result.

The air in an oven or enclosed space heated by flames inside is similar in character to highly superheated steam. It contains a large proportion of moisture, and yet has the power of drying any substance which is heated to near its own temperature. A mass of cold metal placed in the oven is instantly bedewed with moisture, which dries up as the temperature of the metal rises. This is, for many purposes, an objection, and the remedy is to close the bottom of the oven and place burners underneath. If for drying purposes, and a current of air is necessary, the simplest way is to place in the bottom of the oven a number of tubes hanging downwards in such a position that the heat of the flame acts both on the bottom of the oven and the sides of the tubes which, of course, must be long enough for the lower opening to be well below the level of the flame. The exit may be at any level, but for drying purposes it is better at the top, and it should be controlled by a damper to prevent cooling by excessive currents of air. If not otherwise objectionable, the arrangement of flames inside the oven is far the most economical in use.

Where an oven or drying chamber is used continuously, it should be jacketted with slag wool or boiler composition, but for many purposes this is no advantage. As an example both ways, I will instance the drying of founders' cores where there is only one blow per day. The cores of an ordinary foundry can be dried by gas in a common sheet-iron oven in about half-an-hour; any accumulation of heat after that time would be useless, and a jacketted oven would be of no advantage.

For the disinfection of clothes in vagrant wards and hospitals for infectious diseases, on the contrary, a continued heat is necessary, and in this case the accumulation of reserve heat, which takes place slowly in a jacketted oven, becomes of value, as the gas can be turned low or out, and the ventilators closed, ensuring a more complete disinfection with a much smaller gas consumption. Where an oven or heated chamber is much used for periods of over half-an-hour at once, a non-conducting casing pays well by reduced gas consumption.

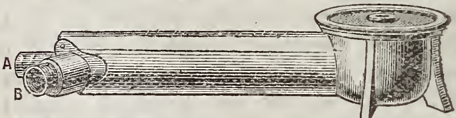
For albumen and glue drying, leather enamelling, tobacco drying, and purposes where a large space has to be very slightly and equally warmed when the weather is unfavourable, steam-pipes are generally used, but, not being always available, an exceedingly good arrangement may be made by placing at intervals in the room gas burners, of any construction, close to the floor, and surrounded with a sheet-iron cylinder, say, 2 ft. or 3 ft. high. The top of these cylinders must be connected throughout with a fairly large flue, which will take the products of combustion from the whole, and this flue must be carried either horizontally, or with a slight rise, so as to utilise all the waste heat. The reason for having a number of stoves at intervals is that the heat in a flue will not carry, for any useful purpose, more than about 8 ft. or 10 ft., and a single stove would give an irregular temperature in any except a very small room. If all are not used at once, the flues of those not in use may be closed by a damper to prevent down draught. The use of hot-water pipes heated by gas may also be occasionally advisable, but, unless for some special reason, it is much more economical to use coal or coke, as the bulk of water makes an exceedingly good regulator, and makes a fire practically as steady and reliable as gas, thus superseding the more costly fuel.

For one of my own purposes I need hot-water pipes, having very little variation in temperature night and day, and using coke for economy's sake, I get a regular temperature by heating a large quantity of water, about 200 gallons, with the fire, and enclosing this in a tank jacketted with slag wool. My circulating pipes run from this tank, and a practically steady temperature, night and day, can be obtained with the most irregular firing, and occasional extinction of the fire for several hours at once.

For the heating of liquids, the greatest economy is to be obtained from one single flame, of as high a temperature as can conveniently be obtained, and the flame must be in actual contact with the vessel to be heated. In jacketting vessels, to prevent draughts, care must be taken that the jackets do not cause currents of cold air to rise rapidly up the sides of the vessel, and so cool it. If this is the case, the use of a jacket, instead of being an economy, is a positive expense, and waste of heat. Many processes, such as making oil and turpentine varnishes, require a heat under instant control, and in these, the use of gas is an important matter, as the loss and risk of fire are very serious elements of expense, more especially in small works where special and costly preparations for contingencies cannot be afforded. I have here a burner which, for its power, is, perhaps, the most compact, and gives the highest temperature of any burner yet known, and it is easily made in almost any size; it has, I think, many special advantages.

FIG. 1.

SPECIAL HIGH POWER BURNER



SHEWING ATTACHMENT B WHEN USED WITH A BLAST OF AIR

The use of gauze, which is its only weak point, is more than compensated for by the very high duties obtained in practice with it, owing to the compactness and concentration of the heat obtained. The following extract from my communication to the Gas Institute will give all particulars as to the constructive detail of this burner. Those who wish to go further into the matter, will find the paper referred to in the publication of the Gas Institute for the current year, and also in the *Journal of Gas Lighting*, June 26th, 1883, and the *Review of Gas and Water Engineering*, June 16th, 1883.

"The first and most important part is the mixing chamber or tube, one end of which is supplied separately with gas and air, which at the other end are, or should be, delivered as a perfect mixture. It may be taken as a rule that this tube, if horizontal, should not be less in length than four and a-half times, or more than six times its diameter. It is a common practice to diminish or make conical-shaped tubes. All my experience goes to prove that, excepting a very trifling allowance for friction, the area of the smallest part of the tube rules the power, the value of the mixing-tube being no more than that of the smallest part. If the mixing-tube is upright, new sources of interference comes in; notably the varying specific gravity of the mixture. Except with one definite gas supply, the result is always more or less imperfect, and regular proportions cannot be obtained. This is now so well known that the upright form has been practically discarded for many years, and is now only used where the peculiar necessities of the case give some special advantage.

"The diameter of the mixing-tube is a matter of importance, as it rules the quantity of gas which can be satisfactorily burnt in any arrangement. With large flames, given a certain size of gas-jet, the diameter of the mixing-tube should be not less than ten times as great. For instance, at 1 inch pressure, a jet having a bore of 1-8th inch will pass about 20 cubic feet of gas per hour. To burn this quantity of gas, a mixing-tube is necessary 10-8ths or $1\frac{1}{4}$-inch in diameter. By the first rule this tube must be in length equal to four and a-half times its diameter, or $5\frac{5}{8}$ inches. It would appear that the mixing-tube, having 100 times the area of the gas-jet, is out of all proportion to the size necessary for obtaining a mixture of one of gas to nine or ten of air; but it must be remembered that the gas is supplied under pressure. It is therefore evident that no mere calculation of areas can be taken into account, unless the difference in pressure of the supply is also considered. A complete reversal of this law is shown in that ruling the construction of blowpipes, which I have already given in a previous paper on 'The Use and Construction of the Blowpipe.' In these, the air supply, being under a heavier pressure, is much smaller in area than the gas inlet; and, to obtain maximum power, the air-jet requires to be enlarged in proportion to the gas pressure.

"Given a certain area of tube delivering a combustible mixture, the outlet for this mixture must be neither more nor less than the size of the tube. Taking an ordinary drilled tube, such as is commonly made, and of the dimensions before given—*i.e.*, $1\frac{1}{4}$ inch bore—if the holes are drilled $\frac{1}{8}$ inch in diameter the tube will supply $10 + 10 = 100$ of these holes. In practice this rule may be modified.

"The variations from the rule, however, must be a matter of experience with each form of burner. There is also the fact that with small divided flames it is not necessary to mix so large a proportion of air, as each flame will take up air, on its external surface; but in this case the flames are longer, hollow, and of lower temperature. As a matter of actual practice, where a burner is used which gives a number of flames or jets, the diameter of the mixing-tube does not need to exceed eight times the diameter of the gas jet; the remainder of the air required being taken up by the surfaces of the flames.

"Wire gauze, made of wire the thickness of 22 iron wire gauge, 20 wires to the linear inch, and tinned after weaving, has an area in the holes of 1-4th its surface. By calculation, the area of a gauze surface in a burner should, therefore, be taken at four times that of the tube, and our standard of $1\frac{1}{4}$ inch tube requires a gauze surface of $2\frac{1}{2}$ inches in diameter. This rule is subject to variation in burners of a small size, owing to the air that can, if required, be taken up by the external surface of the flame, which, of course, is much greater in proportion in a small flame than in a large one. Where the diameter of the gauze is, say, not over one or two inches, the theoretical maximum gas supply may be exceeded, and a varying compensation is necessary with each size. My rule is intended to apply to burners of larger diameters, where the external air supply plays a comparatively unimportant part.

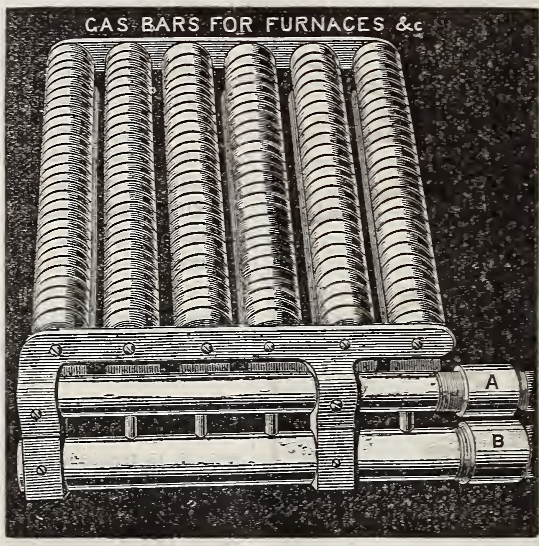
"It must be remembered that burners of this class, which burn without the necessity of an external air supply in a flame which is solid, require the mixture to be correct in proportions. A very slight variation makes an imperfect flame. Not only does the gas-jet require to be adjusted with great precision, but it also needs more or less adjustment for different qualities of gas. An ordinary hollow or divided flame is able to take up on its surface any deficiency of air supply; but with the high-power solid flames the outside surface is small, and the consequence is that one of these burners, adjusted for gas of poor quality, may, when used with rich gas, give a long hollow or smoky flame, unless the gas-jet be reduced in size. When perfect, the flame shows a film of green on the surface of the gauze; and if a richer gas is used, the green film lifts away. To cause this to fall again, and to produce a solid flame, it is necessary to take out the gas-jet, and tap the end with a hammer until, on trial, it is found correct. If too small, the green film lies so closely as to make the gauze red hot. Where the 'tailing up' of the carbonic oxide flame is objectionable, there is no practical difficulty whatever in constructing these burners as a ring, with an air supply in the centre, which greatly reduces the length of the 'tail.' In practice it is a decided advantage to have a centre air-way in all burners of more than about 2-in. diameter, as it enables the injecting tube to be slightly shortened, and lessens the liability of the green film to lift with varying qualities of gas. In this class of burner I have adopted the small central air-way as a decided improvement in the burners."

In such processes as the roasting of coffee, chicory, grain, &c., a diffused heat is necessary, but of much greater intensity than can be obtained with economy from heated air. In these cases the application of a direct flame is necessary, and it may be in actual contact with the substances to be heated, provided these are kept in constant and rapid motion.

The use of a revolving cylinder brings in complications with any burner which is supplied with gas at ordinary pressures without any artificial air supply, as the currents of air caused by the motion of the cylinder interfere with the satisfactory working of any burner, and the air supply must be either protected from draughts and irregular air currents, or the air must be applied artificially from some independent source. One exceedingly good way of making any burner work, independently of the currents caused by a revolving cylinder, is to apply the flame inside the cylinder at the centre, making the substances to be heated to fall in a continuous stream through the flame. This system is not applicable to fine powders, or sticky substances, as it necessitates the perforation of the cylinder, to allow of the escape of products of combustion.

For this class of work, a very concentrated heat is not desirable, as a rule, and a slit, or perforated burner is preferable. Of this class of burner I have here a sample, which is not only new in its constructive details, but has great and special advantages for many purposes. As you see, it resembles a number of ordinary furnace bars, with this difference, that each bar is a burner; in fact, it is an ordinary furnace grate, which supplies its own fuel. With the usual day pressure of gas, = 1 inch of water, this burner will, at its maximum power, consume about 100 cubic feet of gas per hour, per square foot of burner surface, and as it can readily be made almost any form or size, its adaptability for a great number of uses is evident. I have made it in many sizes and shapes, to give flames from ½ inch wide by 5 feet long, to large square or oblong blocks. By applying a blast of air at the ordinary gas jets, and supplying the gas by a separate pipe, or series of pipes, below the open end of the burner, this can be converted into a furnace of extraordinary power. It is quite possible to burn as much as 2,000 cubic feet of gas per hour, per square foot of burner surface, producing a heat sufficient to fuse any ordinary crucible. You see its power when I place a bundle of iron wire in the flame; it is, in fact, a concentration of hundreds or thousands of powerful blowpipe flames in one mass. It has also this advantage, that with a blast of air it will burn and work equally well any side up, and the flames can therefore be directed straight on their work without loss. It is, in one form or another, almost a universal burner, as it can be readily adapted to almost any purpose, from tempering a row of needles to making steam for a 200 horse-power steam-engine. It is easy to make, easy to manage, practically indestructible, and for commercial purposes has, I think, a general adaptability which will bring it, in one form or another, into almost universal use. I may say that when we are in a special fix, this has in every case landed us out of the difficulty.

Fig. 2.



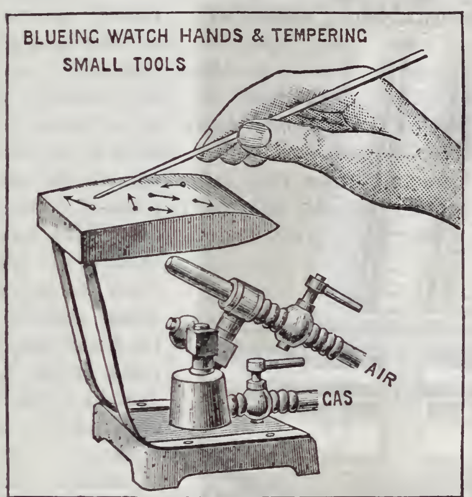
For heating large plates of metal equally, for drying paper impressions for stereotypers, hot-pressing hosiery, crumpet baking, working up plastic masses which can only be worked hot, and work of this class, a number of separate flames equally diffused under the whole surface of the plate are necessary to equalise the heat, unless the plate is very thick, and these are better if produced by a mixture of gas and air, but in heating wide plates one difficulty must always be remembered, the burnt gases from the centre flames can only escape by passing over the outer flames, and therefore a space must be left between the top of the flame and the plate, or the outer flames will be smothered and make a most offensive smell.

In hosiery presses, printers' arming presses, and many others, the top plate also requires to be heated. The best way to do this is to use a number of blowpipe flames directed downwards. In many cases the supply of air under pressure is a practical difficulty and objection. This is overcome, to a certain extent, by the use of a thick upper plate with a number of horizontal holes, into which a Bunsen flame is directed. In every case I have seen, without one single exception, the holes are either too small, or the burner is placed too close, and the consequence is that the gas, instead of burning inside the holes, as it should, passes through partially unburnt, and is consumed at the opposite end, where it is absolutely useless, the flame not being in contact with or under the surface to be heated, and therefore doing no work. In hosiery presses this is a great objection, as the holes are so long that an equal heat is simply impossible, and the only remedy is to use a blowpipe flame, which forces sufficient air in with the gas to ensure combustion where the heat is necessary. The same remark applies to crape and embossing rollers.

For the production of heat in confined spaces and difficult position, the use of an artificial blast of air is becoming an acknowledged necessity, and the small Roots blowers now made for such purposes, and driven by power, are coming rapidly into use.

Sometimes a plate is required to be heated to a high temperature in one confined spot,

FIG. 3.



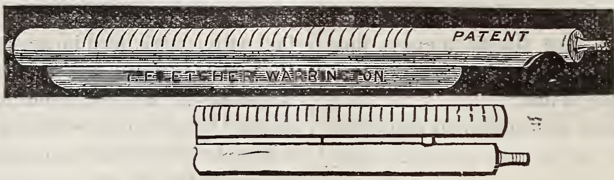
and, as a example of this, I may take the blueing of the hands of watches. For this purpose I have made several arrangements, and perhaps the best is a thin copper plate, bent down at one side to a right angle. In this angle, underneath is directed a very fine blowpipe flame on one spot, and the hands are passed singly over this spot until the colour comes, when they are instantly pushed over the edge. I have here the arrangement which is generally used for this purpose. For the blueing of clock hands, a larger and more equally heated surface is required, and this can be obtained by a small powerful burner without a blast of air, using a rather thicker plate to equalise the heat. The same arrangement may be used with advantage for tempering small cutters for ornamental turning, penknife-blades, &c., and in these cases the cooler part of the plate is of great value, as it enables the thicker parts to be slowly and equally heated up; the application of a mechanical arrangement to pass the articles to be heated in a regular succession is a matter easily managed.

Among other things which have several times come under my notice, may be mentioned cremation furnaces, but I have not yet met with, or been able to devise, any burner for ordinary coal gas which has worked satisfactorily. This fuel is apparently unfitted for the work, and the best arrangement I know is a number of pipes delivering ordinary "producer" gas from the Wilson or Dowson generators, in exactly the same way as is at present used for firing horizontal steam boilers. For heating book-finishers' tools, a ring-flame is the simplest, the tools being supported a little distance above the flame; the usual plan of heating a plate, and placing the ends of the tools on this, necessitates at least double the gas consumption as compared with an open flame. For type-founding machines, bullet moulding, stereotype metal melting, solder making, lead melting, &c., one burner, or rather one flame, should be used of a suitable power for the work, and this should be as perfect and of as high a temperature as possible to ensure economy. It is now a simple matter, owing to recent researches in the theory of heating burners, to obtain flames of any power without practical limit, which, without any artificial air supply, will do all which is necessary in this class of work, and the required arrangements are exceedingly simple. With these trades may be classed, also, the concentration and distillation of acids and liquids boiling at a high temperature, and we may also include baths for tinning small articles, and the tinning by fusion of sheet copper, the same burners being applicable, and perfectly suited to all these requirements, unless the tinning baths are long and narrow, in which case the furnace-bar burners again come to the front as the best; as, if we are to use gas economically, the flame must be the same shape as the vessel to be treated.

We may now consider the heating of blanks for stamping, hardening the points of spindles, finishing the ends of umbrella tips, and work where a small article, or a small part of any article, has to be heated to a high temperature with speed and certainty. For these a long and narrow flame is necessary, and I may mention that in cases where a high speed of delivery is required, and a small part only has to be heated, such as, for instance, in the hardening of the points of spindles for cotton machinery, I have made burners giving a flame of exceedingly high temperature only ¼-inch wide and 5 ft. long. This flame is produced by the assistance of a blast of air, and is of sufficiently high temperature to fuse the spindle in a few minutes.

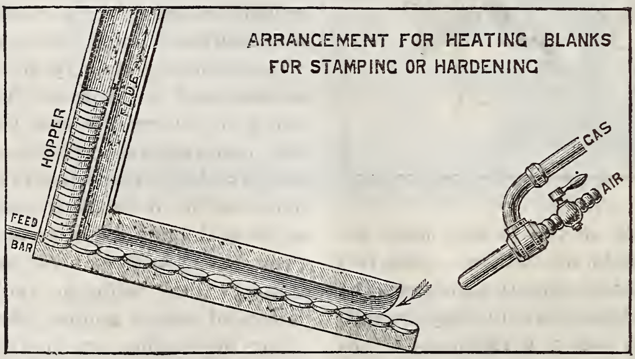
The points only project over the flame, and the spindles are carried mechanically at such a speed that at the end of the 5 ft. traverse they are red-hot, and drop into water. More than one hundred are in the flame at once, lying side by side.

Fig. 4.



For heating blanks for stamping, the furnace bar-burner is perfectly suited, and in this work the shoot supplying the blanks to the machine should be made of two fireclay sides, with an opening for the flame between the shoot and flame being placed at a sharp angle, to prevent risk of the blanks sticking or over-riding each other. A blowpipe may also be used with good effect, as shown in the above engraving, and in many cases it is preferable and much easier to manage.

Fig. 5.



In some cases, the direct contact of the flame would spoil the articles to be heated, and instead of the arrangement mentioned, a tube of iron, fire-clay, or other suitable material is heated, and the articles are passed through it. This system of continuous feed, through a tube, has been applied to the firing of small articles of pottery, and might possibly be well adapted, amongst other things, to the production of gas-burners.

Where the contact of air with the heated articles is injurious, many plans have been tried to keep the ends closed as much as possible, but I believe no more perfect and simple seal against the admission of air can be devised than to turn a jet of pure gas, unmixed with air, into each end of the tube. This is an absolute seal against the entry of oxygen in an uncombined state; free oxygen cannot exist at a very high temperature in the presence of coal gas.

For many trades there is a demand for hardened and tempered steel wire, either round or flattened, and the production of this has led to many attempts to obtain a satisfactory continuous process. The common method now, which is worked as a "secret" process by most firms, is to pass the wire through a tube to heat it, as already described, and to run it direct from the tube through a hole in the side of a box filled with oil, the hole being packed with asbestos, to prevent leakage; from this it is passed through another similar hole on the opposite side, either over a plate heated to the right temperature, or over a narrow open flame of sufficient length and power to give the correct heat for tempering.

Where absolute precision is necessary, the gas supply must be adapted by an automatic regulator on the main, to prevent the slightest variation of heat. Once adjusted, the production of flat and round spring wire by the mile is an exceedingly simple matter. It is quite possible to obtain absolute precision in temperature by a proper adjustment of the gas pressure, and as this is, for tempering steel articles and some other purposes, a matter of great importance, it is worth some consideration. No pressure regulator alone will give an absolutely steady supply; but if we put on first a regulator, adjusted to the minimum pressure of supply, say 1 inch of water; and then fix another on the same pipe, adjusted to a slightly lower pressure, say 9-10ths of an inch, the first regulator does the rough adjustment, and the second one will then give an absolutely steady supply, providing always that the regulators are both capable of passing more gas than is likely to be ever required. No regulator can be relied on for absolute precision, if worked up to its maximum possible capacity.

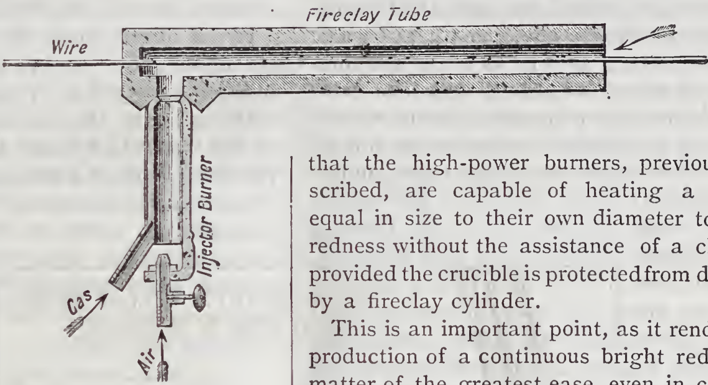
Amongst other applications of a long narrow flame of high power, may be mentioned the brazing of long lengths of tube, in fact the application of flames of this form, with and without a blast of air, for different temperatures, are almost endless.

The thousands of uses to which blowpipes are adapted are so well known, that they need no mention, except the curiously ignored fact that the power of any blowpipe depends on the air pressure. A compact flame of high temperature cannot be obtained except with a heavy air pressure, and the ignorance of this fact has caused an immense number of unexplained failures. Many people think that one blower is as good as another, and expect that a fan giving a pressure equal to, say, the height of a 2 inch column of water, should do the same work as a blower giving a pressure ten to twenty times as great. The construction and power of blowpipes, with the laws ruling the proportions and power, will be found in an article on "Blowpipe Construction," published in *Design and Work*, March, 1881, and as the matter is there fully treated, no further reference to the subject is necessary.

In the more recent forms of gas-engine, the charge is exploded by a wrought iron tube, heated to redness by the external application of a gas flame. This, although considered satisfactory by the makers, appears to me to be an exceedingly crude way of getting over the difficulty; and I offer it as a suggestion, that a very small platinum tube shall be used instead of iron. This, if made with a porous or spongy internal coating, would fire the charge with certainty, at a lower temperature than iron, and it could be made so thin and small in diameter, without risk of deterioration or loss of strength, that an exceedingly small flame could be used to heat it up. As it would be fully heated in a very few seconds, the delay in starting would be obviated.

There are many purposes for which a red heat is needed for slow continuous processes on a small scale, such as case-hardening small steel goods, annealing, heating light steel articles for hardening, and a great variety of other similar processes. This, until recently, has required the use either of a rather complicated furnace, or a blast of air under pressure, to increase the rapidity of combustion. Since the conclusion of my experiments on the theoretical construction of burners, I have found that the high-power burners, previously described, are capable of heating a crucible equal in size to their own diameter to bright redness without the assistance of a chimney, provided the crucible is protected from draughts by a fireclay cylinder.

Fig. 6.



This is an important point, as it renders the production of a continuous bright red heat a matter of the greatest ease, even in crucibles of a comparatively large size. Where the heat is steady, and certain not to rise above a definite point, it can safely be used for such purposes as hardening penknife blades, and other articles which are very irregular in thickness, the thin edges not being liable to be burnt or damaged by over-heating.

For the highest temperatures air under pressure is a necessity, as we require a large quantity of gas burnt in as small a space as possible with the maximum speed, and, given this air supply, we are very little hampered by conditions, as an explosive mixture may be blown through a gauze into a fireclay chamber, closed, except so far as is necessary to allow the escape of burnt gases. The speed of combustion is limited only by the speed of supply of air and gas, and by increasing these there is no practical limit to the heat which can be obtained. When we have to do with the reduction of samples of refractory ores, testing the comparative fusibility of different samples of firebricks, or alloys, &c., the use of an explosive mixture blown into and burning in a close chamber is invaluable, and the ease and certainty with which any temperature may be obtained has led to great discoveries, and the revolutionising of many commercial processes. Recent experiments have proved that, by a modification in the form of the well-known injector furnace, an enormous increase of temperature may be obtained. I have, in actual work, obtained the fusing point of cast-iron in two minutes, starting all cold, and have fused every furnace casing I have yet been able to produce. If infusible casings can be made, I think I am not overstating facts in saying that any temperature required can and will eventually be obtained with the greatest ease. What the limit is I have as yet not been able to discover.

There is one more application of gas, as a fuel, which, discovered and published by myself some two years ago, has yet to become generally known, and in some special processes may prove exceedingly valuable. This is the addition of a very small quantity of coal gas, or light petroleum vapours, to the air supplied by a blower or chimney pull, to furnaces burning coke or charcoal. The instant and great rise in temperature of the furnace, and the greater stability of the solid fuel used, are extraordinary. This is, in fact, a practical application of the well-known "flameless combustion," the only signs that the gas is being burnt being a great rise in temperature and a decreased consumption of the solid fuel; in fact, if the gas is in correct proportion, the solid fuel remains unburnt, or nearly so, in spite of the high temperature. In cases where a sudden rise in temperature is required in a furnace, or where the power is deficient, this method of supplementing and increasing the heat will be found of very great service, and processes liable to be checked by making up a fire with fresh fuel can be carried on without check, even after the solid fuel has almost entirely disappeared.

That a solid fuel is quite unnecessary, I will prove in a very simple manner, by burning a mixture of coal gas and air without a flame, in a bundle of iron wire. The heat is sufficient to fuse the wrought iron with ease, and the glare inside the bundle of wire is painful to the eyes. The same result could be obtained by a pile of red-hot lumps of firebrick, and the same heat obtained also without a trace of flame.

It is not possible to enter fully into such a wide and important subject in a single lecture, and the suggestions now given are simply hints for the guidance of those who need or desire to experiment. No doubt we shall have, after a time, some text-books and other literature on this subject, which is one of great importance to many industries; and it is necessary for experimental work and applications to new industries, that the experimenter shall not only be able to purchase special burners, but that he shall have fundamental laws laid down which will enable him to construct them for himself, so as to have his experiments under his own control. The difficulty in the way of literature on the subject is that those few who have worked in the matter are busy men, with little time which is not already fully employed.

Pioneers on new ground have a great liability to generalise and jump at conclusions, and the necessary exact work and detail must, to a great extent, be left to those who follow on tracks already roughly marked out.

Of the special trades which have come under my observation, I have only had time to mention a very few. It appears to me that there are very few manufacturing processes of any kind which could not be simplified by the use of gas as a fuel, from the production of electric light apparatus to the manufacture of explosives, cotton stockings, beer, catgut, glue, umbrellas, ink, fish-hooks, medals, stained glass windows, brushes, and other trades equally various, which come daily under my own notice.

DISCUSSION.

The CHAIRMAN, in inviting discussion on the paper, said it was well known that the general laws guiding the combustion of gaseous fuel had been laid down by Scheurer-Kestner, St. Claire Deville, and Frankland, and they all knew that the late Sir William Siemens had obtained splendid results by the use of gaseous fuel. Quite apart from the industrial application of gas, its use was of great importance, especially at a time when so many efforts were being made to get rid of the nuisance arising from smoke. Perhaps the most interesting point developed in the paper was the fact that explosive mixtures of gas and air could safely be introduced into a chamber, provided it was previously heated. In many of the appliances, ordinary illuminating gas was employed, and that, of course, was not the most economical method; but these were put forward rather as labour-saving appliances than as being economical in every respect. He could speak with real gratitude of Mr. Fletcher's labours, for he was constantly using several of his furnaces in the Mint, for ordinary assaying purposes. With regard to the difficulty he had found in getting a material sufficiently fire-resisting to stand very high temperatures, he would ask him if he had tried lime, and particularly the very refractory kind resulting from the ignition of dolomite. That was a material which withstood the melting of platinum, even with a whole battery of oxyhydrogen blowpipes. He must say that Mr. Fletcher's fertility of resource was sometimes almost a cause of embarrassment to chemists and metallurgists, for he (the Chairman) was frequently asked by students whether they should procure a particular form of burner, or wait a few days for the improvement Mr. Fletcher would be sure to make; but still that in no way diminished the gratitude they must all feel towards him.

Mr. W. R. E. Coles said he could endorse from his own experience what the Chairman had said of the value of Mr. Fletcher's apparatus for laboratory purposes; and he also knew that some of his cooking stoves were very effective. He was able to state that gas was coming very considerably into use for heating purposes, and it was not at all unreasonable to look for its introduction in towns for many purposes for which coal was now used, producing a great deal of smoke, and being objectionable in many respects. One recent introduction of gas, since the Smoke Abatement Exhibition at South Kensington, was for bakers' ovens, which had not only the advantage of preventing smoke, but it made the preparation of the bread more cleanly, and improved the hygienic condition of the bakehouse. He looked forward to the time when there would be very considerable improvements in the heating of towns.

Mr. Bower remarked, that he had used Mr. Fletcher's furnaces for a long time in his laboratory as an amateur; and so far from finding fault with the improvements which he made from time to time, he was quite sure that each new one gave him greater power than he had before. However they might dislike to have an old friend turned out and replaced by a new one, yet if the new one was better, they should certainly have it. But they would never get the full benefit of these improved burners and furnaces until they had a higher and more constant pressure of gas. He only spoke as an amateur, but manufacturers must feel the difficulty still more; they did not want to be plagued by having at one time a pressure of 1 inch, and at another of more than 3 inches, thereby continually altering the temperature of the furnace they were using. Again, he did not think the full benefit of gas would ever be obtained until there were two kinds supplied, the higher quality for illumination, and the second, which though inferior for lighting purposes, was equally efficient for heating, being supplied from a separate meter, and at a cost which would bring gas fuel into general use.

Col. Meakins, M.P, said it would be impossible for a gas company to maintain the same pressure constantly in the mains without increasing leakage, and the amount of gas unaccounted for, thereby decreasing its profits, and thus preventing the supply becoming cheaper. Perhaps Mr. Fletcher could devise a pressure-giving governor which could be applied by each individual for his own purposes, taking the gas at the normal pressure, and adding to it such pressure as he might wish by his own governor. He did not know if this was a practical suggestion, but if it were, no doubt Mr. Fletcher would be able to put it into shape.

Mr. Haughton protested against the idea that gas companies could never be expected to make their pipes tight. Much had already been done in the way of preventing leakage, which gas companies used to say was unavoidable; and where they had gone to the necessary expense, they had stopped it entirely. Those who used gas in the arts, and in chemical laboratories, were specially indebted to Mr. Fletcher for his many improvements, and he had also conferred many benefits on those who used it in their kitchens; he would be adding still further to the obligations under which they were already, if he could devise an apparatus for grilling over the flame; for none of the gas cookers he had yet seen would grill properly either a steak or a chop. You could cook meat under the flame, but you could not grill it, the radiated heat not being sufficient for the purpose.

Mr. Johnson said he had a little apparatus, 16 in. square and 20 in. high, in which he could grill a chop or steak in the most satisfactory way, as was testified by all those who had tried the results.

Mr. Coles added that he had just been informed by Mr. Kinnear Clark that there were several very efficient grillers, in some of which the meat was placed over the flame, and in some under.

Colonel Campbell asked Mr. Fletcher whether he thought there was a possibility of using the gas from peat as a source of motive power. He had lived a long time in the west of Ireland, where the manufactures which had once existed had been destroyed, and he would not say anything about the possibility of their being revived; but there was no part of the world where traction, either by land or water, was not required, and in the district he referred to, if peat gas could be used for gas-engines, it could be had in any quantity. He knew the calorific power was small, but he believed it was as nearly as rich in hydrogen as coal gas, and if it could be made to serve as a motive power, there would be a large future for it.

Mr. Gumpel said there were many places in the country where coal gas was not available, and he should like to know if the gas produced by the "Alpha" or the "Sunlight" machine could be used with Mr. Fletcher's apparatus.

Mr. FLETCHER, in reply, said he understood the Chairman wished to know whether his assistants should buy a burner now or wait a couple of days for the next improvement. He could only say that if they wanted the burner, they had better procure the best they could; but if they did not want it, they had better wait. If this were meant as a hint to him to discontinue his experiments, he could only say it would have no effect. He had tried lime casings, and found that he required a new case every time. If such casings were used in Professor Roberts's laboratory, his assistants would not have to wait two days, for they would be sure to constantly have the latest improvement. As to the pressure of gas, that was out of his department. A pressure-giving governor was equivalent to what was known as a power-meter; a meter driven by a weight which would give pressures considerably above what were now obtained. This apparatus could be obtained from several makers. The grilling of meat over a flame was already done successfully, and the appliances were to be had. He had had no experience in the use of peat gas, and could not, therefore, say anything about it, as he confined himself entirely to that which he had actual knowledge of. There was a pretty extensive peat-bog near to where he lived, and if ever it were utilised, and peat gas made he might be able to say something about it.

The CHAIRMAN then proposed a vote of thanks to Mr. Fletcher, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

FOOD.—SUB-COMMITTEE C.

Wednesday, January 23rd.—Present: Sir Henry Thompson, in the chair; Professor A. H. Church; Mr. H. Trueman Wood.

SICK AND AMBULANCE.

Wednesday, January 23rd.—Present: Director-General Crawford, A.M.D., in the chair; Deputy Surgeon-General Bostock, C.B.; Brigade-Surgeon W. G. Don, A.M.G.; Surgeon-Major G. J. H. Evatt, M.D., A.M.D.; Mr. John Furley; Mr. V. B. Barrington-Kennett; Surgeon-General W. A. Mackinnon, C.B., A.M.D.; Director-General Reid; Dr. J. C. Steele; Mr. H. T. Wood.

DRESS.

Thursday, January 24th. — Present: Mr. F. Treves, in the chair; General Erskine; Mr. C. M. McHardy; Deputy Surgeon-General Jeffrey Marston, A.M.D.; Mr. O. H. Morshead (for Mr. G. D. Ramsay, C.B.); Mr. Samuel Osborn; Mr. T. Thorn; Surgeon-General Townsend, C.B.; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III. SUB-COMMITTEE A.

Thursday, January 24th.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. J. Bailey Denton; Mr. Rogers Field; Dr. E. Frankland, F.R.S.; Mr. Charles Heisch; Mr. Baldwin Latham; Mr. Shirley F. Murphy; Mr. George Shaw; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III. SUB-COMMITTEE C.

Friday, January 25th.—Present: Prof. T. Hayter Lewis, in the chair; Mr. A. T. Atchison; Mr. W. R. E. Coles; Mr. Charles Heisch; Prof. W. Chandler Roberts, F.R.S.; Mr. E. C. Spagnoletti; Sir Harry Verney, Bart., M.P.; M. C. Greville Williams, F.R.S.; Mr. H. T. Wood.

WORKSHOPS.

Saturday, January 26th.—Present: Dr. George Buchanan, in the chair; Dr. J. H. Bridges; Mr. Alexander Redgrave, C.B.; Mr. Warington Smyth, F.R.S.

LABORATORY.

Monday, January 28th.—Present: Sir Joseph Lister, Bart., F.R.S., in the chair; Dr. George Buchanan, F.R.S.; Mr. Watson Cheyne; Mr. H. T. Wood.

SCHOOL AND EDUCATION.

Monday, January 28th.—Present: Lord Reay, in the chair; Mr. B. St. John Ackers; Mr. Alfred Bourne; Mr. E. N. Buxton; Rev. Canon Cromwell, M.A.; Sir Philip Cunliffe-Owen, K.C.M.G.; Dr. J. H. Gladstone, F.R.S.; Rev. Thomas Graham, D.D.; Mr. T. E. Heller; Mr. A. C. King; Colonel W. Nassau Lees; Lieut.-Col. W. R. Lewis, R.A.; Inspector-General F. G. Mouat, M.D.; Mr. T. Nordenfelt; Mr. Owen Roberts, M.A.; Rev. T. W. Sharpe; Mr. H. T. Wood.

MEMORANDUM FROM THE SUB-COMMITTEE ON "FOOD."

The following is the official classification of Group 1 of the Exhibition, in which are comprised Classes 1 to 12:—

Class 1.—Selected displays of unprepared animal and vegetable substances used as food in various countries. Stuffed specimens of animals, birds, &c. Models, drawings, and illustrations of the same.

Class 2.—Prepared vegetable substances used as food, including tin, compressed, and preserved fruits and vegetables. Bread, cakes and biscuits of all kinds.

Class 3.—Prepared animal substances used as food in a preserved form—tinned, smoked, salted, compressed and prepared animal foods of all kinds. Food produced by insects, such as honey, &c.

Class 4.—Beverages of all kinds—*(a)* Alcoholic; *(b)* non-alcoholic; *(c)* infusions (tea, coffee, cocoa, chocolate, &c.).

Class 5.—New varieties of food, food for infants, food for invalids, new concentrated foods of all kinds.

Class 6.—Cookery practically demonstrated—Economical cooking, workmen's and other kitchens, cheap restaurants, bakeries, cafés, foreign cookery, &c.

Class 7.—The chemistry and physiology of food and drink. The detection of adulteration, materials used as adulterants, analyses, food constituents and equivalents, tables, diagrams, &c.

Class 8.—Diseases due to unwholesome and improper food. Drawings and models of animal and vegetable parasites, &c.

Class 9.—Practical dietetics. Army and Navy rations, prison and workhouse diet, foreign dietaries, &c.

Class 10.—Publications and literature, models and diagrams relating to Group 1.

Class 11.—Apparatus and processes for conserving, storing, conveying, and distributing fresh foods of all kinds.

Class 12.—Machinery and appliances for the preparation of articles under Group 1.

In the first three classes are included what may be termed the raw materials of food. In Class 1, specimens of the actual foods themselves may, when possible, be exhibited, and when this cannot be done, they should be represented by models. The exhibition, for instance, of uncooked meat would be neither desirable nor practicable, but any exhibits tending to give information as to the various animals used for the food of man, their nature, habits, characteristics, &c., will be welcomed. In the case of cereals and other food-stuffs, the raw grain and the products may be exhibited. Fruits and vegetables will for the most part be represented by models, but the Executive are also considering the establishment of periodical shows, at which the articles themselves can be exhibited (and sold). Specimens of foreign fruits, &c., will be gladly received for this purpose. Models of the different fruits imported in a dried or preserved state into this country are specially desirable, in order to illustrate their natural forms.

The classification sufficiently indicates the class of exhibits desired for Classes 2 and 3. It may be added that, where possible, preserved provisions should be put up in bottles, so that they may be visible, not in tins. Not more than three specimens of each kind should be sent in.

In Class 4 are to be included every sort of drink, including milk, as well as those enumerated in the classification. It will take in all exhibits connected with the production of tea, coffee, and other beverages (except those relegated to Class 12), and all illustrating new or little-known beverages, such as Maté or Paraguay tea, Coca, Koumiss, &c.

The exhibition, in Class 5, will naturally also be capable of being placed in one or other of the previous classes, but this arrangement has been adopted with the view of giving prominence to any novelties. Food for children and invalids will form a special feature in this class.

As regards Class 6, the Committee think it well to draw attention to the announcement already made by the Executive, that, as refreshments come within the scope of the Exhibition, all methods of preparing the same, whether by cookery or otherwise, and the display and sale thereof, will be matters of separate arrangement with those wishing to be represented in this section.

One principal object to be kept in view in this department of the Exhibition will be the diffusion of information as to the economical cooking of food, and the best way of utilising the various kinds of food available to the people of this country. Cheap cooking, both at home and by means of public kitchens, should be amply illustrated. For the purposes of comparison there should be illustrations of every class of foreign cookery, not only of the luxurious sort, but of that practised in the homes of the well-to-do, of the middle class, and of the poorer classes, in foreign countries. As a matter of interest, and with the object of diffusing information on the manner of life of nations differing yet further from ourselves, the Committee hope that means may be found for exhibiting the practice of Eastern cooks, Chinese, Japanese, Indian (Mohammedan and Hindoo), &c.

Bakeries will be included in this class, and the Committee hope that the fittings and appliances of the most modern establishments (both English and foreign) may be fully shown.

The object of Classes 7 and 8 is to diffuse popular information as to the nature, constituents, uses, and adulterations of food. Exhibits illustrating these and similar points will be welcome. The Committee trust that the Science and Art Department will assist this portion of the Exhibition by lending (and supplementing) one of the collections formed by Professor Church.

As regards the last item in Class 8, it should be noted that parasites or other organisms injurious in any way to food or its sources are included.

As regards foreign dietaries in Class 9, the Committee consider that this expression must be taken in its widest sense, and as including the food of savage races all over the world. It would therefore comprise specimens of the animal and vegetable substances used as food, beverages, stimulants, &c., by savages or native races of low civilisation, both in the raw and prepared condition, together with appliances and utensils of all kinds used in their manufacture or consumption. Models and drawings illustrative of the subject would also be desirable. As examples may be mentioned, sago, and its native manufacture by Malays, natives of New Guineas, &c.; cassava, and its manufacture, in British Guiana; taro, the Polynesian food, and the manfacture of roi from it; kaava and kaava bowls of Fiji and elsewhere. The Committee hope that the materials for a valuable ethnological collection of this sort would be forthcoming from private owners in England.

The exhibits admissible to Class 10 are clearly indicated in the classification.

Classes 11 and 12 are added as separate classes, because it is necessary that all machinery should be placed together in one gallery where the motive power is provided. Among the processes which the Committee hope to see illustrated, may be mentioned methods of cold storage and transport of fresh meat, ice making, dairy operations, the preservation of food, making bread, biscuits, &c., the manufacture of confectionery, of condiments, of coca and chocolate, the production and bottling of aërated waters.

GUTTA-PERCHA.

By James Collins.

(Continued from p. 150.)

The trees yielding gutta-percha are very restricted in their geographical distribution. Gutzlaff defines the limits as 6° N. and S.L., and 100° to 120° E.L., but I am inclined to think this area much too wide. In this I am supported by Captain Lingard, who has traded largely in gutta-percha, and collected it on the spot. He gives the limits 4° N. and 3° S., still further restricting the finer varieties to 4° 50′ N. and 1° S., with a temperature whose outside limits is 66° to 90° Fahr., and a very moist atmosphere. The lower kinds, of course, grow outside of these circumscribed limits, and are found near the sea coast on low but not swampy ground, whilst the best varieties grow inland on hill slopes and in groves, surrounded by other forest trees, at an elevation said to be from 100 to 600 feet above the sea. Gutta-percha trees are indigenous to Singapore, although only two or three are now to be seen as curiosities. In that island the mean total rainfall for five years ending 1873 was:—1869, 90·63 in.; 1870, 123·24; 1871, 109·45; 1872, 75·30; and in 1873, 85·60 inches. This rainfall is variable at different periods, and the year may be divided into three periods of four months each:—

1st. From January to April, during which the rainfall is very variable and uncertain.

2nd. From May to August, which may be termed the dry season, and is the period, as a rule, in which the rainfall is least.

3rd. From September to December, which may be called the wet season, and during which, as a rule, the rainfall is greatest.

As to temperature for the same period:—The highest was in 1869, 92°; 1870, 93°; 1871, 91°5′; 1872, 92°; 1873, 92°5′. The lowest was in 1869, 69°; 1870, 69°; 1871, 69°; 1872, 67°; 1873 68°5′.

It appears, therefore, that gutta-percha trees thrive best where they have a light loamy soil, at the foot or slopes of hills, surrounded by primitive jungle, and with a moist temperature not rising above 95° or sinking below 66° Fahr.

The collection of gutta-percha generally takes place directly after the rainy season is over, as in the dry season the gutta does not flow so readily; during the rainy season much gutta is washed away as it flows out, and the collectors are more liable to ague and jungle fever. Often the natives go in companies, receiving advances in money, clothes, food, and tools to be afterwards deducted, although it is not uncommon that through the non-success, death, or knavery of the collectors, the trader loses both principal and interest. Natives, too, collect gutta in their own vicinities, and barter it at trading stations.

The yield of a well-grown tree of the first or best variety is from 2 to 3-lbs. of gutta-percha, whilst full-grown trees of from 100 to 140 feet high have been known to yield as much as 50 to 60-lbs. of gutta. The average yield of different varieties, differs materially, sometimes as much as 30 per per cent. Gutta-percha, too, often loses 35 per cent. of its weight in drying during the first six months after collection.

The method of extracting gutta-percha is much the same among the Malays, Chinese, and Dyaks. The trees are cut down just above the buttresses by means of "billiongs," a chisel-like axe, a "parang," or long knife with a sword-blade, 12 to 14 inches long, or an axe perfectly wedge-shaped. The last is used by Chinese, the two former by Malays; they are all of native manufacture. As soon as the tree is felled, the greatest haste is made to lop off all the branches, otherwise the gutta-percha ascends to the leaves and is thus lost. Narrow strips of bark, 1 inch broad, and six inches apart, are next cut out around the tree, except the part of the trunk buried in the ground, the contained gutta of which, about 25 per cent., is lost. The bark is then beaten with mallets, and the gutta flows slowly, changing from a yellowish white to a reddish tinge, and rapidly concreting. Bamboos, pieces of bark, &c., receive the juice as it flows. This "raw" or gutta-muntah, is collected together and pressed into a ball or slab, a hole being made in it for facility of carriage. It often reaches our market in this raw state. For the preparation of good gutta, these balls are boiled in a shallow iron pan, called a "quali," kneaded into balls or fanciful shapes, and then the result is ready for exportation. This boiling is most important if the good qualities of the gutta are to be preserved.

There is a further process which the gutta-percha has often to undergo at the port of shipment, that of "reboiling." This consists of classifying and assorting the numerous parcels, of all sizes, shapes, colours, and qualities, into certain classes. These parcels are often adulterated to an alarming extent. The Chinese are great adepts at this classification, and the custom is to mix together small parcels of different varieties, so as to produce a "standard sample." This is done by slicing the gutta, boiling in large shallow iron pans, and constantly stirring. Sometimes the juice of the lime fruit or cocoa-nut oil is added during the boiling, the former to hasten coalescence, and the latter to give a better appearance to the product. When sufficiently boiled, the gutta is taken out of the pans, pressed into large moulds, and packed for shipment.

At various periods during the last 15 years, the subject of gutta-percha and its supply for commercial purposes has engaged my attention, and a brief *résumé* of the results of these inquiries may not prove out of place. In these remarks I may have to repeat a little of what I have stated with regard to pseudo-guttas, but this I do for sake of completeness.

As will be seen, there are numerous varieties of gutta-percha, and these differ most materially in character and value. These varieties are often mixed by natives, and great harm is done thereby to a good gutta. But the greatest harm in this direction is done by the Chinese and others, at the port of shipment, by the process of "reboiling." Parcels of different varieties, particularly if of low or inferior quality, are mixed together, and a certain quantity of best gutta added to give "tone" to the parcel, and allow of its passing muster. Sometimes this "tone" only consists of a skin of good gutta over a core of bad. Now, some of these "low varieties" have no right to be classed as "gutta-percha," unless, indeed, we extend or "expand" the significance of the term so as to include such substances as kowrie gum, gambier, and cutch. This indiscriminate mixing, to a manufacturer, is a serious matter, and I believe that, in some cases, where a "fault" occurs in a cable, it arises from the fraudulent admixture in the gutta of some such resinous substance and its subsequent crystallising out. It must be borne in mind that a small per-centage of such an admixture may render a cable utterly useless at a most critical moment. That such a reprehensible practice of admixture does take place, I have had personal opportunities of observing. There are many varieties of gutta-percha which are valuable, but the mixing of these different varieties should be left to the manufacturer at home, as he alone can best judge of the mixture or blending most adapted for the purpose he has in contemplation.

That there is a necessity for boiling gutta-percha before sending it home seems to me conclusive, and if not properly performed by the natives it should be done by the merchants before shipment, and for the following reasons:—

Pure gutta-percha, as it flows from the tree, is a viscid fluid, acquiring milkiness and concreteness on exposure to the atmosphere. By the absorption of oxygen it splits up in time into two resins, known as *albine* and *fluavile*. This proneness to resinification in gutta-percha I have often noticed and experimented upon, and that by boiling the gutta-percha as soon as possible after collection this is arrested, I have proved both at home and abroad. Thus if a piece of "raw," or gutta-muntah, be taken, and the half be well boiled and pressed, it will retain its good qualities, whereas the other will become a resinous mass. Thus, through the gutta not being thoroughly well boiled at first, what would otherwise be of good quality becomes deteriorated in quality, or absolutely useless.*

In preparing gutta, therefore, for market, all large blocks should be cut open, well boiled, and pressed in the form of small thin slabs. This should also be done with gutta-muntah, and thus not only will freight be saved, but gross adulteration and depreciation of value by chemical changes will be reduced to a minimum.

In my paper at the Society of Arts, on "India-rubber," and my report on the same subject to the Secretary of State for India, I gave the opinion that it was not necessary to cut trees down to obtain the India-rubber, and that trees, after allowing a certain period of rest, could again be "tapped." This, where carried out as I indicated, has not only proved practicable, but also a great saving, and a much more economical method of working a forest.

The native evidence against "tapping" gutta-percha trees is nearly overwhelming. They insist on the necessity of cutting down the trees. This may arise from indolence, a wish at one operation to obtain the greatest possible quantity without a thought to future supply, or from the want of sufficient aggregation of the trees within a reasonable distance, to obtain a sufficient quantity of gutta to repay collection. Gutta-percha does not flow so readily as Caoutchouc does, and also more rapidly concretes. The yield in the rainy season is nearly double that of the dry season, due possibly to two reasons, first, that nature has not yet been called upon to use up the gutta-percha for the elaboration of new tissues, or, second, the greater amount of moisture causing greater fluidity in the gutta-percha milk. The Dutch Government tried to induce the natives to practice "tapping," but without success, and "boring," as is practised with the sugar maple, met with a like result. The question can only be set at rest in a well regulated plantation.

The many and various purposes to which gutta-percha is now applied are legion, rendering an enormous and regular supply absolutely necessary. For our commercial supplies of any staple article, we cannot long depend on the spontaneous products of the forest; a statement that, to an economic botanist, has the full force of an axiom. These products are collected in a most reckless and destructive manner, and then only when other and better, or, at least, easier means of livelihood fail. The requirements of civilisation and space for agricultural pursuits, jungle fires, &c., are great destructive agents to the existence of forests. Often have I seen a spot which had cost nature centuries to fill with her wondrous handi-

* *Vide* "Remarks on Balata and other Pseudo-Guttas," Jour. Soc. Arts, Nov. 23, 1883, pages 15 and 16.

work, turned by recklessness into a veritable charnel house.

As to the number of gutta-percha trees which have been destroyed, Dr. Oxley calculated that to supply the 6,918 piculs (1 picul equal $133\frac{1}{3}$ lbs.) exported from Singapore, from the first of January, 1845 to 1847, 69,180 trees were sacrificed; and, according to the *Sarawak Gazette*, 3,000,000 trees were required to supply the 90,000 piculs exported from this district during 1854 to 1874. These are only two instances, the first, showing the trade in its infancy; and the second, that of a limited and comparatively small producing locality. In fact, the gutta-percha tree has only been saved from utter annihilation because trees under the age of 12 years do not repay the trouble of cutting down. Still, it is clear that the growth of young trees of the best varieties has not kept pace with the destruction, but are becoming much scarcer, so that recourse now, more than ever, has to be had to the products of very inferior varieties.

At the present time there is a great difficulty in obtaining sufficient supplies of the best varieties, especially for telegraphic purposes.

Cultivation and acclimatisation is our only resource, and the Government of the Straits Settlements have a splendid opportunity for carrying this matter out. We have now a great amount of power and influence in the Malayan Peninsula, and could easily introduce a form of Forest Conservancy. By letting or "farming" out these forests for collecting gutta and other forest products, the working expenses of conservancy would be secured, the native rajahs paid a small royalty, and possibly an addition made to the colonial revenue. A clause to be stringently enforced should be inserted in all such contracts, namely, that for every tree cut down, two or three should be planted in the place thereof.

The Indian Government, acting on the advice of the late Mr. Howard, F.R.S., Mr. Markham, Dr. Spruce, and others, did, with rare forethought, undertake the initiative in introducing the cultivation and acclimatisation of the cinchonas, and private planters, seeing the success achieved, have also taken up the matter. They have also taken up the India-rubber question. The Colonial Government should now take up the question of gutta-percha. Borneo, Labuan, the southern portions of the Malayan Peninsula, are the natural homes of these trees; possibly the Nicobars, Ceylon, and some parts of Assam, would prove equally congenial, and Singapore could be used as a nursery for the young plants.

Correspondence.

ELECTRIC LAUNCHES.

The discussion following Mr. Reckenzaun's paper on Wednesday, January 16th, as also the many erroneous statements made in the daily and weekly papers with regard to the efficiency of primary batteries, induces me to send the following figures, relating to the quantity of fuel required to produce 1 horse-power per hour by means of steam, and by electricity. Perhaps these figures may be thought of sufficient interest for insertion in your next issue.

		Foot-pounds.
1 Heat-unit (Fahrenheit)	=	772
Ditto (Centigrade)	=	1,390
1 Horse-power per minute	=	33,000
Ditto per hour	=	1,980,000

Ditto ditto in heat-units—

$$\frac{1,980,000}{1,390} = 1,425$$

Heat-units (Centigrade) contained in—

1 lb. of coal..............	=	8,000
1 lb. of hydrocarbon (liquid)	=	11,000 (about)
1 lb. of hydrogen	=	34,000

Assuming with Professor Adams (see opening address at the Society of Electricians), the greatest efficiency of a theoretically perfect heat-engine to be = 23 per cent. We have—

for coal	23 per cent. of 8,000	= 1,840
for hydrocarbon	,, ,, 11,000	= 2,530
for hydrogen ..	,, ,, 34,000	= 7,820

Hence, 1 horse-power requires for its development in such a theoretically perfect engine at least—

$$\frac{1,425}{1,840} = 0{\cdot}774 \text{ lb. of carbon,}$$

$$\text{or } \frac{1,425}{2,530} = 0{\cdot}563 \text{ lb. of hydrocarbon,}$$

$$\text{or } \frac{1,425}{7,820} = 0{\cdot}182 \text{ lb. of hydrogen.}$$

The effieiency of a perfect voltaic battery and electric motor may, at the lowest estimate, be assumed as 90 per cent.

1 lb. of zinc = 1,300 J; 90 per cent. = 1,170. One horse-power developed in an electric motor by a current from a voltaic battery requires hence at least—

$$\frac{1,425}{1,170} = 1{\cdot}133 \text{ lbs. of zinc.}$$

The above will elucidate the assertion about 1 horse-power being produced by 0·166 lbs. of hydrocarbon, against the lowest possible 0·563 lbs.; but it also shows Mr. Reckenzaun's modest estimate of 2 lbs. of zinc per horse-power per hour in its proper light.

I may here add, that D'Arsonval (see *La Lumière Electrique*, vol. v., p. 90) has obtained 368 kilogramme metres with 1 gramme of zinc; this corresponds to a consumption of 1·42 lbs. of zinc per horse-power per hour.

C. GODFREY GUMPEL.

VISIT OF THE BRITISH ASSOCIATION TO CANADA.

It gave me much pleasure to attend last night at the meeting of the Society of Arts, and to listen to Mr. Colmer's paper, and the discussion that followed it. Had time not been fully taken up by speakers who had better claims on the audience, I should have been glad of the opportunity of saying that it was strongly felt by the Committee of Section F (the Statistical and Economic Section) at Southport, that their work at Montreal should be the collection of materials for a complete and authoritative survey of the economic condition of the Colony. The following subjects were specially chosen as the most suitable for discussion :—Agriculture; education—(1) primary, (2) scientific, (3) technical; fiscal policy and foreign trade; fisheries; population and immigration; pauperism; shipping; tariff.

It is probable that your *Journal* containing Mr. Colmer's paper will be extensively read, not only by members of your Society, but also by many persons connected with or resident in Canada, and that you may be able, through its means, to promote the success of the Economic Section of the British Association at Montreal, by giving publicity to its object.

It may be well to state that it is the practice to devote each day to the consideration of one or more special topics, according to the number of papers prepared on each subject. The papers should not take more than twenty-five or thirty minutes at most in the reading; and it was thought desirable, in view of the length of time inevitably taken up in communicating by post, that all papers from Canada should be sent in to the Secretary of the British Association, 22, Albemarle-street, not later than the beginning of June.

I hope that you will accept as my excuse for troubling you, that I am pledged to do my best to promote the success of the Economic Section at the Montreal meeting.

JOHN B. MARTIN.

68, Lombard-street, London,
Jan. 30, 1880.

General Notes.

TYPOGRAPHIC ETCHING ON GLASS.—The new Sydney paper, *The Australian Graphic*, is illustrated by typographic etchings on glass plates, made by the process of Mr. H. S. Crocker. The writing or drawing is executed with a resist crayon made of a waxy material, and it need scarcely be said that hydrofluoric acid is used as the etching fluid. It has been noticed that the tendency to undercutting is remarkably small, so that no precautions are required but an occasional stopping out of the finer parts. The glass plates are cemented down on metal blocks for use in the printing machine, but it is not stated how the clearing out of large whites and the turning of the blocks is effected. It is said that the inventor originally intended to print from electrotypes taken off the glass, but this was found unnecessary in practice, as no inconvenience is caused by the use of the glass itself in the printing press.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock :—

FEBRUARY 6.—"The Sanitation and Reconstruction of Central London." By WILLIAM WESTGARTH. Sir FREDERICK ABEL, C.B., F.R.S., Chairman of Council, will preside.

FEBRUARY 13.—"New Process of Permanent Mural Painting, invented by Adolph Keim, of Munich. By Rev. J. A. RIVINGTON. HUBERT HERKOMER, A.R.A., will preside.

FEBRUARY 20.—"Reclamation of Land on the North-Western Coast of England." By HYDE CLARKE.

FEBRUARY 27.—"Vital Steps in Sanitary Progress." By B. W. RICHARDSON, M.D., F.R.S.

MARCH 5.—"The Progress of Electric Lighting." By W. H. PREECE, F.R.S.

MARCH 12.—"Water Regulation, in regard to Supply, Floods, Drainage, and Transit." By General RUNDALL.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings :—

FEBRUARY 12.—"The Portuguese Colonies of West Africa." By H. H. JOHNSTON. Sir FREDERICK JOHN GOLDSMID, K.C.S.I., C.B., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

FEBRUARY 28.—"Recent Progress in Dynamo-electric Machinery." By Professor SILVANUS P. THOMPSON.

MARCH 13.—"The Upper Thames as a Source of Water Supply." By Dr. PERCY T. FRANKLAND.

INDIAN SECTION.

Friday evenings :—

FEBRUARY 15.—"State Monopoly of Railways in India." By J. M. MACLEAN. SIR JAMES CAIRD, K.C.B., will preside.

CANTOR LECTURES.

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By THOMAS BOLAS, F.C.S.

LECTURE II. Feb. 4.—Type Blocks from Line Drawings and Half Tone subjects.

LECTURE III. Feb. 11.—Intaglio Plates. Collotypes. Photo-Mechanical Methods, as applied to the Decoration of Pottery. Miscellaneous Processes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "Recent Improvements in Photo-Mechanical Printing Methods." (Lecture II.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. S. B. L. Druce, "The Agricultural Holdings (England) Act, 1883."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. 1. Presentation of Prizes by Mr. Jabez Church. 2. Inaugural Address by the President, Mr. Arthur Rigg.

Chemical Industry (London Section), Burlington-house, W. 8 p.m. 1. Mr. C. C. Hutchinson, "The Disposal of Sewage Sludge." 2. Mr. J. H. Porter, "The Porter-Clark Process for the Purification of Water." 3. Paper on "Some Technical Applications of Keiselguhr."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. H. White, "Review of the Education and Position of Architects in France, since the year 1671."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. Ernest A. Budge, "Nebuchadnezzar, King of Babylon—On Recently Discovered Inscriptions of this King."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Ruskin, "The Storm Cloud of the Nineteenth Century."

TUESDAY, FEB. 5...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Geikie, "The Origin of the Scenery of the British Isles." (Lecture II.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. F. R. Conder, "Speed on Canals."

Pathological, 53, Berners-st., Oxford-st., W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Mr. J. Peters, "The Babylonian Origin of the Phœnician Alphabet." 2. Mr. George Bertin, "Notes on Babylonian Contract Tablets."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. W. Leche, "Notes on some Species of Chiroptera from Australia." 2. Mr. P. L. Sclater, "The Lesser Koodoo, *Strepsiceros imberbis* of Blyth." 3. Prof. F. Jeffrey Bell, "Contributions to the Systematic Arrangement of the Asteroidea. —Part II. The Species of *Oreaster*." Mr. R. Bowdler Sharpe, "Description of a new Species of *Laniarius* from Ashantee."

WEDNESDAY, FEB. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Westgarth, "The Sanitation and Reconstruction of Central London."

Geological, Burlington-house, W., 8 p.m. 1. Mr. T. Mellard Reade, "A Delta in Miniature—Twenty-seven years' work." 2. Professor John W. Judd, "The Nature and Relations of the Jurassic Deposits which underlie London." With an Introductory Note on a Deep Boring at Richmond, Surrey, by Mr. Collett Homersham. 3. Mr. G. W. Lamplugh, "A Recent Exposure of the Shelly Patches in the Boulder-clay at Bridlington."

Shorthand, 55 Chancery-lane, W.C., 8 p.m.

United Service Institution, Whitehall-yard, S.W., 3 p.m. Captain R. F. Johnson, "Night Attacks." (Part II.)

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Messrs. Wyndham R. Dunstan and F. W. Short, "Report upon the Pharmaceutical Preparation of Nux Vomica" (continued). 2. Messrs. Wyndham R. Dunstan and Francis Ransom, "The Assay of Atropa Belladonna." (Part I.) 3. Mr. Boverton Redwood, "A Sample of Sophisticated Oil of Turpentine."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. Alfred B. Wyon, "The Seals of Henry VI. as King of France."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.

THURSDAY, FEB. 7...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. O. Bower, "The Gemmæ of *Aulacomnion palustre*." 2. Rev. A. E. Eaton, "Monograph of Recent Ephemeridæ" (Part II.). 3. Mr. B. T. Lowne, "Compound Vision of Insects." 4. Mr. H. N. Ridley, "Cyperaceæ of West Africa." 5. Rev. A. M. Norman, "European and North Atlantic Crustacea."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. L. T. Wright, "The Influence of the Temperature of Distillation on the Composition of Coal Gas." 2. Mr. R. Meldola, "Researches on Secondary and Tertiary Azo-Compounds." (No. II.)

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Norman Lockyer, "The Last Two Eclipses of the Sun."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Paper on "Willesden Paper and Canvas, and Some of their Uses in connection with Photography."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Pauer, "The History and Development of the Music for the Pianoforte, &c." (Lecture IV.)

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, FEB. 8...United Service Inst., Whitehall-yard, 3 p.m. Captain C. O. Brown, "The Present Position of the Armour Question, with a Summary of the Recent Plate Experiments."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Professor G. J. Romanes, "The Darwinian Theory of Instinct."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. 1. Miss Grace Latham, "Ophelia." 2. Mr. G. B. Shaw, "Troilus and Cressida."

SATURDAY, FEB. 9...Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Morley, "Life and Literature under Charles I." (Lecture IV.)

Physical, Science Schools, South Kensington, S.W., 3 p.m. Annual General Meeting.

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,629. Vol. XXXII.

FRIDAY, FEBRUARY 8, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. Thomas Bolas, F.C.S., delivered the Second Lecture of his Course of Cantor Lectures on "Recent Improvements in Photo-Mechanical Printing Methods," on Monday, the 4th inst., in which he dealt with various processes of making type blocks from line drawings and half-tone subjects.

The lectures will be printed in the *Journal* during the summer recess.

FOTHERGILL PRIZE.

The Council of the Society of Arts, having carefully considered the models, plans, drawings, &c., submitted in competition for the prize of a Gold Medal, or £20, offered for the best invention having for its object the Prevention or Extinction of Fires in Theatres, have determined that the papers by Captain Shean and Mr. Ernest A. E. Woodrow, on arrangements for the prevention and extinction of fires in theatres, are the best of all the contributions sent in; but they are of opinion that neither of these papers come within the terms of the offer of the prize. They have, therefore, decided not to award the prize.

Proceedings of the Society.

NINTH ORDINARY MEETING.

Wednesday, February 6th, 1884: Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Baillie, Major-General John, 4, Queensborough-terrace, W.
Bostock, John Yates, M.R.C.S., M.B., 73, Onslow-gardens, S.W.
Evans, Edward Probert, Ross-house, London-road, Worcester, and Royal Porcelain Works, Worcester.
Lewin, Miss Constance, 25, Wimpole-street, Cavendish-square, W., and The Bourne, Widford, Hertfordshire.
Macdonald, Thomas, 5, Essex-court, Temple, E.C.
Mackinnon, W., Balinakill, Clachan, Argyleshire.
Scudder, Frank, 22, Devonshire-street, All Saints, Manchester.
Wilkinson, Captain Edward, R.N., Army and Navy Club, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Blyth, Alexander Wynter, M.R.C.S., The Court House, Marylebone, W.
Bond, Henry Chas., B.A., Brasenose, Bromley, Kent.
Campbell, F. J., Royal Normal College and Academy of Music for the Blind, Westow-street, Upper Norwood, S.E.
Johnston, Archibald, 6, Paternoster-buildings, E.C.
Lascelles, Brian Piers, 9 Holywell-street, Oxford.
Palmer, Walter, B.Sc., F.C.S., Westfield, Reading.
Ruscoe, John, Albion Works, Hyde, Manchester and Prospect-house, Hyde, Manchester.
Stopes, Henry, 24A, Southwark-street, S.E., and Kenwyn, Cintra-park, Upper Norwood, S.E.
Van Gelder, Pieter, Sowerby-bridge, Yorkshire.

The Chairman said it was a source of great pleasure and thankfulness to him that he was able to take the chair at this meeting, and introduce Mr. Westgarth, who had given an immense amount of study to this important subject. He had gone so zealously and patriotically into it, that he had offered prizes amounting in the aggregate to £1,200, for essays on the reconstruction of Central London.

The paper read was—

THE SANITATION AND RECONSTRUCTION OF CENTRAL LONDON.

By William Westgarth.

Introductory Remarks.

Owing to the attention which has of late been so strongly aroused to the insanitary condition—and, as it has been emphatically and most deservedly called, the horrible condition—of the dwellings of the poorer classes of London, there seems to me a favourable opportunity for arousing a like attention the still larger and not less pressing question which I propose to discuss with you this evening—namely, the sanitation and reconstruction of our Central London. The suitable rehousing of the poorer classes of the metropolis, which is now such an absorbing public topic, is also a part of my present question, although not the largest or most important part; and I shall have occasion further on to allude to the experience already acquired towards enabling us to deal successfully, and in a purely business way, with that difficult problem. The name of Miss Octavia Hill comes before us as associated with much of the most practical and useful of that experience. But my principal subject is, as I said, the larger, and, as I may add, the not less pressing question of the sanitation, the street re-alignment, and the reconstruction of our Central London. Much the larger interests, very much more of human life, and in every rank and class of it, are at stake in this larger question. I may add that, in this larger question also, I bring before you a self-supporting business project, and no mere scheme of philanthropy.

The Increasing Greatness of London.

Those of my audience who may have read the late admirable address of Sir J. W. Bazalgette, delivered, as President of the Institution of Civil Engineers, on the 8th ultimo, and reported in the papers of the following day, will have already a good idea of that great London which I am now to discourse upon, and whose traffic-blocked and insanitary central areas call so urgently to-day for relief. The remarkable growth of the Institution itself, of which he is the distinguished head, is strikingly illustrative of that of his subject, London; for whereas the membership of all grades numbered only 351 when he joined it in 1838, there is now a total of no less than 4,443. Our great metropolis, as defined by the Act of 1855, stands upon an area of 117 square miles, and that area is now covered with half-a-million of houses, and very nearly four millions of people. The growth which now characterises the metropolis has been, in regard at least to its present rapidity of pace, a feature limited to this century, and especially to its later half. In this respect, indeed, London, it may be said, only follows with other cities and countries in the wake of that striking progress everywhere which is the conspicuous feature of our modern civilised life. That is, happily, the common case; but London, as we may claim, is already specially conspicuous in the common rule, and we must hope that a resanitated and reconstructed London will still be much more so.

But the rapid growth of London, which I have alluded to as the feature of this century, is, as I have said, much more in the century's later than its earlier section. Indeed, the law of modern progress, as exemplified by London at least, appears, if I may so distinguish it, to be geometrical, and not merely arithmetical. The advance of the last ten or twenty years seems to be always greater, actually and relatively, than that of any previous like interval. This is shown in the population returns, but is still more striking in those of the City valuations. In 1841, the rateable yearly value of the city amounted to six million pounds. In 1855 it was ten and a half millions. But to-day the advance is to no less than twenty-eight millions. I call your special attention to this very remarkable advance of value, because we are to be much concerned with this feature of value increment in our projected sanitation reconstruction project. Some part of this striking increase is attributable—as Mr. St. Quintin, with his large experience of City valuations past and present, informs me—to a stricter system, of late years, in assessing value, and it must be largely due, of course, to extension of the City. But the increase in question is not due wholly, or perhaps even chiefly, to either of these causes, but arises also from what economists have, rather invidiously, called the "unearned" increment; as an increment of value due not to capital expended in improvement, but to increase of commerce, wealth, and population upon a limited and inextensible site area.

Its Overcrowded and Insanitary Condition.

Such, then, is the great London which I bring before you. Its central parts have become congested by the vast increase of traffic that daily struggles through the narrow and tortuous streets and lanes of an earlier and much smaller London; while the highly insanitary conditions are proportionately injurious and distressing to the crowded human life which is daily and nightly packed in these unsuitable quarters. The science or art of sanitation has now happily advanced sufficiently to give us some due appreciation of these evils, as well as the desire to remedy them. The difficulty has lain in the question of the best kind of agency for grappling with the evil, and even more in that of meeting the enormous cost of the work. In the following remarks I propose to deal with both of these most important questions, and to offer a solution which will, as I hope, admit of the great work being carried out. I wish to show that this great work may be done by private enterprise, in reliance upon an ultimate recoupment of cost from that natural increment of site value which, as I have shown, has been, and inferentially still is, the sure result of our modern progress. Let me add, that we are all concerned not only to have this work done, but to have it done promptly. Every year's delay continues, of course, a comparatively high death-rate; and this means not only premature death to many thousands of citizens, but, what is even still worse, constant deterioration of health, vigour, and vital enjoyment during the abbreviated life. But further, every year's delay also increases the cost and difficulty of the work, because the business to be disturbed is greater, and the necessary expropriations more expensive, while the current desultory efforts at improvement and reconstruction have mostly, I fear, to be undone, or to be done over again, in the grand street re-alignment which seems to me indispensable to the new city.

The Scope and Method of my Subject.

With these introductory remarks, I now proceed to explain how this great and beneficial work may be undertaken in an ordinary business way; how it may be done so as to prove self-remunerative, and how we may best minimise the expropriations and other social or business disturbance of such a vast undertaking. I shall first describe Central London as it is, in its irregular, narrow, and tortuous streets and lanes, with their most insanitary condition. I shall then sketch out, in some prominent features, what I think London ought to be—what also it may be, if its people have the courage to face the work. Lastly, I shall take up the business part of the question, explaining the ground of reliance for balancing the vast way-bill of costs, and the fitting special constitution of the company or trust which is to accomplish the undertaking.

Central London as it is.

We are all familiar with the map of our Central London, meeting our eyes as it does in the shops of every street, and at every Metropolitan Railway Station. Consider the chance-medley of even its main streets, as they pervade the map in utterly planless directions. They seem to run all about to nowhere in particular, and to reach that abstract destination in lines most oddly devious and independent. The feature of a straight street, such, for instance, as the old "High" street of Cheapside and the Poultry, does here and there occur, and ought of undesigned and mathematical right to occur in the ordinary doctrine of probabilities; but it is the very rare exception of the case. The newer streets, such, for instance, as King William-street and Queen Victoria-street, introduce principle and design into all this bundle of accidents. They give us broad, straight, uniform ways to definite objects, whether river bridges, railway stations, or other chief destinations. But these benefits have come only latterly out of the costly process of destruction of this planless past, and re-alignment and reconstruction.

Origin of its Irregularity of Plan.

There is no difficulty in guessing how our old London has come down to us so oddly parcelled out. The chance-medley process goes on even to-day, and so near us as the London suburbs. There is first a devious pathway through the fields. This broadens into a road, with dwellings and gardens on either side. Then, as population streams out, it is a thoroughfare, or main street, and eventually it is surrounded by modern streets and squares, which adapt themselves as they best can to the hap-hazard lines of the original free field path. I am an old enough resident of Western London to have witnessed all this process, in the case, for instance, of the old Portobello-road, running between Notting-hill and Kensal-green. I have often sauntered through the pleasant original field pathway, have seen it graduate into the thronged thoroughfare, then into the compact and crowded street, until now it forms the oddly independent diagonal amongst the regular streets and squares of a principal outer section of the great metropolis. In the marvels of London's progress, too, all this has happened within the brief space of the last twenty-five years. If you could transport yourselves back nearly as many centuries, you also might traverse field pathways that have since become the oddly twisting Lombard and Fenchurch-street, Cornhill and Leadenhall-street, the Old Broad-street, Threadneedle, Gracechurch and Bishopsgate streets of our old central city.

But, unfortunately, our central city is not, like modern Notting-hill, with its Portobello-road, one irregular which is all surrounded by the regular. Its case is an exact reversal, for it consists nearly all, so to say, of Portobello-roads, and its regularities have yet to come by force of almost entire stieet realigment and reconstruction. London has been expanding all over its circumference much in the wondrous way which we have seen as to Notting-hill, and now there is hopeless congestion in those narrow and devious tracks of the original city.

Its Insanitary Condition.

Let me turn now to the sanitation question. Although possibly less objective, this is of far more serious import than questions of the traffic block, or of any other merely material or business inconvenience. But only those comparative few who have given intelligent attention to the subject can fully realise the terrible condition. To all others it is, more or less, an unknown and incredible quantity. The latter may, however, realise something of the case, if they will glance into the many small courts and narrow passages on either side of such a principal city thoroughfare, and of such fair external pretensions as, for instance, Fleet-street. Indeed, in this matter of externals, our most central parts are getting to be, comparatively speaking, perfect, for the cleanness and neat finish of the asphalte paving, throughout even our very narrowest lanes, seems to leave nothing to be desired. But, alas! it leaves everything untouched within the buildings themselves on either side, packed as they usually are, from underground basement to attic, with teeming and toiling human life.

We may, perhaps, best form a correct idea of the insanitary conditions of this crowded central scene, by looking at those of other metropolitan quarters much less crowded, and, as we might suppose, much more cared for by comparatively wealthy occcupants. "In the older streets of the West-end," says the *Medical Times*, "it is probable that a perfectly sanitary dwelling could only be obtained by rebuilding from the basement. The old brick drains have, in many cases, been leaking for years; and even where they have been replaced by earthenware, the whole subsoil still remains permeated with the filth of generations." The poisoned subsoil, as I shall presently have occasion to say, is one of the chief evils of which, as I feel assured, we must thoroughly purge our central city. The journal I quote goes on to allude to the sanitary ignorance and incompetency in the building art of the past. Indeed, it is only within the last very few years that proper sanitary principles have been so fully and generally known as to ensure their practical application. The whole metropolis is now hopefully alive—to a degree never before attained—to sanitary defects and dangers; and efforts, at a vast collective cost, are now being made everywhere to remedy them.

The London Death-rate.

Sir Joseph Bazalgette has given us a comparison between London and some other great city death-rates. When London, which has now, in its sanitary march, such excellent sewerage, is compared with great cities without sewerage, such as St. Petersburg; or with those of still more crowded housing, and still worse sanitation generally than itself, such as Vienna, our capital appears to no small advantage. Its death-rate is now down to 21·4 yearly per 1,000 of population, after having been about 24 for twenty years prior to 1870, and 22·5 for ten years thereafter. The St. Petersburg rate is 35·2, and that of Vienna 29·2, while that of Cairo is 37, and of Pekin 50.

But the improvement hitherto in the reduction of the London death-rate—where so very much still obviously remains to be done in improving the sanitation—shows us what better things may still be hoped for. After the notable instance of Salisbury, as well as of other re-sanitated towns, it seems not impossible still to reduce our London mortality rate almost by one-half. It is not unlikely that, by due attention to sanitary rules, the centre of London may enjoy a less—even much less—mortality than the healthiest country districts hundreds of miles away, where sanitary ignorance and negligence still prevail. In our Scotch Highlands, for instance, to which so many of us Londoners annually flee for change and health, the careless country people too often vitiate their pure outside atmosphere surroundings by pestiferous "middens," while, in most cases, within doors, the fresh air, as the common enemy, is studiously excluded. We thus explain much sickness, physical suffering, and early death, in those otherwise healthful regions.

Now what, let me ask, is the full meaning of such a reduced mortality? It means, of course, a much longer average duration of life. But it means also something besides, whose social and moral importance far exceeds that of more prolonged existence. It means all the joy and all the vigour of healthful life. We are too much in the habit of thinking that if the stomach of the toiling millions is filled with good and sufficient food, there is nothing else to think about in that particular direction. But we have, all of us, yet another stomach in our system, which must also be filled with its own proper food, and that is the lungs, with pure air; otherwise even the best of food may, in its comparatively imperfect digestion, give weakness and pain instead of strength and enjoyment. Let us hope that such attainments are not to continue to pertain only to mere dreamland, but that we may some day, and that, perhaps, a day not very far a-head, realise the vigorous and joyous life of a resanitated London, and all the benefit, economic and social, which is to come of it.

Central London as it Ought to be.

I must content myself with very general remarks on this part of my subject; for although it may be called the most important of all, as embodying the final outcome of result, it is much too technical in character for any closer treatment at my hands. I speak, however, as a London citizen of long standing, who aims to rise to an adequate idea of all the greatness of his adopted City, and who has been long impressed, and each succeeding year more and more strongly, that its accommodations and its general aspect fall utterly short of the needs of its millions of people, and of its surpassing position in the wealth and commerce of the world.

Two Chief Central Sites.

I have spoken of the hap-hazard direction of our original City thoroughfares. In this comparatively limited area with which our project has more especially to do, two chief centres stand out before us. The lesser of the two, comprising the site of St. Paul's, I would distinguish as the art centre; the greater being, of course, that great centre of the world's commerce and finance, which is now indicated as the fertile site of our Royal Exchange and Stock Exchange, of Lloyd's, of the Bank of England, other chief banks, Lombard-street, and of the Mansion-house. Is it too much for London to claim that these two chief centres should be connected by the grandest of streets, not merely of London but of the world? From these centres, but especially from this latter business centre, should radiate all the chief thoroughfares of great London. Sir Christopher Wren, and others after him, have in vain draughted plans for a reconstructed London. The great fire of two centuries ago might have given a fitting opportunity, but it was not availed of. To-day, in attempting the work, we would not have quite the same freedom of the ideal, for there are not only the many river bridges to be considered, but well nigh a host of great railway stations penetrating and permeating London. The plan of a reconstituted London of to-day must be, therefore, an artisto-economic contest mainly with reference to those bridges and stations.

The Great Business Centre.

But let me return for a moment to the great business centre. When our noble St. Paul's has been "unstifled," by concession of some little more of surrounding breathing room, when we have the finest of streets running from the noble cathedral to that other centre, what ought we to aspire to as worthy of the latter? Our climate is suggestive of the comfort and convenience, to say nothing of modern possibilities of elegance, of the arcade form of edifice. Repeatedly, as I stood under the beautiful new structure of this kind in Central Milan, constructed, too, as I was told, by English enterprise and capital, I have asked why London should be so contemptibly inferior in that way. If we, then, are also to have a central arcade, let us hope that it is to excel in magnificence even that of Milan by as much as London excels, in population, wealth, and commerce, her fair rival of Northern Italy.

But I have yet another idea with regard to London's grand business centre. It is already, as we have seen, the common meeting-gronnd of many of our leading city interests. I would complete, as far as might be, this central representative character, by providing accommodation for every kind of institution with which the public were largely or frequently concerned. There would not, of course, be full accommodation for all, but all might "enter an appearance," and the modern facilities of telegraph, telephone, &c., would do the rest. I do not limit this idea to public institutions, such as Parliament, the various Government offices, the legal and judicial, the postal, the customs and excise, and so on. The chief trading interests might be there also, including even hotels, theatres, &c. The railways also, of course, must enter their appearance here, and perhaps adequate subterranean accommodation might permit of a convergence of all the lines to this great centre.

Centralising of the Public Offices.

When we have once experienced the incredible business facilities of this centralising official system, we shall look back with amazement upon our present utterly unsystematic site scattering of all these public and business interests, and the time and trouble which are thus involved to everybody. Indeed I have long entertained the still larger idea, in the interests of economies and conveniences of every kind, of bringing together all the chief public offices into one great commodious common edifice. No central site is now possible for so comprehensive a structure, but a near suburban site might still be found, and a special railway service at nominal charges might bring these collective offices, as a whole, much nearer to every citizen than at present. Of course any hope for this very disturbing idea arises out of a reconstructing of London.

Other Chief Considerations in the Sanitation and Reconstruction.

I must now hasten through some other chief considerations of a reconstructed Central London. As we are to indulge in unprecedented width of our chief streets, we may recompense the sacrifice of accomodations in one direction by seizing upon more of them in another; that is to say, by giving a greater height to our new buildings. We have plenty of room both towards heaven above, and in the earth beneath, and the modern facility of perpetually-going lifts will almost abolish wearisome staircases. Let us begin with our subterranean. We must eject all the old poisoned soil, and, in so doing, institute a new level of construction. An ample subterranean will give us at once business storage, and the due facility for availing of all the progress of art and science in the future, in our lighting, watering, sewerage, and the application of energy or power in all ways, without the heretofore incessant breaking up, over and over again, of our streets.

Next, we have a lofty ground floor—so lofty as to allow, without serious reduction of light to that floor, a terrace or upper promenade, with bridged connections, for foot passengers, so as to put an end to those countless street dangers and accidents which already cost London and its suburbs the yearly sacrifice of 270 lives. This level, as well as that of the ground, will have its shops and traffic, to swell out a remunerative rent roll.

We continue our ascent through successive floors of offices or dwellings, until the public lift lands us, without fatigue, upon the roof. Here is something entirely new to London experience, and possibly to any other as yet, but entirely attainable under a systematic reconstruction. In short, the roofage of our chief streets is a public promenade, a continuous park or garden. The original idea in this grateful direction is due, I believe, to Dr. Richardson, who, in removing the too savoury kitchen from the very bottom of the house to the very top, would have the house surmounted by a garden. The chief or only obstacle in the way of such enjoyments is the difficulty of dislodging the ordinary Englishman from his accustomed groove of comparative discomfort. In this time of scientific promise and attainment, we may venture to prohibit smoke entirely to the new city. The sanitary conditions will thus combine with the scenic to give us, with these "hanging gardens" of the modern Babylon, a new era of health and enjoyment for its crowd of citizens.

The Business Part of the Project.

The project we are now discussing involves the turn over of probably not less than one hundred millions of money. How is all that money to be duly found, and how is the great work, with all this great cost, to be remuneratively executed? This may seem, at first thought, the most difficult section of the whole project. But after much consideration of the subject, based on large business experience, I feel myself on surer ground and more at home in this section of my project, than in the somewhat technical bearings of the other sections, to which I have already alluded.

The great difficulty hitherto in the way of the much needed clearing and improving of the congested centres of our larger towns has been the terrible amount of the unrecouped balance of the cost. The famous Paris reconstruction has certainly given a most enviable result, so far as regards improvement, but it has been at the cost of a very onerous heritage of City debt. In proposing, as I now do, to execute all the reconstruction of Central London without any such undesirable heritage, and even without appeal to the State for any pecuniary help whatever, I must explain how very differently we are to conduct the proposed work from the methods adopted in Paris and elsewhere, and even in London itself, so far as reconstruction has yet proceeded.

The spirit of improvement and reconstruction is indeed already manifest all over our crowded metropolis. But if we except the occasional larger aims of the Board of Works, this enterprise has mostly been mere individual effort, with the result of a grotesque effect within the narrow tortuous lines of our old streets and lanes. Let us mark, however, that although these many isolated and individual efforts must be made at great disadvantage amongst unimproved surroundings, yet, from their great collective total, we may infer not only the pressing urgency of the general case, but also that such work does, in a business sense, prove ultimately remunerative, or it would not otherwise be so largely undertaken. This is a very important encouragement to our project, and we are further furnished with guidance from these operations as to the method we should adopt in that project. The difference of method and of result between a private interest and a public body in effecting such improvement works is usually very apparent, especially as affecting the profit and loss account. In the Paris case, for instance, a great area would be completely and simultaneously expropriated and cleared out, and be shortly afterwards resold in a market which, with the large supply of the article offered, and the necessarily suspended or diverted traffic of the locality, was more or less of a forced character. No wonder, therefore, that the result has been that, on the one hand, of a great debt bequeathed to Paris, and on the other, of a great reward eventually to the new proprietary, inheriting as they did the increase of value due to time and to the improved city. Thus we are instructed to adopt methods which shall minimise business disturbance, and not too readily part with the unavoidable expropriations. So far as I can learn, the Paris reconstruction cost eighty millions sterling, and the recoupment did not exceed twenty millions, thus leaving sixty millions of city debt.

The Natural, or So-called "Unearned" Increment of Site Value.

Let me now briefly allude to a chief factor in the great recoupment question. This is what economists have termed the "unearned" increment of site value—of the value generally of our real estate—due to the simple effluxion of time in any progressive society occupying a limited site area. The theory which underlies this increment is neither uncertain nor unintelligible, but until quite recently it was left all but entirely to the theories of economists, and anything approaching a practical application of its principle was hardly dreamt of. The past experience of the advance of London site values and rentals, and more especially of those of the central areas of the City, indicates clearly to us now that the cost of a great reconstruction scheme, such as that here proposed, would have been entirely recouped within any thirty years of the past of this century. I mean that if, for instance, in the year 1854, such a great project of reconstruction as I now suggest had been actually undertaken, the present enhanced values of the expropriations, had these been held over until now, would have recouped the whole cost, after the fullest compensation at the time to all the expropriated parties. The practical question for us is as to this "unearned" increment of value, or as I would less invidiously call it, this natural increment, continuing to be a feature of the future as of the past. We can hardly doubt that this will be the case, seeing that the causes to which it is assignable are still in as full force as ever; namely, the increase of commerce, wealth, and population, upon a site area which is itself inextensible.

We must not overlook a subwave feature of this increment. Over long intervals its course is steadily upwards, but intermediately there are reactions of depression and elevation. We had the elevation for some years succeeding the great Franco-German war, and the depression has succeeded and still continues. This temporary condition, however, is peculiarly favourable for inaugurating our project. Had it been begun ten years ago, the excited real estate market would have placed our project at serious disadvantage as compared with our present prospect.

We are to bear in mind, however, with regard to this said future increment, that the more it is explained and generally understood, the more will the effect be to convert future value, by intelligent speculative anticipation, into present value. But, on the other hand, there will always still remain a substantial future increment, both because the calculation must ever be wanting in elements of precision, at least, as regards any particular cases of site investment, and because present values and rentals will always depend more upon the present scale and returns of business than upon any speculative estimate as to what these may possibly attain in the next generation. And, again, behind this prospect of recouping increment, we have in store all the additional value of a resanitated London, a value which, in its heretofore unknown quantity and power, may possibly prove the most secure and effective factor of all.

Method of Procedure so as to Reduce Cost and Minimise Disturbance.

Presuming that my proposition is to carry out this project in an ordinary business way, by means of a company or joint-stock trust, I shall offer a few practical remarks upon the method of procedure, before dealing with the proposed trust, and certain specialities of constitution and management to be given to it.

There construction of Central London, in all that thoroughness of resanitation which I would advocate, in the interests of the daily life and health of perhaps above a million of human beings, would probably involve still larger monetary figures than even that of Paris. The total turn-over of money might not be short of £100,000,000. How is the trust to find so large a sum, and how is the recoupment and the final wind-up of the trust to be arranged? The great object of the trust, in this direction, should be to minimise disturbance of every kind. This policy should be enjoined on the trust; but, happily, it is also for the trust's own interests. Let us look then at some chief points of this ameliorating procedure.

1. The expropriations, instead of being complete, as in the Paris case, will, as far as possible, be optional to the proprietary or lessees, who may retain their sites, subject to co-operation in the proposed improvements. Some must needs be expropriated, partially or wholly, were it only in giving greater width to the streets; but it may suit some also to prefer to accept the full compensation to be offered, relatively in the cases (probably many) where street re-alignments have cut up old sites, or practically displaced them from old positions. On this latter account, indeed, there must be much and varied special arrangement. On the whole, it is not unlikely that the trust may be able to meet satisfactorily every case, and entirely to avoid coercive expropriation. Looking at the vigour with which individual reconstruction now goes on, in its patching way, along the old lines, and under the disadvantages of unimproved surroundings, as already alluded to, we may safely infer that very many would prefer to co-operate rather than surrender their interests. By this means, therefore, the dimensions of the reconstruction account will probably be reduced—so far as the trust is concerned—to a mere fraction of the great estimated total.

2. Reconstruction must be gradual, in the sense of minimising interruption to business. But this does not necessarily mean slowness of work, as work may so go on simultaneously in many places. On the contrary, it is to the interest of all concerned to effect the reconstruction quickly, and perhaps the modern modes and resources will prove unprecedentedly marvellous in this respect. An entirely new street realignment seems, at first, a far more disturbing course than merely to widen the devious old ways; but alike in the interests of sanitation and non-disturbance it is really the least so. We are thus enabled to effect a thorough reconstruction, and also to minimise business disturbance by having the new lines progressively ready ere the old lines, marching more or less alongside, are invaded.

3. Business disturbance may prove a serious item of cost to the trust, if treated in the offhand mode of the Paris reconstruction. Public bodies are less adaptable in such cases than may be expected of our proposed trust. In taking all possible care to avoid the interruption or divergence of the current tide of business in each locality dealt with, the trust should replace the evicted trader, with as little delay, and as nearly as may be relatively in his old position. The occupant in a superseded old main street should have the refusal of the relatively same position in the new thoroughfare. We thus minimise that serious item of all reconstruction schemes, business disturbance; and even disturbance in general ought always to be part of a fair and full compensation. I quite approve of Mr. Cohen's proposed Act for giving the poorer classes, even when without leases, compensation for disturbance. To evict a large number of such at one time, who, in perhaps a comparatively limited market, are to compete with each other for their rehousing, may cause not only great inconvenience, but also what is to them serious pecuniary loss. Our proposed trust may lean even to the generous side of fairness, seeing that it has, as I feel assured, ample prospective guarantees of ultimate success to enable it to do so.

The Agency to be a Joint-stock Company or Trust.

Certainly it has been the rare exception to carry out any great urban reconstruction as a matter of ordinary independent enterprise. We have the exceptional case of Newcastle-on-Tyne, about half-a-century ago, which has proved a success eventually, although, at the time, upon a rather ambitious scale for the attainments and wants of the place. But, in general, this kind of work, when not to be longer delayed, has been at the hands of the Government or the municipality, or, as in the case of London latterly, those of a *pro re nata* Board of Works. The usual result has been, as is conspicuously illustrated in the Paris case, a heritage of more or less inconvenient debt. Occasionally, in some partial field, there may have been a full recouping result, as with that great improvement of our West London, the new Northumberland-avenue. But the rule in such cases has been loss, and relatively no small loss too; while, as to our great London, all efforts, whether of public bodies or of private interests, have been as yet of a totally inadequate character. One chief defect in all these attempts has been their comparatively limited range, as the improved sections have thus been left bedded, so to say, in all the disadvantages of unimproved and insanitary surroundings.

Constitution of the Trust: its Special Character.

The proposed Central London Reconstruction Trust should have an adequate, but not a too exacting, guarantee of capital. Accordingly I would have a capital, nominally, of £10,000,000, with £1,000,000 to be paid up, and £9,000,000 to remain as liability. In view of raising the enterprise above the shiftings of the Stock Exchange, I would have the shares to be of £10,000 each, and would hope for a comparatively permanent proprietary of one thousand persons with one share each, and the trust receiving throughout interested and intelligent co-operation from all of them.

The board of management of the trust should include a representation of the Government and the corporation, so as to place all its procedure under control of these authorities. There may also, with advantage, be a representation of the Board of Works. There should be the best representation of the science or art of the engineering, architecture, and sanitation of urban improvement and reconstruction.

The trust, in a loyal spirit of confidence in the mutuality of aim, will submit to the condition that no step is to be taken without consent of the Government and corporation, represented, as I have said, upon its Board. Indeed the Government should have absolute intervention power at all times, and be the final arbiter in all possible differences. Under these safeguards to the public, the trust may apply for the fullest and most free powers of action. The powers may extend to the entire metropolis, as the trust need not limit its beneficial action to the central section, if it can also find any useful remunerative field outside.

The trust, in addition to its capital, will find money for its purposes by the issue of stock, whose security will be based, first, on the capital and effects of the trust, and ultimately, if need be, on the rating of the improved City.

The remuneration of the trust I would propose thus:—On the paid-up amount a dividend annually of 6 per cent.; on the liability amount 1 per cent. Although there is thus the apparently high dividend of 15 per cent., if we regard only the actual money advance, yet, viewing the whole ten millions as available guarantee, the reconstruction scheme is weighted to the extent of a dividend of only 1½ per cent. upon that quasi-capital account.

But this dividend may be reasonably increased, should the prospect so warrant, as the undertaking proceeds. Any such increase, however, should release the City from rating liability, and in that case all preceding stock issues secured by that liability should, in the interests of the City, become a first charge on all the trust assets. The trust thereafter must raise its money supplies by issues of stock secured solely upon its own means and credit. Thus the trust will not depend upon, nor will it seek financial aid from, the Government.

In a work which in itself is so noble and interesting, there need be no necessity for shareholding, at least as regards the representative element invited from outside.

Termination of the Trust.

I have suggested some considerations from which it might be hoped that the enterprise in question would prove remunerative, under the adaptive methods I have proposed, even without reference to the recouping guarantee of "the natural increment of value." But as we must rise to our grand prospect, and not "scamp" the future city, either in its street-widths or its other sanitations, conveniences, and adornments, we are wise to secure all the guarantees we can get. The trust will, therefore, demand thirty years of value-recouping time. This does not necessarily protract the reconstruction to a like term. On the contrary, I fully expect that modern modes and modern resource may finish the work within half that time. I shall not raise questions of detail or deal with specialities. The best arrangement, as the general rule, would probably be to grant thirty years' leases, terminable at any time by optional purchase, at a price that clears all cost to the trust. This price to each plot should not be merely one that exactly clears its share of the account. The price should, in each case, be something substantially more, so as to provide a fund in the nature of a guarantee for particular localities which might possibly fall short in the estimated value-increment. There might thus arise a considerable surplus fund for eventual distribution. This would belong to the trust; but not entirely, as some consideration would be due to the City for the benefit the trust may have derived from the rating liability.

Concluding Reflections.

Allow me a few concluding thoughts on a thoroughly reconstructed and resanitated London. What is its full meaning? Taking, naturally enough, only a business view of the question, we think of unimpeded traffic and all other business convenience and accommodation, and in the same direction we may think also of the increased wealth-producing power of the population from their greatly improved health and vigour. But all this business part of the case is, comparatively speaking, of a very secondary importance. Social and moral interests, although possibly the last to be thought about in such a business concentration, must stand even there pre-eminently first. Conceive our great city clean swept, not only of its fever dens and all other unsanitariness, but of all those dark recesses which are the favouring haunts, the shelter, the breeding grounds of vice and crime. The night owls of evil are thus unhoused, and thrust naked and defenceless into the clear light of day.

The whole field is thus improved, thus rendered more fitting and less inaccessible to every good end and purpose. My project is directly and strictly one of business, but much else may follow in its wake. I have alluded repeatedly to the improved health of city life, and all that hangs upon this result in the chequered lot of the people. The law will have increased facilities for the detection, or far better the prevention, of crime; and organised charity may permeate its great field with more system, and with less danger and less shock, especially to its many missionaries of the other sex. The pariahs of society, in the sense of its sanitary and cleanly aspects, will have a new leaf turned over for them, and we may hope that it is not to be all blotted and blurred over again like the preceding pages.

I promised, at the beginning of my paper, to recur to the great rehousing question, as regarded the masses of the poorer classes. But the great length of the paper leaves space for only the very briefest further notice. This subject, although not, as I have remarked, the chief section of my great scheme, is yet of vast importance, seeing that a great mass of the working and poorer class both work and live within the bounds of that crowded centre with which I propose to deal. Nor need we be limited to this central area as regards any useful improvement in this or in any other direction, which is suitable or remunerative to the trust. As very much experience has of late been brought to bear upon this question, all tending more or less to smooth the way towards a purely business or self-supporting result, I look for large possibilities and much social amelioration in this particular direction. Miss Hill's experience, alike as to management and remuneration, is highly promising. I have not time here for details, but will briefly allude to one plan of minimising difficulties which I should like to see tried and superadded to others, namely, that of giving to tenants a proprietary interest in their respective rooms or homes. A redemption fund spread over a term, say of thirty years, would add but 4d. to 6d. per week to rent, and this, in the economies of the great scale of the trust's business, would scarcely be felt. Another plan, found successful in rudimentary forms in present cheap common lodging houses, gives a great common hall or sitting-room to all the tenants, which may have great social and recreational as well as economic benefits. The active public discussion now going on in all branches of this question, is daily supplying an invaluable guidance of practical suggestion. I should be glad to see the same public attention, and the same useful guidance from actual results, bestowed also upon my larger question of the sanitation and reconstruction project. It was, indeed, partly in view of arousing such attention, that I lately offered, through this Society, a series of prizes for essays connected with this larger question, as well as with the other. If my project is successful, the information to be derived from these expected essays will find its use.

Miss Octavia Hill, whose name is so closely associated with this great housing and rehousing question of our poorer classes, has lately organised a courageous band of her own sex to take in hand, for purposes of improvement, but in a business and remunerative way to proprietors, some of the existing ill-favoured but improvable quarters of crowded London. There are some, even of the weaker sex, whose moral courage is equal to anything, as Miss Hill in one direction, and Miss Isabella Bird (now Mrs. Bishop) in another, may aptly illustrate. But these are the rare exceptions. Female delicacy shrinks from the revolting and even dangerous conditions of unsanitary and unimproved London. The success of our project, as not the least valuable of its results, will expand in every way the sympathising action of society in response to the wants and needs of its many suffering sections.

APPENDIX.

The two following appendixes deal more at large with parts of our subject which are of great general interest, but which have, of necessity, been very cursorily alluded to in the foregoing paper. They concern, first, some particulars, specially obtained, of the great Paris reconstruction; and, second, the experiences now available in dealing, in a purely business way, with the improved rehousing of the poor and the poorest classes:—

A.—The Reconstruction of the City of Paris.

In reply to my inquiries on this subject, I have been favoured with the following very interesting letter from the Secretary to the British Chamber of Commerce at Paris, kindly procured for me by Mr. Murray, the Secretary of the London Chamber:—

"The system adopted by Baron Haussman for the reconstruction of Paris was this:—

"The expropriations were complete. The city bought out the tenants of houses, compensating them for their compulsory removal according to the nature of their business, and especially the length of the leases unexpired. Persons in business were very liberally paid, the landlords also. If the offer was not accepted, the parties went before a jury, and the award was generally about midway between the sum offered by the city and that demanded by the landlords or tenants. Persons without leases received no compensation beyond one quarter's rent. The property being bought by means of a loan raised for he purpose, the city pulled down the houses, laid out the new thoroughfares, making the roads, &c., and then sold the ground for building by tender. Purchasers were bound by certain rules relative to the height of the houses, façades, thickness of walls, and in some measure as to the architecture. The ground was sold freehold and absolutely, and the city retained no interest in the future improved value of the property. The debt of the city is much greater than mentioned by Mr. Westgarth. The total loans raised during the last thirty years amount to nearly £80 millions, and possibly about £60 millions is still due. The present annual charge, interest and redemption, is nearly £4 millions, which, at 6 per cent. for interest and redemption, would represent £64 millions. The reconstruction was not carried out by the city, and the debt represents principally the difference between the price at which the ground was sold and the sum paid for purchase, compensation, levelling, and road-making, excepting of course the portions of the loans expended in municipal buildings, which was considerable, for the city has built or rebuilt mairies or town-halls in most of the twenty arrondissements of Paris, theatres, hospitals, churches, &c., besides the new Hotel de Ville. Some of the buildings, the theatres for example, produce a revenue, but they were built with borrowed capital.

"Builders also worked with borrowed money, obtained from the Credit Fonciers, and generally sold the houses when finished; many were rented or bought by insurance companies as a permanent investment. In most cases the builders, and particularly the purchasers of houses, have done well, as the improvements were carried out in central parts of Paris. The population has increased very rapidly during the last thirty years, and as the number of houses built was much less than those pulled down—more space being occupied by the thoroughfares—rents have risen enormously in the neighbourhoods in which the improvements were carried out. As an inducement to builders to purchase the ground and build on it, the new houses were freed from all municipal taxes for a certain period, thirty years I believe, but I am not sure that the practice is continued.

"In fine, the unearned increment has benefited the landlords alone, and the city derives no direct benefit from the increase in the value of house property."

B.—The Experience now Available in Dealing, in a Purely Business Way, with the Improved Rehousing of the Poorer and the Poorest Classes.

I do not doubt that the proposed trust, if successfully established, would early turn its attention to this question, looking to its extreme interest even as an economic problem, and apart from its social importance. In comparing notes with Miss Hill and others, as well as drawing upon twenty years' thought of the subject on my own part, I have arrived at the following conclusions upon the leading points:—

1. The poorer classes will now readily accommodate themselves to living in great edifices of many homes, and hence economies of the most important kind in their housing.

2. But they will not co-operate; they must be individually free.

3. Hence, these buildings must be under a proprietor or manager, with whom the tenants or occupants freely deal.

4. The modern great lodging-houses for the very poor supply our typical building, and we must improve upon its lines; that is to say, our building should have many separate homes, of one or more rooms, grouped around a commodious hall or common sitting and recreation room, which comprises common kitchen, manager's shop or store, &c. The manager may supply things cooked as well as raw. On a great scale of operation, he might have a very first-class cook.

5. When this common hall is well lighted and warmed, could not fires, kitchens, and even lighting apparatus in the various homes be all dispensed with, to the incredihle economising alike of the time and money of the occupants?

6. Partial furnishing, by the way of fixtures, of an ndestructible and incombustible kind, would, at a very small addition to rent, greatly help poor tenants, and exclude much cause of dirt and vermin, and risk of fire.

7. The danger of fire is thus minimised in this direction, and further by dispensing with firing and lighting in the rooms. The warm air of the hall fills the rooms, and plentiful use of glass allows light also to pass into them.

8. Rent should include a redemption fund, to make the tenant eventual proprietor, and possess him, meanwhile, of a fund of savings to fall back upon. This may be so protracted as to make it unfelt in the economies of the system. It will ensure more care of the property, and it may save to the management all trouble and loss from unlet rooms or homes. But, on the other hand, a new occupant, selected by the vacating tenant as offering the highest price for the title deed, may be an objectionable person. Miss Hill, although alive to the advantages, fears that control may be less effective over such prospective proprietors. But, altogether, the balance of advantage for this plan seems to me undoubted.

9. Lastly, comes the profit and loss account, the business part of the question. Two shillings a week seems as yet the lowest price of a room in and about London, and 6d. must be added for a thirty years, redemption. Elsewhere than London, the houses come cheaper, and Mr. Forwood mentions the low price of 2s. 6d. to 3s. as the rent of three rooms in Liverpool. Doubtless there are "rooms and rooms," and we must aim at a good room. The scale of our proposed operations, as well as all previous experience, will help the economy, so that even Sir R. Cross's 1s. 3d. a room may be approached. A little more is due for redemption, and still a little more for the use of the hall, which is practically a sitting-room added to each bed-room. Miss Hill seems sure that 5 per cent. may be cleared out of well-managed buildings, and this has been already done lately at Glasgow, even under municipal management, as Mr. Chamberlain mentions in his article in the December (1883) issue of the *Nineteenth Century*. Nor does this redemption plan quite deprive us of all the "natural increment" resource, because the ground floor, and even ground and first floors, may be made shops or warehouses, and separately dealt with. The comparatively cheap financing of the company would be a further resource, as the 5 per cent. of expected profit stands against only $3\frac{1}{2}$ per cent. or so of the probable cost to the trust of raising money. There seems thus the promise of even more than enough proportion from this particular source towards the proposed company's dividend. An interesting experiment would be some very large building of this kind, so as to test to the full all its possible economies. It might comprise an agency for mutual lending and borrowing, upon the security of the titles to each room or home. Punctuality of rent payment must be strictly enforced, but all facilities may be given to meet emergencies by temporary loans on the title deeds.

DISCUSSION.

The CHAIRMAN said he felt sure that many present could bear testimony to the truthfulness of the picture which had been drawn of Central London, but Mr. Westgarth had gone on to draw a most attractive picture of what Central London might be, and had also pointed out how that picture might be realised.

Mr. CATES said he had anticipated hearing this subject dealt with in a more practical manner than it was in the paper, for he thought the scheme suggested was somewhat Utopian. The picture the author had drawn of the London of the future was very beautiful, and made everyone regret that they did not inhabit such a healthy and charming city; but he feared the period of thirty years would be long gone by before any such dream were realised. It would be impossible to enter into the financial details without a careful study of the paper, but they could only judge by the experience of the past how impossible it was to carry out such a scheme. He had himself had some experience in metropolitan improvements, and in every instance they had resulted in very heavy loss. The special case of Northumberland-avenue was very exceptional, the expropriation being almost confined to one house and garden, whilst the new thoroughfare formed a grand avenue leading to the Embankment. Mr. Westgarth had spoken of the congeries of alleys, and tortuous and devious ways and streets which constituted the centre of London, but, notwithstanding their narrowness, in them the whole of our commerce was concentrated. It might be unfortunate that nearly all our literature should originate in Paternoster-row, and that Wood-street and other great seats of commerce should be so narrow, but he must say he contemplated with something like horror the idea of driving a new street through the centre of those crowded localities. If a plan on a larger scale had been exhibited, with all the small freeholds and separate properties marked upon it which would be interfered with, many of which would entirely vanish under the arrangements for Mr. Westgarth's broad thoroughfares, and the owners of which could not at any reasonable cost be provided with fresh accommodation, every one would be appalled at the character of the scheme. He hoped that, from all the study and attention the author had given to the subject, some more feasible plan would be evolved; but whilst thinking of Central London, it would be as well if he also paid some attention to what had been going on in the outskirts during the last twenty-five years. There was hardly any city which possessed more spacious thoroughfares or better roads of approach than London, but what had become of them? They were now mere crowded streets, with shops up to the pavement, where some few years ago there were pleasant gardens and tree-planted margins to the roads. The grasping devices of the landlords, the so-called energy of the shopkeepers, and the absence of all proper control by the authorities, had been the cause of this change; in place of the gardens, shops were built out on the forecourts, no provision being made for the increased traffic, except in a few instances. The most remarkable fact was that the great thoroughfare—the New-road—which might have been equivalent to the Boulevard des Italiens, but which was now become quite a term of reproach, was actually protected by the Act under which it was formed from any such encroachment, for there was an express provision that no building should be erected within fifty feet of the margin of the road, under penalty of being destroyed as a common nuisance. The execution of the Act, however, seemed to have been left in the hands of the Vestries, and the result might be seen by any one who would walk from the Portland-road Station to Islington. It was only by good fortune that the portion of the road in the parish of Marylebone, which was mostly in the hands of one large landowner, had escaped the same fate.

Mr. MARTIN WOOD said it was very usual to speak of the French economists as possessing superior ability in their science, at any rate in its exposition; but, to night, they had an instance in which a Scotch economist showed a practical application of one of the central truths of political economy, which was to his mind very gratifying. He referred to the way in which Mr. Westgarth had treated the doctrine of unearned increment. He spoke of this phrase as being rather an invidious one, for what reason he did not quite understand; but, at any rate, the term he used was a strictly scientific one, and nothing could be more admirable than the practical way in which he applied the principle as the keystone to the financial portion of his scheme. With regard to the other aspect of the matter, the constitution of a trust, he did not see why such an enterprise should not be undertaken by a proper civic authority, not such as now existed, and had sacrificed the public interest in the way described by the last speaker, but such an authority as might be easily supposed to exist. Mr. Westgarth proposed that the Board of Works and the Corporation of London should be represented on the trust, and he could not see why a truly imperial municipality should not manage the whole thing in the public interest.

Mr. KLENCK had been somewhat disappointed with the paper, and did not think there was the least chance of success for a scheme which contemplated an expenditure of a hundred millions, and yet only proposed that one million of capital should be called up in cash. A trust of ten millions, with one tenth called up, would never execute such a work as was proposed. It would soon be found that the whole ten millions would have to be called up, and 6 per cent. would have to be paid on the whole; and thirty years was certainly not long enough to realise the property, and recoup the outlay. If Mr. Westgarth went carefully into the subject, he would find that it would take considerably more than one hundred millions to remodel London.

Mr. C. F. HAYWARD desired to thank Mr. Westgarth for his paper, and thought they ought to welcome the scheme rather than attempt to throw cold water on it. The map exhibited only showed a very small portion of the centre of London, in which it might be very difficult to carry out the desired improvements; but London was not one square mile, but 117, and he believed that only that small portion had been shown because it would have been impossible to represent the whole area on a sufficiently large scale. The West Central district was as important as the City proper. He recollected in 1869, a Committee of the Society of Arts holding many sittings to consider the subject of the Thames Embankment. If such a comprehensive scheme as that now brought forward had been carried out then, and the frontages towards the river had been properly utilised, it would long since have repaid the outlay The same thing might have been done with the space surrounding the new Law Courts, including Clare-market and the district immediately adjoining and reaching from the Strand to Holborn. He had studied that neighbourhood with a view to seeing if some large building scheme could be carried out there, and he was satisfied that if a good scheme had been launched at the time the foundation of the new Law Courts were being laid, not only might good approaches to that building have been provided, but sufficient room might have been found for artisans' dwellings. Ample accommodation for offices, &c., might also have been provided, and the whole expense could have been recouped. He was not in favour of a grand street from St. Paul's to the Mansion-house in a straight line, which they were so anxious for in Paris, and which to his mind, gave a very monotonous appearance to that city. He did not think such an improvement necessary, or that it would pay; but in other directions, improvements might be made on the same lines, and in any such scheme the accommodation of the poorer classes must not be forgotten. It must also be remembered that, as was found in the case of railways, unless the scheme were large enough, it would entail a great loss. Those who had to do with railway undertakings knew that, unless sufficient property were taken, they simply improved the adjoining property, and had themselves to bear all the expense, but if they took enough they shared in the improvement, and got their outlay recouped.

Mr. LIGGINS said that London was not to be improved in the way described by the reader of the paper in thirty years, nor yet in 300. He was disappointed not to hear something said about the accommodation of the working classes, who certainly would never live in the magnificent buildings which had been described. Some fifty years ago, he visited, in company with his friend Mr. Forrester, better known as Alfred Crowquill, many of the worst slums of the metropolis. He was soon after followed by Charles Dickens; but from that day to this very little had been done to remedy the evils which were then depicted by those writers. But this was the fault not of the citizens, not of the vestries, but of the law makers. As a vestryman of Kensington, he was often grieved that he could not do his duty to his poorer brethren, because the law was defective. But it was a fact that proper buildings could be erected for the working classes, which would pay a profit of 4 per cent., as he had been informed by a trustee of the Peabody Fund; and it was also a fact, which some might not be aware of, that the rents paid by the tenants of that Trust were over a thousand pounds a week. Mr. Westgarth seemed to forget that most of the London thoroughfares had been very much widened; Portobello-road had been more than doubled, and though the shops were not equal to those in Bond-street, they were suited to the wants of the neighbourhood, and the sanitary arrangements were not unsatisfactory. Many of the streets from Kensington to Hyde-park-corner had been widened considerably within the last few years; the high brick wall which formerly bounded the Green-park in Piccadilly was removed by Sir Robert Peel, and the road was widened by at least one-third, and the streets all over London had been treated in the same way. He remembered when parts of the Strand were not half the present width, and when Trafalgar-square was a ploughed field. It was the Board of Works which had made most of these improvements, and the ratepayers found the money. The same thing had taken place in the City—in the Poultry, in Eastcheap, and Queen Victoria-street. But at what cost was it done? Many persons were ruined by being turned out of their premises. It was no use to tell them they should have the first choice in the new street; they found plate-glass and polished granite fronts, and had to pay three times their former rent, which left them no chance of making a living. Again, with regard to covered ways and arcades, he did not consider they were suitable for London; the cost would be immense, and until smoke was abolished, which it was far from being yet, the glass would get so covered with blacks as to prevent sufficient light coming through for purposes of business. This scheme was very grand, but at the same time it was very limited, and would, practically, do nothing to remedy the evils they had to encounter.

Colonel CAMPBELL said that poor men wanted good dwellings, but they wanted also food, and to enable them to get food they wanted work. One of the reasons why they congregated in places like London and Glasgow was because the food coming from abroad was brought in ships to these large seaports, and thus a state of congestion was established. After the Haussmannising period in Paris, the working classes were in a very miserable condition, and this was caused not only by the turning out of the poor, but because so many new houses had been built, that hardly any repairs were needed, and there was a great scarcity of work. If any large reconstruction scheme were carried out, that must be the result. Paris had been improved, and now they were beginning to cheapen the means of transport, spending £40,000,000 in improving the water ways, so that coal and building materials might be brought there more cheaply. In the case of a large city, the question of cheap transport ought to precede that of reconstruction. A great deal had been said lately on the question of improved dwellings, but how could you have cheap dwellings while the carriage of building materials remained at present rates. London, big as it was, was but an incident in the valley of the Thames, and improved transport by means of the Thames was certainly worth consideration before the question of reconstruction was gone into.

Mr. DIPNALL said he had resided in London for the last 30 years, and could speak not only of the rise in value, but also of the great improvements in health and in the buildings generally, which had taken place. In former days, however, the windows of the houses were all lighted up after dark, and had the comfortable look of residences, but now the City of an evening looked like an uninhabited place. It was crowded by day, but it was the dullest of all dull places at night and on Sundays. He had recently observed the splendid buildings erected by the Peabody Fund in Bunhill-row, and also in Bethnal-green and elsewhere, and there was no doubt that great efforts had been made to improve the dwellings of the poor, but still there were many defects. Where in the Peabody-buildings was there any accommodation for the storage of the merchandise which the people dealt in, or for the donkeys which many of them kept to aid them in their trade? If the city of London were to be rebuilt in thirty years, what would be its condition in the meanwhile? It would be like a city in a state of siege, with earthworks thrown up everywhere, and no possibility of carrying on either business or the traffic of the streets. Paris had been referred to, and he considered that it had lost much of its charm by the construction of so many broad and straight thoroughfares. He thought that both this generation and the next would die out before the fringe of this subject had been touched. He did not doubt the good intentions of Mr. Westgarth, but he feared that, both in his facts and figures, he was considerably astray.

Mr. WESTGARTH, in reply, said it was, of course, rather formidable to look forward to so great a work, but if the task were to be done thoroughly, there was no other course. Business people were very apt to look with terror at such an upturning as he had described, but there was the sanitary aspect of the question to be considered, and, bearing that in mind, he did not see how it was to be avoided. Mr. Liggins said it would be an impossibility to rebuild the whole of London in thirty years, but that was no plan of his; he proposed not to rebuild the whole 117 square miles, but probably less than one, for he referred only to Central London. No doubt something beyond that might be done also, and if the trust came into existence, the desirability of grand streets going north, south, east, and west, would no doubt be considered; but his own idea was to limit this great reconstruction to the crowded central part only. Mr. Klenck said it would be impossible to carry out so great a work with so small a capital. That was a business question on which he thought he could speak with some authority. It was not a very small capital, for though he only proposed that one million should be paid up, the remaining nine would be guaranteed, and the greater part of the money would no doubt be raised by the issue of 3½ per cent. stock, secured on the rates of the improved city. Besides, he reckoned that the larger portion of the proprietary would prefer not to be expropriated, but to join the undertaking, so that the £100,000,000 might very likely be considerably reduced.

The CHAIRMAN remarked that Mr. Westgarth had only touched very briefly on the points which had been mentioned in the discussion, and his modesty had prevented him from referring to one subject on which complaint had been made without, as he thought, sufficient justification. He alluded to the question of dwellings for the poor, which had certainly occupied a very prominent place in his mind when considering this subject, as was shown by the fact that the foremost rank amongst the subjects for which he had offered prizes was the best means of constructing dwellings for the poor in great cities. Many of the ideas he had thrown out would no doubt set them thinking, even if they were not at once accepted, and when they fructified in that way, by leading those who were technically qualified to deal with the various branches of the subject, might lead to very great improvements, which all would agree were needed, not only in Central but in London generally. He would conclude by proposing a vote of thanks to Mr. Westgarth for his able paper.

The vote of thanks was carried unanimously, and the meeting separated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

MEMORANDUM FROM THE SUB-COMMITTEE ON "AMBULANCE."

The following heads indicate the articles and appliances which the Committee are anxious may be shown by the Army Medical Departments of various countries, the societies established to render aid to the sick and wounded in war, and other organisations which may be able and willing to contribute.

1. Personal surgical equipment as carried by the medical officers of the army in question.

2. Appliances for treatment of wounds, carried by the soldier himself in the field.

3. Personal surgical equipment carried by ambulance attendants in the field, consisting of surgical haversacks (*havresacs sanitaires*), medical panniers (*caisses sanitaires*), surgical knapsacks, field companions.

4. Ambulance appliances carried by men, such as stretchers (*brancards*), hammocks, dhoolies, and palanquins.

5. Wheeled conveyances wheeled by men—wheeled stretchers.

6. Ambulance equipment carried by mules, horses, &c. Cacolets, litières, mountain ambulance equipment (*ambulance de montagne*), cooking equipment for mountain campaigns—portable medicine chests, compressed drugs, &c.

7. Wheeled vehicles used for the conveyance of sick, fourgons containing the equipment of hospital corps, surgery waggons, equipment waggons, field cooking waggons, pharmacy waggons, nursing utensils carried in waggons of field hospital. Books of instruction for use, diagrams.

8. Railway ambulances, consisting of carriages for wounded, with fittings, cooking carriages, and all the equipment of ambulance trains. Materials for converting ordinary carriages into ambulance carriages.

9. It would be useful if some attendants accustomed to the use of the *materiel* accompanied the articles.

The articles will be arranged in accordance with the following classification :—

Group IIIa.—Ambulance.

Class 31a.—Aid to sick and wounded in war. Transport—(*a*) By human agency ; stretchers, litters, dhoolies, palanquins, handcarts, stretchers on wheels. (*b*) By animal traction ; mule litters and chairs, camel and elephant litters, wheel carriages. (*c*) By mechanical means ; railway ambulances, ship or water carriage. Treatment (with portable appliances and portable drugs). (*a*) On the field. (*b*) In hut hospitals. (*c*) In tent hospitals.

Class 31b.—Aid to sick and injured in peace. Transport—(*a*) By human agency; stretchers, litters, dhoolies, palanquins, hand-carts. (*b*) By animal traction ; for accidents and injuries, for infectious diseases, for ordinary sickness. (*c*) By mechanical means ; railway carriages for sick and invalids, water carriage. Treatment (with appliances). (*a*) Hut hospitals for infectious fevers and for epidemic diseases. (*b*) In tent hospitals. (*c*) In hospital ships. (*d*) In sick rooms.

Memorandum from the Sub-Committee on "Dress."

The following is the classification of the Group :—

Class 13.—Collections illustrative of the history of dress, national costume, &c.

Class 14.—Waterproof clothing, india-rubber, gutta-percha, &c.

Class 15.—Furs, skins, and feathers, dresses for extreme climates, &c.

Class 16.—Dress for sport, hunting suits, &c.

Class 17.—Life-saving dress, divers' dress, fire-proof dress, &c.

Class 17a.—The comparative value of different dress materials for articles of clothing.

Class 18.—Publications and literature relating to Group II, patterns, statistics, diagrams, models.

Class 19.—Machinery and appliances for the preparation of articles under Group II.

Class 17a, has been added at the suggestion of the Sub-Committee. Under it should be displayed a number of illustrative specimens to show the comparative value or different dress fabrics with reference to their "warmth," their hygroscopic properties, the influence of the colour of materials in modifying the effects of sun-heat, and the like.

It would be well to show under this class models and drawings illustrative of the effects of poisonous dyes (in clothing) upon the skin. Materials dyed with poisonous and non-poisonous dyes could be placed together for purposes of comparison.

The scope of this class may be considerably extended, and the section be made to demonstrate the scientific bases of healthy clothing.

The subject of underclothing is of such great importance that the Sub-Committee are prepared to arrange for a special display of materials and garments, &c., worn next to the skin. Some of these will be shown in a special annexe, to which females alone will have access, or which will, at least, not be open to both sexes at one time. As one special feature in such an exhibition, the Sub-Committee would suggest a series of models displaying the first clothing of infants as adopted in the various countries of the world—so far as such examples could be obtained.

Class 13.—It is suggested that, as far as possible, dresses and costumes shown should be displayed upon lay figures, and that the exhibition of ancient costumes should be encouraged in preference to modern reproductions of the same.

Class 15.—It is suggested that the subject of suitable dresses for extreme climates should be demonstrated with as much detail as possible.

Class 16.—Under this class it is suggested that especial attention should be given to dresses suitable for women engaging in exercise, such as dresses for mountaineering, for the moors, for swimming, for horse exercise, for gymnastics and the like.

Class 17.—Under this class should be actually demonstrated the value of certain substances used for making muslin and like fabrics non-inflammable. The various artificial starches made for this purpose should be displayed, and their use and effect demonstrated.

The dress of female operatives engaged among machinery may be dealt with in this class, also special dresses recommended, or in use in factories and occupations of special character, *e.g.*—dresses for lead and other factories; dresses of nurses and sick attendants; of soldiers and sailors; life-saving dresses; firemen's dresses.

Class 18.—Under this class will be exhibited dress injurious to health, casts of feet deformed by boots, &c., spinal and thoracic deformities ascribed to tight-lacing, models to show the position of the viscera displaced by such practices and the like.

Class 19.—The Sub-Committee would suggest the following under this heading :—Machine *versus* hand-weaving, glove-making by machinery, lace-making illustrated by operatives from Honiton, Nottingham, Brussels, &c., the making of hats, the making of boots and shoes, and of lasts for the same, the dressing of furs and certain skins, sewing and knitting machines, &c. (in limited number), the manufacture of waterproof fabrics, the making of crape and some special fabrics, the application of jute to the manufacture of dress fabrics, imitation fabrics.

THE ORANGE TRADE.

Few importations have increased so rapidly as that of oranges during the last ten years. It is within the memory of many that they were really a scarce fruit, and comparatively dear, and when none could be got at all for many months of the year. But now we have oranges all the year round, and they can often be bought at the rate of three or four a penny in almost every street. The recognised season for importation covers, generally speaking, about nine months of the year, beginning in November and ending in July, but consignments continue to come in after that, though not large ones, and so the market is never without oranges. The revolution in, and development of, the trade has been brought about mainly by the employment in it of large steamers, the first of which exclusively engaged in the trade arrived in London, in November, 1867. In the recent Christmas week there were nine ships of various kinds laden with oranges in the port of London. The first mention of oranges being brought to this country is in the reign of Edward I., when it is recorded that in 1290 that the Queen bought various fruits from the cargo of a Spanish ship which came to Portsmouth, and that among them were seven oranges *(Poma de Orenge)*. But no mention of this fruit is found in the "Libell of English Policy" or the "Liber Albus of London," in which most articles of fruit and grocery find a record. We read, however, of oranges in the reign of Henry VI. (1432); and they are mentioned in the "Paston Letters" in 1470. They are entered in the "household expenses" both of Henry VIII. (1530), and in that of his daughter the Princess Mary (1539); and by the end of the 16th century they were recognised as a notable article of commerce, and, according to Stow (1598), Billingsgate was the principal quay at which they were landed. Sir Walter Raleigh, "the father of tobacco," is credited with having brought oranges to England, and it is said that Sir Francis Carew, who married his niece, planted their seeds and produced orange trees at Beddington, in Surrey; of which Bishop Gibson, in his additions to Camden's "Britannia," speaks as having been there for a hundred years previous to 1695. These trees perished in the "great frost" in 1739. At Hampton Court there are still several orange trees, believed to be 300 years old. The most interesting feature in the growth of the orange tree is that it bears at one time what may be called three different stages—the blossom, the immature fruit, and the ripe oranges. We read of oranges in Shakespeare; and the famous Mistress Nell Gwynne carried her orange basket in Drury-lane, and probably from an earlier period "bills of the play" were associated with oranges. When Pepys went to the "King's Playhouse" with an "order," the successors of "pretty, witty Nelly" with these orange baskets were a recognised institution; and to the present day the odour of orange peel has a peculiar affinity to the flare of the footlights, at least among the "gods of the gallery."

Our chief orange supply comes from Valencia and other Spanish seaports; but Lisbon, Villa Real, Ariero, and Oporto also contribute their quota. Other consignments hail from the Azores, Brazil, Palermo, and Malta, and other Mediterranean port. The St. Michael's oranges are held in high esteem by connoisseurs, and they are pre-eminently the Christmas fruit, as they do not begin to arrive in this country till the end of November. The St. Michael's crop was, in 1882, almost a total failure, in consequence of a disease among the trees, caused, it is supposed, by some insect; and fears were entertained that eventually the supply from the island would almost cease, as it has from others of the Azores group, such as Terceira, Fayal, and St. George's, which once produced a large quantity of fruit. St. Michael oranges, as are most Brazilian, are separately wrapped, in the packages, in the leaves of Indian corn, while oranges from all other parts are wrapped in thin paper. The "blood" oranges, as they are called, come mostly from Valencia, but a few from Malta. The aromatic and delicious Tangierenes hail from St. Michael's, and also from Lisbon, and vary considerably in price, according to the supply. Seville oranges (specially alluded to in Shakespeare's "Much Ado about Nothing") come from the place of that name, and, as most people know, are now almost exclusively used for making marmalade and orange wine. For both these purposes, however, the Palermo "bitters" are really better adapted; and it may not be generally known that the best marmalade of all is produced from the shaddock, a sort of cross between the orange and the lemon, and named after a Captain Shaddock, who first brought it from China, or, as some say, from Guinea, and planted it in the West Indies, whence we derive our limited supply. It is the bitter element in the Seville and Palermo oranges which fits them for marmalade, as it preserves their skins while they are drying. We need not be much alarmed at the stories we hear of orange peel being collected at places of entertainment and in the streets for marmalade making, as the skins of ordinary oranges, instead of drying, simply become rotten.

The head-quarters of the orange trade is Pudding-lane, Lower Thames-street, where, during the height of the season, the chief brokers hold sales three or four times a week. Pudding-lane, where the Great Fire of London is said to have begun, is not exactly an orange grove, but the fruit trade makes it about as busy a spot as any in the City; and if an unwary passenger happens to get in the way of the "fellowship" porters carrying along it, without intermission, the wooden packages of oranges, he is not unlikely to become the object of some Billingsgate vernacular. The trade in oranges and other fruits has now become so enormous, that Lower Thames-street and its vicinity is all too small to accommodate it, even if the fish trade were removed. There are many things more unlikely than that this may be eventually the case, and that the more sweetly-smelling fruit trade may one day occupy the historical market of Billingsgate itself. A large quantity of the oranges sold in Pudding-lane afterwards finds its way to Duke's-place, a quarter of the Hebrew region on the west of Houndsditch, where it is re-sold to shopkeepers and costermongers. This locality is redolent of oranges, and it is no exaggeration to say that, in wet weather, you may walk literally ankle-deep in orange pulp and peel, mixed with cocoa-nut fibre. The appetite for oranges among the masses in London seems almost insatiable, and it is said that nearly half the retail trade in them is done by the itinerant street vendors. A package of oranges contains, on an average, 400; and in the season of 1881-2, nearly a million packages were landed in London; and not far short of that number were landed in Liverpool. Glasgow receives a large, and each year an increasing supply; while Bristol and Hull account for many thousands. Altogether, it was computed that in the season of 1881-82, two and a-half million packages were imported into this country, which would represent something like 1,000,000,000 of oranges for home consumption. This season will show a still greater advance, as in most orange-growing districts the supply is plentiful; and the market value of the total importation, including lemons, will represent something not far short of two millions sterling, first hand. The increase in the trade is due not only to increased facilities of transport, but to the abolition of the duty on the fruit. Formerly, 2s. 6d. per package was the impost; in 1853 it was reduced to 8d; and was altogether abolished in 1861. Happily, the orange is a very harmless, if not a decidedly wholesome, fruit.

Correspondence.

CHINESE COOKERY.

In the Cantor Lecture (II.) delivered December 10th, 1883, Mr. Mattieu Williams observes, at page 115:—"That large tracts of country should be periodically desolated by locusts, is a striking proof of the neglected condition of the science of cookery. If the locusts devour the crops, why not cook, preserve, and eat the locusts?"

It may be of interest to note, in connection with this suggestion, that the Chinese, who have anticipated western nations in so many things, have shown the way in this matter also.

Chancing to be at Teintsin in the early part of the summer of 1877, when the country was being devastated by dense flights of locusts, I observed the natives to be busily employed in catching them; and writing in connection with this circumstance, remarked as follows:—"The insects are much used as food, and the people thus compensate themselves, to some degree, for the loss of crops. The insects are fried in fat, wings and all, just like a fish. They are caught mostly by dragging the fields with nets, but when quite young and unable to fly, they are trapped as follows:—A triangular enclosure of matting is built, open at the base, and a hole dug in the ground, containing a large jar at the apex. The fields are then beaten, and the locusts driven into the enclosure, and then at last in the jar."*

There are many points in connection with the science of cookery in regard to which we might, with profit, take some hints from our "Celestial" friends, especially with reference to the utilisation of waste, and the methods of turning to account, in a savoury way, the good things of nature. The poorest family in China rarely sits down to a meal of less than three varieties of hot cooked food, and there are a few more interesting sights than watching the preparation of the family meal.

The boilers in which the staff of life in Southern China—rice—is prepared, is made of the thinnest cast iron, so thin that a very slight tap is enough to fracture it, heated over an earthenware vessel, containing a few pieces of charcoal; and, directly the cooking is completed, each piece of charcoal is carefully lifted out, extinguished, and put away for future use. An enterprising European firm once thought to supersede the "jimcrack" native pot by a good substantial article of Birmingham make, but the natives soon found that, with the "improved" article, three times as much fuel was required to heat the metal through as would cook their meal in the old one, and so the superior Birmingham boiler was discarded.

HENRY N. SHORE,
Lieut. R.N.

Coastguard, Greenock.
February 2nd, 1884.

ECONOMY OF FUEL.

In the year 1867, I had the pleasure of showing the late Professor Macquorn Rankine, at Messrs. Field's Paraffin Works, Lambeth, a boiler burning mineral oil, which he told me was the first time he had ever seen chemical combustion perfectly attained on the large scale. This was under the Wise, Field, and Aydon patent. Afterwards, at my special request, he read at the United Service Institution, on the 1st of April, 1867, a most valuable paper on the "Economy of Fuel." This will be found in the journal of the institution of that date, and will serve to correct some of Mr. Gümpel's impressions as to the efficiency of heat-engines; as also the idea that I, personally, am ignorant of the chemical theory involved. I much prefer the "British" unit of evaporation, used in the paper referred to, to the centigrade unit, because the "British unit" shows the theoretic evaporation value of each substance used as fuel, in terms of pounds of water evaporated from, and at 212° Fahr.; but the centigrade unit involves further calculation, thereby rendering the theory more obscure. Later on, I

* "Jottings in China, &c."

shall be prepared to show how, under what conditions, and to what extent, the burning of the hydrogen of the steam used to blow in the oil, can add to the total calorific power of liquid or condensed fuel, so as to bring it up to the 46 lbs. of water per pound of oil, which I announced as having been obtained under a common Cornish boiler, in my paper on "Liquid Fuel," read before the Institution of Naval Architects, April 2nd, 1868. I could not then account for the fact which I recorded, but by continued study of the subject, I believe I have now established the conditions under which that result can be constantly and readily obtained. This, as in that paper I showed, was not the case with those who were then, by a fortunate but accidental combination, obtaining, at intervals, that extremely satisfactory result of replacing 3 tons per diem of Butterley coal by 109 gals. (1,090 lbs.) of oil, *i.e.*, six times the duty of coal, nearly.

When this is done, and Mr. Perkins's engines and boilers are used, which now give one indicated horsepower per hour, according to Sir Frederick Bramwell's observations on the *Anthracite* (a comparatively small steamer), for 1·2 lbs. of coal per hour, I think it will be evident that an indicated horse-power will be obtained for considerably less than one-sixth of a pound of fuel, and corresponding facilities will be available for those who wish to develop the question of electric launches, or electric lights, or the conversion of heat into electricity for whatever purpose. Among such purposes, not the least important, in my opinion, is the deposition of metals from the solutions of their ores in a perfectly pure state, after the applications of the humid processes of metallurgy.

J. H. Selwyn.

16, Gloucester-crescent, Hyde-park,
February 5th, 1884.

General Notes.

Grocers' Company.—Three Scholarships, each of the value of £250 per annum, tenable for one year, with eligibility for re-appointment, for the encouragement of original research in sanitary science, are offered for competition by the Grocers' Company. Two of these scholarships will be filled up in May next, and candidates (British subjects only) must not apply later than the last day of April. In addition to these scholarships, a Discovery Prize of £1,000 will be offered for universal competition once in every four years. The subject for the first award relates to a method for the cultivation of the vaccine contagium apart from the animal body, in some medium not otherwise zymotic. Essays must be sent in before December 31st, 1886. Particulars can be obtained on written application to the Clerk of the Grocers' Company, Grocers'-hall, London, E.C.

New Paper Material.—Consul Gade, of Christiania, has submitted to the United States Government a report relative to a new industry, or, rather, the use of a raw material for the manufacture of paper, which will soon be in use in Norway and Sweden. Among the raw materials already employed in the manufacture of paper are rags, esparto, straw, and wool, but all these are expensive, and this new and cheaper one, which consists of white moss, will now be added to the list. The moss is found in immense quantities in Norway and Sweden, but it is not the living plant as it grows in the fields which is used for making paper, but the remains of this kind of moss which have gradually accumulated in the woods. The mouldering which the moss has gradually undergone constitutes a preparation for the paper manufacture made by nature herself. A factory is now building for the manufacture in Sweden, and examination has shown that near this place many millions of pounds of the raw material are to be found; in fact, a quantity sufficient to support a large manufactory for many years. Paper of different thicknesses, and pasteboard made of the white moss, have already been shown, the latter even in sheets three-quarters of an inch thick. It is as hard as wood, and can easily be painted and polished. This manufacture is said to be very well suited for taking the place of wood for many purposes. It has all the good qualities but none of the defects of wood, as it neither cracks nor warps. The pasteboard can consequently be used for door and window frames, and for architectural ornaments of all kinds of furniture. —*The Times*.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

February 13.—"New Process of Permanent Mural Painting, invented by Adolph Keim, of Munich. By Rev. J. A. Rivington. Hubert Herkomer, A.R.A., will preside.

February 20.—"Reclamation of Land on the North-Western Coast of England." By Hyde Clarke.

February 27.—"Vital Steps in Sanitary Progress." By B. W. Richardson, M.D., F.R.S.

March 5.—"The Progress of Electric Lighting." By W. H. Preece, F.R.S.

March 12.—"Water Regulation, in regard to Supply, Floods, Drainage, and Transit." By General Rundall.

Foreign and Colonial Section.

Tuesday evenings:—

February 12.—"The Portuguese Colonies of

West Africa." By H. H. Johnston. Sir Frederick John Goldsmid, K.C.S.I., C.B., will preside.

Applied Chemistry and Physics Section.

Thursday evenings:—

February 28.—"Recent Progress in Dynamo-electric Machinery." By Professor Silvanus P. Thompson.

Indian Section.

Friday evenings:—

February 15.—"State Monopoly of Railways in India." By J. M. Maclean. Sir James Caird, K.C.B., will preside.

Cantor Lectures.

The Second Course will be on "Recent Improvements in Photo-Mechanical Printing Methods." By Thomas Bolas, F.C.S.

Lecture III. Feb. 11.—Intaglio Plates. Collotypes. Photo-Mechanical Methods, as applied to the Decoration of Pottery. Miscellaneous Processes.

The Third Course will be on "Building of London Houses." By Robert W. Edis, F.S.A.

Lecture 1. Feb. 18.—Their Arrangements, Aspect, Design, and General Planning.

Lecture 2. Feb. 25.—Sanitation, Lighting, Heating, and Ventilation.

Lecture 3. Mar. 3.—Fittings, Planned Furniture, Constructive Decoration.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "Recent Improvements in Photo-Mechanical Printing Methods." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. T. M. Rickman's paper, "Building Risks and their Incidence."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. General Sir Frederic J. Goldsmid, "My Recent Visit to the Congo." 2. Mr. E. Delmar Morgan, "Notes on the Lower Congo."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Professor Ruskin, "The Storm-cloud of the Nineteenth Century."

Tuesday, Feb. 12 ... SOCIETY OF ARTS, John-street, Adelphi, W.C. (Foreign and Colonial Section.) Mr. H. H. Johnston, "The Portuguese Colonies of West Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Geikie, "The Origin of the Scenery of the British Isles." (Lecture III.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Adjourned discussion on Mr. F. R. Conder's paper, "Speed on Canals."

Photographic, 5A, Pall-mall East, S.W., 8 p.m. Annual Meeting.

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. J. Park Harrison, "Exhibition of Skulls and other Remains from a Cemetery at Wheatley." 2. Dr. G. B. Barron, "A Humna Skull found near Southport." 3. Miss A. W. Buckland, "Traces of Commerce in Prehistoric Times." 4. Mr. John T. Young, "Some Palæolithic Fishing Implements from the Stoke Newington and Clapton Gravels."

Colonial Inst., St. James's Banqueting-hall, W., 8 p.m. Mr. Murray Smith, "The Australasian Dominion."

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 5 p.m. Mr. J. P. Seddon, "The Ventilation of Theatres."

Wednesday, Feb. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Rev. J. A. Rivington, "New Process of Permanent Mural Painting, Invented by Adolph Keim, of Munich."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Annual Meeting.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. A. Myall, "Machine Tools."

Thursday, Feb. 14...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. F. Gale, "Modern English Sports—their Use and Abuse."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Lennox Browne, "Science and Singing, with Vocal Illustration."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Pauer, "The History and Development of the Music for the Pianoforte, &c." (Lecture V.)

Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Messrs. R. E. Crompton and Gisbert Kapp, "Some New Instruments for Indicating Current and Electromotive Force."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. H. M. Taylor, "The Relations of the Intersections of a Circle with a Triangle." 2. Mr. J. W. L. Glaisher, "The Difference between the Number of the $(4n+1)$ Divisors, and the Number of $(4n+3)$ Divisors of a Number. 3. Mr. A. Buchheim, "A General Theory, including the Theories of Systems of Complexes and Spheres."

Friday, Feb. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) J. M Maclean, "State Monopoly of Railways in India."

Geological, Burlington-house, W., 8 p.m. Annual Meeting.

United Service Institution, Whitehall-yard, S.W., 3 p.m. Lieut.-Col. A. C. Hamilton, "Our Field Telegraph—Its Work in Recent Campaigns, and its Present Organisation."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly meeting, 9 p.m. Professor T. E. Thorpe, "The Chemical Work of Wöhler."

Philological, University College, W.C., 8 p.m. Mr. F. T. Elworthy, "Extracts from my Dialect Glossaries."

Medical Officers of Health, 1, Adam-street, Adelphi, W.C., 7½ p.m.

Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Messrs. Cowan and Fawcus, "Light-Draught Launch."

Saturday, Feb. 16...Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Morley, "Life and Literature under Charles I." (Lecture V.)

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FRIDAY, FEBRUARY 15, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and last lecture of the course of Cantor Lectures on "Recent Improvements in Photo-Mechanical Printing Methods," was delivered by Mr. Thomas Bolas, F.C.S., on Monday, 11th instant, in which he dealt with the subject of intaglio-plates, collotype, and photo-mechanical methods, as applied to the decoration of pottery. The lecturer concluded with a description of some miscellaneous processes.

The Chairman (Mr. B. Francis Cobb, Vice-President of the Society) moved a vote of thanks to Mr. Bolas for his interesting course of lectures, which was carried unanimously.

The lectures were illustrated by a large number of specimens kindly lent by various gentlemen and firms, and the following may be especially mentioned:—Mr. Geo. Smith, of Colebrooke-row, Islington; Messrs. Woodbury Treadaway and Co., of South Norwood; Dr. Pick (the representative of the Meisenbach Photo-Block Company), Mr. Dallas, Mr. E. de Zuccato, the Autotype Company, and Mr. Frewing, of Clapham.

Proceedings of the Society

FOREIGN AND COLONIAL SECTION.

Tuesday, February 12, 1884; Sir Frederick John Goldsmid, K.C.S.I., C.B., in the chair.

The paper read was—

THE PORTUGUESE COLONIES OF WEST AFRICA.

By H. H. Johnston.

Few Englishmen—and for the matter of that few Portuguese—often realsie or take into account that Portugal possesses more territory in Africa than any other European power. Without counting the lands over which she has merely a nominal right unenforced by occupation, there still remain over a million square miles of the African Continent, and its small adjacent islands, which belong to, and are administered by, the Crown of Portugal, and of these large colonies about one-half lies on the West Coast of Africa.

It is my intention to-night, with your kind permission, to give a brief account of my recent visit to these West African colonies of Portugal, and endeavour to lay before you, as succintly as possible, their present condition, and their future prospects.

Of course the first Portuguese possession off the Western Coast of Africa is Madeira, but this is too well-known for me to touch on, so I will pass on to the Cape Verde Islands, an archipelago lying about 300 miles out at sea opposite Senegal, between the parallels of 14° and 17° N. These islands are ten in number, not counting many smaller barren rocks, and their entire population is about 100,000, or 30 to the square mile. In spite of their apparently barren and sterile look from the sea, they are productive, and in the interior of most of the islands there are springs of water which, with careful manipulation, irrigate large quantities of fertile soil, and compensate for the almost entire absence of rain. The productions of the Cape Verde archipelago consist of superior coffee, cacao, orchilla-weed, castor-oil, rum, maize, salt, cotton, indigo, oranges of fine quality, limes, lemons, pine-apples, cocoa-nuts, bananas, and most tropical fruits, sugar-cane, tobacco, coral, and much cattle and other live stock, including a hardy and veiy serviceable breed of horses, which are constantly exported to the neighbouring continent.

The largest island of the group is Santiago, whereon is the seat of government for the whole archipelago. Its superficies is a little under 500 square miles. The interior is fertile and well cultivated, and traversed by excellent roads, with strongly made bridges across the many ravines. The mountains rise to over 4,000 feet, and from their sides gush springs of delicious water which is carefully husbanded, and used to irrigate vast plantations of Indian corn, castor-oil plant, sugar-cane, pine-apples, and tobacco. Water is also conveyed in leaden pipes from a considerable distance into the town of Praia, the capital of the island, where it is stored in an immense reservoir.

Though Santiago is the largest island of the Cape Verdes, it is but little known to English people, for only Portuguese steamers call at its port, which is not a remarkably safe one; on the other hand, the miserable little desert islet of Sao Vicente, owing to its splendid harbour, is become a place of cosmopolitan resort, where the Anglo-Brazilian Telegraph Company has a station, and where many great lines of steamers have their place of call. The jagged coast of Sao Vicente is grandly awful in its sublimity of desolation. Sharply peaked and precipitous mountains descend to the water's edge; and in between their masses are little inlets of blue foam-streaked sea. The mountains are variegated with the long sloping lines of their different strata; they are scarped, and worn, and twisted into fantastic shapes, and they look like the earth's throes of agony hardened into stone. There is not a sign of life, not a bird or a plant visible about them. As they stand out in their dead neutral tints against a glaring blue sky, they might represent a landscape in a lifeless planet. In the interior of Sao Vicente there is one spring of water where a little vegetation grows, and a few people live and try to raise fruit and vegetables for the town, but, as a rule, Sao Vicente is entirely nourished by the great island of Sant Antao opposite, from which it receives not only food and water, but even the very soil necessary to grow the few plants and trees which decorate its sandy streets.

The town itself is tidy, clean, and prosperous, with a fluctuating population of about 5,000, very mixed in nationality. There are English, French, Italian, Spanish, Portuguese, German, and Dutch hotels and restaurants. Steamers and warships of all nations come here to coal and telegraph, and the shops and stores are excellent and well provided with all necessary articles.

When we leave the prosperous and civilised Cape Verde Islands and arrive at the Portuguese possessions in Senegambia, which lie some 500 miles to the south-east, the contrast is very great in every way. We find ourselves in a most typically African part of Africa. The high and arid mountains of the Cape Verde archipelago are exchanged for a flat, marshy country, covered with the densest forest, and civilisation yields to utter savagery. Portuguese Guinea, which extends from about the 13th parallel to the 10th, just comes in between our colonies of the Gambia and Sierra Leone. This territory has about 200 miles of coast line, and offers many ways into the rich interior, by means of the great and navigable rivers, Casamança, Geba, and Cochen. Portuguese Guinea is, in fact, little more than the vast delta of these three great rivers, which communicate with each other by many natural canals. There is also the large archipelago of the Bissagos Islands, lying close to the mainland, and on one of these is placed the capital of the province, Bolama, where the Government and principal merchants reside. This town has a very pretty and inviting appearance from the river, its houses being mostly white with red roofs, or entirely built of red bricks, and surrounded by the brightest green vegetation. Fine lofty trees are dotted here and there, and the general aspect of colour is very pleasing and gay. The town is large, and the streets are broad, clean, and lighted throughout with lamps. Several well-built houses are to be seen, especially that of the Visconde d'Almeida, a Portuguese merchant, and about most of the buildings is a Moorish look, suggested by the Portuguese style of architecture which prevails, and which has inherited its long arcades and hollow squares, or *patios*, from its Arab parentage. This is a mode of building far better suited to the climate of Africa than many of the absurdly incongruous houses of Sierra Leone. Bolama possesses handsome and extensive barracks, and a fine church, all built of red brick and iron, very pleasing in appearance, but, I am told, rather hot. The most prevalent type of native house is one of rectangular shape, with an immense thatched roof stretching right out at an angle of 45° towards the ground, and forming a sort of sheltered court all round the house, wherein the inhabitants sleep in the daytime.

Bolama can exhibit a great concourse and diversity of African races. These are the indigenes of the island and neighbouring mainland, the Papeiis, a race whose skins are literally black as soot, and whose faces offer a singularly low and degraded type, with prognathous jaws and retreating forehead. Their figures are tall and well built, and they generally go about stark naked, the Portuguese not being so squeamish on this point as the English, and leaving the natives full liberty in their sumptuary laws. Then there are Mussulman people who come to Bolama to trade, Fulahs, Mandingoes, and others, always noticeable by their finer features and Moorish clothing. Besides these may be noticed many different tribes of negroes, each distinct from the other, and each speaking a widely different language; and further, the Krumen of the south, the hybrids between all these races; and lastly, the intermixture of Potuguese mulattoes add to the diversity of types and the Babel of tongues.

Amongst the white inhabitants, those of Portuguese nationality naturally prevail, owing to the soldiers and officers of the garrison, but all the principal merchants are French, and the commerce of Portuguese Senegambia is almost within their hands. They have many commercial houses, not only in Bolama, but in most of the neighbouring islands, and the greatest trade is done in the export of ground-nuts, of which shipful after shipful is sent to Marseilles, there to be turned into spurious olive oil. Besides this, wax, coffee, cacao, india-rubber, sugar, ivory, and wild beasts' skins are also exported. Gold is found in the interior.

The principal centres of Portuguese rule and trade in Senegambia are Bolama, the capital; Bissan and Cachen, fortified places; the rich island of Gallinhas; Colonia, at the mouth of the Rio Grande; Géba, a hundred miles inland on the river of that name; Ganjarra and Fâ, on the same river; Farim, on the Cachen; Bolor, on the Casamança; and Jafunca, and Zeginchor.

The temperature of this part of Africa is very high, and the heat is more oppressive than in most parts of the continent; nevertheless, Portuguese Guinea is not very unhealthy. Yellow fever is quite unknown, and marsh fevers with rheumatism and ague are the most prevalent forms of disease. Everywhere the most perfect drinking water, cold and sparkling, is to be procured, not on the surface, but from wells of about 20 ft. in depth. Time forbids me to descant on the extreme richness of this possession, or, more strictly, on the latent richness of its soil and productions. Vegetation here reaches a development almost unparalleled; and I might state that Portuguese Guinea for the naturalist and anthropologist is one of the least known and most promising fields of study.

Though many traces of ancient Portuguese occupation may be found on the Gold Coast and the Niger Delta, the only remaining relic of their former possessions in this part of Africa is the solitary fortress of Sao Joao d'Ajudà, in the kingdom of Dahomé. "Whydah" it is called by the English, and it is the principal or the only seaport of that still independent kingdom. Sao Joao d'Ajudà is a useless possession to the Portuguese. They have had it ever since 1680, but to this day have made no attempts to increase their hold in the country. They retain this solitary fortress solely at the good pleasure of the King of Dahomé, who wishes the Portuguese to remain, so that no more powerful or energetic nation may step into their place. Last summer a rumour floated about the coast that England was going to take over Whydah from the Portuguese. Thereupon the French, who are jealous of us in this quarter, went and told the King of Dahomé, and this irascible monarch threatened to cut off the heads of the Portuguese garrison if they dreamt of yielding their fortress to the dreaded English. The King of Dahomé knows that if we possessed Whydah, we should irresistibly interfere in the horrible and foul customs of his wicked rule. Whydah is almost the only place of importance that separates our colonies of Lagos and the Gold Coast from one another. It is almost inaccessible from the sea, owing to the furious surf that rages along the coast. Ships of any size cannot approach nearer than seven miles, and the safest mode of reaching Whydah is to land at Lagos, and journey along the shore, crossing Lake Avon on the way.

At the present time, Whydah, or, as the Portuguese call it, Sao Joao d'Ajudà, is under the administrative government of the colonial district of Sao Thomé and Principé. These latter are two islands of singular natural wealth and incomparable natural beauty, lying from one to two hundred miles from the African coast, about the region of the equator.

Principé, which is distant from its sister island about a hundred miles, offers to the delighted gaze of a Nature worshipper one of the most beautiful spectacles in the world. As you enter the fine lake-like harbour of its only town, a wealth of vegetation is spread before you. On the spits of projecting rock and sand, coco palms grow in sturdy groups, while the rapidly rising land is one dense mass of dark green forest. Immediately behind the town, a great sugar-loaf peak rises nearly 3,000 feet into the sky, clothed up to the very top, save for one small streak of grey rock, with velvety forest which, from its proximity to the shore, presents a most imposing spectacle.

In the town, there is a general appearance of desolation and decay. Soon after landing on a stone quay projecting into the water, and evidently a fortunate relic of the magnificence of former days, you pass through some ramshackle streets, and cross a stone bridge over the little river. Here, there is a charming view of the distant peak reflected in its still waters. Many coco palms droop over the stream. Women come here to wash clothes, and their little naked children chase the mud fish and land crabs through the ooze. There are, in this town, no less than five ruined churches, their roofless interiors choked with ferns. But whichever way you turn, nothing but ruin, abandonment, decay, meets the saddened eye. It is like a dead town surprised by some calamity, and offering its ruined houses—many of them of magnificent proportions—and its deserted public buildings as a mute record of the disaster. The river, in its different branches, was once spanned by fine stone bridges, whose massive foundations attest their former stability; now, shaky and miserable structures of planks and ropes offer a hazardous method of crossing the stream dry shod. A little way in the interior, immense cacao plantations begin where the undergrowth is a thick brake of pine-apples, loaded with deep red fruit. Very little of the land in Principé is under cultivation; the principal estate belongs to a merchant in Sao Thomé. Cacao is the chief product of the island. Coffee hardly exists, although to encourage its cultivation the Government has made its exportation free of duty, whereas in Sao Thomé, coffee exported pays 5 per cent. The interior is very mountainous, and covered everywhere with unbroken forest. The uplands enjoy a fairly healthy climate, although occasionally the whole island is subjected to attacks of marsh fever, caused by the emanations from the dreadful Niger delta, which the north wind blows over to Principé.

The island possesses at the present day some 3,000 inhabitants, of whom not more than 100 are white. The black population is descended from old slaves, most of them Guinea negroes. There are two white padres for the church, a Government doctor, a military commander of the one fort—a building which I took at first sight for a summer-house on the cliff—finally, the Governor, who receives £300 a-year, and is a poor incapable old man in his dotage.

The prosperity of Principé fell, because the sugar-cane plantations which caused its wealth were forbidden by the Portuguese Government, some two centuries ago, in case they should interfere with the rising sugar trade of Brazil. The island, however, still continued wealthy until the middle of the present century, when the abolition of slavery gave the finishing touch to its ruin.

The population of Principé was once 30,000; it is less than 3,000 at the present day. Its palaces and churches of former days have become magnificent ferneries, and if it were possible to forgive this retrogression of civilisation, it would be so from the beautiful mask of vegetation that everywhere conceals the ruin and decay.

Sao Thomé presents a much more cheering prospect. While in its natural beauties and its great fertility it rivals Principé, it far exceeds that island in population, cultivation, and development. The superficies of Sao Thomé is about 700 square miles. It is traversed by the equator. The character of the island is extremely mountainous, some of the peaks reaching 6,000 feet in height, and many of them assuming the most fantastic forms. The climate varies greatly. In the lowlands it is hot and unhealthy, on the upper plateaux it is salubrious and warm, and high up on the mountains, it is mild and sometimes even chilly. Europeans can live in perfect health and comfort in the uplands, and, indeed, the Portuguese that reside there are most favourable specimens of colonists, with their pretty wives and their large families of fresh-coloured children.

The capital of the island and town of Sao Thomé extends along a shallow bay, which is one of the few harbours of the island. It contains several fine buildings in good repair, and its streets are clean and well kept, patrolled by a police force, and are planted with shady trees. There are public gardens and fountains, plenty of churches and good schools, shops, cafés and clubs, and a large hospital.

Shortly after my arrival at the island, I made an excursion into the interior to visit some of the "roças," or country houses situated between two and three thousand feet above the sea, on the thickly wooded mountain sides. My guide and companion was a kind and erudite Portuguese, who was a Government doctor and medical officer to many of the great coffee and quina plantations in the interior.

In the cool of the afternoon we left the city of Sao Thomé, and journeyed along an excellent road, bordered with the most splendid vegetation, amidst which nestled the little wooden houses of the coloured inhabitants. Sao Thomé must be the ideal of a black man's paradise, and the negroes of Sao Thomé the happiest in the world. These little homesteads are surrounded by innumerable bananas, with plantations of manioc and sweet potatoes. Pine-apples form the rank undergrowth of their gardens, and the ground nut is a weed. Here and there is an old chapel with lichen-stained belfry and silent bells. A civilised feature amid these little hamlets is the general shop, where a quaint assortment of things is sold, and where it is curious to see advertisements of English sewing-machines hung up to decorate the walls. By the side of the road are magnificent trees from most parts of the tropics, but principally from Brazil. Africa is represented by the baobabs, mimosas, fig trees, dracænas, and the bombax, or cotton wood. There are also guavas, oranges, limes, and papaws, and both the coffee and cacao are beginning, as the distance from the town increases, to take a prominent place. We crossed many brawling streams, and soon—were it not for the civilised-looking road—we might have believed ourselves in virgin Africa, for signs of cultivation began to disappear, and we wound higher and higher up the hills, through the most magnificent forest. The air was musical with the continued sound of falling water; but, except now and then a glint of spray amid the foliage, the tumbling brooks were invisible. The soil was a rich red colour, and when, as we ascended to some height, the bracken fern began to show itself, and to cover with its dewy fronds the steep banks that bordered the road, the scenery, with its red soil and intense greenery, recalled very forcibly the Monmouthshire lanes which border the River Wye in England.

The roças, or country houses, that now began to crown the heights, were very Swiss-like in appearance, generally several storeys high, and with many little outside ladders going from storey to storey. Sometimes the houses are dazzlingly white, and remind one of the charming little quintas of Madeira, like which they are pleasantly embosomed in bright flowers and vegetation of dark velvet green.

We passed the night in one of these little chalets, meeting with a most hospitable reception from its occupants. It surprised me to encounter, amid these wilds of tropical nature, little circles of civilisation like these Portuguese country houses, where there were white ladies of education and refinement, and where the male inmates were capable of discussing political and scientific topics with intelligence and discernment. Pianos stood in the prettily furnished salons, scientific periodicals and journals in different European languages were strewn on the tables, and the furniture and appointments of these houses would not have been out of place in any gentleman's house.

Early the next morning we started to visit the quina plantations, high up the hills, ascending to about 3,500 feet. The quinine plant, or quina, exhibits several varieties, all of which are cultivated in Sao Thomé. The propagation of this precious tree is fortunately easy. Besides growing it from the tiny and abundant seed, the new leaf-buds or "rebutes," as the Portuguese call them, are turned down by their long stalks, and fastened into little boxes of earth, raised from the ground to the proper height, and in these boxes the buds throw out roots and become new plants.

The price of quinine bark brings in, on an average, £4 per tree, when the tree has attained the age of six years. So that a man who plants 100,000 quina plants, at a preliminary cost of £100, stands to gain in six years' time £400,000. Nor does his fortune end there, for after stripping the tree of its bark, it is cut down, and in some five years more has sprung up again from the roots, and gives an even greater yield. Land is sold for a mere nothing in Sao Thomé, for only about one-third of the island is under cultivation; labour, thanks to the excellent system of Government apprenticeship, is cheap and plentiful; the climate on the uplands is perfectly salubrious; there are pleasant society, glorious scenery, and good horses are to be had. Why do not some of our younger sons try quinine growing in Sao Thomé?

I left this beautiful island with regret; but just as I was compelled then to continue my journeyings, so now, in my description of the subject in hand, though I would prefer to dilate on the lovely scenery and many charms of Sao Thomé, I am obliged to curtail my notice of the island, and pass on to other scenes.

Since I left West Africa, the Portuguese have formally taken possession of a point on the South-West Coast, a little to the north of the Congo. This is generally called Landana, and is situated close to the *embouchure* of the River Chiloango, an important highway into the interior. Landana is nearly a hundred miles from the mouth of the Congo, but receives a great deal of the Congo trade, which follows the course of the Upper Chiloango. It is a prosperous place, with four or five large trading establishments, a flourishing Catholic mission, a church, and a doctor. It is, in fact, a ready-made colony, into the possession of which the Portuguese have entered for no particular reason except that they were preferable to the French in the eyes of our Government. English Ministers seem to have the vaguest notions of geography; and when Portugal asked their permission to occupy Landana, they assented willingly, because they had no knowledge where Landana was. South of the Congo the Portuguese have, at present, no recognised possession before we arrive at Ambriz; unless, indeed, there be any fresh arrangement with the British Government empowering them to occupy territory north of the River Loge, in 7° 40′, S., their present limit. Ambriz has been a Portuguese possession ever since 1855, when they annexed it to Angola for the purpose of more effectually suppressing the slave trade which, to do them justice, they have really done.

The habitable town of Ambriz rises to the top of a bold red cliff, at the base of which great rollers dash themselves into foam. Ambriz is sandy, and infested with the horrible "jigger," or burrowing flea, originally introduced here from America, and now fast spreading over West Africa.

The local commerce of this district is in coffee, which grows wild on the neighbouring hills, and is also cultivated by the natives. Ambriz is the natural outlet for the trade of all the interior lying about the 7th and 8th degrees of S. latitude, and stretching inland to the River Luango; but it does not seem to prosper somehow, in spite of being the only kind of port between Loanda and the Congo. Many of its merchants have migrated across the Portuguese boundary to Kinsambo, where, perhaps, the landing is the most dangerous on all the South-West Coast, in order to escape the duties imposed by the Portuguese custom-house. Though these duties are much fairer and lighter than at Loanda or other Angolan ports, they are much complained of by traders; still in Ambriz, at least, there is some excuse for them, as the Portuguese have spent considerable sums in order to construct a pier, and render the landing of goods both safe and easy. Going south from Ambriz, we must travel by sea for a distance of thirty miles to reach the settlements on the River Dande. The intervening district between the Dande and Ambriz has never been conquered by the Portuguese, and still remains impassible to Europeans. A force of twenty armed policemen would suffice to clear the road, but although Portugal can dream of military expeditions to the Congo, she cannot afford a few soldiers to connect Loanda and Ambriz by land.

The estates in the fertile valley of the Dande are magnificent properties, growing immense quantities of sugar-cane, bananas, pine-apples, and oranges. The climate is good, and the scenery beautiful. Horses are successfully bred here, and supplied to the colony of Angola.

Continuing southwards from the Dande, we pass the great River Bengo, and soon afterwards, if the journey is by sea, arrive at the fine bay of Loanda. Sao Paulo de Loanda, the capital of Angola, the largest European city in all Western Africa, dates its existence from the 15th century. The early Portuguese discoverers had the wish to choose its fine harbour as the rendezvous of their ships, and the starting point of their African Empire.

Loando presents a decidedly picturesque and imposing appearance from the sea, placed in the centre of a nearly land-locked bay, faced by low islands, fringed with cocoa-nut palms, and with a sunset-blue sky above, and a violent sea at its feet, it has an imperial look as its white or orange-tinted houses climb the steep slopes, and crown the distant height with their not inelegant architecture. It comes to the African traveller, moreover, somewhat as a surprise. Yesterday, perhaps, or for many preceding days, he coasted along a savage shore, and whenever he landed it was to view the virgin wilderness, or, perchance, to frighten from the foaming beach a few miserable native fishermen. To-day he rounds the headlands of the Bengo, and now a fair and populated city rises before him, and seems by force of contrast civilisation itself. Loanda, to use a common English qualification, is not half a bad place, but it has some marked disadvantages. Its streets are ankle-deep in sand, and it has no drinking water of its own. Every drop of water that is drunk at Loanda, and all that is used for irrigation, must be brought in casks from the rivers to the north and south of the town, from either the Bengo or the Quanza.

The population of Loanda and its suburbs exceeds 14,000, of whom 1,500 are white. There are at present 800 degredados, or convicts, in the town, most of them at liberty, and even serving in the police force or the army. A man that may have committed a brutal murder in Portugal suffers no greater punishment than deportation to Angola, where he probably becomes a wealthy proprietor, and dies twice as rich and respected as he would have done had he vegetated in uprightness in his native country. The Portuguese sometimes say playfully that murder is the best passport to Africa. "Dar um passeio na Angola," "To make a trip to Angola," is a slang euphemism to express the punishment awarded to evil doers in Portugal.

The entire garrison of Loanda is 600 men. It is defended by Fort Sao Miguel. The Governor-General of Angola resides here in a vast but somewhat tawdry palace. His salary is £2,000. Loanda has a fine hospital, a theatre, several good markets well organised by the municipality, an observatory, and several churches and convents. There are fine promenades planted with trees, and many pleasant rides in the neighbourhood. A British consul and vice-consul reside here, and there are representatives of most European nations. There is pleasant and refined society; and regattas, picnics, dances, musical and theatrical performances are much in vogue. The trade of Loanda is greatly in the hands of a well-known English firm, who also manage the navigation of the Quanza.

The Quanza has been termed by many writers "the gem of Angola," and with reason, for this navigable river offers a great highway to the rich regions of the interior. The Quanza rises not far from the source of the Ku-néné, that other great river of the Portuguese Lower Guinea, in Lat. 14° S., and flows south and then westward to the sea, which it enters a little to the south of the Loanda.

It is navigable by river steamers of some burthen for over 200 miles from its mouth, and at this extremest point, just below the last falls, Dondo, an important commercial town, is placed. The old capital of the Quanza was Cambambe, founded by the Portuguese in the 16th century, Its ruins are still remaining, and lie about ten miles distant from the present site of Dondo. This latter place is extremely hot, and certainly unhealthy; whereas Cambambe was placed on the breezy heights, and was infinitely more salubrious. However, Cambambe was abandoned for the present capital on account of the difficulties of navigation that prejudiced the older city. Dondo can with ease be reached by steamers, but to ascend the river higher, to Cambambe, is difficult, and full of risk. As the point at which the commerce of the interior is focussed and concentrated in its relations with the coast, Dondo is a great emporium of Central African trade, and attracts to its markets the products of the far interior, of the Rivers Quango and Kassaï, both of them huge affluents of the Congo (the Kassaï being Stanley's Mobindu or Ikelemba), and all the outward trade of the Muata Yanvo's Empire. In fact, one may say, without exaggeration, that the trade of the Upper Quanza has relations with Nyangwé and the East Coast.

The inhabitants of Dondo, demoralised by the heat, no doubt, are inhospitable, fearful gamblers, and terribly immoral. They all look listless, miserable, and careworn. The town is of considerable extent, and is divided into several large and not ill-built squares. There is a Government doctor, a hospital, a powder magazine without a roof, and a church in the same condition; also a club, where the Dondoese play "batote" until six in the morning. The place is apparently very populous, and there is always a large assemblage of natives from the far interior, who come down to Dondo to exchange their ground-nuts, and other country products. There are people from Cassange, the turbulent Bangalas, who wear strange monkey caps, made from the skin of a *colobus* monkey, with long black and white hair. It is a curious coincidence that the same monkey-skin caps are worn by natives on the Upper Congo, and that there is a well-known race on that river also called Bangala. Dondo is a splendid place to study types of Bantu people. You have here, besides the Bangala, occasional specimens of Balunda, of the natives of Muata Yanvo's kingdom, and of races more remotely placed in the interior of Africa. There are Quissamas and Libellos from the south and south-east, Congo people from the north, and representatives of all the important tribes, Ambaquistas, and others. What Dondo might be made in the hands of a richer and more vigorous power than Portugal it is difficult to say; but, even as it is, we must not forget to give the Portuguese their due. Of all the European Powers that rule in Tropical Africa, none have pushed their influence so far into the interior as Portugal. And the Portuguese rule more by influence over the natives than by actual force. The garrisons at Dondo, Malange, and other places in the interior, range, perhaps, from 50 to 200 men, and these are almost entirely native soldiers. The country is so thickly populated, that the inhabitants could in a moment sweep away the Portuguese if they disliked their rule.

Although, during the Portuguese decadence of the last century, the establishments and commerce of the Quanza fell into complete decay; still, during the last half century great efforts have been made to resuscitate them. Silva Americano, a Brazilian, Oliveira Massango, and other Brazilo-Portuguese merchants, got up a service of excellent river steamboats to navigate the Quanza and develop its trade. These boats are now being worked on behalf of the company by an enterprising English firm, Messrs. Newton and Carnegie, of Loanda, and it was at their courteous invitation that I visited this river in detail by means of the comfortable steamers of the Quanza Navigation Company. Travelling here is quite as comfortable as, and slightly more interesting than, a journey up the Rhine. Not only is the scenery very pretty and thoroughly African, but the river contains more history than, perhaps, any other part of Tropical Africa; for, as I have before remarked, the Quanza has been continuously occupied by Portugal since the 15th century, and can show on its banks many signs of the former puissance and religious fervour of that interesting country.

South of the Quanza river, as far as the 12th degree of latitude, the Portuguese rule is confined to the strip of coast. The interior, where the powerful tribes of Kissamas, Libollos, and Ba-ilundo have their territories, is quite independent of Portugal, although on all but the careful German maps it is coloured Portuguese. Between the Quanza and Benguella, there are, however, several important places on the coast, such as Novo Redondo, and Catumbéla. This is the most wonderful country for wild animals. Benguella itself is quite an *entrepôt* for the supply of wild birds and beasts to divers Zoological-gardens and to dealers. Every homeward-bound steamer is laden with monkeys, parrots, cage birds of all descriptions, and occasionally even a lion or leopard may be seen.

Benguella is an important place, especially as regards trade. I have spoken of Dondo, on the Quanza, having relations with the far interior. How much more Benguella, whose merchants range all over Central Africa, encounter their countrymen from the East Coast on the Upper Zambezi, and even penetrate to the copper country of Katanga and Lake Bangwéolo, whence rises the Congo. The rule of the Portuguese extends nearly 500 miles inland from Benguella, and their political influence even further. From Benguella, now, there is a road to the mountain ranges of the interior, where a healthful and bracing climate is to be found, and where the scenery is of great beauty.

Benguella itself is said to be unhealthy. It has, at any rate, a bad reputation, although its sanitary condition has certainly improved since the surrounding marshes were drained. I always found it a very pleasant resort. Its inhabitants are pre-eminently hospitable, and in their comfortable, well-appointed houses, you may meet with unexpected luxuries. The town is unlike any other Portuguese settlement on the coast, and more resembles the outskirts of Algiers or some Mediterranean city. Its houses are somewhat Moorish in style, and each villa stands apart embosomed in vegetation. There is a beautiful public garden, full of flowers and shady trees, where a military band discourses music in the cool of the afternoon.

Benguella, like Ambriz, Loanda, and Mossâmedes, is the capital of a separate district, and has a governor and administration of its own. Between Benguella and Mossâmedes there is scarcely any place of importance. The coast becomes increasingly barren, and assumes an absolutely desert character.

Mossâmedes is the most flourishing town, perhaps, in all Portuguese Africa. It is situated in a tract of absolute desert, with a fine deep bay in front of the town. The houses have rather a formal look, as seen from the rocky eminence on which the fort is placed. The town, in fact, looked somewhat as if it had been "plumped" down into the desert already made, and had as little to do with the local soil as possible. The atmosphere is, of course, splendidly clear and dry. It does not rain here sometimes for seven years at a stretch, and the immense amount of fish refuse thrown up on the shore, from the great amount of fishing that goes on in the bay, is quickly withered up by the desert wind, and breeds no disagreeable smells. The houses at Mossâmedes are mostly whitewashed cubes, the streets are ankle-deep in shifting sand, and the only oasis of verdure is the well-kept public Botanical Garden. Above and beyond this all is blue sky, yellow desert, and ultramarine sea. But the inhabitants of Mossâmedes are mostly refined, well-educated, hospitable people. There is a surprising amount of civilisation here. Many retired officers of the Portuguese Army and Navy have settled here with their wives and families, finding it cheaper to live, and easier to keep up some appearance of state than in Portugal, so that there is quite a pleasant nucleus of society in the place. Afternoon receptions, musical evenings, tea and whist, and even periodical evening parties, give quite an air of gaiety to the ugly little place.

On the map, this part of Africa seems anything but devoid of water, and it appears incredible that the district of Mossâmedes should be what it really is, a great offshoot of the Kalahari desert; but the fact is, that the three principal rivers of this province, the Giraül, the Béro, and the Croque, are but occasional torrents, flowing for about two months in the year, when the heavy rains of January and February drain off the distant Serra de Chella. During the other months, the body of the river dries up, the water sinks some feet below the sandy bed, and only occasional great lagoons retain a portion of the flood which at one time covered acres of level plain. It is in these great river beds that lies the richness of the country. Their splendid soil can be made to grow cotton of superior quality, sugar-cane, maize, castor oil, oranges, limes, and vegetables of every description. But in most places, especially in the valley of the Croene, cotton is lord of all, and fetches such high prices, on account of its quality, that scarcely an inch of ground is spared to anything else. Forty miles south of Mossâmedes there are several rich plantations on the River Croque, which are at present the farthest extension of Portuguese colonisation to the southward, except the fort and settlement at Humbi, on the Cunéné. As this latter place was one of the furthest limits of Portuguese possession, I was anxious to visit it, and accordingly joined Lord Mayo's hunting party which was journeying in that direction. We travelled at first due west from Mossâmedes, crossed a desert tract of 40 miles in width, and then arrived at the first spurs of the Chella mountains. This range, which lies at a varying distance of 70 to 100 miles from the coast, is part of the mountain barrier or girdle which encircles the interior plateau of Tropical Africa. Some of the Chella peaks rise to 8,000 or 9,000 feet in height, while the forest scenery on their slopes is of unparalleled beauty. When the mountain chain is crossed, you arrive on the other side at an elevated plateau, some three thousand feet above the sea, eminently healthy, and possessing a delightful climate. Here there are several important picturesque settlements and garrison towns, such as Huilla and Quillengues, and here, too, are settled a colony of Transvaal Boers. This new and important element has lately been introduced into the somewhat sluggish province of Mossâmedes. The Boers that "trekked" away north from the Transvaal, as far back as 1874, after undergoing, thanks to their own obstinacy and ignorance, trials far more terrible and incredible than those of the boasted pilgrimages of antiquity, began gradually to approach the banks of the Cunéné in the year 1880. Here they halted for some time, and had many squabbles with the natives, from their overbearing behaviour and unscrupulous dishonesty, and on one or two occasions their enraged opponents nearly cut them to pieces. In the meantime, some of the less ignorant among them were negotiating with the Portuguese Government for permission to cross the Cunéné, and settle in the fertile lands beyond. An answer was some time in arriving. It needed a little consideration before the Angolan authorities could agree to the entry into their sleepy peaceful lands of these quarrelsome, turbulent, though energetic people. The Boers grew impatient, and sent word to say that if the local authorities could not arive at a speedy decision, they (the Boers) would "trek" farther north, and interview the King of Portugal himself. However, consent was at length given, and the Boers were assigned territories at Humpata, a district in the vicinity of the Chella mountains. Thither they proceeded, and have since settled down, and find little to grumble at in the indulgent rule of Portugal. Their lands form one of the finest corn-growing districts in all Africa. There is abundance of running limpid water, a rich soil, and a perfect climate. The great elevation of the Humpata plateau above the sea produces a European temperature, and the thermometer is frequently at freezing point before dawn. Here some sixty families of Boers have settled down to corn-growing and cattle-rearing, hoping to dispose of their agricultural produce in the markets of Angola. From Humpata to the Cunéné is a distance of about 200 miles, traversed by a waggon-road, and dotted at rare intervals with Portuguese forts and garrisons. There is a Government postal service along this route once a month, and it is everywhere safe travelling, except, perhaps, for the abundance of lions that at certain times infest it. The game is wonderfully abundant and varied in character. Great herds of giraffes, elands, zebras, and antelopes may be encountered, together with occasional elephants, rhinoceroses, and buffaloes. In fact it is one of the finest sporting countries in the world.

I found the only possession of the Portuguese, on the River Cunéné, was the fort of Humbi, which boasts of a commandant and a garrison of ten soldiers. The Portuguese, however, have great influence here, and rule the natives more by commerce than by any display of armed strength, which, indeed, would be quite ineffectual in coercing the 80,000 inhabitants of Humbi. As the Portuguese are extending their power and influence, little by little, in this direction, there is small doubt that in the course of time the whole course of the Cunéné will come under their sway.

And now, having rapidly sketched out the principal centres of Portuguese dominion in West Africa, from the Cape Verde Islands and the Casamança to the Cunéné, from 17° North of the Equator to 17° South of the line, I will, in conclusion, draw your attention to certain inferences and reflections that a careful consideration of the present state of Portuguese colonies suggests.

In the first place, although the Portuguese cannot offer the same imposing spectacle of colonising force as England, nor the organising genius of the French and Dutch, still, I am greatly of opinion that Portuguese colonisation is to be preferred to the pristine condition of a savage country governed by itself. Wherever the Portuguese go, they at least make roads, drain swamps, construct rivers, and build towns. In their colonies a traveller may travel in reasonable security, sure, moreover, of an unbounded hospitality from the kindly Lusitanians. I even go so far as to fancy sometimes that the Portuguese are wiser in their relations with the native races than either the French or English. The French are disposed to be cruel, and the English sentimental; the one brutalises the native, the other renders him insufferable with conceit. On the other hand, in any modern Portuguese colony, the natives regard the white man with respect, and, at the same time, with cheerful friendliness. One of the silliest mistakes in England is to accuse the Portuguese of cruelty towards the natives; they are, on the contrary, disposed to be almost too gentle in demeanour towards the black races, that require for their proper development and governance a firm and vigorous rule. The Portuguese, in contrast with the Boers, are "angels of light," and are as much liked by the natives of South-Western Africa as the domineering Dutchmen are hated. People at home do not do the Portuguese justice as regards their relations with African races. They sneer at the excellent and wise system of Government apprenticeship as slavery.

Wherever the Portuguese really rule, actual slavery is not practised, but a regularised system of apprenticeship is in vogue, which some have assumed to be the same thing. Somebody must till the soil, and if left to himself, the negro will prefer not to be the "somebody." He will never work unless he is obliged. Among the independent tribes, domestic slavery is universally practised, and when the country comes to be ruled by a civilising power, although slavery might be rightly, from principle, abolished, some system of enforced labour must be invented to take its place. And the Portuguese idea of apprenticing under Government supervision all minors whose parents or relations agree to it, and all indigent persons who apply for relief, for the present, at any rate, fills up the terrible want of manual labour.

Again, many people in England accuse the Portuguese of keeping their black subjects in utter ignorance. These unjust and hasty critics would be surprised to find, 500 miles from the coast, natives who have been taught in Portuguese schools, and who can read and write Portuguese with accuracy. It is astonishing to see how many full-blooded negroes there are in the Portuguese African administration. Moreover, under Portuguese rule all men are equal. Grades of colour are not developed into social castes, and negro blood is never sneered at. If I were a negro I would infinitely prefer to be a subject of Portugal than of any of the greater powers. That the Portuguese rule must be acceptable to the African, is shown by the almost nominal garrisons with which the vast possessions are retained, by the absence of outbreaks and disturbances, and by the fact that the army which defends these countries from disorder is autochthonous, is composed of natives of the soil. If, however, I have endeavoured to put Portuguese colonisation in a fairer light, and to show up its good points, I have not intended to do this as a plea for extension of Portuguese power over fresh parts of Africa.

Portugal, at present, resembles a greedy child, whose eyes are bigger than its stomach. Its political platter is covered with all sorts of good things, which it has neither consumed nor even nibbled at, and yet it hungers for other dainties beyond its reach. Portugal has sufficient colonies at the present day to last her all her national lifetime; and yet, while she pleads poverty as an excuse for not developing what she has already got, she can afford to equip costly expeditions in view of further and fantastic conquests. The idea of Portugal on the Congo is simply preposterous. She has no interests and no commerce to defend there, like the English or the Dutch, and while her ancient and legitimate colonies are crying out for railways and public works, and are being repulsed with the answer that there is no money in the national coffers, expensive and Quixotic expeditions are, at the present time, being fitted out to explore—I might say to re-explore—the Congo territories, with a view to political occupation. Even supposing Portugal was allowed by the English, French, and International African Association to occupy the Lower Congo, what would she do with it? Stick on differential duties, and try to divert the trade from Liverpool to Lisbon? Never! Manchester would intervene, and few of our Governments can withstand her terribly powerful Chamber of Commerce. Then, would Portugal really, as she pretends, care to act, in the interests of everyone but herself, as the platonic policeman of the Lower Congo, and exert a beneficent rule over this great river at her own expense, and from pure love of humanity? I think not; we live in a too material age, when there is always a *quid pro quo* expected.

If Portugal is wise, she will abandon any such idea, and seek to develop the admirable colonies she already possesses. Her colonists cry out for free trade, and complain that the differential duties not only hamper, as they are intended to do, the commerce of foreign countries, but also stifle the trade of the colonies themselves. Let every inducement be held out to the cultivation of virgin land; let the mountains of Sao Thomé grow forests of quinine, and the swampy lowlands of Senegambia be covered with the sugar-cane; let railways be built, canals dug, telegraph wires suspended. "Alas!" reply the Portuguese to all these suggestions, "we have no money and we have no men." Portugal is too poor and too thinly populated to be able to supply these essentials herself, and she is too much afraid of foreign aggression to invite them from other nations. There is, for example, such a great and important enterprise as the Ambaca Railway. This line, from Sao Paulo de Loanda to the heart of Angola, would bring all the trade of South-Central Africa into Portuguese hands, especially if it were extended to the River Quango, where it would somewhat tap the Congo trade. Yet, although the Portuguese know better than any one else its importance and feasibility, and have already made capital Government surveys to ascertain the difficulties and expense that would stand in the way, they are unable of themselves to find the money necessary to the making of this line, and at the same time refuse to grant the concession to either an English or American company.

Then there is the question of the Loanda water supply. Sao Paulo de Loanda is the only place fitted to be a great African capital between Senegal and Cape Town. It has a magnificent land-locked bay, which, with a little dredging, would simply be one of the finest harbours in the world. Loanda alone has an imperial look as it rises on its red hills above the glassy-blue bay. But it has no local water supply. The wells only give a brackish, unwholesome fluid, and every drop of water you drink, and every drop that you water your gardens with, must be brought in casks from the River Bengo, fourteen miles away. Now it would be neither difficult nor very expensive to make an aqueduct, either from the Quanza, sixteen miles distant, or from the nearer river Bengo. (The Quanza should be made the water supply of Loanda, as its water is much wholesomer than that of the Bengo.) Only, of course, it would cost some thousand pounds, which the Portuguese are not prepared to spend. So Loanda, the greatest European city of Tropical Africa, remains to this day dependent for its drinking water on the arrival of a fleet of little sailing boats. The more one travels in Africa, the more one arrives at the conclusion that the Portuguese have got the pick of the coastlands; but, unfortunately, another conviction forces itself upon the mind, that they have far more than they can be reasonably expected to develop with their individual resources. There is no reason why they should sell, cede, or exchange them, but let them be thrown open unreservedly to all comers and all capitalists, and Portugal will soon, as their suzerain, become a wealthy power.

DISCUSSION.

Dr. MANN remarked that the Society was greatly indebted to Mr. Johnston for the time he had given to preparing this paper; just when he was about to embark on a work of very great importance, and when every minute must be most valuable to him. For some little time he had been preparing to go to the eastern side of Africa, for a very definite and important purpose. All along the eastern side of that great continent was a great range of mountains, stretching from Cape Colony at a distance of some 200 miles, more or less, from the coast, right up into the highlands of Abyssinia, with only a few gaps through which the great rivers found their way to the coast. The dominant point of this whole range was the magnificent mountain Kilimanjaro, and it had been for a long time felt desirable that the natural and physical history of this almost unknown part of Africa should be well understood. The only way, however, in which it appeared possible to get exact information about it was for some enterprising traveller to stay for some time on the spot, and investigate the fauna and flora of the district. This Mr. Johnston was about to do under the auspices of the Royal Geographical Society and the British Association. He was to find his way as best he could to this mountain, whose summit rose about 12,000 feet above the sea, and was covered with perpetual snow; and to reside on the lower slopes for some six months, during which time he would scientifically investigate the plants and animals to be found there, in order that some light might be thrown on the question whether this mountain was really allied with the true mountain range of Africa, or whether it did not belong to the Asiatic system, the only break with which was formed by the basin of the Red Sea. It was quite possible that, at some earlier period of the world's history, the two might have been connected. If this were the case, evidence would undoubtedly be found in the forms of organisation now present on the spot. This was the problem which Mr. Johnston was going to attack. He would certainly perform this task in a very efficient way. He was quite sure that he would set out with the best wishes of all present, and he hoped that at some future time when he returned, he would be able to give them an opportunity to congratulate him on what he had accomplished.

The Rev. HORACE WALLER said he had listened with very great pleasure to the paper, which contained one of the most interesting chapters of geography it had ever been his lot to hear. If up to the present time Mr. Johnston had been able to make such good use of his eyes, ears, and artistic skill, he was sure that every one would look forward with great interest to his future travels in Eastern Africa. He had had the pleasure of seeing some of Mr. Johnston's sketch-books, and though he remembered those of Mr. Davis, who accompanied Dr. Livingstone, he must say that these were superior to them; in fact there were few, if any, in public exhibitions which would equal them, though the sketches were taken in many cases under most difficult circumstances. They included not only sketches of the country and beautiful landscapes, but the most exquisite delineations of animal and plant life. In fact, in these early years of his life he had already furnished the scientific world with an amount of treasure which might be considered full work from one of three times his age. Having listened to this interesting account of the Portuguese settlements, on the East Coast of Africa, his first idea was to contrast it with what he knew of the West Coast. It was not fair to taunt Portugal with her poverty, nor even with her ambition, considering her past glories, but she certainly was unreasonable. Take, for instance, the question of Whydah; she had clung to it more out of pride than anything else, and there had been a whisper that England was about to acquire it. If she did, there would probably soon be another little war, because it was on the borders of Dahomey, the king of which would probably much prefer the Portuguese, whom he could bully, to the English. With regard to the Congo, he was glad that one so well acquainted with the country had sounded the right keynote. It had been shown that Portugal had a great number of possessions there, and that in ancient times her explorers had pitched on the most desirable quarters, and the most valuable rivers, and she might well be contented without interfering with the mouth of the Congo. This was an enormous river, stretching half across Africa, and was about to bring the European nations into contact with millions of people who had never heard anything better than the tramp of the slave trader. Mr. Stanley had opened the country, Captain Cameron had been across it, and Dr. Livingstone had got as far as Nyangwè. If Mr. Stanley's accounts could be relied upon, there was water communication down to the edge of the plateau which, unfortunately, was found throughout Africa. All African rivers and lakes were on the first floor, as it were, and you had to come down a staircase before you got into the street. You might go some miles up these African rivers, and then you came to a series of cataracts, where you had to get out and walk overland until you got to the higher waters, upon which you could launch steamers in sections, and proceed into the interior. This was proposed to be done on the Congo, as it was done on the Zambesi and other rivers. The important question was, what was to become of the mouth of this river? At present it was no man's land, and such it ought to continue. It would be a great pity if Portugal were allowed to have control of the north and south bank. Large vessels could not ascend higher than Bomah, about eighty miles up the river, and there the goods would have to be transhipped into small steamers, or else carried on men's heads to the higher reaches of the river. It was most essential to the carrying out of the great scheme supported by the King of the Belgians that there should be no obstacle of any description; there should be no establishments of Portuguese at the mouth of the river; no fluttering of Portuguese flags; and, above all, no duties levied on overland transit. A year ago, all this was laid before the House of Commons, and it naturally attracted the attention of men of all shades of politics, more particularly in Glasgow, Manchester, Liverpool, and so on, and they all agreed that England must consent to no treaty granting to the Portuguese the north and south bank of the Congo. The consequence was that Mr. Gladstone said that if he found it necessary during the recess to sign a treaty with Portugal concerning the mouth of the Congo, at any rate, before it was ratified, full opportunity should be given for discussion and objection. He did not know whether things remained still in the same state; some persons said the treaty had been signed, but they might be mistaken; but, at any rate, he mentioned it in order that the public might be on the *qui vive*, because, if such a treaty were ratified, England would lose the most important chance connected with that part of West Africa. He knew what all this meant; it meant the future welfare of the tribes in the interior; it meant either more slavery or less; facilities for mission work or obstructions of all kinds. With regard to the Portuguese rule, he was delighted to find that a different state of things existed here to that which prevailed in other parts; but they must not forget the important fact that this was a penal settlement. At Loanda, for instance, as they had heard, there were 800 convicts, many of whom were murderers of the worst kind. The same state presented itself on the East Coast, and the people there had caused Livingstone an immense deal of trouble. Anything more atrocious than the cruelties practised by these men it was impossible to conceive. These degradados practised every villany on the natives, and when they were told of the influence which the Portuguese had over the natives, it was only right to say how that influence was acquired. It was simply a system of terrorism. A Portuguese came there with barrels of gunpowder and muskets, and had so many strong slaves whom he petted, and who became as great tyrants as he was himself, and if any unfortunate slave misbehaved he was put to death with horrible tortures. That was how their influence spread, the natives being cowed with horror at what they did. He defied any place to have 800 convicts in it without their leaving their black mark on everything around them. With regard to the Island of Saint Thomas, Captain Cameron reported that there was a covert slave trade carried on there.

Mr. JOHNSTON said he did not detect anything of the kind.

The Rev. H. WALLER said he knew an English officer who had a very queer story to tell about the apprenticeship system, as it was called. Five hundred or a thousand natives were brought down from the interior, they were asked by a man, who professed to know their language, if they would consent to go and work on one of these islands at so much a month for so many years; the interpreter said they were desirous of going, and immediately a piece of paper was handed to these poor wretches, who knew nothing of what it meant, and from that time they were in the hands of the master, and it very often happened that they did not live out the time of their apprenticeship. In East Africa about three years was the average period of life after the contract was made. Everyone who knew what the slave trade was, shuddered when they heard of this apprenticeship system.

Mr. LIGGINS said he knew nothing of Africa, but he knew something of the Portuguese, and had had them in his service as apprentices, on his West Indian estates, though they were not called by that name. They came from the island of Madeira, and willingly made contract of service to work on his estates in Antigua, and he denied that there was the slightest coercion or cruelty, either on the part of himself or of the authorities of the island. He quite agreed with Mr. Johnston that a certain amount of coercion or compulsory labour was necessary if work was to be done. He remembered the abolition of slavery in the West India Islands, and had received part of the compensation. Under the former law, every planter was compelled to have so many slaves for every acre of land, and for some of them he might have given £200 a-piece, for which he was paid compensation, perhaps, £17 a head. He denied that, because they were called apprentices, they were necessarily subjected to harsh treatment. Compulsory labour was necessary, and it was one of the most human and excellent things that civilised man could accomplish, to take a lazy indolent savage, and make him do honest work. He received wages which he could accumulate, and become wealthy, as some of them did, and in all cases they became better citizens, and more obedient to the laws of God and man. He hoped no cold water would be thrown on the attempt to reach the interior of Africa through the Congo; it would be well if the mouth could be kept open for all nations, but he questioned whether it would be to the benefit of the world at large for England to take possession of it. The obstruction and difficulties raised in England by such societies as the Anti-slavery Society, were enough to damp the ardour and ruin the pockets of all who engaged in any enterprise of this sort.

Mr. H. G. FORBES said he had travelled in the Island of Timor, in the lesser Sunda group, which was possessed partly by the Portuguese, and partly by the Dutch, and had found an immense difference between the two, greatly to the advantage of the Portuguese. The Dutch had supremacy on the western half of the island, and there it was almost impossible for a traveller to penetrate; but on the eastern side, he not only met with a most hospitable reception, but was able to travel right across the island accompanied only by an escort of one officer and one soldier. He was very much surprised to find the high esteem in which the Portuguese were held; many of the native rajahs spoke Portuguese, and though they had to pay a considerable tribute, they all said they would not be without the Portuguese Government on any account. There was neither apprenticeship nor slavery there of any kind. He had been exceedingly pleased with the paper, and especially to hear a good word said for the Portuguese, who were very generally caluminated.

Admiral Sir ERASMUS OMMANNEY, C.B., F.R.S., said Dr. Mann had referred to the scientific work which Mr. Johnston was about to undertake. But to his mind there was another piece of work of the same kind equally important, and that was a scientific exploration of the River Congo. Hitherto, even the main points of it were merely laid down by what sailors called "dead reckoning," and as to the means of navigation, their information was very hazy. From an able paper he heard on the previous evening, he found there were more cataracts than he was prepared for; but every one must agree that it was most important for this great artery to be opened to European commerce. He hoped the Society would take means to press this matter on the attention of the Government. This was the first time he had heard so full an account of the Portuguese colonies on the West Coast, but he could confirm a great deal of what had been said by his own experience.

The Rev. H. WALLER wished to add, in explanation, that in what he had said of the Portuguese character, he was referring to the convict settlements in Africa; of course, in either Madeira or Timor, the conditions were totally different, and such conduct as he had referred to would be wholly impossible. Mr. Liggins had spoken of slaves costing £200; the ones he had been speaking of cost three or four yards of calico, and he had known one of the officers he had referred to go up country and purchase 200 or 300 at such a price. If people found a costermonger driving a donkey which had cost him 30s., they would not expect that animal to have as good treatment as a thorough-bred colt which might have cost 3,000 guineas, and the same rule held good with human chattels. There might, in some countries, be slaves who were very valuable; but to learn what slavery was in its essence, they must go to the fountain head. He had seen the poor wretches in strings of several hundreds, and if they could not keep up with the march they were knocked on the head with an axe, and the children taken by the feet and their brains dashed out against the nearest tree.

Admiral Sir ERASMUS OMMANNEY said he must say, in justice to Mr. Waller, that for fifty years he had been in contact with brother officers who had served on the East Coast, and had heard but one opinion as to those parts of the country which were under Portuguese rule.

Mr. FORBES remarked that in Timor the Portuguese were quite uninfluenced by European public opinion.

The CHAIRMAN said the paper might convey the impression to some minds that the Portuguese rule in Africa was very admirable. They had heard both sides of the question stated, and he did not know that he was called upon to give his own opinion, but if he did, he thought he should prefer not to have the Portuguese as his masters, and he had seen something of them, both in the East and in Africa. He had been to those islands which had been described, and he was sorry to say that when coming from Loanda, on a Portuguese steamer, an officer, whom he knew, having asked him if he should like to see something, which, as he had not seen much, he was quite willing to do, took him to the forepart of the ship, where he saw some sixty or seventy natives of some part of the coast, each with a ticket round the neck, and not looking like ordinary servants, or ordinary human beings at all; they were all huddled together, and the women certainly looked very unhappy. He saw no cruelty, but the impression on his mind was that they were like so many sheep or cattle being exported to Saint Thomas. He said to his companion, "Surely these people are not slaves?" The answer was that they were under contract for five years, but they never came back again. That gave him a sort of idea of what this contract service was, very different to anything which would be tolerated in this country. It was no use to re-argue the question of slavery, which had been settled once for all by the English public. In other respects he did not think there was much difference of opinion, for although Mr. Johnston spoke in favour of the Portuguese, he did not advocate their having possession of the Congo, or, in fact, extending their territory in Africa at all. There was no doubt that their rule was very lenient in some respects, but it was a question whether that leniency was not carried too far, when the result was that you could not travel from one place to another on account of the unruly character of the inhabitants. You could not go from Ambriz to Loanda without a very considerable escort. He was not an Anti-Portuguese, but there was a philanthropy of expediency as well as a natural philanthropy, and he was afraid that a good deal of it was of the former on the part of the Portuguese. Every one would agree on the very great merits of the paper, and he had much pleasure in proposing a cordial vote of thanks to Mr. Johnston.

The resolution having been carried unanimously,

Mr. JOHNSTON said he might perhaps be a little prejudiced in favour of the Portuguese, but it was natural to every one to be susceptible to kindness, besides which, most Englishmen liked to stand up for those whom they thought were unfairly run down.

The Rev. H. WALLER desired to add, that he did not for a moment wish to imply that there were not many Portuguese gentlemen of the highest character; he had referred only to the inevitable consequences of the system pursued of placing convicts of the worst character in official positions.

TENTH ORDINARY MEETING.

Wednesday, February 13th, 1884; Lieut.-Col. C. E. WEBBER, C.B., R.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, Richard, Morialta, Forest-hill, S.E.
Binns, Edmund Knowles, The Rosary, 3, Montgomery-road, Sharrow, Sheffield.
Chester, Henry, 2, The Elms, Clapham-common, S.W.
Crossman, Colonel William, R.E., C.M.G., United Service Club, S.W.
Duncan, David John Russell, 32, Queen Victoria-street, E.C.
Habgood, William, 20, Farringdon-street, E.C.
Howard, Frank Geere, Oaklands, Cricklewood, N.W.
Humber, Thomas, Beeston, Notts.
Immisch, Moritz, 119, Torriano-avenue, Camden-town, N.W.
Jármay, Gustav, Winnington-park, Northwich.
Jones, Edward, 145, Strand, W.C., and Holmdale, Wimbledon.
Mills, Percy Batt, Belmont, Chigwell, Essex.
Parkes, Dr. Louis C., 51, Cadogan-square, S.W.
Sharp, Sidney, Millmead, Guildford, Surrey.
Wilson, Miss Lillian, Boston-house, Chiswick.

The following candidates were balloted for and duly elected members of the Society:—

Colthurst, Sir George St. John, Bart., Blarney Castle, Co. Cork.
Dalton, William Henry, 118, Gower-street, W.C., and Melbourne, Australia.
Elieson, Chaimsonovitz Prosper, 7, Drayton-terrace, Drayton-road, Leytonstone, E.
Knowles, Thomas, Fir Tree-cottage, Turton, near Bolton.
Miller, John Ezra, 1, Tunstall-road, Sunderland.
Nicholson, Robert, J.P., Loanend-house, Norham, near Berwick-on-Tweed.
Pengelly, Thomas, Bodriggy-villas, Hayle, Cornwall.
Richardson, H. Cameron, 2, Carlton-villas, Elm-park-road, Finchley, N.
Sadler, Lieut.-Colonel, The Southlands, Preston-on-Tees, *via* Darlington.
Scott, Major-General Alexander de Courcy, Woodfield, Lytton-grove, Putney-hill, S.W.
Staples, Henry John, 87, Avenue-road, Regent's-park, N.W.
Thornton, Thomas Henry, C.S.I., D.C.L., Leigham Holme, Streatham, S.W.

The SECRETARY announced that, owing to indisposition, Mr. Hubert Herkomer was unable to take the chair, but that Colonel Webber had kindly undertaken to preside. He drew attention to a head painted by Mr. Herkomer, which that gentleman had kindly sent as a specimen of the work done by the Keim process.

The paper read was—

A NEW PROCESS FOR PRODUCING PERMANENT MURAL PAINTINGS, INVENTED BY ADOLF KEIM, OF MUNICH.

By REV. J. A. RIVINGTON, M.A.

It is now rather more than forty years since the decision of Parliament to decorate the new Palace of Westminster with frescoes was welcomed as the beginning of a new epoch in English Art. The most sanguine hopes were entertained, and even confidently expressed, that this step would result in the formation of a great school of painting adapted to the new requirements of art in this country, and would, moreover, lead to the improvement of the sister arts of sculpture and architecture.

"The young artist may be assured," says a well-known writer on art at that time, "that fresco-painting will succeed, and be extensively practised in this country. The commencement has been most auspicious. The patronage of Government has been offered. The assistance of Parliament has been obtained; and with such encouragement and patronage, ability and genius will not be wanting. No opposition can now prevent its success. The die is cast, the path will be trodden."

Alas for these glowing anticipations, these flattering prophecies; not even the original project was carried to completion. One factor in the calculation, an all-important one, had not been taken into account. Not the patronage of Government, not the assistance of Parliament, not the genius or ability of the artist could avail anything against the power of an existing influence, fatally opposed to all such art works—the influence of the English climate.

A comparatively short time sufficed to prove that no dependence whatever could be placed on the permanence of works executed in fresco, and from that time to the present, it has been taken as an accepted fact that English art must develop itself in other directions than in that of fresco-painting, the field where it could find room for the highest and grandest expression of its powers. It is not, perhaps, too much to say that such a limitation to the development of art has something in it of the nature of a national misfortune, and that it would be hardly possible to over-estimate the value of any discovery which would make us independent, for art purposes in this direction, of all influence of weather or climate, under any conditions of exposure.

It is the confident assurance that I am able to bring under your notice an invention capable of securing to us this absolute immunity from climatic influence, in the highest and most perfect degree, that gives me courage to appear before you to-night.

And, first, I must claim your attention a few minutes for some brief remarks on other existing processes for mural paintings, which will help you to appreciate better the superiority of Mr. Keim's system.

Fresco-painting, properly so-called, is the process of painting in water-colours upon wet mortar containing lime. In this process, the action of the carbonic acid in the atmosphere converts the lime of the mortar into carbonate of lime, and this latter it is which forms the preservative or fixing medium for the colours. The carbonic acid is driven out of the limestone or chalk originally by the process of burning, and the lime remains. When slaked, the lime is converted into a pulp of hydrate of lime. In this form it exists in the mortar, and greedily absorbs the water with which the colours are applied. This water, together with that already in the mortar, dissolves a portion of the hydrate of lime, and after a time this solution finds its way, through the supervening layer of colour, to the surface, where it absorbs carbonic acid gas from the atmosphere. By this means it becomes converted into carbonate of lime, and lies upon the surface of the painting in the form of a thin crystallic film, protecting and securing it to such a degree that it will admit of being washed, provided no great amount of friction be employed.

Experiment has shown that in fresco-painting the colour does not sink further into the ground than in the case of any water-colour laid on a dry ground. On the contrary, the pigment becomes saturated with the solution of hydrate of lime which exudes from the mortar, and which can only become converted into a film of carbonate of lime on the surface; beneath this, the adherence of the pigment to the mortar is very slight, as may be easily proved when the crystallic film has been scraped off, or dissolved away by the application of an acid, or even removed, as is sometimes possible, by merely rubbing the surface with the moistened finger. After the removal of the protecting film of carbonate of lime by some such means, the pigment gives way readily when rubbed with the finger, and with even still greater readiness if moisture be also applied. A very striking illustration of this is afforded by the fate of the frescoes executed about eighteen or twenty years ago on the exterior of the new Pinakothek in Munich. On the northern and eastern sides, the hail and rain have destroyed and washed away not only the protecting film of carbonate of lime, but also almost every vestige of colour.

The tendency to peel off in flakes, which paintings executed in fresco have often shown, admits likewise of a very simple explanation.

As a consequence of the greedy absorption by the mortar of the water contained in the pigments, the particles of the latter adhere mechanically to the surface of the mortar by capillary attraction, and that so closely as to permit of a second layer being very shortly after laid upon the first, without mixing with it in any way. Similarly, the second layer will admit of a third being superimposed. All three layers now become saturated with the solution of hydrate of lime, and are united by a real process of cohesion. This process is, however, only in the highest degree perfect where the superimposed layers have been applied before the hydrate of lime has completely penetrated the pigments. In those cases where it has so penetrated, and the crystallic film has already partly formed, the saturation cannot be so perfect; and where colours have been laid on after the film is fully developed, these can only adhere to the surface in a very imperfect degree. It follows that damp, or other causes, are sufficient to induce them to peel off very readily from the more firmly attached layers beneath.

It has been thought by some that the paintings discovered in the excavations at Pompeii, and elsewhere, are evidence that the ancients were in possession of a process that would ensure the permanence of paintings for some two thousand years at least, and doubt was thrown, therefore, for a time, on the possibility of their being fresco work. But recent examination, while it has proved their claims to be classed among genuine fresco-paintings, has also explained the seeming mystery of their permanent qualities. In the first place, it must be borne in mind that they have been preserved from the action of air and light, and, in some degree at least, of damp also, for almost the whole of their existence, and in the next place, their apparently indestructible character has vanished before those simple tests to which fresco-painting has invariably succumbed.

All such paintings as have been, since their excavation, exposed to the action of the weather, have undergone rapid decay, so much so, indeed, that within the short space of nine years some of them have almost entirely disappeared.

I have felt it necessary to speak of fresco-painting at some length, and indeed it is due to a process which, for so many centuries, was the acknowledged system for all great works of art of this class, to discuss the causes of its failure with full consideration. It is a dead system now, or soon will be; but it has played a great part in the past, and art owes it a debt of gratitude. I feel that it deserves a worthier funeral oration than the amateur *post-mortem* examination to which I have just treated it.

With regard to the more or less inefficient modern substitutes for fresco, I shall not need to tax your patience so greatly, as they are infinitely less deserving of respect. Most of them, if not all, such as wax colour, casein, as employed abroad, do not profess to be capable of resisting the influence of weather, when exposed to the open air. They are, therefore, only comparatively permanent, even when used for interior decoration, and may be dismissed without further mention.

Mr. Gambier Parry's process of "spirit fresco" appears to possess merits beyond such methods as are employed abroad, but, like them, it is not intended for exposure to the open air, and cannot enter into competition with the process which is the subject of this paper. It is, perhaps, unnecessary to remind you that the only sure guarantee for the permanence of any painting must rest its claims on a thoroughly scientific observance of, and adherence to, the laws of chemistry. Unless the painting is executed under conditions which can be proved to comply with the demands of chemical laws, its permanence is a mere matter of hap-hazard experiment, and a perfectly open question, which even the test of time itself can hardly settle conclusively, since, without a thoroughly scientific basis, there is no real guarantee that the conditions will not vary.*

The process which it is my privilege to introduce to your notice this evening, claims our attention as being the result of nearly twelve years thoroughly scientific labour and research on the part of the inventor, and is based on the stereo-chrome process of Schlotthauer and Fuchs, differing however from that in such important particulars as to constitute, practically, an entirely new process of itself.

In the year 1848, Professor Schlotthauer, of the Munich Academy, who had for some time been engaged in experiments with a view to discovering some permanent process for mural paintings, turned his attention to the substance known as water-glass (silicate of sodium), the invention of the chemist Fuchs. The result was the adoption of the stereo-chrome process.

In this process the surface to be painted on consisted of an ordinary mortar of lime and sand, impregnated with water-glass. Upon this surface the painting was executed in water-colour, and was then fixed by water glass thrown against the surface in the form of a fine spray, the water-glass in this case forming the fixative for the painting.

In practice, it soon became evident that a simple spraying of water-glass, applied to heterogeneous pigments, without reference to their peculiar properties as regards chemical composition, cohesive capability, &c., was not sufficient to ensure their permanence. Certain colours in particular, as ultramarine, umber, and black, were observed to be always the first to detach themselves in the form of powder, or by scaling off from the painting; thus pointing to the fact that their destruction was not owing to any accidental defect in the manner of their application, but to some radical unsuitability arising from the chemical conditions of the process.

In Mr. Keim's process great regard is paid in the first instance to the ground upon which the painting is to be executed. A careful

* A substitute for fresco-painting has been adopted of late years in this country, for paintings on a small scale, by the employment of oil colours, with a matt medium to destroy the gloss peculiar to oil pigments, and to impart the dead surface so necessary to mural decorative paintings. Very little consideration is required to show that this method presents, perhaps, the least guarantee of any process, for the permanence of the painting. In oil colours, it is the oil which, by filling the pores of the pigments, serves at once as a preservative and binding medium, while the varnish forms an additional protection against atmospheric influence. The various mediums used to destroy the characteristic effect of oil, effect this by expelling or neutralising it. The volatile elements of the mediums then evaporate, leaving the pores open for the chemical action of carbonic acid gas, sulphuretted hydrogen, or any other deleterious agent in the atmosphere, to destroy the colour, while little or nothing remains to bind the substance of the pigments together. The comparatively rapid ruin of such paintings is the only possible result.

study of the best examples of the fresco paintings of former times, convinced him that the painting ground was a feature of supreme importance. I have here some fragments of Pompeian wall-paintings, which will illustrate the extreme care which was bestowed at that time upon the preparation of the wall surface. An examination of them shows that two different qualities of mortar, in distinct layers, were employed in their construction. That which lay underneath is coarser in texture, but very firm, and evenly mixed. Upon this is laid a very thin coating of a much finer composition, spread over the surface with the greatest care and accuracy. Here is a fragment of a Roman fresco, from Bavaria, of a much later date. The different character of the mortar can be seen at a glance. There is only one coating, and that one not only far coarser than even the first coating of the Pompeiian fresco grounds, but very roughly and carelessly mixed. No trouble appears to have been taken to sift the sand so as to produce evenness of texture, as is evident by the presence of small stones and lumps occurring throughout. The deterioration of character in the later specimen is very marked.

The preparation of the wall, then, in Mr. Keim's process, receives the most elaborate and careful attention. Great care is taken, in the first place, that the wall to be treated contains no damp or decaying stones or bricks, and the latter must have been sufficiently baked, otherwise they will develop an efflorescence most injurious to the process.

If the wall be already covered with stucco or mortar, this will serve as the first ground, provided it be in a thoroughly sound and dry condition, and it will then be sufficient to clean and level it before applying the second, or painting ground. If not, the stucco must be cleared off, the bricks laid bare, and the mortar between the bricks picked out to a depth of about three-quarters of an inch.

This more thorough preparation is always preferable in a work of greater importance, or where special pains are advisable to secure durability, as, for instance, when undertaking the exterior decoration of a building.

Upon this surface a thin squirting is cast, composed of the following mortar—coarse quartz sand, infusorial earth, and powdered marble, mixed in certain proportions. Of this mixture four parts are taken to one part of quick-lime, slaked with distilled water. Upon this squirting-cast, the object of which is to secure adhesion to the surface of the wall, follows mortar of ordinary consistency, composed of the same ingredients, to fill up all inequalities and produce a smooth surface, and upon this, again, the second or painting ground is applied.

The painting ground is composed of the finest white quartz sand, marble sand, artificially prepared, and free from dust, marble meal, and calcined fossil meal (infusorial earth). The sand composed of these materials, carefully mixed in the proper proportions, is mixed with quicklime slaked with parts of distilled water, in the proportion of eight parts sand to one part slaked lime. This mortar is applied to the wall as thin as possible, not exceeding one-eighth to one-quarter inch in depth.

For work executed on the exterior of buildings, Mr. Keim recommends the employment of pumice sand, in addition to the other ingredients of the mortar. When coated with a stucco of this composition, the wall presents so hard a surface as to admit of sparks being struck from it with a steel.

It is absolutely essential that throughout the work, only distilled, or filtered rain water be employed. The reason for this is to obviate any possibility of the water containing lime, as that would affect the solution employed for fixing so as to impair the effect of the painting.

It will be observed that in this process Mr. Keim not only is careful to follow the best examples of antiquity in the manner in which the stucco is laid on the wall, but that he has adopted the use of a mortar composed of carefully selected materials, in preference to that of an ordinary kind, such as was employed in the stereo-chrome process. The object of this is to attain a far higher degree of durability. The nature of the sand selected for this purpose is eminently calculated to ensure this. Marble sand, such as he employs (carbonate of calcium in crystalline form), has been proved by experience to add very greatly to the firmness of the mortar, containing many advantages above quartz sand, such as greater porosity for the absorption of the colours and fixing liquid, &c.

Again, the infusorial earth mixed with it (a form of silica), has a double effect in consolidating the mass. First, it acts mechanically, cementing and binding together, with the lime, the coarser particles. Secondly, it forms, to some extent, with the lime, a silicate of calcium, such as afterwards results from the addition of the water-glass. The presence of this silicate within the mortar adds, in a very high degree, to its hardness and power of resistance to chemical and mechanical influences.

The intense power of increased durability which Mr. Keim obtains by these improvements, can be best estimated by a regard to the fact that paintings executed by the stereochrome process, while they have for the most part lost the coating of paint or their colour, have, save in such cases where the preparation has been carelessly carried out, retained the painting ground up to the present day, after exposure to weather for nearly forty years, in perfect and sound preservation.

When the mortar is perfectly dry, down to the stone or brick of the wall, it is treated to a solution of hydro-fluo-silicic acid, to remove the thin crust of crystallic carbonate of lime which has formed on the surface, and thus to open the pores. It is then soaked with two applications of potash water-glass (silicate of potassium) diluted with distilled water, and when dry, the ground will be found hard, but perfectly absorbent, and ready for painting.

The surface layer of mortar, or painting ground, can be prepared in various degrees of coarseness of grain to suit the artist's requirements. The more smooth and polished however the surface is made, the greater are the difficulties in the subsequent process of fixing, owing to the absorbent qualities of such a ground being necessarily less perfect. The ground can also be prepared in any tint or colour that may be desired, and can be applied to any suitable substance, if needed for a removable decoration. Stone, tile, slate, wire-gauze, glass, and canvas form an efficient substitute for the wall in such cases. If applied to canvas, it can in this form be fixed to wood-panels, mill-board, ceilings, &c., and admits of being rolled with perfect safety. The advantage of this to the artist is sufficiently obvious. If a ceiling, for instance, has to be decorated by this process, it can be painted with the same convenience as an ordinary picture in the studio. After it is fixed, it can be rolled up, taken to its destination and fastened on to the ceiling, either temporarily or permanently, at the cost of very little expenditure of time or labour. Similarly (unless it were permanently fastened up), the ceiling would admit of being removed for the purpose of being cleaned.

I come now to speak of the colours used in this process. Certain pigments only are admissible, in order to ensure permanence, and regard must be had to the purity of these, and to their absolute freedom from adulteration. All the colours found available for the stereochrome process can be employed; these are, for the most part, composed of natural earths or metallic oxides, since experience has proved that the most permanent colours are those derived from such sources. In their preparation, due account has been taken of the well-known law in optics, which teaches that colour does not lie in the substances themselves, but in the rays of light, which are divided, reflected, or absorbed by the substances in such a manner as to produce the effect of colour upon the eye. Substances, therefore, which readily undergo change, whether by reason of their affinity to other substances with which they are brought into contact, or by the action of the light itself, which often causes molecular change, must, whenever such change takes place, lose, or modify their original colour, since, under their altered conditions they absorb or reflect the rays of light in a different manner.

It is clearly then of the greatest importance that each pigment should remain chemically unaffected by the substance of the painting ground on which it is laid, and by the substance of any other pigment employed, as well as by that of the material used for fixing them. To meet this end, the colours in this process are treated beforehand with alkaline solutions (of potash or ammonia), to anticipate any change of hue which might result from the use of the alkaline liquids which form the fixative. In addition to this, they are further prepared with certain other substances, such as oxide of zinc, carbonate of baryta, felspar, powdered glass, &c., as required by the peculiar properties of each, in order to obviate any other danger of chemical change taking place.

The colours found available present a very full scale. They are thirty-eight in number, and there are several other colours which could be added if required. They consist, speaking in general terms, of four varieties of white, six of ochre, two of sienna, ten of red, two of brown umber, two of Naples yellow, two of ultramarine, five of green, three of black, and cobalt blue. Cadmium will shortly be added to them. The whites are, perhaps, in unnecessary profusion. Zinc white, for its opaque qualities, and baryta white for purposes where great opacity is not desirable, would be probably found quite enough in practice.

Zinc white is oxide of zinc. It is especially valuable in this process, forming a silicate in combination with the fixing solution, and thus adding greatly to the hardness and durability of any colours with which it is mixed.

Baryta white is artificial sulphate of barium. It is useful for giving a lighter tone to colours without greatly detracting from their transparent qualities, and is on this account useful in glazing, where zinc white would be too opaque.

Of the ochres and siennas I need not speak in detail. They consist of various combinations of oxy-hydrates of iron, calcium, alumina, magnesia, and silica. The violet oxides of iron belong to this class. The colour is due to their being subjected to the action of heat for a longer period of time.

The reds are chiefly oxides. The chrome is a sub-chromate of lead. This colour, you will observe in the specimens before you, is prepared in dry powder instead of in a moist paste, as in the case of the others. The reason for this lies in the fact that the colour depends on the size of the crystals, which would be destroyed by further grinding, with the result of the pigments assuming an orange hue. It will, therefore, only admit of being mixed with water by the means of the brush. I need hardly observe that I am using a relative term in speaking of the size of the crystals. The pigment is in the form of an almost impalpable powder, but the exceptional degree of fineness which is attained in the other colours, forces me to speak of this in terms which might be misleading.

The lake is only suitable for interior decoration, and has been prepared by Mr. Keim, under protest, for artists who found themselves unable to forego its use. He does not guarantee its permanence if exposed to weather in the open air. He has proposed an ultramarine red as an efficient substitute.

The colour named mennig is an oxide of lead.

The umber is an oxide of iron and of manganese, combined with silica.

The Naples yellow is a compound of oxide of lead and antimony, or antimoniate of lead.

The ultramarine is artificial, and consists of silica, alumina, and sulphate of sodium.

The cobalt blue is protoxide of cobalt, compounded with alumina.

The cobalt green is protoxide of cobalt, in combination with oxide of zinc.

The green earth consists chiefly of silicic protoxide of iron. It also contains magnesia, alumina, and potash.

The chrome oxide green is oxy-hydrate of chromium.

Over no part of his process has Mr. Keim expended more labour and thought than in the preparation of the colours. From the various nature of the properties possessed by some of the pigments, it was found that their capacity for absorbing the alkaline silicate with which they were fixed varied very greatly. There was also a marked difference in the degree of mechanical cohesive capacity which they respectively possessed. To equalise them in these respects, without which the fixing would have been a work of great difficulty and uncertainty, alumina, magnesia, and hydrate of silica were added as required. The result is, that all the colours are equally acted upon by the fixing solution, and all attain an equal degree of durability after fixing, both as regards the mechanical and chemical action of this process upon them.

It is significant of the success which has attended Mr. Keim's thorough appreciation of the requirements of the pigments, that his labours in this direction have so perfectly adapted them to the chemical condition of the ground, as to show that, to a very appreciable extent, fixation will be found to have already taken place before even the application of the solution employed for that purpose.

In the year 1878, a large mural painting was executed by this process on the exterior of the parish church at Eichelberg, near Regensburg. Before its completion, and therefore before any of the fixing solution had been applied to it, it was drenched by a heavy storm of rain. Contrary to anticipation, it was found that the painting, so far from being in any degree washed away, had held perfectly firm, and even in some places seemed to be as hard as if already fixed. Mr. Keim's explanation of this unexpected result, which he subsequently confirmed by experiments, was, that a chemical cohesion had already taken place by the action of the alkali set free in the mortar upon the silicates in the pigments.

Again, when it was determined to execute the mural paintings in the Franciscan Monastery, at Lechfeld, in 1879, it was desired to wash off a painting executed in this process a year previously, which had never been fixed. Neither water, nor even a tolerably strong solution of acetic acid, had the slightest effect upon it.

If the process, so far as I have described it, appear to you, from the thoughtful and laborious pains bestowed upon it by the inventor, to be somewhat of a complicated character, involving considerable study to understand the nature of its claims to durability, as well as scrupulous care in the preparation of the materials, it will be at least a comfort and a relief to you to learn that exactly the reverse is the case, as regards the use of this process from the artist's point of view. For him are no complications or difficulties whatever. So far from approaching in any degree the difficulties or inconveniences possessed to a greater or smaller extent by fresco-painting, or any of its more modern substitutes, this process is even far pleasanter and easier to work in than oils or water-colours. Every variety of treatment is possible, and it adapts itself to any individual style of painting. It presents perfect facility for transparent glazing as a water-colour, and for painting in body colour it even surpasses the capabilities of oil colours in its power of opaque treatment.

The examples before you will be a sufficient illustration to anyone practically acquainted with oil or water-colours.

Moreover, the most delicate tints, when laid over darker tones, do not in the slightest degree darken over them, as they are apt to do in oils, but keep their full value perfectly. Retouching and correction can be effected with the greatest ease, and to an almost unlimited extent. The system admits also of great economy. To begin with, the pigments are by no means expensive, in spite of the labour expended on their preparation, and a very sparing use of them is sufficient to meet all possible requirements in painting, a far less amount requiring to be expended than in other processes. This is due mainly to their being ground so exceedingly fine, so that they need only be very thinly laid on; in fact, this consideration has always to be borne in mind, that the thinner the coat of painting is, the greater the degree of security that can be attained by the fixing. Moreover, there need be no waste of pigment at the end of the day's work, as in oils. The palettes employed for the process, as you see by the one before you, are constructed with small pans to hold the pigments. If any paint remains after the work is finished, it can either be replaced in the bottle, or it can be kept moist in the pan with distilled water for the next day's work. Even if a considerable amount of the pigment should by inadvertence have been allowed to become dry, all that need be done is to grind it up again with a little distilled water, a task involving no labour.

The process has the further recommendation of great cleanliness, distilled water being the only medium used in painting. The porous nature of the ground, and its peculiar texture, have had great fascination for those who have made practical acquaintance with the working of it.

The last stage in the process is the work of fixing. In the stereo-chrome process the fixing medium employed was silicate of potash, thoroughly saturated with silica, in combination with sufficient sodic silicate to prevent it from opalescing. The chief defect of this lay in the fact that it was often apt to produce spots upon the painting. Mr. Keim, after much careful study, has substituted silicate of potash treated with caustic ammonia and caustic potash. The action of the carbonic acid in the atmosphere and in the water during the process, leads to the formation of carbonated alkali, which makes its way to the surface, and would form, when dry, a whitish film over the painting. To obviate this danger, as well as to expedite the process of converting the silicate of potash with the basic oxides existing in the substance of the painting into silicate, the fixing solution is treated further with carbonate of ammonia. The effect of this upon silicate of potash is that silica is precipitated in a fine gelatinous form, and ammonia set free. This latter volatilises, and carbonate of potash is formed, which is easily removed by washing after the completion of the fixing.

Having regard to the value of heat in accelerating the action of chemical processes, the fixing solution is employed hot, with the advantage of obtaining a quicker and more perfect formation of silicate than was possible in the stereo-chrome process, where the solution was applied cold.

The effect of the fixing is not very difficult to understand. I have already pointed out, in speaking of the pigments, that the result of their being treated with certain substances is to effect the formation of silicate, both in the constituent parts of the pigments themselves, as well as of those in combination with the painting-ground. The additional presence of the fixing solution intensifies this process to the greatest extent. The free alkali of the solution acts upon certain of the substances which have been added to the pigments—such as oxide of zinc, hydrate of alumina, and hydrate of silica—at first by dissolving them. By the action of the carbonic acid in the atmosphere, these solutions are again decomposed by parting with the hydrates, which, through this process, are converted into silicates. The pure colours are enclosed in these silicates; whenever that is, the pigments themselves do not take part in the formation of silicate.

The hardening process of mortar I have

described—in speaking of fresco-painting—to be due to the formation of a crust of carbonate of lime upon the surface. The action of the fixing solution in Mr. Keim's process, when applied before and after the painting, is to form, in addition, a silicate of calcium with the particles of lime, the presence of which within the mortar increases beyond comparison the hardness and durability of the whole; silicate of calcium, no less than carbonate of lime being, as is well known, constituent parts of some of the hardest marbles.

Briefly described, then, the effect of the fixative as it sinks into the ground, which has already absorbed the pigments, is to convert the painting into a veritable casting, uniting with colours and ground in one hard homogeneous mass of artificial stone, partaking of the nature of marble in its power of resistance to mechanical disturbance, partaking of the nature of glass in the impervious front it presents to the chemical action of the atmosphere.

The finished painting has proved itself absolutely impervious to all tests. It will admit of any acid, even in a concentrated form, being poured over it (save, of course, hydrofluoric acid). Caustic potash, also, has no effect upon it, indeed nothing can be employed with greater advantage than this for cleansing the painting when its condition requires that process. I will give you a practical illustration of this, as well as of the perfect safety with which soap and water may be applied with a hard brush, as vigorously as may be desired. The surface is so hard as to present a perfect resistance if scratched with the finger nail. If anyone likes to convince himself of this, by making the experiment for himself at the close of the lecture, he is perfectly welcome to do so. I will only advise him, if he has any regard for his finger ends, to approach the experiment with caution. The hardness and durability of the finished painting has been subjected to very severe trials abroad. It has defied the elements in very bad climates, having been exposed to the weather on the exterior of buildings for some years.

In Munich a specimen of the process was subjected to incessant tests, and put to every form of torture without intermission, for two years, and I may say, in language which, if not classical, is at least familiar to English ears, it "came up smiling" after each attack, and, at the end, was as fresh and uninjured as at the beginning.

On the 25th of last month, I delivered over to Professor Barff four small specimens, to test their claims to resisting atmospheric influence. He is unfortunately prevented by ill-health from attending this evening, but he has supplied me with the following statement to read to you:—

"100, Abbey-road, Feb. 11th, 1884.

"The Rev. J. A. Rivington gave me four specimens of his painting to submit to any tests I pleased. Three of these were half protected and half exposed. No. I. was treated by me in the exposed part, first with a solution of oil of vitriol, one part oil of vitriol to four parts water, for some minutes, after that I washed it in cold water. It was then treated with bromine water for some minutes; after that, to destroy the yellow tint given by the bromine water, and to further test it, it was washed with a solution of strong caustic soda. A few days after, it was treated with saturated chlorine water. These tests proved that the protecting influence of the silicates is very great. Chlorine and bromine do not occur in the air, but they are most powerful bleaching agents, and, therefore, rapidly destroy unprotected colours.

"No. II was kept moist for nearly a week under a bell glass full of carbonic acid gas; I then placed it in water through which carbonic acid was passed continuously for twenty-four hours. This proves that the lime ground can resist the most powerful disintegrating agent which exists in the air.

"No. III. was placed for a week in a bell glass of sulphurous acid gas, and kept moist. The result is, that it resisted this most powerful disintegrating gas; it also resisted its bleaching powers. Sulphurous acid destroys substances by its becoming oxidised in the presence of moisture into sulphuric acid, which, continually applied, has a most destructive effect.

"My opinion, therefore, is that paintings properly executed with these materials will resist the destructive influences in the air. The fourth specimen proves that however dirty a painting in these materials may become, it can be made as fresh as when new by simple washing.

"I have studied silicious painting for thirty years, and have therefore had some experience.

"FRED. S. BARFF, M.A., Cantab."

Mr. Barff has left me to tell you the test he applied to the specimen No. IV. It was wetted, and then held over a gas-flame till thoroughly blackened. Scrubbing it with water completely removed the smoke stains, and when he showed it me it was as fresh and uninjured as when I gave it into his hands. He repeated the process of blackening it in my presence, in order that you might have a practical illustration of how little London smoke is likely to injure such paintings.

Now, these specimens, which have so successfully resisted such extreme tests, were not fixed with the utmost degree of care. I did not apply the solution hot, nor did I, as Mr. Keim recommends for the more practical formation of the silicates, allow from twelve to twenty-four hours to elapse between each application of the fixing solution. They received each four or five coatings, but were dried rapidly, and received a fresh coating as soon as they were dry. They were painted and fixed in the course of one day. I had, however, previously to giving them to Professor Barff, treated No. II. to a bath of undiluted sulphuric acid, scrubbed well in with a hard brush, and afterwards had treated it in the same way with undiluted caustic potash, so that I had tolerable confidence that they were fixed sufficiently to resist any legitimate test that might be applied.

We have now abundant testimony to the invulnerability of the painting to any chemical action of weather or climate, as well as to its power of resistance to injury from mechanical causes, such as friction. If it should be damaged by a violent blow from a hard instrument, it can be repaired and re-touched with the greatest ease. The carbonic acid of the atmosphere is distinctly beneficial to it, imparting to it by degrees the consistency and hardness of actual marble, when absorbed by the lime in its composition. The moisture of the atmosphere, even in the form of heavy rain, is also an advantage, in dissolving away the free carbonate of potash to which I have before alluded.

It is worth while pointing out that, although this process has been designed to meet the requirements of mural painting, it is capable of application to other purposes with great advantage. For instance, it would have great merit in its durable qualities, and in the readiness with which it can be cleaned, for scene painting, in addition to which it possesses the important advantage of being uninflammable, owing to the presence of the silicate.

For ordinary house-painting, it would last as long as the building itself, only needing to be scrubbed down from time to time. I need scarcely point out that it would, when used for this purpose, be an effectual protection against damp.

It can also be employed for tapestry painting. I am indebted to the kindness of the authorities of the Science and Art Department of the South Kensington Museum for the loan of the specimens before you. You will see that in this case no special ground is required. Canvas of proper texture, prepared by soaking it in a special solution, forms a suitable ground for the colours, which are laid on and fixed as in the case of the prepared mortar. The work is equally permanent in character, and entirely unaffected by light. It is uninflammable, and can be cleaned without the least injury to the most delicate colours.

It might, perhaps, be feared that such exceptional qualities could only be taken advantage of at a prohibitive cost, but this is not the case. The expense will bear favourable comparison with that of other systems, without taking into full account the lasting nature of the work executed.

It only remains for me to add the testimony of a Commission appointed in the spring of 1882, by the Royal Bavarian Academy, at Munich, to examine into and report on this process. The members of the Commission consisted of Professors Lindenschmit, Müller, and Max, artists; Albert Schmidt and Fritz Hasselmann, architects; and Dr. Lietzenmayer, chemist. The report was published on the 18th of May of the same year, and deals most exhaustively with the subject from three points of view—(1) the chemist's, (2) the builder's, (3) the artist's. The following is the summing up under each of these three heads.

1. The chemical report says:—

"Mineral painting guarantees with certainty that, by means of this process, mural paintings can be executed, which—presupposing a correct and conscientious treatment—are capable of the greatest and most enduring resistance to climate."

2. The architects conclude as follows:—

"The evident hardness and capability of resistance presented by the specimens laid before us, as well as the fact that, amongst others, Professor Lindenschmit has buried one such painting a whole winter under a roof gutter in the snow without its having received the slightest damage, leave no doubt that Mr. Keim has, through his very able method, succeeded in perfectly solving the problem of producing mural paintings indestructible by weather."

3. The artists on the Commission sum up their report with these remarks:—

"According to the foregoing opinions, Mr. Keim has undoubtedly succeeded in providing a method of monumental painting, carefully thought out, even to the smallest detail, grounded on scientific principles, and practically verified by visible facts, which is by far to be preferred to all methods of painting hitherto existent, and which, once recognised for its high value, would bring about a complete revolution in all our monumental and decorative art, and which deserves the widest publication and practical employment."

I have trespassed too long already upon your attention, but before I take leave of the subject of what I fear may seem to many of you to be somewhat hard and dry facts, I may perhaps be pardoned if I allow myself a little flight of fancy. I have confident hopes that the great merit and intrinsic value of this process will meet with that recognition in this country which it is already rapidly winning for itself abroad; nay, I will even venture to revive those dazzling but short-lived prophecies to which I referred at the beginning of this paper. I see, in the solid guarantees which this system affords us, the art of mural painting no longer a dream of Utopia, waiting for the labours of smoke abatement exhibitions to make room for its development, but an actual reality in English art. I see Westminster Palace glowing with the productions of the best masters of our day, productions which we should be proud to think of as carrying down to future generations the evidence of the genius of our times. I see London, and all our great centres of life, blossoming like a garden with artistic creations that serve to break the hideous monotony of nineteenth century streets. I see interiors decorated with scrupulous and cultivated taste, under a sense of having to select a style that will last as long as the walls themselves. I see Art, under these influences, taking its place as a mighty teacher, with a voice more potent and far-reaching than it ever could possess before, a voice that cries from the walls, the streets, the public buildings of our cities, that "those who run may read." I see Art opening in this way the door of history, of poetry, of nature, to those who else would lack instruction. I see the heroism of the past, the nobility of duty, the recognition of virtue, handed down to all ages to tell their living truths in language ineffaceable. I see these enduring appeals to the higher instincts of our being, lifting a nation above the grovelling cares of wealth, above the narrowing claims of selfish interests, above the petty jealousies of party strife. I see Art, by this means, developing patriotism, generosity, honour, and noble sacrifice of self. Above all, I see Art taking once more a place worthy of her powers as the handmaid of Religion, when our churches shall be no longer delivered over to the stunted mannerisms of mere decorative style, but when our greatest artists, encouraged by the thought that their work will prove enduring, will give their highest talents to teach the most sublime of lessons, seeing no worthier field than this, of usefulness and honour.

DISCUSSION.

The following letter from Mr. G. F. Watts, R.A., was received by Mr. Rivington:—

I am sorry that an engagement will prevent me from being present at your lecture. A method at once easy and durable might bring about the practice and re-create the habit of mural decoration, now fallen almost completely out of use, on account of the difficulty and uncertainty of known methods. The highest expression of painting, as an intellectual effort, belongs to designs composed with reference to architectural combinations, and I cannot but feel that when the habit of requiring and producing such works falls into absolute disuse, art must take the lower place of only a luxury.

G. F. WATTS.

Little Holland-house,
Feb. 11, 1884.

Professor CHURCH said there was so much in the paper that he could only touch upon the various subjects mentioned in a very rapid and possibly somewhat disconnected manner. Mr. Rivington seemed to have grasped the chemistry of a somewhat difficult process very accurately, and with considerable fulness of detail. With regard to his introductory remarks on frescoes, he would say that the climate of this country was not the only hostile agency against their preservation. The deterioration was in great measure caused by the sulphurous acid air produced by the combustion of gas which existed, not only inside buildings, but, unfortunately to a large extent, in the external air also, and which arose from the use of coal containing sulphur. It produced sulphate of lime and sulphate of magnesia, and caused not only the disintegration of the surface, but destruction of the stone itself, and the disappearance of the colour. With reference to the wax process, wax had long ago proved its feeble character as a binding material. Paraffin, however, which was positively unalterable by all influences, was an admirable substitute, and he felt sure painting with solid paraffin as a vehicle would, in some measure, take its place for internal, and, to some extent for external purposes. In calling this a new process, he thought an injustice was done to the memory of three men to whom the use of silicate of potash, silicate of soda, and alkaline silicate of soda, was really due. In the *Journal of the Society of Arts*, some quarter of a century ago, was published a process, with which they were all familiar, under the name of stereochromy, and nearly every feature claimed as a novelty in this process of Keim's, had been published and worked upon by numerous persons interested in the fine arts, for a great number of years.

Carbonate of ammonia, carbonate of potash, caustic potash, dolomite, or magnesian limestone, powdered marble, sifted marble, pumice and baryta water, but not infusorial earth, as far as he remembered, had all been employed, although not in the same systematic and perfect manner in which they were suggested in the process of Keim. It was, therefore, hardly right to call it a new process; it was the development, the perfectionment of a former process, and one which made a great step in advance, but not an original process. Having seen all the original papers, and having tried a few experiments himself, he thought the materials of the colours, although in some measure new, had been to some extent anticipated, not by Fuchs, but by Kuhlmann, who mixed water-glass with his colours, so that the action of this material in fixing might be anticipated, and so that you might not get so great a change in the fixing as occurred with some of the less suitable materials. He would not dwell on the use of hydro-fluo-silicic acid, but that the use of that material produced a certain degree of porosity had been long known, and had been actually patented here, in conjunction with another substance, for the preservation of stone; in this particular process it was no doubt a very desirable addition. With reference to the asbestos millboard, it was curious that his predecessor in the chair of Chemistry at the Royal Academy should have mentioned it to Mr. Rivington, for about sixteen months ago, he got a number of specimens of this material for stereochromy, and showed some at his last course of lectures at the Academy, in November and December last, with a few streaks of colour painted upon them. At present they had not got a millboard which was actually perfect in surface; the silky fibres were very useful to give a tooth for the ground, but they often lay in parallel masses, and interfered with the working of the colour. When they got a better millboard, he thought that it would, from its uninflammability and many other important properties, afford a splendid material, not only for this particular process but for oil painting. In this latter case, however, it was necessary to saturate it with a mixture of copal varnish and turpentine. The only other point he need mention was that he thought a little to much stress had been laid, not only by Mr. Rivington, but by the improver of the original stereochromic process, on the formation of silicate of lime. Countless experiments had been made on soluble silicates and carbonates of lime, and oxide of zinc even, and a large number of other substances which entered into composition when ground with the pigments, and the general result had been that you did not get silicate of lime, and silicate of magnesia, and silicate of baryta; but a double silicate of potash and lime, of potash and magnesia, or of potash and barium. It was not one silicate uniting with the carbonate to form carbonate of potash and silicate of lime, but the formation of an entirely new substance, consisting of two bases and one acid, the acid being silicic acid, and the bases lime and potash, or whatever other substance was employed. In conclusion, he must add that none of these remarks must be taken as in any way invalidating his opening words of commendation for the very clear exposition of the improvement of the imperfect, but still developable and useful, process originally called stereochromy, which depended on the use of soluble silicate of potash, without which neither process could exist. In both it was the essential element of fixation.

Mr. ARMSTRONG said that when, two years ago, he was at Nuremberg on the public service, he saw in the principal room of the Fine Art Exhibition a frieze of decoration and ornament which had so many charming artistic qualities, that he thought it would serve as a very useful encouragement to the students at South Kensington, and when he returned home he obtained leave to purchase a portion of it. He was sorry that a piece of it was not there that evening, but there were two pieces in the Architectural Court at South Kensington, one on the ground, and the other high up on the wall, in about the same position as the original occupied. He knew nothing at first of the process by which it was produced, but finding it was very interesting, he got permission to invite Herr Schraudolph, the artist, to come to England and illustrate his method before the students. He came over in May or June last, but, unfortunately, owing to various circumstances, the results of his visit were not so great as he had expected. Mr. Rivington had rendered great service by acting as an interpreter. The students saw the process at work, and did little bits of painting here and there, but there was no proper supervision. Herr Schraudolph also executed another piece of work somewhat similar to the one he had mentioned. Last autumn, being anxious to do something in the way of decorative painting—not on account of this particular method, but for other reasons—he selected two of the best students in the ordinary school competition, and set them to carry out a portion of his design on a large scale, one of which was now exhibited being in Keim's process, the other being in distemper. It was the first attempt of the student at this kind of thing, and was, he thought, a very creditable performance. He hoped they would have further opportunities of testing the process, and if there were any artists present who wished to practice a little in it, he should be very glad to afford them facilities for doing so. They had all the materials at South Kensington, and the pump for applying the fixing solution. He could not say much as to the process itself, or as to its permanence, until they had tried it longer. They had all heard of the person who being told that the raven lived a hundred years bought one to try, and they were somewhat in the same position as yet.

Mr. POWELL thought some mention ought to have been made of Professor Barff's process, described in that room in 1872, which consisted in the use of aluminate and silicate of potassium. Mr. Rivington had spoken of the necessity in preparing the ground for this process, to see that there was no damp; but in the majority of churches the walls were very damp, and this had been the cause of a great deal of trouble with regard to mural decoration. He should like to ask what would be the result if this process were applied to a damp wall, as it most likely would be very frequently, if it were adopted to any extent. They heard about silicate of lime and various other silicates, but it seemed to him very doubtful if these were really formed during the process. His own experience of silicates was that the majority of them required very great heat for their formation, and that those which did not were not generally very stable. Another question was whether there would be any danger of efflorescence after a series of years.

The Chairman said everyone who was engaged in building operations must have felt very strongly the want of some means of laying flat colours on wall surfaces in a permanent and durable manner. Great stress had been laid on the importance of properly preparing the ground before the colour was applied, and one of the greatest difficulties which builders had to encounter, was that the groundwork which existed in most London houses was of a remarkably defective character. In some neighbourhoods, built at a time when the so-called stucco was really of a most scandalous character in its formation and manner of application, it would be found that on scraping off the surface, a very rotten sub-structure was revealed; and it was obvious that if the larger proportion of London houses were covered in this way, this process could only be applicable after the complete removal of an enormous surface of bad work. Of late, however, builders who had been called upon by house-owners to replace this rotten surface had done so with a material which was, to a certain extent, hydraulic, and a chemical change had resulted which had perhaps rendered the groundwork suitable for the application of this method. If such were the case, it was quite within the range of hope that an owner might look forward to covering his house with a permanent surface of colour, either in one or several shades, the features of the architecture being tinted various shades according to fancy. In this way our gloomy and dreary streets might be enlivened to an extent and with a success far beyond anything at present achieved by the present method of applying oil colours. When ordinary colouring was applied to stuccoed walls, the result was often very disheartening. The colour was laid on with a mineral or vegetable vehicle, which for a short time resisted the influence of the weather; but in a little while, when you came to rub it, you found a velvety surface, and a large part of the colour came off. Take, for instance, the Wellington-barracks in Birdcage-walk: that building was coloured every seven years, at a cost of £400, but within the second or third year all the bright appearance disappeared, and for the remaining four it reverted to its original gloomy aspect. That was not a very satisfactory way of spending either private or public money, and if any process could be found which, once for all, would produce a colour which would be cheerful to the eyes of passers by, and which could be renovated simply by periodical washing, it would be an immense boon to our street architecture. Not being a chemist, he could not very well follow the reasons given for the indestructibility of the pigments, but there was one practical point apart from the artistic side of the question which all could appreciate, viz., what would be the probable cost, per yard super, of laying a flat colour by this process. Further than that, they would all be be glad to know that there was a plain, simple, specification ready for publication in trade journals, so that an ordinary painter and decorator would be able to apply the process to any building upon which he was engaged.

The Rev. J. Rivington, in reply, said he was very glad to find Professor Church present, as he had been trying for some time in vain to meet him, in order to obtain his services in testing the process. He regretted if he had, consciously or unconsciously, failed to do full justice to the former inventors of the stereochrome process; but he certainly had no wish, nor had Mr. Keim, to claim for the inventor any merit which was due to others; and he had certainly endeavoured to explain the former process and to show wherein it failed. His reason for calling this process new was, because it practically remodelled the system by improving upon every single detail. With regard to damp in walls making its appearance after a few years, when he was in Munich last year, a portion of the king's palace was being done, and some of the walls were being recoated with this process; Mr. Keim then showed him certain places where damp spots in the wall showed themselves. Even if it did not show itself when the wall was laid bare, the dampness would soon discolour the ground before the painting could be commenced, and the proper thing to do was to cut it out and replace the faulty stone. But Mr. Keim had means by which he could apply the process to an incurably damp wall, on which no one in his senses would think of putting a fresco; he did this by a system of glazed tiles. He had not gone into that himself, because it occurred to him that few persons would think of decorating an incurably damp wall. Mr. Keim also told him that he thought he saw his way soon to being able to modify the process, so that it would be entirely unaffected by dampness in the wall itself. What the Chairman had spoken of as so desirable, was exactly what could be done by this process. With regard to the cost of simple house-painting, it was reckoned at about 5s. per square metre; for decorative work, where a greater variety and perhaps more expensive colours were used, from 10s. to 20s., but that included the whole preparation from the bare bricks; everything in fact but the artist's work. With regard to a complete specification and price list, he should be very glad if one could be published, but at present it would be premature. He hoped someone would take the matter up commercially, and prepare the materials in England; at present they all had to be imported, which, of course, added considerably to the expense. If some commercial man could be found who had sufficient faith in the process to take it up, that difficulty would be got over.

The CHAIRMAN then moved a vote of thanks to Mr. Rivington, which was carried unanimously.

Mr. W. G. TREWBY writes:—"Respecting the paper on 'Mural Decoration,' I have always understood that the reason for the decay of the frescoes in the Houses of Parliament was not only the dampness of the surface, but also that the stone was constantly saturated by moisture from the River Thames." He adds that, "by the use of glazed tiles, arranged in the hexagonal form of the bee's cell, a perfectly waterproof back was obtained."

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings last recorded:—

TECHNICAL EDUCATION.

Wednesday, February 6th.—Present: Lord Reay, in the chair; Prof. W. Garnett; Mr. J. F. Moss; Mr. Gilbert Redgrave; Mr. H. Trueman Wood.

THE DWELLING HOUSE.—GROUP III.—SUB-COMMITTEE A.

Monday, February 11th.—Present: Capt. Douglas Galton, C.B., F.R.S., in the chair; Sir Frederick Abel, C.B., F.R.S.; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. Baldwin Latham; Mr. Shirley F. Murphy; Mr. E. C. Robins; Mr. H. Saxon Snell; Mr. H. T. Wood.

THE LIBRARY.

Monday, February 11th.—Present: Mr. Ernest Clarke; Dr. W. Ogle; Mr. J. L. Clifford-Smith; Mr. D. Williams; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III. SUB-COMMITTEE C.

Tuesday, February 12th.—Present: Prof. W. G. Adams, F.R.S.; Mr. Arthur T. Atchison; Mr. W. R. E. Coles; Capt. Douglas Galton, C.B., F.R.S.; Prof. T. Hayter Lewis; Mr. W. H. Preece, F.R.S.; Prof. Chandler Roberts, F.R.S.; Mr. C. E. Spagnoletti; Mr. Greville Williams, F.R.S.; Mr. H. T. Wood.

SCHOOL AND EDUCATION.

Tuesday, February 12th.—Present: Lord Reay; B. St. John Ackers; Alfred Bourne, B.A.; J. G. Fitch; J. H. Gladstone, Ph.D., F.R.S.; Rev. T. Graham; Arnold F. Graves; Major-General F. Hammersley; T. E. Heller; T. C. Horsfall; A. C. King, F.S.A.; Lieut.-Col. W. R. Lewis, R.A.; Phllip Magnus; R. J. Mann, M.D.; Inspector-General F. J. Mouat, M.D.; C. R. Robson, F.R.I.B.A., F.S.A.; Rev. T. W. Sharpe, W. H. Stone; W. Woodall, M.P.

Other meetings of the several Committees have been held at the Exhibition Buildings, South Kensington, for the purpose of considering the applications for space.

WATER SUPPLY AND SANITATION OF THE DWELLING HOUSE.—GROUP III. A.

This Committee deal with the following Classes of Group 3—21, 22, 23, and 27, the following being the official classifications:—

Class 21.—Water supply and purification—Meters, filters, water-fittings, cisterns.

Class 22.—House drains, their construction and ventilation — Sewer disconnection; sinks, traps, gullies; the disposal and utilisation of house refuse.

Class 23.—Water and earth closets, ash closets, commodes, urinals, disinfecting powders and fluids, insect destroyers.

Class 27.—Fire prevention apparatus—Extincteurs, portable engines, domestic fire escapes, &c.

With a view of bringing before the public examples not only of thoroughly good sanitary arrangements, but also of the defects existing in ordinary houses, the Committee have, with the sanction of the Executive Council, undertaken to supervise the erection of two model dwellings in the grounds of the Exhibition, one of which will show, as far as can be done on the limited scale, a house with good sanitary arrangements, while the other will show the usual defects. In the latter case, no attempt will be made to exaggrate the ordinary conditions; but the object will be to reproduce accurately a state of things unfortunately but too common.

In erecting and fitting these typical houses, the Committee will have to rely on the assistance of manufacturers; but they wish it most distinctly to be understood that while they must of necessity adopt, for purposes of illustration, fittings made by particular manufacturers, they do not in any case recommend these special fittings for adoption, or wish to give the idea that the special fittings adopted are superior to those produced by other makers. In many cases it is quite certain that there are several appliances, all equally good; but the space at the disposal of the Committee will not permit examples of all these appliances to be shown.

Besides these typical illustrations, the Committee will be glad to receive from manufacturers whatever examples they may think proper to submit for exhibition of the articles indicated by the classification. It is to be borne in mind that in all cases the exhibits must have a distinct bearing on health, and that architecture or building construction generally is outside the scope of the Exhibition.

The exigencies of space will not permit the Executive of the Exhibition to invite contributions illustrative of schemes for drainage, water supply, &c., applicable to towns or large districts, and it is therefore to be understood that the exhibits must be confined to domestic sanitation alone.

The classification sufficiently indicates the class of objects desired for exhibition. The Committee would impress upon exhibitors the desirability of, as far as possible, exhibiting their own manufactures only, not those of other makers; and also of restricting their exhibits to typical examples of their appliances, and of not sending more than a single example of each article. Indeed, the Committee cannot undertake to find space for things which are substantially duplicates of one another.

As the Exhibition will be a place of popular resort, and is intended for the instruction of the general public rather than specialists, it will be desirable that exhibitors of sanitary wares should assist the Committee in making such arrangements as will bring the articles which it is necessary to show before the notice of the public in a manner as agreeable as possible. It will of course be necessary to show examples of closets, urinals, &c., but these should be so arranged that while it may be possible for anybody desiring to inspect their action to have full opportunity of doing so, they yet will not attract general attention in an undesirable manner.

Construction and Fittings of the Dwelling House.—Group III. B.

The portion of Group 3, the Dwelling, with which this Committee deal, is that comprised within Classes 20, 28, 29, 30, and 31. The following are the official classifications:—

Class 20.—Dwellings, models, and designs for the same, and specimens of buildings erected in the grounds. Fittings and accessories for dwelling-houses. Completely fitted apartments.

Class 28.—Materials for sanitary house construction—Roofs, walls, damp courses, solid floors, damp proof wall coverings, cements, &c.

Class 29.—Materials for sanitary house decoration, non-poisonous paints and papers, floor coverings, washable decoration, &c.

Class 30.—Objects for international decoration and use in the dwelling. Fittings and furniture.

Class 31.—Baths, bathing requisites, public and private wash-houses, washing apparatus, detergents, appliances for personal cleanliness, &c.

It should be distinctly understood, with regard to all the above classes, that only such exhibits as have a distinct bearing on health can be admitted. Specimens, therefore, illustrating building construction generally, the decoration of houses, or their furniture, cannot be admitted unless they are shown to have actual reference to the health of the inmates of the houses.

This Committee is co-operating with the Committee on Water Supply and Sanitation, in superintending the erection of two model dwellings in the Exhibition grounds, the one showing good, and the other showing defective sanitary arrangements. Further particulars about these model dwellings will be found in the Memorandum issued by the Sub-Committee above referred to.

It is desired that exhibitors should show, as far as possible, their own manufactures only, and not those of other makers, and they should restrict their exhibits to typical examples of their appliances, not sending more than a single example of each article.

In Class 20, it is desired to show not only models and designs for sanitary houses, but also, as far as possible, specimens showing their construction. It is desirable that those exhibitors who are prepared to erect specimens of actual buildings should, as far as possible, co-operate with other exhibitors who may be desirous of showing fittings or furniture for such buildings. The Executive Council will endeavour to facilitate such arrangements, but it will be desirable that the exhibitors should agree between themselves as to the manner in which such collective exhibits may be arranged.

The classification in Class 28 sufficiently indicates the objects it is desirable to show.

Under Class 29 may be included, in order to draw attention to existing defects, specimens of insanitary decoration, such as arsenical wall papers, hangings, &c., so that the public may be taught what to avoid. Special interest would attach to any evidence of equally good effects being obtained by the use of harmless materials, and in many cases it may be desirable to show, side by side for purposes of comparison, papers, fabrics, &c., treated with poisonous colouring matters, and also with colouring matters of a harmless character.

With regard to Class 30, it may be noted that specimens of furniture would be readily received which can be shown to have any connection with health.

The original arrangement of Class 31 has been somewhat altered. Matters relating to the care of the sick and wounded in war, or of those injured by accident at any time, have been taken out of this class, and a special group has been formed to which they have been referred, namely, Group IIIa. Ambulance. The Class has also been somewhat enlarged in another direction, so that it includes all appliances for personal cleanliness, public and private baths, &c. It is hoped that a full display of these may be forthcoming. The Executive Council have had under consideration the question of fitting up baths for actual use in the Exhibition, as was done in the Berlin Exhibition, but it has been decided that it would be sufficient to show baths completely fitted, without putting them into action.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the third course of Cantor Lectures was delivered by Mr. Robert W. Edis, F.S.A., on Monday the 18th inst., the subject being the "Building of London Houses." The lecturer dealt with the arrangements, the aspect, design, and general planning of the houses. The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society

INDIAN SECTION.

Friday, February 15, 1884; Sir James Caird, K.C.B., in the chair.

The paper read was—

THE STATE MONOPOLY OF RAILWAYS IN INDIA.

By J. M. Maclean.

I propose in this paper to examine the results of the policy pursued by the Government of India, in reserving to itself a right of property, in Indian railways, and the lion's share of authority in their management. Such an inquiry, if impartially conducted, ought to be of general interest at the present moment, when we seem to have gone back to the discussion of first principles, as regards the limits that should be assigned to the respective fields of action of private enterprise and State interference. Owing, no doubt, to the reduction which has taken place of late years in the profits of trade, producers and merchants are now obliged to scrutinise very closely indeed the cost of carriage of their goods to market, and both in England and in India the trading community has come to the conclusion that the railway rates for goods traffic are in many instances excessive, and not to be endured. But by a strange, and yet perhaps natural, contrast, while the cause of complaint is the same in the two countries, the remedies suggested are quite different. In England, on the one hand, where the doctrine of *laissez faire* has hitherto been applied with unbounded faith, and, as it seemed, with conspicuous success in the construction and administration of railways, a strong demand has now sprung up, at all events in some quarters, for the intervention of the State, to compel boards of directors to give to the public those benefits which had been vainly expected from the free competition of rival lines. From India, on the other hand, every mail brings vehement denunciations of the evils that have arisen out of the absence of competition, and urgent appeals that private capitalists may be allowed to step in, and take the place of the Government in supplying such an extension of the railway system as will provide adequate and cheap facilities of communication between the agricultural districts and the seaports. Parliament will probably be asked, in the present Session, to sanction, at one and the same time, an extension of the powers of Railway Commissioners in England, and a relaxation of the restrictions by means of which the Government of India has, till now, kept so tight a hand on the Indian railways. In these circumstances, a political philosopher might console himself with the reflection that there must be a good deal to be said on both sides of the controversy between *laissez faire* and State control. Still, it is well to look into the merits of the case on either side; and I trust that I may do useful service by trying to show both the advantages and the defects of the Indian railway policy. I should warn you beforehand, however, that I cannot pretend to speak with any technical knowledge of the working of railways, although for many years, while resident in Bombay, I took an active part in advocating the construction of new lines, and the modification of the railway tariff to suit the requirements of Indian commerce.

Monopolies have always struck root and flourished in the soil of India. Under the rule of its native princes, the crushing pressure of arbitrary power, exercised either in the form of the creation of distinct imperial monopolies, or in that of vexatious tolls and transit duties collected on all the roads and navigable rivers, was felt in every branch of industry and commerce. The East India Company inherited this fiscal system from the native governments, and did nothing to amend it. Indeed, a fellow feeling must have made the Company, itself the greatest of trading monopolies, be very kindly disposed towards financial advisers who recommended it to raise revenue after the manner of its native predecessors. We are apt to forget that it is only fifty years since the Company was forced to open the trade of the East to private adventurers, and to permit Europeans to hold land in India. Up to the year 1833, the commercial resources of both India and China had been strictly preserved for the exclusive profit of the proprietors of East India stock. A great change has occurred since those days. India is now emphatically a free trade country, free not only through the almost complete removal of duties on its international commerce, but through the abolition of that inland customs line described by Sir John Strachey, who had the honour of destroying it, as "a monstrous system to which it would be almost impossible to find a parallel in any civilised country." This line extended, even after some reduction had been made in it, a distance of more than 1,500 miles, and was guarded by some 8,000 men. If put down in Europe, it would have stretched from London to Constantinople. Along the greater part of its extent it consisted of a huge material barrier, which Mr. Grant Duff, speaking from personal observation, said "could be compared to nothing else in the world except the great wall of China; it consisted principally of an immense impenetrable hedge of thorny trees and bushes, supplemented by stone walls and ditches, across which no human being, or beast of burden, or vehicle could pass without being subjected to detention and search." But, although this abominable obstruction to inland trade has, to the credit of the Government of India, been done away with, the revenue of the State still depends chiefly on three great monopolies, those of the land, of salt, and of opium. I must not be misunderstood as wishing to find fault with these modes of raising money for the service of the State. The incidence of the land-tax is in some districts and seasons oppressive, but still the monopolies in question are equitable in character, and less unpopular than other forms of taxation would be with the natives of India. I only refer to them as illustrations of the much wider scope given to the functions of Government in India than in the countries of the West. Englishmen have not yet discarded their old conviction that the State should not attempt anything which can be equally well done by private individuals; while the Government of India, not content with looking after such matters of business as the working of the Post-office and the Telegraphs, is at once the greatest landlord, and the sole manufacturer of salt and producer of opium, in its wide dominions.

It is not surprising, then, that railways also should, from their first introduction into India, have been included in the list of Government monopolies. No doubt it will be said that this is an inaccurate description of the true state of the case, since most of the railways in India have been constructed by joint-stock companies. Thus, out of the total length of 12,655 miles open on March 31, 1883, the Government had built only 5,037 miles, including 597 miles in native States; and for the balance of 7,618 miles, India was indebted to guaranteed and assisted companies. But the very epithets, "guaranteed" and "assisted," imply the subjection of the private enterprise engaged in these undertakings to the supreme control of the State which gives the guarantee, or lends the assistance. Lord Dalhousie—who in framing, thirty-one years ago, a comprehensive plan of arterial railways for India, displayed a far-reaching grasp of mind worthy of the Governor-General whom Anglo-Indians love to speak of as the "Great Proconsul"—held that it was no part of the business of the Government "to conduct an enterprise which is undertaken mainly for commercial purposes, and which private parties are willing to engage for." In his famous railway minute of 1853 he deplored the lack of private enterprise in India. "One of the greatest drawbacks," he said, "to the advance of this country in material prosperity, has been the total dependence upon the Government in which the community has placed itself, and its apparent utter helplessness to do anything for itself." Hence, he maintained that it was the duty and the interest of the State to encourage the investment of "English capital and English energy" in India, by entrusting the work of supplying her with railways to the associations formed for that purpose. But, at the same time, he considered that the best system for the country would be "a union of private enterprise with State control." Lord Dalhousie had, as Vice-President of the Board of Trade in Sir Robert Peel's administration, been at the head of the Railway Department in England during the railway mania of

1845-46, and, while holding that office, he strenuously endeavoured, until overruled by the House of Commons, to preserve to the State a regulating power over the host of competing schemes that then sprang into existence. Fortified by the experience gained, in the interval between that time and the year 1853, of the evils of unlimited competition in this country, he determined to avoid a repetition of them in India, where at least he could have his own way. To quote his own words:—"The enlistment of private enterprise for the formation of these great works, directly, but not vexatiously, controlled by the Government of the country, acting for the interests of the public, was a principle for which I contended several years ago, when closely connected with that branch of public works. I may venture without arrogance to say that, if that principle had been then more fully recognised, the proprietors of railway property in England, and the suffering public, would have been in a better condition now than they appear to be."

State control, then, vigilant but not vexatious, was the essence of the system to which Lord Dalhousie gave the sanction of his name. The success of the system has been, in many respects, remarkable. It is a great thing, in the first place, to be able to say that the railway capital raised for investment in India has been spent honestly. The check applied by the Government has made jobbery and corruption all but impossible, and India has happily escaped the fate, reserved for so many other eastern countries, of becoming the prey of all the greedy speculators of Europe, eager to develop her resources at a profit to themselves of 50 to 100 per cent. on the nominal capital of their philanthropic projects. No doubt the cost of the guaranteed lines has been heavy, amounting on the average to £16,000 a-mile; but it must be remembered that the English engineers who built these railways had to buy their experience in a land where they were complete strangers, and where the physical obstacles they had to contend against were quite unfamiliar. They had to carry the iron road up lofty ranges of mountains, through pathless jungles, and across water-courses which, almost dry for the greater portion of the year, are swollen into rivers of mighty volume and force during the rainy season. The organisation of native labour, too, on which they had mainly to depend, was necessarily a tedious and expensive process. Then India could produce neither rails, machinery, nor carriages, and every single article of railway material had to be conveyed from England to Bombay or Calcutta, at a time when ocean freights were five or six times as heavy as they now are. When we think of the difficulties they had to overcome, we must acknowledge that the pioneers of railway enterprise in India, many of whom fell victims to their own zeal in labouring steadily on through the unhealthiest seasons, did their work economically as well as efficiently, and some portion of this credit may fairly be assigned to the strict supervision exercised by the Government. The expense of constructing the subsidised lines was increased in another way, by the adoption of a special railway gauge for India, that which is now known as the standard, or 5 feet 6 inches gauge. Lord Dalhousie was determined that India should not be annoyed with that battle of the gauges which had caused so many heartburnings, and wasted so much money in England; and, as all his resolutions were framed in an imperial mould—it might be said of him that "he nothing common did or mean, upon that memorable scene"—he would not take as the uniform gauge for India the narrow 4 feet 8½ inch gauge, which has now been found good enough for all the railways in this country. It was his ambition to build these new roads on a grand scale, and as solidly as the Romans built theirs; and travellers in India must always feel grateful to him for the comfort which this decision has secured to them. There is no better railway travelling to be had anywhere in the world, as I am sure our chairman (Sir James Caird) will admit, than that which is afforded by the guaranteed lines in India. The rolling stock is excellent in quality, although, as is said of the British infantry, there is sometimes not enough of it. The track is thoroughly well laid, and the width of the gauge allows a high rate of speed to be maintained without inconvenience to the passengers. But it must be confessed that a great saving of expenditure might have been effected if the gauge and the patterns of rolling stock had been the same as used in England.

The feeling that slighter and less costly works might have sufficed for a poor country like India was one of the motives that induced Lord Lawrence's Government,* in 1870, to

* Lord Mayo had succeeded Lord Lawrence as Viceroy when the first practical step was taken to give effect to this change of policy; but for the decision to make the change Lord Lawrence's Government must be held responsible. The minute recording this fatal decision was, says Sir John Strachey, "drafted by General Strachey, and accepted by Lord Lawrence without reservation."

resolve upon taking the extension of the Indian railway system into its own hands. The guaranteed lines, at that time, were far from paying their way; and the Government, alarmed at having to make good the yearly deficits, yielded to the plausible suggestion that cheap railways might be constructed, which would serve all the purposes of goods and passenger traffic, and be worked from the outset at a profit to the State. The decision was a most unfortunate one. The weakness of the Government of India is that it consists merely of able officials who have no practical knowledge of mercantile business. Had there been in Lord Lawrence's Council but one representative of the trading class, to support the protests of the military authorities against the introduction of break of gauge on Indian railways, the monstrous error could never have been committed of destroying one of the best features of Lord Dalhousie's scheme. It may safely be stated, as an axiom of railway construction, that the difference in cost of a narrow as compared with a broad guage is as nothing in comparison with the waste of time and money caused by break of gauge on a main line. Yet several Viceroys of India in succession, Lord Lawrence, Lord Mayo, Lord Northbrook, and Lord Lytton, have concurred in permitting General Strachey and his brother, Sir John, to spoil the usefulness of the railway from Bombay to Delhi and Agra, by insisting that this line, which has a 5 ft. 6 in. gauge as far as Ahmedabad, shall only have a 3 ft. 3·3 in. gauge for the rest of the distance. It is difficult to understand why this latter gauge was selected, unless its ingenious patrons conceived the brilliant idea that they would go as far below the ordinary English gauge as Lord Dalhousie had gone above it, and thus, between the two, make a fair average. Now that the mischief is done, there is one universal outcry in India against the metre gauge. No one has a good word to say for it, and the latest joke against it is that in Rajputana, lately, three different trains were required, on three successive days, to move a squadron of cavalry a distance of 240 miles. It would be true economy for the Government of India, even now, to take up the rails from Ahmedabad to Delhi and Agra, and reconstruct the line on the standard gauge. There has been some talk of repeating the blunder of break of gauge on the line from Nagpore to Calcutta, which will shorten by more than 123 miles the distance between the latter city and Bombay; but, as Sir John Strachey, since his retirement from the Indian Civil Service, has come forward as chairman of a company formed to lay down broad gauge lines in the poor native State of Hyderabad, where there is no through traffic, and where cheap railways would have sufficed for the local traffic, it may perhaps be assumed that General Strachey also will no longer raise his voice in the Council of India in defence of the metre gauge.

So much with regard to the construction of Indian railways under the supervision of the State. With the best of motives grave faults have been committed, faults which are absolutely inexcusable, for at a very early period in the history of English railways, Parliament, at the instance of Mr. Cobden, asserted the supreme importance of uniformity of gauge; and, had the autocratic Government of India deigned to take warning by the experience of the greatest of commercial nations, it might now have been in possession of a system of railways of unequalled excellence. But now let us consider what has been done with the railways since they were built. Has the management of this monopoly been of such a kind as to encourage a belief in the gain to be derived from the collective action of the State?

Colonel Stanton, the Director-General of Indian Railways, in his report for the year 1882-83, complacently remarks that "the net receipts for the year were sufficient to yield a dividend of 5·37 on the capital expended on the lines open for traffic." This is a very plausible way of stating the case; and the few members of the House of Commons who dutifully remain to listen to the annual discourse on Indian finance, at the end of the Parliamentary Session, feel quite re-assured as to the results of railway enterprise in India, when they are told on official authority that the net yield exceeds the guaranteed dividend, and is nearly one per cent. larger than the average return on the capital invested in the railways of the United Kingdom. But, when we come to look into this matter more closely, how do we find that the average is made up? Colonel Stanton gives figures to show that, in the year 1882, the East Indian Railway, originally a guaranteed line, but taken over in 1879 by the State, paid 8·56 per cent., and the guaranteed lines 4·94 per cent., while the State lines only earned a revenue of 3·03 per cent. But these figures include the share of the surplus profits on several of the guaranteed lines which was distributed among the shareholders, in addition to the regular interest of 5 per cent. By an arrangement which does not work very fairly for the State, the Government of India is bound by its contracts with the guaranteed companies to secure to the shareholders a payment of 2½ per cent. in each half year. If the net earnings of any line fall below this rate in a particular half year, the Government has to make good the deficit; if, on the other hand, the net earnings exceed the guaranteed rate of interest, the excess is equally divided between the Government and the shareholders. Now, in Western India, the traffic is not spread equally over the whole year. The first six months form the busy season, in which the bulk of the agricultural produce is moved down to the seaport of Bombay. The Bombay railways, therefore, earn in the first six months of the year surplus profits amounting to hundreds of thousands of pounds, of which the Government gets one-half, while in the second six months the net earnings may not suffice to pay the guaranteed dividend, and then the Government bears the whole burden of the loss. Thus, for example, in the year 1882, the Great Indian Peninsula Railway earned £7 11s. 10d. on the share capital; and yet, in the second half of that year, the earnings were only at the rate of £4 5s. 1d. per cent. per annum; so that the Government lost in one half-year a considerable proportion of what it had gained in the other. Thus we have the anomaly that the State may be a loser, even when a guaranteed line yields to the shareholders a return exceeding the stipulated 5 per cent. interest. In fact, during the financial year 1882-83, the net traffic receipts of the guaranteed lines, after deducting the moieties of surplus profits paid to the companies, only amounted to £3,054,500, while the guaranteed interest came to £3,301,180, so that the net loss on these lines to the State for the year was £231,380. In the same year the loss on the State lines was £176,186; and it was only the large gain of £891,150 on the working of the East Indian Railway which compensated for these deficiencies, and left the State a gainer on the whole of £483,584.

But the custom, which Indian financiers find so convenient when they are preparing their annual budgets, of regarding the Indian railways as one great property, and thinking all is well provided they can show a net surplus, leads to results which are by no means advantageous or just to the trade of the country. The inherent weakness of the State monopoly becomes apparent when we find that this system tempts the Government to cover deficits on unprofitable lines by making illegitimate gains out of excessive rates charged on the traffic of productive lines. To illustrate my meaning, let me point out that there are only four of the broad gauge railways, the East Indian, the Eastern Bengal, the Great Indian Peninsula, and the Bombay and Baroda, which have earned surplus profits. None of the others have yet come even within a measurable distance of paying their way, and those of them which have been built of late years by the State, viz., the Punjab Northern and the Indus Valley and Kandahar, are unlikely for many a year to come to yield a fair return on capital. The metre gauge lines, having been constructed much more cheaply, ought to show more uniformly good results; but here, again, the profitable working of the Rajputana, the Northern Bengal, and the Rangoon lines compensates for the shortcomings of the rest. (See Table, p. 266.)

These inequalities naturally suggest a suspicion that what may be called the commercial lines are forced to bear not only their own expenses, but also a large proportion of the cost of working the lines constructed mainly for political and military purposes. This mode of converting the Indian railways into a directly profitable pecuniary speculation for the State cannot but be unfair and injurious to the commerce and industry of India. Each railway ought to be treated as a separate undertaking. The East Indian and the Great Indian Peninsula should no more be required to yield a constantly increasing revenue, in order to make good the losses on the Punjab Northern and the Indus Valley lines, than the North-Western in this country should be expected to supply any deficiency in the returns of railways in Sutherlandshire or Galway. India is, first of all, a military empire, and a number of railways, which commercial men would have fought shy of, have necessarily been laid down to facilitate the transport of troops and warlike material within the country, and the strategical operations required for the defence of the inland frontier. Lord Dalhousie had the courage to foresee that perhaps none of the railways, the construction of which he recommended, might prove clearly remunerative; but for all that, he urged, the Government ought not to shrink from making them. Even, he said, "if the Honourable East India Company should be called upon to make good yearly a considerable portion of the interest it has guaranteed, the direct advantage it will derive from railways, in the reduction of military force which they will render

Statement showing the Net Earnings and their Percentage on the Capital Expenditure finally charged off (excluding Suspense Accounts) for the Principal Railways during the last Five Years, 1878—1882.

(*From Colonel Stanton's Annual Report.*)

Railway.	1882.		1881.		1880.		1879.		1878.	
	Net Earnings.	Percentage of Net Earnings per annum on Capital Expenditure.	Net Earnings.	Percentage of Net Earnings per annum on Capital Expenditure.	Net Earnings.	Percentage of Net Earnings per annum on Capital Expenditure.	Net Earnings.	Percentage of Net Earnings per annum on Capital Expenditure.	Net Earnings.	Percentage of Net Earnings per annum on Capital Expenditure.
Broad Gauge.	Rs.		Rs.		Rs.		Rs.		Rs.	
East Indian	2,97,12,511	8·80	3,09,48,310	9·30	2,87,54,418	8·70	2,90,80,929	8·83	2,55,81,189	7·86
Guaranteed—										
Madras	25,70,841	2·30	20,75,856	1·87	19,57,136	1·77	20,75,170	1·88	15,87,980	1·44
Great Indian Peninsula	1,83,89,856	7·29	1,62,19,488	6·46	1,11,05,551	4·44	1,01,90,601	4·10	1,44,91,248	5·88
Bombay, Baroda, and Central India	50,10,872	5·91	57,45,702	6·86	47,34,653	5·77	37,92,898	4·61	36,87,126	4·52
Eastern Bengal	36,38,438	10·52	33,69,281	9·72	27,24,310	7·88	24,33,530	7·10	26,15,072	7·73
Sind, Punjab, and Delhi	34,10,880	2·94	30,76,660	2·65	54,70,862	4·75	45,40,520	3·99	31,70,091	2·86
Oudh and Rohilkhand	18,01,371	3·07	19,75,698	3·28	19,04,410	3·28	18,19,936	3·24	21,15,469	3·83
Imperial State—										
Punjab Northern	5,09,018	0·83	3,59,598	0·58	5,64,171	1·40	3,78,889	1·54	5,810	0·03
IndusValleyandKandahar	15,76,113	2·03	11,77,288	1·58	19,22,399	2·77	6,17,459	1·08	—1,34,441	—0·26
Provincial State—										
Patna-Gya	2,15,705	5·68	1,79,145	5·11	2,11,256	6·56	1,01,787	3·58	—	—
Native States—										
Nizam's	3,75,099	3·08	2,92,775	2·40	2,24,309	1·86	89,925	0·77	1,11,846	0·98
Metre Gauge.										
Guaranteed—										
South Indian	14,02,329	3·26	12,37,726	2·89	9,30,018	2·23	10,63,252	2·60	10,78,107	2·74
Imperial State—										
Rajputana-Malwa: Rajputana	51,29,252	5·87	28,67,041	5·51	12,33,305	3·62	11,79,167	3·81	11,30,471	3·99
Rajputana-Malwa: Holkar & Sindia										
Rajputana-Malwa: Neemuch			6,02,299	1·90	3,53,991	1·40	2,91,828	1·46	3,01,917	1·54
Provincial State—										
Northern Bengal	10,93,553	5·33	8,99,316	4·41	6,43,509	3·20	1,25,120	0.66	2,41,806	1·43
Tirhoot	2,54,047	3·91	2,36,200	3·70	2,40,272	4·49	1,07,818	2·10	1,08,808	2·17
Cawnpore-Farukhabad	1,17,110	3·74	84,231	2.70	—	—	—	—	—	—
Nagpur and Chhattisgarh	1,89,171	2·15	66,056	0·95	21,272	0·70	—	—	—	—
Rangoon and Irrawaddy Valley	6,30,431	4·97	6·45,077	5·16	5,21,084	4·23	1,41,743	1·19	67,157	0·60
Native States—										
Bhavnagar-Gondal	3,54,647	3·99	2,05,254	3·05	—	—	—	—	—	—

practicable, and the many other direct and indirect benefits which will accrue to it politically, commercially, and socially, from their existence, will render the payment of guaranteed interest a burden which the Honourable Company may cheerfully and contentedly bear; more especially when it calls to mind the peculiar relation "—that is to say, no doubt, the relation of a landlord to his tenants—"in which it stands to the people over whom it has been set to rule." It is unnecessary to remark that the indirect advantages the Indian Government has derived from railways have more than borne out these sanguine anticipations. This is now confessed on all hands. It is, then, a matter for profound regret that that Government has, nevertheless, taken a purely mercenary view of its connection with the railway system, and chosen to make the passengers and carriers of goods on the East Indian, the Great Indian Peninsula, and the Bombay and Baroda lines, pay for the unremunerative character of the traffic on military and administrative lines, the loss on which ought to fall upon the general taxpayer, in whose interest they were undertaken. With regard to the East India Railway, which has, for a good many years now, paid from 8 to 10 per cent., Sir John Strachey estimates that its purchase by the Government will, at the end of seventy years, bring in to the State a clear income of £2,500,000 sterling, and probably much more. This, of course, is on the supposition that its sole command of the Ganges Valley traffic will never be interfered with, and that its present tariff can be maintained. Nor, perhaps, is there wanting a special reason why the Government should consider itself entitled to make money out of this line, which runs through the districts where the State has deprived itself, by the permanent settlement, of its share in that increase of agricultural wealth which springs from improved communications. But this excuse does not apply in the case of the railways running from Bombay into the interior, which help to bring waste lands into cultivation, and to raise the rent of land already cultivated, throughout vast tracts of country where the State has not parted with the ownership of the soil.

Yet the rates for the carriage of merchandise on these lines are so high, that the Bombay Chamber of Commerce is engaged for the greater part of every year in a constant warfare with the Government and the Railway Companies, to secure a reduction in them. The Rajputana line, which is an extension under State management of the Bombay and Baroda, brought in a revenue of 5·87, in 1882, on capital borrowed by the Government at 4 per cent. In the same year the Bombay and Baroda itself paid the Government 5·91, or an excess of nearly 1 per cent. above the guaranteed interest. The Great Indian Peninsula yielded 7·29, or the full amount of the guaranteed interest, with a bonus of 2·29 per cent. These figures, too, as I have shown, do not represent the whole income of the guaranteed lines, as the shareholders in the Companies make a considerably larger per-centage of profit. Thus, in the first half of 1883, the Great Indian Peninsula paid to its proprietors £3 17s. 4d. per cent., and to the State £1 7s. 4d., the total net earnings thus amounting to £5 4s. 8d., or at the rate of very nearly 11 per cent. per annum. What great English railway is there whose shareholders would not rub their hands with joy at the prospect of receiving such a dividend?

But what makes the position of the Indian shareholders so much the more enviable is, that they are absolutely guaranteed against any risk of loss on their investments. A high rate of dividend one year is not counterbalanced by a low rate in the next. Whatever happens, the investor in Indian railways can never get less than 5 per cent. for his money, this being the rate secured to him by a Government whose credit stands as high as that of any of the Continental Powers of Europe. Now where, except in India, is it possible for a capitalist in these days to get an absolutely certain 5 per cent. for his money, with a fair chance of receiving, in addition, a bonus that doubles the interest?

Is it right that the Government of India should help its fellow-shareholders in the guaranteed lines to make these extravagant profits? Ought it to enable them to combine two things so rarely found in union with one another as excellent security and a very high rate of interest? It is idle to say that the charges on these lines are already very low. Even if that were the case, we all know that India is an exceedingly poor country, and that rates which, judged by our English standard, might seem reasonable enough, may be oppressive where the labourer's wages are only sixpence a day, and where the native merchandise carried by the railways consists almost entirely of bulky and cheap agricultural produce. Experience has recently shown, on the East Indian Railway, that a reduction in the fare for third-class passengers from 3 to $2\frac{1}{2}$ pies (*i.e.*, from $\frac{3}{8}$d. to $\frac{5}{16}$d.) a mile has caused an increase in one year of a million third-class passengers. Similarly, on the Bombay and Baroda Railway, a slight reduction in the rate for wheat had the remarkable effect last year of quadrupling the quantity carried on that line. We may reasonably, then, accept it as a maxim that low rates in India are invariably followed by increase of traffic.

But really low rates for goods traffic in India are out of the question, so long as the Government counts upon the large profits derived from this source to maintain the equilibrium of its finances. The Bombay Chamber of Commerce, in a letter commenting upon a most valuable pamphlet, "Indian Wheat *versus* American Protection," published at Calcutta last year, concurs with the writer of that pamphlet in the opinion that "Government should consistently reserve to itself the right of fixing absolutely the rates on all lines for the carriage of staple goods." But the Government practically possesses this power already; what is required, is the willingness to exercise it. In the contracts with the guaranteed companies, the right is reserved to the State of fixing the maxima of all rates and fares. Yet, after formally and ostentatiously declaring that its policy was to keep railway rates at a minimum, in order to encourage the development of the export trade in wheat, the Government "fixed as the maximum rate for food grain 12 pies (1½d.) per ton per mile, which," the Bombay Chamber of Commerce, in its letter of July 9, 1883, says, "is nearly double the general rates charged by the Great Indian Peninsula Railway, high as those rates are in comparison with those adopted on other routes. The Chamber, in September, 1881, protested against this maximum rate as being unnecessarily and excessively high, and represented that it should be reduced; but the Government of Bombay declined to interfere with the discretionary power vested in the Board of Directors, with the approval of the Government of India and the Secretary of State." This is an admirable example of the illusory nature of the check supposed to be applied by the action of the State to the money-making instincts of the ordinary shareholders in the railway companies. Whenever the commercial community has any complaints to make regarding the management of the railways, the companies' agents in India, the local Governments, the Government of India, the Boards of Directors in London, and the Secretary of State, straightway begin to play an elaborate and interminable game of battledore and shuttlecock with the public interests. Any suggestion that is offered is minuted upon, referred, transferred, and generally knocked about, till the authors of it are ready to abandon it in despair. The truth is, the State, which ought to be an independent judge in disputes between the railway companies and the public, is itself an interested party in such cases. When called upon to interfere, it is always, perhaps unconsciously, influenced by the thought that, if it sanctions increase of expenditure or reduction of rates, it may diminish its share of surplus profits.

Hence the unwise parsimony which leaves main lines insufficiently supplied with rolling stock to meet any sudden expansion of traffic. The American Civil War began, lasted over four years, and was brought to a close, long before the Great Indian Peninsula Railway had obtained an adequate number of engines and waggons to carry down to Bombay the cotton which choked all its stations. In like manner, since the export trade in Indian wheat began to assume large dimensions, merchants have been crying out in vain to the directors of the same railway to put more engines on the line, so that it might not remain blocked with bags of wheat. The directors gravely reply that they have been trying since 1881 to induce the Government to let them have more engines made; and at the half-yearly meeting in December, 1883, the chairman said, with a simplicity which is really laughable, that he was "happy to be able to state that the Government of India has, during the present year, sanctioned an addition of 100 engines to the stock of the company." These engines may be placed on the line in India perhaps by the end of 1885, so that it will have taken the most important commercial railway in India five years to procure the additional rolling stock declared by the directors to be absolutely necessary for the proper working of the line. The reluctance of the Government to sanction the application for more engines may easily be understood, when the chairman of the company tells us that "their cost, and that of shedding, workshops, and so forth, will require fully half a million of capital." It is this expenditure of fresh capital, which means a reduction of profits, that the Government grudges. Take, as another instance of this miserliness, the delay in making new sidings, or doubling the line, in the grain-producing districts. When the charge is urged that the railway is checking the development of the trade by its high rates, the ready answer is offered that this cannot be the case, as more grain is brought to the stations than can be conveyed to the coast. Of course, the true explanation of this state of things is that the single line is no longer equal to the increasing strain of the traffic, and that the Government and the railway company, secure in their monopoly, refuse to lay out any more capital.

Now there has been a good deal of discussion lately as to whether the rates of freight for grain and seeds in India can be reduced with advantage. The author of the Calcutta pamphlet estimates that, "taking the average distance from the seaboard of the principal centres of the wheat trade in India, Indian wheat is, through the indifference shown to the whole subject, unnecessarily weighted in the competition with America to the extent of more than 3s. a quarter." He also fixes upon the Government the direct responsibility for this unfair handicapping of the Indian wheat trade, by showing that the State is bound down in its recent contract with the Southern Mahratta Railway "to sanction a rate of 1·05 shillings per quarter each 100 miles, or double the American rate; and in the contract with the Eastern Bengal Railway a rate of 1·47, or actually more than three times the present American rates." The directors of the Great Indian Peninsula

Railway have made a desperate but vain attempt to prove that their rates are reasonable enough, as they allow wheat from Jubbulpore (616 miles from Bombay) to be laid down in London at 38s. 9d. a quarter. But the Bombay Chamber of Commerce has exposed the inaccuracy of this estimate, by pointing out that it does not include a number of mercantile charges which swell the total cost to 44s. 10·61d. in London.* The market price for Indian wheat in the London market has recently fallen as low as 32s. 6d.; but we may assume that this is an exceptional rate, and that an average rate of 44s. to 45s. may be counted upon. But Mr. Finlay Dun, in his book on "American Farming and Food," calculates than American wheat can be sold in Great Britain, with profit to growers, railway carriers, shippers, aud all concerned, at the moderate cost of 42s. per quarter, or 3s. a quarter below the present minimum cost of Indian wheat. India cannot, therefore, compete profitably with America till the cost price in London of Indian wheat is considerably reduced. How can this reduction be effected? The grower of Indian wheat does not make a very large margin of profit. The Chief Commissioner of the Central Provinces says that the cost of growing a quarter of wheat comes to 11s. 8d. The cost of cartage to the nearest railway station is about 3s.; so that, as the average price per quarter in the Jubbulpore railway market is 20s., the margin of profit left to the farmer is only 5s. 4d. a quarter, which, as the Chief Commissioner remarks, "does not seem very extravagant, especially when, as is often the case, it is divided between two traders." Indeed, the narrowness of the margin of profit is clearly proved by the fact that "wheat is at present only grown on the most productive soils." It is possible that a number of the petty charges for packing, cleaning, weighing, and so forth, might be done away with, if the Railway Company had the enterprise to introduce the labour-saving appliances employed in the United States; but everyone engaged in the Indian trade knows that the merchant now works at a very small per-centage of profit, and that no saving in this direction can be looked for. Ocean freights, again, which are taken in the Bombay Chamber's estimate at 35s. a ton, or 9s. 9d. a quarter, have now been driven down to so low a level as to be actually unprofitable. The distance between London and Bombay is twice that from New York to Liverpool, yet the ocean freight for American wheat is from 5s. to 6s. a quarter, as against 9s. 9d, from India, and there are no Suez Canal dues to be paid out of this amount. No further saving, therefore, can be made on the sea voyage. There remains only the supposition that the railway charges must be excessively heavy, and the fairness of this conclusion is borne out by the large profits earned by the Great Indian Penin-

		s. d.	Per Qr. s. d.
* Price at Jubbulpore			22 4·00
Up-country charges—			
Weighing	at $\frac{1}{2}$ per cent.	0 1·34	
Brokerage	" $\frac{3}{8}$ "	0 1·00	
Godown rent	" $\frac{1}{4}$ "	0 0·67	
Telegrams and petties	" $\frac{1}{4}$ "	0 0.67	
Cartage from bazaar to godown on uncleaned parcels; Ditto from godown to station	1 anna per bag	0 2·74	
Hamalage of weighing and loading, Rs. $2\frac{3}{4}$ per 100 bags; Cleaning " 3 " "; Twine for sewing " 1 " "; Railway carriage on new bags " 2 " "	Rs. $8\frac{3}{4}$ per 100 bags	0 3·85	
Agency, working charge	1 per cent.	0 2·78	
Discount on demand bills	$\frac{1}{2}$ "	0 1·41	
Railway freight in Bombay		6 8·00	7 10·46
Shipping charges in Bombay		0 8·04	
Wharfage		0 1·64	
New bagging		1 3·39	
Freight to London		9 9·00	11 10·08
2 per cent. for loss in weight			10·0
Actual charges in London			2 0·
			44 10·61
Market price, London			44s. to 45s.

sula Railway, mainly out of the transport of grain.* When a railway company, which has a dividend of 5 per cent. guaranteed, actually earns from 10 to 11 per cent., we may be sure that it does not act equitably towards its customers. The Government of India must be considered as part of the railway company, since it participates in the surplus profits; and I charge the Government, therefore, with deliberately hampering the Indian wheat trade in order to produce the impression that its railway system, as a whole, is remunerative. Whatever is charged on the carriage of wheat in excess of a fair profit is virtually a toll or transit duty levied by the Government on the export trade; so that, as a partner in the railway companies, the Government is now raising up again an inland barrier to the development of the commerce of India, as objectionable as that which it prides itself on having abolished when it cleared away the old inland customs line.

I cannot agree with the Bombay Chamber of Commerce, and the Calcutta pamphleteer, in thinking that the remedy for this state of thing is to be found in the reservation by the Government of the right of fixing absolutely the rates for the carriage of agricultural produce. I have given you sufficient reasons for believing that the Government cannot be trusted in the matter. An outside check must be applied, and it can only be applied by the English Parliament, which has no other interest than to remove obstacles to the free importation of Indian wheat into this country. What that check should be seems to me plain enough. The limits of the dividends to be paid by the guaranteed companies ought to be absolutely fixed. As the dividends cannot fall below the minimum of 5 per cent., so they ought not to be allowed to rise above the maximum of, say, 7 per cent. When larger profits are earned than would suffice to pay this maximum rate, the principle should be acted upon which has been successfully asserted in the negotiations between the English shipping interest and the Suez Canal Company, that the customers of a monopoly have a right to share in the gains earned at their expense; and the surplus profits, instead of being distributed between the Government and the shareholders, should be employed in reducing rates and effecting such an enlargement of carrying capacity as will, at all events, remove the scandal that, in districts served by railways earning 10 per cent., "existing means of communication" are declared on high authority to be "insufficient to carry away the annual surplus" of grain available for exportation.

* The Railway Company has reduced its rates from Nagpore and Jubbulpore to Bombay, from Nov. 1, 1883, by about 1s. a quarter, but this is a tardy and insufficient concession.

This paper would be incomplete if I failed to refer to the mischievous effect of the State monopoly in preventing the extension of Indian railways. For many years past no room has been left for doubt as to the immense advantages which India derives from the existing railway system; and everyone interested in the country has earnestly advocated the immediate construction of new lines. Sir James Caird, in his new book, "India, the Land and the People," expresses the general opinion of thoughtful men who have studied the problem of increasing the production of food in India, so as to cope with the steady growth of population, when he says:—"The greatest help that can be given towards this object is, the early construction of railways in all the richer and more populous parts of the country which are still without them. In the next ten years the present mileage of railways in India should be at least doubled, and even then India would not have 1-40th of the mileage, compared with the population and area under crop, which is at present possessed by the United States." Yet, while America goes on building new lines at the rate of 5,000 or 6,000 miles a year, the Indian Government contentedly crawls along with its miserable increase of 300 or 400 miles in the same period. It is not the want of money that makes the rate of progress in India so slow. The sum of £2,500,000 is available out of the annual revenue for the construction of new railways; but the Indian Government, instead of setting this amount aside for the payment of interest at 4 per cent. on a capital of £60,000,000—which it might borrow at once, and which would suffice for the construction of 8,000 to 10,000 miles of railway within the next five years—has the economical pedantry to insist on spending its 2½ millions year by year as principal, and thus renders itself incapable of making progress, except by driblets. The English people ought not to be misled by accounts which appear in the newspapers from time to time of fresh surveys for thousands of miles of railway, which have been completed by the officers of the Government of India. Enough money has been spent in Indian surveys to pay for constructing a line all the way from Constantinople to Calcutta. It is work done, not work promised to be done, which alone can be taken into account.

What, then, are you to think of a Government which sanctioned, eleven years ago, the extension of the Bombay-Nagpore line as far as Calcutta, but is still discussing what the gauge for this line should be, although in the districts through which it would pass the crops rot on the ground for want of carriage when there is a good harvest, and the unhappy peasant proprietor actually dreads having a bumper crop, because there is no market in which he can sell his grain? Do I misjudge the Government in suggesting that it really dislikes the idea of any railway extension which may lessen the profits of the East Indian and Great Indian Peninsula Railways, with which the Nagpore-Calcutta line would come into competition? If you look at the map of India, you will see that the Great Indian Peninsula Railway is at present the most prodigious monopoly in existence. From Delhi and Agra on the north, far away to the southern limit of the Hyderabad State, over an expanse of country as large as Germany and France put together, the Great Indian Peninsula Railway, with its subsidiary groups of lines in Central India and the Deccan, affords the only outlet for all the agricultural produce seeking exportation; and every bag of grain or seeds must be brought down by it to the only shipping port on the western coast of India—Bombay. So jealously has the Government guarded the interests of this monopoly, that the Bombay and Baroda Railway Company has been strictly forbidden to penetrate the interior of India with a competing line up the Nerbudda Valley to Indore, or from beyond Baroda to Rutlam and Gwalior, and has been forced to creep away round the western face of the Aravalli range of hills to the far north-west. Even this opening into the grain-producing provinces of Upper India has been barred by break of gauge, and by the high rates imposed upon the Rajputana State Railway, in order to bring in profits in excess of a fair interest on capital. It must be remembered, too, that the public is absolutely powerless to break down a railway monopoly. The sea is always open to competition, and a subsidised line of packets cannot make unfair profits. But a railway protected by the State crushes every form of competition. It is, therefore, essential that the Government of India should be coerced into sanctioning the construction of new lines, which will afford the producer a choice of means of sending his crops down to the seaboard, either on the east or west coast of India. I rejoice at the prospect of a decision being come to on this subject during the present session by a Committee of the House of Commons.

The question of railway extension is an urgent one, not for India only, but for England. Sir Evelyn Baring, the late Financial Minister of India, said, a year ago:—"It is to be observed that during the last two years the railway policy of the Government of India has been unsettled. I do not think that is a matter for surprise or regret." He then went on to explain that the Government had been accumulating experience as to the expediency of constructing railways through the agency of unaided private enterprise, and he added that he and his colleagues were prepared to "lay down a definite policy for the immediate future, say for five years." Nothing more has yet been heard of that policy; nothing will be heard of it, unless Parliament interferes, and takes the matter into its own hands. I cannot share the complacency with which Sir E. Baring regards the waste of a few years. There never was a time when railways could be constructed more cheaply than now, or when English capitalists were more favourably disposed towards investments in Indian lines. If some projects of working through the agency of private enterprise have miscarried, the explanation must be sought in the mystery that enfolds the dealings of the Government of of India. The public naturally looks askance on concessions granted secretly to financiers, however influential, or to retired Government officials, however distinguished. Private enterprise can only thrive on publicity and fair play. Let all the railway projects contemplated by the Government of India be frankly made known far and wide, and the terms on which capital may be invested in them, and there will be plenty of money forthcoming. The Government may very well raise the capital and do the work itself, if only Parliament once lay down certain principles for the protection of trade against the caprice or greed of officialism. But, above all, there should be no delay. The Government must abandon its dog-in-the-manger policy, and either do what is wanted itself, or let it be done by others. It would be superfluous for me to dwell on the supreme importance to English industries of a cheap supply of wheat from a country which is the best customer England has for her own manufactures, and which can make her quite independent of America. But the necessity for relying almost entirely on the Indian wheat supply may arise at any moment, as suddenly as the necessity arose in 1861 for looking to India alone for the cotton required to keep the mills going in Lancashire. The capacity of India to export grain is now recognised as practically unlimited. Her total production is estimated at 40,000,000 quarters, three-fourths of which is, except in years of famine, available for export, as not much wheat is eaten in India; and the United Kingdom only imports 11,000,000 quarters a year. All the conditions of an abundant and cheap supply—a most fertile soil, a most docile, industrious, and frugal population, a swarm of steamers at the seaports eagerly competing for cargoes of grain—are present in the Indian trade, with the exception of proper facilities of railway communication and low rates of land carriage. Nothing is wanted, therefore, on our part to emancipate ourselves from dependence on the United States for the bread we eat, but to infuse into the administration of Indian railways more courage and energy than the Government of India has hitherto shown itself possessed of, and a feeling of keener sympathy with that spirit of free enterprise which has raised Great Britain to such a height of material prosperity.

DISCUSSION.

Mr. J. T. Wood had listened with great attention to the very able paper which had been read, but he thought it hardly dealt sufficiently with the extent to which railways might be made, or would be made by private enterprise if that enterprise were unfettered, except as regards general regulations, such as were laid down in the Companies Clauses Act, from State interference. The question of exercising State control by general regulations was, about fifteen years ago, considered by different companies, and a draft was prepared, but, somehow or other, the matter was shelved, and nothing more was heard about it until a few months ago, when a paper upon the subject was read at the East India Association. In February, 1877, he made some remarks in that room, which would be found in the Society's *Journal*, which were not quite in accordance with what had fallen from the reader of the paper that evening. What Mr. Maclean had called the "money making instincts," had prompted him (Mr. Wood) to make some further remarks. He hoped the Parliamentary Committee would inquire if the guaranteed companies had met with any unfair or "vexatious" treatment—if he might use such words without disrespect—or whether their legitimate interests had been prejudicially affected by the State control. He thought the reader of the paper was somewhat inaccurate in describing the exact state of the railway contracts, for it must be borne in mind that the guaranteed companies had certain rights secured to them by contracts which, at the time the contracts were made, were considered fair and equitable by the contracting parties and by the community in India. The maximum fares, with some tentative exceptions, were fixed in India (pretty much the same as fares were fixed in England) before the lines were opened; and the interpretation put upon the contract was this, that those maximum fares could not be altered by the Government without the consent of the companies, until such time as the shareholders were receiving 10 per cent. But it was by no means clear that, if in any half-year the working expenses on a railway exceeded the earnings, the shareholders would get the whole of the 5 per cent. guaranteed. On several occasions, owing to accidental floods and the like, it had happened that the legitimate working expenses had exceeded the earnings, but it had always been so arranged as to spread that expenditure over several years. He recollected a despatch from the Secretary of State to the effect that it was the wish and intention of the Government that railway companies should earn a full dividend of 10 per cent., but there was hardly a single case in which that dividend had been earned by the shareholders. Mr. Maclean did not tell them what rate of interest on their own business capital would satisfy the people in Bombay. Mos people would agree that 10 per cent. was not an exorbitant rate. To go a step farther, the question was whether the profit made on the carriage of wheat was or was not excessive. Was the rate received for wheat sufficient to pay the proper proportion of the working expenses, and the proper proportion of the 5 per cent. dividend. In the case of the Great Indian Peninsula Railway, which was an exceptional railway, inasmuch as it had very steep gradients, and consequently the working expenses were very heavy, it would be found that where the ordinary net profits amounted to 50 per cent. of the gross receipts, in the case of wheat it would barely exceed 15 or 20 per per cent. Then they came to a very important question, namely, whether the good railways should be made to pay for the bad, and whether any payment in excess of the ordinary mercantile profit was, or was not, attached to the trade of the country. As far as the guaranteed companies went, the good railways could hardly be said to pay for the bad, but as regards the State railways, they might be looked upon as all belonging to the same great proprietor, and therefore, might be amalgamated as far as regards carrying his produce to market. The most lucrative of Indian railways was the East Indian, and the profit made by that railway last year was 16½ per cent. on the nominal share capital; of that sum £6 10s. went to the shareholders, and £10 to the Government. It was a matter well worthy of consideration whether the allegation that the £10 was a repayment to the Government of a loan made in respect of the deficits of the guaranteed interest, or whether the Government advances represented taxation on the fathers of the present generation. He thought the advances were paid by taxation of the country, and, therefore, he agreed with Mr. Maclean that the 10 per cent. was simply, under the guise of a tax upon the trade of the country, taxing the children for the special reason that you had taxed their fathers, and that both were able to pay it. It could never have been contemplated by Lord Dalhousie that the profits should exceed 10 per cent., and it would be unfair to reduce the profit of £6 10s. payable to the shareholders of the East Indian upon the nominal capital, which, to say the least, was more than 8 per cent. upon the original capital; but at the same time it would be desirable to reduce this tax on trade, and the only thing that could be done would be by reducing the already low rates which existed in the company by re-adjusting the proportion of the net earnings payable to the Government. The East Indian Railway was exceptionally favoured by easy gradients and facilities for traffic, and was able consequently to carry goods at a very low rate, but the rates were still fnrther capable of being reduced. India, as regards the import of wheat into England, was a favoured country, but it must be borne in mind that the Australian colonies and the Dominion of Canada, and also the interests of British agriculturists, had to be considered.

Mr. E. Kimber said he should fancy, from the way in which the remarks of the last speaker had been received, that there were many present in favour of the sumptuary law which, at some time or other, prevented ladies from wearing jewellery. What was the proposal which had been placed before them that evening by Mr. Maclean? He boldly proposed that the interest should be cut down to 7 per cent., that Parliament should enact that no profits should be made beyond a certain sum, and that the persons who had invested money in different undertakings should be cut short of all which the original contract provided. He would ask, in the first instance, was that fair, and in the second place, could it be done? The contract originally made was for the very purpose of inviting capital for the construction of railways, that the persons providing the capital should be guaranteed by the State 5 per cent., and that they should have half of the profits made by the concern after 5 per cent. was earned, and that if there was a deficit, the Government should find the difference. That was the original contract; could they upon any principle of justice or fair play depart from such a contract? If they could, then some fine new principles were coming in; and he did not hesitate to say that if those principles were received, the time would come when they would have a sumptuary law in this country. His second point was, could it be done? The persons who had invested their money had done so upon certain conditions, but it was now proposed absolutely and violently to abrogate those principles. That could not be done without returning the money which had been subscribed. Upon the commercial part of the question as to whether 10 or 11 per cent. was an extraordinary profit, it must not be forgotten that persons invested their money upon the construction of railways in India at a time when, according to Mr. Maclean, India was one mass of jungle, impenetrable morass, mountains and rivers, and, therefore, the undertakings required a little patting on the back by the Government. Was that principle of legislation to be cast to the wind? In his opinion, it was just legislation. It was the same principle upon which they proceeded now with regard to the encouragement of public works by local authorities. The important question which had been raised by Mr. Maclean was as to what Parliament should do, and no doubt the discussion that evening would have some influence on the House of Commons. Under no conditions whatever could Parliament be recommended to abrogate the obligations and provisions which they laid down when the present shareholders invested their money. The only true remedy for the evils complained of were those indicated by Mr. Maclean at the outset of the paper, though apparently ignored by him before he reached the end, and that was the encouragement of private enterprise by the means of competition. He hoped some conditions would be laid down by the Committee of the House, whereby private enterprise would be encouraged, and competition encouraged, so that the rates might be brought down.

Mr. Matthew said he most fully concurred in the concluding observations of the last speaker, but regretted that he could not agree with all his observations. What India wanted was a large extension of railways. The shareholders in the old guaranteed companies had benefited very largely by the control of the State in their operations. No doubt the important question was the minimum rate to be charged, for it was plain that they had not yet arrived at that low charge which was the profitable charge. The ships now running between Chicago and London had a greater carrying capacity than formerly, and consequently were enabled to carry at a lower rate, and it was well known that it paid better to run a train heavily loaded at a low price, than a half-empty one at a high price. In India, the passenger rates had been considerably reduced, with considerable profit to the company; and a further reduction would, in his opinion, be very beneficial to all concerned. The extension of railways would be a great benefit to the Empire, and profit to the State.

Mr. Martin Wood agreed that there never was a time when railways could be constructed more cheaply than the present, and that there should be no delay in making railways in India; also that in all matters connected with public works one of the great conditions required was early and prompt publicity, in order that the proposals might be examined by all parties concerned. With regard to what Mr. Maclean had stated as an axiom, that nothing could compensate for a break of gauge on a main line, he would ask them to take that as mere assertion. It was a question of comparative cost and relative distance, one which assumed entirely different proportions in a vast country like India, as compared with this small island. Break of gauge was a mere incident in the movement for reform in railways, which was instituted by Lord Lawrence, and had been followed by four successive Viceroys. Surely it might be supposed that these eminent men, and especially Lord Mayo, had very substantial grounds for promoting the more economical railway system, which had been disparaged in the paper before them. The cheaper method of railway construction had been supported by each Secretary of State for India, and by their responsible and experienced advisers. As to the abuses under the lavish system of the 5 per cent. guarantees, of which Mr. Maclean had spoken, these were all recognised in Lord Lawrence's minutes of 1868-9, and there could be no thought of returning to that plan; but without some definite though moderate guarantee English investors would not supply capital for Indian railways. There were two points arising out of the subject of the paper, but not mentioned in it, to which he wished briefly to refer. First, while it is good for England to draw large supplies of wheat from India, it might be more to the advantage of India itself to grow less bulky and more valuable products. Then, as this is a question of inland communications, it must be remembered that railways would not suffice to carry the bulky produce of India cheaply enough; but water would both increase the growth of produce and could convey that produce at low rates to the coast.

Mr. SETON KARR said, he might, perhaps, be permitted to correct one error which he noticed in the paper. Mr. Maclean had stated, "the feeling that slighter and less costly works might have sufficed for a poor country like India was one of the motives that induced Lord Lawrence's Government, in 1870, to resolve upon taking the extension of the Indian railway system into its own hands." Lord Lawrence was not in India in 1870. He left in 1869, and was succeeded by Lord Mayo. He entirely concurred in what had been said upon the subject of the break of gauge. Having been for many years a shareholder in the Great Indian Peninsula, he could contradict the statement that that company had paid dividends of 10 and 11 per cent.; it had never been his good fortune to have a share of more than 7 per cent. He concurred with what had been said as to the propriety of opening up railways to public competition, though he knew there would be great difficulties in finding persons, either English or native, to construct a railway without some guarantee from the State, because estimates for the construction of railways in India generally proved rather fallacious. When Lord Hardinge wrote his first minute very many years ago, about the construction of railways, he calculated that railways could be made for £5,000 a mile, but, as everyone knew, they had cost £10,000, and in some cases as much as £16,000.

Mr. MATTHEW remarked that he had built some hundreds of miles of railway in India, and in no single instance had he ever exceeded the estimate.

Mr. ANDREW CASSELS entirely agreed with Mr. Maclean as to the desirability of constructing more railways in India, and that there should be one uniform gauge. He had heard many hard words uttered about the stinginess of the Government in India in not spending money on railways, but he thought a good deal of that blame should be transferred to the shoulders of Parliament, because when the limit of 2½ millions was fixed for public works, that was done upon the recommendation of a committee of the House of Commons. Now that the question was once more to be considered by a committee, he hoped that they would see fit to relax that arrangement in some degree. He had heard of the most magnificent projects for spending £10,000,000 a year upon railways in India, and comparisons made between what was done in America; but it must not be forgotten that in India the lines were constructed by the Government, and that in America they were constructed by private enterprise. If the Indian Government was to be called upon to construct these railways at the rate so glibly proposed, he must ask seriously where was the money required to come from?

Mr. PEDDER said Mr. Maclean had spoken of the Government monopoly in India being opposed to the extension of railways, and that it was time for Government to construct railways themselves, or to permit private persons to do so; but he might say with some confidence, though he was not in the secrets of the Public Works Department, that if any company or individual would come forward and offer to make railways in India without State aid, the Secretary of State would hail the proposal with the greatest delight, and perhaps go so far as to give them the land for the purpose. But the fact was that no company would come forward and propose to make a railway without first asking for a guarantee, and of course if a guarantee were asked for, it was not unreasonable that the Government should retain in its hands some check upon the action of the company, and the way in which it dealt with public money. The real difficulty of constructing railways in India arose from the fact that the British public would not subscribe money for the purpose without having a guarantee.

Sir GEORGE CAMPBELL, M.P., said that Mr. Maclean had been somewhat hard upon the Government of India in his criticisms, but had not suggested a remedy for the evil. If there was one thing worse than a public monopoly, it was a private monopoly; and in England where they had private monopolies, they were beginning to rebel against them, and to think that they should be brought under the control of the State. In the case of private companies constructing works in India, they proceeded upon the principle of "Heads I win, tails you lose;" if they found the enterprise was profitable, they wished to stretch to the utmost their profits; but, on the other hand, if they found they had made a bad bargain, they immediately turned round to the Government, and cried for recompense. He was afraid that they had not yet arrived at a solution of the difficulty which presented itself. With regard to the observation about the miserliness of the Committee of the House of Commons in not providing more than two and a-half millions for public works in India, he might say that that sum was practically decided upon in the India-office rather than in Committee.

Mr. ANDREW CASSELS pointed out, he believed, that the proposal to spend two and a-half millions a-year originated with Lord Northbrook, who said that India could not raise more than two and a-half millions a-year, but the Committee in Parliament had sanctioned it.

Mr. CONNELL wished to point out the great difference which existed between railways in India and America. When capital was raised in India for railways it could not be got rid of, but in America a great deal of the capital was dropped, and rates were fixed upon without any reference to the capital so dropped. In the next place American railways recouped themselves, to a great extent, by the sale of land plots upon the side of the railway, which in India could not be done. Mr. Maclean had compared India with America in the production of wheat, but he might point out that India, with its teeming population, required the greater part of the produce of the country, whereas America did not. Having lately worked out the figures on this question, he found that, on many points, Mr. Maclean was not quite accurate, and that there was not the surplus of wheat in India which Mr. Maclean supposed. If more railways were constructed and did not pay, the Government would have to bear the burden, or rather the taxpayers would, and these people were not able to afford it. Comparing India with America was like drawing an analogy between the moon and the earth.

Captain MOLESWORTH thought the object of the reader of the paper was to make India the market of this country for corn, and that railways might be constructed so that wheat might be brought down to the coast at a price which would enable it to be sold in this country at a profit. One reason why the railways should be constructed was, because money could be obtained now at a cheap rate; and in the next place, because materials were now cheap. It had been asked, where was the money to come from for the construction of these railways, but there ought to be no difficulty upon that point, because, at the present moment, there was over £7,000,000 in the Bank of England lying idle, which could be utilised for the purpose, if the Government would only guarantee interest at the rate of 4 per cent. upon it.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Maclean for his interesting and well-timed paper, said, no doubt it had lost some of its importance from the fact that the Government had moved for and obtained a Committee of Inquiry in the House of Commons, very much upon the question which had been discussed that evening. Mr. Maclean had established two points:—First, the evil of double control, which he feared was indispensable, as the Government could hardly give a guarantee without also having some control; and secondly, the great importance of having the interest of trade duly represented in the Viceroy's Council. Next to the preservation of peace in India, there was probably no interest to be represented in the Viceroy's Council so important as that of the prosperity of agriculture. With regard to the cost of production of wheat, he thought Mr. Maclean must have obtained his figures when the cost was exceptionally high, because the inquiries which had been made by the Board of Trade on Agriculture in India, did not support the figures mentioned. In a paper which had been presented to Parliament a year ago, by Mr. Buckland, it was shown that wheat could be produced under 2s. 6d. a bushel, that being about £1 a quarter, therefore making any argument on such a price as 8s. or 10s. a quarter was fallacious. Mr. Maclean had also understated the quantity of wheat imported by about one-half. India, during the last three years, had supplied from 10 to 14 per cent. of the whole quantity consumed in this country, and that would not have been produced were it not from the fact that agriculture had been encouraged. The rapid development of railways in America, from 1866 to 1880, had produced a remarkable result. It had enriched the country and the citizens, and at the same time had enabled those who had carried out the enterprise with great skill and economy, to lower the cost of transportation by one cent per ton per mile. That seemed a very small sum, but it was stated upon authority that that deduction on the quantity of goods carried on the railways of America, during the year, amounted to no less a saving to the consumer and producer than £64,000,000 sterling. What would be the amount of such a saving upon even the present traffic of India. Supposing the different descriptions of goods which passed over the railways amounted to over 500 millions, upon an average, the gain on 5,000,000 tons would be equal to £8,000,000 sterling. He hoped before long to see the mileage doubled, when the saving of one cent per ton per mile would effect a clear saving of £16,000,000 sterling to India. It was only by competition that this great result could be obtained. The extent to which this was applicable in India at present was shown by the proportion in which this country derived a supply of main articles from India, in comparison with that from other sources. The total value imported last year of wheat, seeds, hides, linseed, tea, and other articles was £170,000,000 sterling, of which India gave one-fifth, but that amount could be largely increased if the railway systems were considerably extended, so as to enable it to compete upon favourable terms with America. America produced most of the articles, excepting tea, which India did, and, therefore, it was only by lowering the rates of land carriage that India could hope to favourably compete with America. It had been said that the sea journey from India was longer than from America, but it must not be forgotten that that difference was compensated for by the extra number of miles that the goods had to be carried overland in America. As to the shipment of Indian wheat to Europe, he might perhaps be permitted to say one word. In the last three productive seasons it had grown up to 14 per cent. of the whole foreign supply, and as the foreign supply was about £43,000,000, India was a large and important market, to which the East and West might safely look in the future. The wheat grown in India had been found, after careful experiments, to be of a very valuable description, so that the demand for it might be expected to increase.

Mr. Maclean, in reply, repudiated the charge made by Mr. Kimber that he advocated a policy of confiscation. That was very far indeed from his desire. It was perfectly legitimate for Parliament to fix a maximum beyond which the dividends of guaranteed companies should not go. One gentleman said that 10 per cent. was very little for people to make in trade, but if people were guaranteed that they should not make less than 5 per cent., 10 per cent. was a great amount to make. Mr. Seton Karr had stated that he had never received more than 7 per cent., but he forgot to say that the Government had had the moiety of the balance of 11 per cent. He had suggested a way in which Parliament could interfere to check a railway company from earning large rates. The contract was only granted with certain restrictions; those restrictions had not been put in force, because the Government were interested in the company earning large profits. Lord Dalhousie, in his minute upon Indian railways, stated that a railway capital might be raised at 3½ to 4 per cent., and he (Mr. Maclean) was perfectly certain that Lord Dalhousie never contemplated that the railways should make the large dividends which they were now earning. The remarks which he had made in his paper not only applied to companies now in existence, but to companies which might hereafter be sanctioned by Parliament.

ELEVENTH ORDINARY MEETING.

Wednesday, February 20th, 1884; James Heywood, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, Henry, B.A., 10, Phillimore-gardens, Kensington, W.
Dewar, Prof. James, M.A., F.R.S., 19, Brookside, Cambridge.
Hogg, Stapleton Cotton, 68, Warwick-square, S.W.
Mitting, Ebenezer Kennard, Rye, Sussex.
Preston, Edward, 35, Cornwall-gardens, South Kensington, S.W.
Rivington, Rev. John Alfred, M.A., 32, Eardley-crescent, West Brompton, S.W.
Smith, Harry Fryer, 64, Leinster-square, W.
Venner-Morris, A. A., Ivernolen, Ammanford, R.S.O., Carmarthenshire.

The following candidates were balloted for and duly elected members of the Society:—

Baillie, Major-General John, 4, Queensborough-terrace, W.
Bostock, John Yates, M.R.C.S., M.B., 73, Onslow-gardens, S.W.
Evans, Edward Probert, Rose-house, London-road, Worcester, and Royal Porcelain Works, Worcester.
Lewin, Miss Constance, 25, Wimpole-street, Cavendish-square, W., and The Bourne, Widford, Hertfordshire.
Macdonald, Thomas, 5, Essex-court, Temple, E.C.
Mackinnon, W., Balinakill, Clachan, Argyleshire.
Scudder, Frank, 22, Devonshire-street, All Saints, Manchester.
Wilkinson, Capt. Edward, R.N., Army and Navy Club, S.W.

The Chairman, in introducing Mr. Hyde Clarke, referred to the possibility of hematite iron ore being found under the sands of Morecambe Bay, which would render their reclamation even more profitable than at first sight appeared.

The paper read was—

RECLAMATION OF LAND ON THE NORTH-WESTERN COAST OF ENGLAND.

By Hyde Clarke.

In a society like the Society of Arts, dating beyond a century, the same subject becomes over and over again the purpose of exertion, and from time to time comes under notice. The great end and aim of this Society, like its prototype in Holland, was to increase the national wealth and resources. It was intended practically to put into application those economical ideas which had been under discussion since the time of Elizabeth, and which, in the middle of the last century, became prominent. This period is popularly and familiarly known by the work of Adam Smith, commonly called the "Wealth of Nations," which dealt with the labours of his predecessors, and, in many cases, threw new light on the subjects by his own researches.

By the founders of the Society of Arts it was considered that the desired results would be promoted by the co-operation of the public and learned men, by serious discussion, and by giving honorary and pecuniary rewards as a stimulant to exertion.

The soil of these islands was regarded as the basis of our national wealth, and at a time when the agricultural societies did not exist, the energies of our founders and predecessors were greatly bestowed on plans and projects for reclaiming and planting land, or stimulating production. Although other institutions have taken up part of the work, it is greatly to be regretted that the purposes for which the Society was founded have never been adequately attended to in this country. It was not supposed that the Society was of itself sufficient; and though it greatly influenced the Board of Trade and the Colonial Department in the last century, it never succeeded in obtaining from the Government a proper provision for the administration of what concerns the national wealth. To this day, even with a favourable vote in the Legislature, there is no Ministry of Agriculture or of Commerce. A fitful effort was made when the Liberals came into power after the Reform Bill, to effect improvement, and to appoint commissions of inquiry into the means of increasing our commercial relations abroad, but there is no continuous exertion of policy.

Thus many matters which most affect the community as a whole, and cannot be dealt with except by the community, are left to casual action; and in defiance of the doctrines of political economy and the teachings of free trade, a kind of superstition has sprung up, that the State and the community are to do nothing, and that the citizen, as an isolated individual, is to compass all. We have come to an epoch when, by the growth of population, our water supply has become a matter of general concern, without having provided for it adequate legislation.

The improvement of waste soil can only, to a very limited extent, be accomplished by individual enterprise, and the same is to be said of the reclamation of soil from the water. In these matters even joint-stock enterprise is not always available, because the processes of recovery demand the application of much time as well as money. In Holland, and in England, large tracts have, from time to time, been saved from the sea, or taken absolutely from it. The great works in the Bedford Level, and in the Wash, in extending the productive surface of our eastern counties have added much to our national wealth, and in Holland the draining of the Haarlem Meer, in our days, is fully looked upon as a great conquest of engineering skill and perseverance. Our task on this occasion is less to refer to what has been done than to what remains to be done, and what is practicable of accomplishment in our north-western counties.

My connection with the subject, directly and indirectly, took place as far back as 1836. My own immediate call to action was in that year, in reference to the projected extension of what is now the London and North-Western system from Lancaster to Carlisle. That contemplated what was then, and justly deemed so, the great effort of passing the high mountain of Shap Fell in Westmoreland. Then, as always, the question of gradients attracted attention among engineers and the public, and considerable disfavour was expressed, perhaps without sufficient justification, towards the contemplated line over a mountain so well known at that time in the travelling world.

Into this controversy I, as a young man, was first privately, and then publicly drawn. The engineers of the Shap Fell plan maintained their project, because geographically it appeared impossible to obtain another route than through the natural pass. My chance and my advantage lay in this way, that part of my studies had been devoted to the engineering works of Holland, as some may still remember, from my treatise on that subject in "Weale's Quarterly Papers on Engineering." * Thus, to me, it may be said naturally to have occurred that the great Bay of Morecambe, so far from offering an obstacle, presented the very opportunity of obtaining a level junction between good gradients in North Lancashire and West Cumberland, and that like expedients would carry the line across the Solway, and into Scotland so as to reach Glasgow.

The idea was, in this case, absolutely my own; yet, as it is said there is nothing new under the sun, so it happened here. Half a

* "Weale's Quarterly Papers on Engineering." "Engineering of Holland Dykes." By Hyde Clarke. (London, 1849).

century before me, and nearly a hundred years before this day, in 1790, Mr. John Houseman is related* to have proposed to enclose the Bay, and he then valued the land at £40 per acre. It is also said that Mr. Wilkinson was so satisfied of the undertaking that he was willing to advance £50,000 towards it. This is all the history of the plan which has come n my way, and it seems to have slumbered in ocal tradition until my proposal revived it, and it was brought as evidence in favour of the scheme in 1838 and 1839.†

To some it will appear extraordinary that such a vast plan of embankment, justly regarded as a great undertaking, should date from a century back. There can, however, be little doubt that at that epoch the efforts of the Society of Arts had given a new impulse to such projects, and of this we shall find a direct proof. The Society of Arts was founded at a time when this as well as other European countries in the last century had favourable harvests, and when there was great activity among men of thought. The Society actually gave a prize for embankment in Morecambe Bay. As will be seen further on, one of my supporters, Mr. Edward Dawson, of Aldcliffe-hall, who reclaimed largely from the bay, received the medal of the Society for the skill and judgment with which the work had been effected.

It is not, indeed, at all remarkable that such a plan should be then brought forward as the Bedford Level reclamation had been accomplished a hundred years before. This, however, is worthy of note, that what is practicable should in this and other cases be delayed and neglected to the great prejudice of the national wealth. One great cause of the retardation of Mr. Houseman's efforts was our involvement in the wars of the French Revolution.

My originality as an engineer, as compared with Mr. Houseman's prior idea, consisted not in the proposal to embank Morecambe Bay, but in that of employing the embankment of the reclamation as a means of obtaining arterial communication. This railway, too, I proposed to construct to effect the embankment, and also thereby to obtain funds in the land reclaimed to replace the capital employed. There were also other practical portions, which belonged exclusively to myself. The fact is, that there is seldom anything that is ultimately accomplished, but what it has been obvious to some one, and this concurrence of thought becomes one means by which new inventions are carried out, for when they do appear, some minds are prepared for their reception and advocacy.

It is strange that in a country so well travelled as England, Morecambe Bay may be regarded as having been unknown, and at this day, many cannot tell where it is, though of course it figures clearly on every school and library map. It is a very remarkable indentation of our coasts among the mountains of the Lake District. It was not on the direct road to the lakes, and did not figure as one of the attractive features. Although it takes so large a space on the map, it attracted formerly no attention under the aspect of commerce and navigation. As the chief part of its large surface is bare at low water, navigation then ceases; and when the tide is up, the sandbanks and narrow channels of the rivers are impediments to shipping. In 1836, as for ages, the traveller had to creep by a circuitous route, less direct even than the present railway round the shores of the Bay, or to run the hazard of crossing the sands at certaln times, and in this venture many lives were lost, as the rising tide sweeps swiftly up, and forms quicksands.* Its dangers were too well known to all who travelled over its sands, on account of the constant shifting of the fresh water channels, and the treacherous nature of the sands, more especially during freshets in the rivers. This route has happily long since been superseded by the railway.

Morecambe Bay, it may be stated, is an arm, or bay, of the Irish Sea, situated to the west of Lancaster. Its average width is about twelve miles, and it extends about seventeen miles inland from the mouth, forming a deep gulf of picturesque character, and surrounded by beautiful scenery. A great portion of the bay is left high and dry at low water.

The best description of Morecambe Bay, and of the rivers Kent and Leven, is to be found in the paper read before the Archæological Association of the district, by Mr. John Fell, J.P., of Dane Ghyll, Furness Abbey, late Mayor of Barrow, and one of the trustees for the office of carters over the two fords. Mr. Fell, besides great local advantages, has made an extensive search of the records. These

* Report of Sir H. Le Fleming Senhouse, on West Cumberland and Furness Railway in *Whitehaven Herald*, &c., 1838; also MS. report of Hyde Clarke to Local Committee, 1836.

† It is stated in my MS. report that Mr. Houseman published a work on the topography of this region, p. 93.

* See on this subject the valuable paper of Mr. John Fell, on the "Carters of the Sands."

show the constant danger of the passage of the sands for many centuries, and Mr. Fell is, no doubt, right in supposing that the office of Le Carter had reference to the conveyance of passengers over the fords in a cart. The paper is of great interest.

I proposed to cross the estuaries of Morecombe Bay by embankments or dykes. By this means the land, dry at low water, was to be reclaimed, and this was provided as the resource to furnish part of the heavy capital for making a trunk line from Lancaster to Glasgow, through districts then sparse of population, and with feeble local traffic, and dependent for obtaining an adequate return on securing possession of the through traffic.

The practicability of the plan, bold as it was, was not much questioned among those who were brought into practical contact with it. The reason may have been this, that in those days the great hydraulic works of the east of England, and of Holland, had a stronger hold on the memories and thoughts of men, and their influence had not been weakened or effaced by the successes and remarkable achievements of the railway system. Hydraulic engineering then constituted a great school, in which James Walker and the Rennies, leading men of the day, had earned their distinction. Railway men were only slowly coming to the front, and had not achieved the supremacy and almost monopoly of the profession. During the transition, some who were unfavourable to the Institution of Civil Engineers, taunted it as the institution of railway engineers, in the same spirit as the Royal Academy has been termed the Academy of Portrait Painters.

It was calculated by me that in Morecambe Bay and the Duddon, one twenty-fourth part could be added to the surface of Lancashire. My estimate for the land in Morecambe Bay was 39,210 acres (40,000 acres) and in the Duddon, 4,000 acres. The passage of the Solway was contemplated to be by embankment, which would have provided another 20,000 acres, or more, according to the place of crossing; but this was put forward rather as an alternative.

In a project of mine I was not able to pursue, it was proposed to deal with the Ribble and the Dee. It is much to be regretted that these localities have not been systematically taken in hand, as national projects, instead of piecemeal treatment. Into this matter of the reclamation of the Dee I cannot now enter at length, but that I was right in proposing it has been sufficiently proved by subsequent experience. Although the works are not altogether satisfactory, some 3,000 acres were embanked there, but litigation is going on between the landholders and the River Dee Commissioners.

The opinion of Mr. Allen Wilson, M.Inst.C.E., who has great experience, concurs with mine, that by systematic action the Dee may be made an important harbour for the trade of the district, and that at the same time a large tract of land may be utilised. He agrees with me in preferring the experience of the engineers of Holland for the course of treatment.

In the case of Morecambe Bay, to produce so much surface from the sea, like Dartmoor or Woking Common, would not have been worth the labour. At the best, 40,000 acres of Salisbury Plain would only have grazed some sheep. In my own mind, there was little room for such doubt, as practical expedients for meeting such a case, and providing suitable soil, were suggested by experience. Still, experiment would have been necessary to convince the outside world. It proved, however, from the local tests, that good surface soil could be obtained. This confirmed me, too, as to the course to be adopted.

The local knowledge gradually obtained supplied practical confirmation. Thus it came out that on the Ulverston side small patches of sand had from time to time been reclaimed, and some before the beginning of this century. These had stood well, the land was good and rich, and worth £60 an acre.

In Morecambe Bay the case was very different from the embankment of the Haarlem Meer, the details of which were familiar to me, and also from conference with the engineers concerned. The Haarlem Meer was old inundated land, and during its whole time of being submerged it had been fed with good soil. Polders partially had shown the agricultural quality of the remainder, as the neighbouring enclosures had tested Morecambe Bay.

My provision included that of warping the sands in Morecambe Bay, leaving them to receive for the necessary time the land deposit from the rivers, and which is one of the most effective processes for such reclamation. The object was to produce good land, and although in the prospectus of the Grand Caledonian Junction Railway the value of the land to be reclaimed was taken at £15 to £20 per acre, no doubt was entertained by those who investigated the subject that, under proper treatment, the price realised would not be less than

£40 per acre, and possibly £50 or £60 per acre for much of it.

There was soon sufficient knowledge as to the difficulties to be encountered with existing riparian interests, or no interests, even to those who claimed a valueless foreshore of land to be created, and to which value was to be given by others.

Upon my entering into negotiations with the authorities of the Duchy of Lancaster, or the Crown, the usual contest ensued. In this case there were not only local but national interests concerned, but the Duchy would give no assistance. It set up a broad title to all lands to be reclaimed, would afford no contribution towards the work, and indeed would enter into no equitable compact. Recent experience has been in the same direction as to Preston, Southport, and Morecambe Bay. The large landowners were willing to come to terms, and their influences and those of the local communities were brought to bear in our aid. Crown and Duchy, for we had claimants in both departments, however, concurred in this determination, that they would come to no arrangement until the works were completed, when each assumed to be full proprietor of what might be recovered, and we were to depend on their mercy.

My undertaking received the aid of many influential supporters, Mr. John Rooke, of Akehead; Sir Humphrey Le Fleming Senhouse; Joseph Jopling, the mathematician; Colonel Landmann; William Blamire, M.P.; H. A. Aglionby, M.P.; Sir Hesketh Fleetwood, M.P.; Colonel Braddyll; Mr. Curwen, of Maryport; Sir Wilfred Lawson; Mr. Edward Dawson, of Aldcliffe-hall; Colonel Moody; Captain Beasley; Mr. Stockdale, of Cark; and many others, some of whom were well-known members of that Society.

A committee was formed in West Cumberland and Furness for its promotion, in which Sir H. Le Fleming Senhouse took a leading part. He collected much evidence, which is valuable to this day.

The following is an extract from a letter from Captain Beazley to Sir Humphrey:—

"My opinion certainly was, when I looked at Morecambe Bay, that it would be very possible to carry a bank across for the proposed railroad on the principle which I am adopting, so far successfully, on the Welland, but cannot at present say more, from present ignorance of the bay, having only had a casual view of it."*

* "Caledonian, West Cumberland, and Furness Railway." *Whitehaven Herald*, 12th April, 1838.

Mr. Edward Dawson was also a practical authority of great local influence. Of him Sir H. Senhouse said:—

"Before going further he felt it his duty to state that he had been greatly assisted in his inquiries on the subject of the embankment of Morecambe Bay by Mr. Edward Dawson, of Aldcliffe-hall, near Lancaster, a gentleman of much zeal and perseverance, who had himself embanked a great deal from the sea, and had received the medal of the Society of Arts for the skill and judgment with which the work had been effected. Mr. Dawson was of opinion that the only way of embanking across Morecambe Bay was after the manner in which a portion of the great Wash in Lincolnshire had been recovered; that was by turning the rivers, and quietly allowing the sea to deposit the silt thrown up upon it, so that in time it would enclose itself."*

Although local interests at Lancaster were formerly chiefly in favour of the Shap Fell undertaking, now a main line of the London and North Western Railway, there were yet wanting supporters like Mr. Dawson. At the present time Lancaster men are taking a leading part not only in the embankment, but in advocating the direct line to Barrow.†

I was succeeded as engineer for the embankment and the railway, as far as Whitehaven, by the late George Stephenson and the late John Hague. The railways formed in West Cumberland effected a connection with Carlisle, but that part of my undertaking which was in Scotland, not meeting with sufficient local support, ultimately fell into other hands, and was completed on the line of my original survey at the Glasgow South Western Railway. In the plan for the embankment George Stephenson had great confidence, and it was a favourite subject with him, as mentioned in his life.

Of Mr. Hague, Colonel Movely wrote to Sir H. Senhouse:—

"I sent the heads also of your inquiries to Mr. Hague, a civil engineer in London, who had been employed on the dykes against the sea in Holland under General Blonker, then chief engineer of the Water Staat Department, which I personally know to be scientifically and well conducted. I am sorry I cannot answer your enquiries as to Lincolnshire, but Mr. Hague, who executed extensive works in reclaiming 36,000 acres of land between Lynn and Ely, and embankments against the sea with only peat earth and puddling with clay, as is done in Holland, has promised me to call on you when he goes to Manchester; and as he also executed works in Holland, he

* "Caledonian, West Cumberland, and Furness Railway," *Whitehaven Herald*, 12th April, 1838.

† See the *Lancaster Observer*.

will be able to satisfy you on many points. He perfectly agrees with me as to the practicability of making embankments and a railway on the inner berme on your line." *

Mr. Hague proceeded to bestow his attention more particularly on the plans for Morecambe Bay and the Duddon. In this he was assisted by men who have since become distinguished in engineering circles, and among them his pupils, Sir Frederick Bramwell and Mr. T. R. Crampton.†

While Mr. Hague was employed on the Bay survey, Mr. J. M. Bastrick was engaged on railway survey‡ and both reported strongly in favour. The Government, however, held back against affording any support or co-operation, and the committee was dissolved. Thus the undertaking in this second stage of the West Cumberland and Morecambe Bay Railway once more collapsed.

The attention of the inhabitants of these districts had, however, been aroused by me, and a more decided spirit of energy manifested itself. Furness attracted the attention of many men of enterprise, and the local landowners co-operated.

In 1844, the leading men in Furness, in conjunction with the Duke of Devonshire, formed a committee to promote a mineral line from the iron mines to what had become the port of Barrow. This local line, ultimately carried out as the Furness Railway, became the means of connecting the main southern lines of the kingdom with those of West Cumberland, and thereby forming another but circuitous line of railway communication, reaching to the whole west of Scotland.

In 1851, a local company was formed in Furness, with Mr. Brogden as chairman, an Act of Parliament was obtained, and the line was laid out by Messrs. Maclean and Stileman. This prepared the way for the railway round the Bay, and the important works constructed by Mr. Brunlees, late President of the Institution of Civil Engineers. This may be looked upon as a tentative undertaking, which, by

* "Caledonian, West Cumberland, and Furness Railway." *Whitehaven Herald*, 12th April, 1838.

† When I read this paper last year before the Mechanical Section of the British Association at Southport, Sir Frederick came forward to state this fact, and to give some particulars of Mr. Hague's plans here described. I also read another paper on other features of Morecambe Bay, before the Section of Economic Science and Statistics. These papers were afterwards printed and published at Barrow.

‡ On this survey, Mr. John Fowler, late President of the Institution of Civil Engineers, was engaged, being one of the many men of eminence who have been connected with this undertaking.

carrying a railway and embankment across the estuaries, has prepared the way for the resumption of my original plan, and has afforded a demonstration of its practicability.

The embankment works in Morecambe Bay were described by Mr. Brunlees in a paper sent by him to the Institution of Civil Engineers, and to be found in the proceedings for the session 1854-5. This gives all the necessary details, and to it may be referred those desirous of further information. As much, however, relates to the viaducts, and not to the embankments, only partial extracts are here made.*

In Holland, most of the dykes are formed of sand faced with reeds or wicker-work. In the embankment in the Wash, in Lincolnshire, which is similar to Morecambe Bay, the works are formed of clay and sand, and in many parts of the British Channel wooden jetties are formed in the sea. With such examples, no doubt can be entertained of the practicability of the measure, and the question resolves itself into one of expense.†

On the existing line of railway over Morecambe Bay the sea-works, as carried out by Mr. Brunlees, are rather different from those originally proposed by myself, and afterwards by George Stephenson, Mr. Hague, and Mr. Walduck, in consequence of the present line being carried more inland than that proposed by me, so that the structures across the estuaries of the Kent and Leven are the principal works exposed to the sea. Although the reclamation of land was a secondary object with Mr. Brunlees in laying out this line, the railway embankments and weirs serve so far to fix the fresh water channels as to facilitate the reclamation of a considerable portion of the Bay, as well as to provide for future development.

The sands are to a great extent composed of calcareous matter washed from the limestone of the district, and of this the interior hearting of the banks is almost entirely composed. On the sea-slopes so formed there was placed a layer 12 in. thick of well prepared clay puddle. In the works in Holland this is the chief dependence. In Morecambe Bay, this clay puddle serves the twofold purpose of temporarily protecting the material during the formation of the embankment, and of permanently preventing the sand from being washed out from

* Long extracts were given by me in my paper before the British Association, and in the reprint at Barrow.

† "Caledonian, West Cumberland, and Furness Railway." *Whitehaven Herald*, 12th April, 1838.

between the joints of the pitching by the action of the sea. On the top of the puddle was laid a thickness of 18 in. of small rubble stones, technically termed "quarry rid;" this prevents the action of the sea upon the puddle. The pitching stones, varying from 8 in. to 16 in. in thickness, and of an average depth of 15 in., were compactly set together on this bed of "rid." The limestone from the excavations and the quarries in the immediate vicinity of the works yielded a very excellent stone for this purpose.

The embankment across the Kent Estuary differs from the others in the mode of execution. It is found that the sands stand well in still water, at a slope of 1½ to 1; such a quantity of "rid" was therefore used under the pitching as to prevent any abrading action of the water, and avert any action upon the sand. When it was consolidated by the passage of the horses and carts in the process of formation, and was set by the rains and spring tides, it was found to resist the passage of water through the embankment during the flood of the tides.

The railway over Morecambe Bay was opened in August, 1857, and it was soon demonstrated, by the passage of the ordinary passenger trains and heavy trains laden with minerals and goods, that not the slightest depression in the piles was produced, and but little vibration.*

Of the justice of these first and early plans and estimates, sufficient confirmation has since been obtained. Besides what—as a pioneer, though on a small scale—Mr. Brunlees has done, the Warton Land Company is engaged in reclaiming 7,000 acres of land on the Lancaster side of the Bay, and arrangements have been made with the Crown authorities for a further reclamation in the middle of the Bay of 11,000 acres.

The Warton Land Company, like the other undertaking, is due to the enterprise of Mr. H. J. Walduck, of Silverdale, Carnforth. It provides a sea wall which, by a sweep, is to enclose the east side of Morecambe Bay, in the estuary of the Kent, and in the neighbourhood of the town of Lancaster. This concession is held under a grant from the Duchy of Lancaster, and by arrangements made under the Act of Incorporation.

The engineers of the Warton Land Company are Messrs. Brunlees and McKerrow, and considerable sums have been spent on the works, and sufficient has been done to show that the works and undertaking are thoroughly practicable. Although the works have not been conducted with energy, from restricted means, they have been attended with this curious feature, that although stopped at the end of 1879, when the land was left at a certain level, it has still further silted up, showing a large accretion of soil without further expenditure of labour. An area of some 3,000 acres has thus been raised, as I saw last year.

The Cartmel Wharf reclamation of Mr. Walduck, which the Duchy of Lancaster authorities are prepared to approve, proposes, as stated, to deal with the main body of the sands in the centre of Morecambe Bay.

This plan, however, is connected with a design of Mr. Walduck for the Hest Bank and Barrow District Railway (Morecambe Bay Railway). He proposes to start from the same spot on the Lancaster or east side, at Hest Bank, that I did, and he follows much the same line to the west side of the Bay. For purposes of the through traffic I bore more upon Dalton, but Mr. Walduck wishes to strike the shore a little more south, so as to be nearer to Barrow-in-Furness, and to give it a direct railway communication.

At the mouths of the Leven and the Kent he provides wide viaducts, but the ultimate fate of these estuaries must be to be warped or silted, leaving only the river channels. By this route Mr. Walduck calculates that the distance to Barrow from Hest Bank to Barrow will be shortened from thirty-four miles to seventeen, a most material saving for passengers to that town, and ultimately to Cumberland, and the West of Scotland. The whole line will naturally be on a level.

Mr. Walduck has kindly favoured me with some results of his own experience.

"As to the history of the matter generally," he says, "the earliest reference I find is in Stoat's of Lancaster autobiography. He speaks of the marsh which extended from Arnside Well to Bare, near Morecambe, being washed away by the confluence of the rivers Kent and Kier, in 1677, and to its having been 'gathered in' about 100 years previously, which takes us back to the reign of Elizabeth. However, nothing was done to repair the embankments, or to recover the lands, until 1811, when under the Warton-with-Lindeth Enclosure Act, power was taken to appoint commissioners, to set out 'a large tract of land daily overflowed by the sea, but which is

* Brunlees on "The Iron Viaducts for the Ulverstone and Lancaster Railway," p. 7.

supposed to be capable of being recovered, embanked, and converted into arable land.' Power is also given to sell the land so to be set out to the highest bidder, and the fullest powers are given to the contemplated reclaimers to carry out the work.

"Nothing was done under this Act beyond the award which was duly made, and the tract set out, having for one of its boundaries the mid-stream of the River Kent; its acreage was of course continually varying.

"Then came the railway era and your great project of 1836, with a railway crossing the Bay, very much on the line I have recently advocated.

"Then followed Mr. Hague's plan, which was considered by Parliament, and his railway rejected, and that over Shap Fell (the Lancaster and Carlisle) adopted. Mr. Hague proposed to reclaim the whole Bay, and to put in gates for the Leven, the Kent, and the Kier, which he reduced to canals.

"In 1851, Mr. Brunlees carried the Ulverston and Lancaster Railway successfully across the sands, bringing together the ore of Furness and the coke of Durham, to the immense advantage of both districts.

"In 1864, I went to Carnforth to establish ironworks, which would not have been possible in that position but for this railway, and it was then I became acquainted with the Bay of Morecambe, and the possibility of a large work of reclamation being successfully and profitably carried out. The sands, no doubt, had been gradually rising on the western side, because the River Kent (through, it is said, the effect of its railway works, and training walls necessary to protect them) had shifted but little from the shore line from Grange to Humphrey Head. The time, therefore, was favourable, and I gave a good deal of attention to the subject, and also had reports and plans prepared by the late Mr. Scamp, C.E., who was very enthusiastic in the matter, and made some admirable suggestions.

"Negotiations were at length entered into with the parish of Warton, and in the result they agreed to put up their tract, about 10,000 acres, under the award of the Act of 1811, for sale by auction, and I became the purchaser for the sum of £6,300, in 1871. The land so purchased, however, was of an unsuitable shape for reclamation, it being rectangular, and necessitating a larger length of embankment than would be necessary if the corner pieces at Hest Bank and Arnside Point were secured.

"Then followed negotiations for the land on the south side of the Keir with the Duchy of Lancaster, and for the northerly corner, comprising the Silverdale Sands, between Lindeth and Arnside Point, with the lord of the manor of Silverdale. In the end, both purchases were concluded, but at a further expenditure of several thousand pounds. Here another difficulty presented itself. The Act of 1811 sufficed for the reclamation of the Warton tract, but there were rights of the inhabitants at both ends which I was advised could only be settled by Act of Parliament. It was about this time that Mr. Scamp's health having failed, Mr. Brunlees was called in, and by his recommendation I purchased from the Duchy an additional strip of sands covering the frontage of the London and North-Western Railway at Hest Bank. All was now ready for the application to Parliament, and to Parliament I went in 1874. I will not weary with an account of the Parliamentary struggle. The Bill had been so drafted that in the first instance it was thrown out on a technical objection. The address of our Parliamentary agents, however, got us on our legs again, and, after a debate in the House, we were referred back to the Committee. In the result, the Commons gave me all I asked; the Lords passed the Bill, but struck out that portion which applied to the Silverdale Sands. This was a misfortune: it destroyed the completeness of the work, occasioned delay, and some extra expense.

"In the meantime the Warton Land Company, Limited, had been formed, with a capital nominally of £150,000. The costs of the Parliamentary proceedings had been very great, about £7,000, so that my outlay was a very considerable one.

"The company took over all my purchases of land, and the Act of Parliament. They were to have paid for them half in cash and half in shares; but capital coming in slowly, it was arranged that they should only pay £15,000 in cash, so that I was, and am still, heavily out of pocket. No work was commenced for long. In 1876, it was determined again to apply to Parliament for the Silverdale tract, or, rather, to extinguish the rights of the inhabitants over it, but an offer of a limestone quarry being made at Jenny's Brown Point, it was purchased for about £2,000, and work commenced there.

"The work was continued for two years, and was very successful.

"The quarry, from the dip and nature of the stone, was very easily worked; some old buildings were on the ground, which were converted into barracks for workmen; and, so far as the money went, it was well laid out. Still the public would not subscribe, and then, in a fatal moment, we borrowed £10,000.

"This loan was guaranteed by the chairman, who made it a condition that he should have the office in Lancaster, and appoint the secretary, and, in addition, that the remaining uncalled capital of the company should be mortgaged to him, together with all its effects.

"The work still proceeded well, but no new money came in—times were bad—and the public had lost confidence in limited companies. Ultimately, the chairman agreed that one-half the uncalled capital should be applied to the continuance of the work; when that was expended he, with a certain number of directors, recommended liquidation and reconstruction. As this really meant confiscation of the existing interests, it was strongly opposed by myself, and as I have been supported by the majority of the shareholders, the evil day has been staved off, though, as I have told you, the last call has been made, and an action of foreclosure commenced by the chairman and mortgagee.

"I turn now from these weary details to a more interesting subject. Mr. Brunlees had already, from the Furness Railway, designed a form of embankment which had answered well, and a similar section he adopted in our case.

"The method of construction is first to tip a rubble stone foundation, which ensures the perfect security of the work. We found in practice that this is best carried out at a 14 ft. tide level, and the silt very rapidly accumulates behind it.

"The effect of running out the cross wall from Brown's Point has been to raise some 3,000 acres, at least 6 ft. in level, and the process is still going on, although of course more gradually each year, as a fewer number of tides flow over it, and leave their deposit. Some three square miles are now covered by a short, nutritious herbage, which makes an excellent sheep pasture. The area to be enclosed being surrounded with this foundation, and the 'silting up' being carried out to a minimum of 14 ft., the 'closure' of the top bank can be effected at neap tides in summer, without the slightest risk.

"The perfect confidence that I felt, from watching the work, in the method of construction, induced me to design the larger project for enclosing Cartmel Wharf and Sands, and carrying the railway direct from the Hest Bank to Barrow. After lengthy negotiations, terms were settled with the Duchy of Lancaster which, in my opinion, were favourable, and which I have reason to believe may still be obtained.

"The objects I had in view were:—(*a*) to give direct access to Barrow; (*b*) to reclaim 11,000 acres of land; and to do this in such a way as to interfere as little as possible with existing amenities.

"Cockling is a very important and lucrative trade in the Bay; a large number of men, women, and young persons are engaged in it. It is a healthy, hardy occupation, and the people are devoted to it.

"It is not without danger it is carried on in all weathers; the traffic amounts to some thousands of tons in a year; the bags of cockles go direct from the Bay to the manufacturing towns, and carry with them an unmistakable flavour of the ocean to many a cottage. The cockling trade, therefore, must not be interfered with. The cockles live and flourish in the sand, newly turned up by the action of the tide on the river channels; the cockles, in fact, follow the rivers—to live, they must be covered with sea water twice a day. The estuaries are, therefore, in my designs, left sufficiently wide to admit of the full area of the existing cockling grounds. Then property owners had to be considered.

"The line opposite Grange is fixed by the Warton Land Company's Acts of 1811 and 1874, and the line from Humphrey Head, in a south-easterly direction, can hardly be seen from either Grange or Kent's Bank. In the Leven there is no residential property of much importance.

"The outer embankment of the larger reclamation is attacked by the south western winds in a much more favourable position than would be the outer embankment of the Warton Land Company, which it shelters.

"Mr. Brunlees, who is the highest authority on the subject, has certified that there is no physical difficulty in carrying out the work, and the Duchy of Lancaster had a special report from the late Mr. James Edmund Smith, who was entirely favourable to it. Will it pay?

"From carefully prepared estimates, based on responsible tenders for similar work, I make—

The total cost	£750,000
To this I add for compensation, cost of land, and sundries	100,000
	850,000

The land should realise £50 per acre, giving for 11,000 acres	£550,000
Leaving as the cost of the 17 miles of railway	300,000

or less than £18,000 per mile.

"At the outset, assuming the above figures to stand, the cost is low as compared with existing lines.

"The Furness Railway Company's 108¼ miles of railway, had cost them, in 1879, £2,470,000, or about £23,000 per mile, but this was exclusive of the Barrow Docks, which have cost them £1,700,000, and on which dividend has to be paid. It cannot, however, be assumed that the whole of the dock work is productive, so that the cost of the railway per mile is practically increased; still large dividends are paid, and the shares command a premium.

"The 1,100 miles of the London and North-Western Railway had cost them, in 1879, £55,000,000, or, say, £50,000 per mile; but the public, at the present price of the shares, could not invest under £87,000 per mile. The directness of the route would, however, do much to create a passenger traffic. Mr. Smith, the eminent surveyor, was strongly of this opinion, and told me to rely upon it rather than on the mineral traffic, but the mineral traffic would be immense. The Lancashire coal field would be especially benefited, as would all inland business of hematite ore or Bessemer pig and steel.

"Prior to the opening of the Lancaster and Ulcester Railway, the trade in hematite pig-iron consisted of the produce of five small furnaces, producing about 20,000 tons per annum. At the present time, about ¾ million tons are produced, requiring, in round numbers, 2¼ million tons of minerals.

"In these remarks I have looked at the probabilities of traffic and dividend, but there could be no doubt, from a national point of view, the creation of some 18,000 acres of food-producing land is in itself a great and positive gain. Also, it is a positive loss to the nation that passengers, minerals, and goods, should be carried double the necessary distance, aggravated by the fact that they are taken over unnecessary inclines.

"If a dividend of 3 per cent. only could be shown, it might be supposed that it would attract the attention of capitalists, but a dividend of double that amount can be easily shown as likely to accrue.

"It has been said that no income would accrue until the work was finished, which is no doubt true in the main, but the same may be said of almost all works of magnitude.

"With the necessary capital, the whole of the works could be finished in four years. In this country we have not now to look so much at the gain or loss of particular districts, but to work so as to bring our minerals and products together at the lowest possible price, if we are successfully to continue to compete in the markets of the world.

"I have not touched upon the value of the through level route to Scotland by the West Coast, nor the probability of the existence of minerals under Cartmel Wharf."

The Warton Land and Cartmel Wharf undertakings, severally of 7,000 acres and of 11,000, constitute a total reclamation of 18,000 acres, a most important work in reference to the extension of the material resources of the country.

Among the successful reclamations of late years should be reckoned that effected by Mr. Brogden, M.P., at Meathrop, which has been valued at £60 to £70 per acre. The land reclaimed by the Railway Company at Winster Bay and at Holker is reckoned to be of the same value. Here, perhaps, may be noted the experiment of an early friend of the undertaking, Mr. Stockdale, of Cork, as related by Sir Frederick Bramwell. Mr. Stockdale, during the survey, to show what the soil was, sank a cart in the sands, planted potatoes, and in time sent the crop to be shown in London.

With regard to the Southport foreshore, which has afforded a recent and striking case of the difficulties in dealing with the Crown authorities in these cases, particulars will be found in the appendix.

It has been mentioned by me that one main feature of my plan was the development of the natural harbours of the district and the utilisation of their capabilities, more particularly of the Pile of Fouldry. To me this harbour seemed an endowment of nature given to England, which was lost and unknown. The whole coast from Liverpool to the Solway was unfavourable. Liverpool itself carries on an enormous commerce under the greatest difficulties. Perhaps it may be mentioned that I laboured several times to bring into execution a plan which, at that time, would have greatly assisted Liverpool. There was then a straight channel, probably the remains of a through channel, with good water to Formby Point. A harbour near the Ince Blundell Estate, with a short railway branch, and a short cut to the canal, would have given an outer port where the tide was an hour earlier and an hour later than at Liverpool Docks. At the Ribble I had also proposed an improvement.

Nothing in a region reaching to the Scotch coast could compare with the neglected harbour which could float a navy, and from which only some few cargoes of iron ore were casually shipped. The Pile of Fouldry, or Foudry, was better known from the line relating to it by the Elizabethian poet, Drayton, and from its obscure place in the mediæval history.*

Thus, by the geographical impediments of Morecambe Bay, a large north-western district of England was formerly isolated, including the Peninsula of Furness and Southern Cumberland, until the railway just described, and which is also circuitous, was constructed. So far as these regions were concerned, facilities of communication ceased at Lancaster. One chief means of access to Furness was by the small port of Ulverston. On the southern shore of the Bay was another unfrequented district of Lancashire, the Fylde, with a fine harbour, now known as the harbour of Fleetwood. The Fylde has now been brought within the range of active industry, and has become a practical addition to the resources of the country; for this we are indebted chiefly to three men, Sir Hesketh Fleetwood, Mr. George Walter, also projector of the Greenwich Railway, and Col. Landmann, R.E., the engineer of the Preston and Wyre Railway and Harbour undertaking, now absorbed by the Lancashire and Yorkshire Railway.

Proceeding in detail with the subject, the town of Barrow constitutes one prominent feature. The site of Barrow, as seen by me in 1836, had on it an insignificant hamlet. In ten years, in 1847, it had become a village of about 300. This, in another ten years, in 1857, had grown to a small town of 2,000.

The following return by Mr. Thomas A. Mercer, Borough Treasurer, in the volume—"Abridgement of Accounts of the Corporation of Barrow-in-Furness, 1882," p. 189, shows the successive increase:—

	1867	1872	1877	1882
Population	12,000 ...	18,000 ...	38,000 ...	50,000
Rateable Value ..	£43,534 ...	£76,182 ...	£163,800 ...	£215,000
Mortality per 1,000	...	...	18·84	18·50

The inventory of this town or city of 50,000 people, in the borough accounts, contains some interesting entries. There are enumerated portraits, a statue of Sir James Ramsden, Ramsden Baths, presented by Sir James, and numerous town buildings. The amount of the rateable value is, however, one of the best testimonies to the solid character of the progress of Barrow.

In my original report much future importance was attached to Foudrey (Barrow), and its availability for the Isle of Man and Irish Channel trade pointed out. This has been realised, but of late it has shown its capabilities as an ocean steam port. At the earlier time Fleetwood-on-Wyre, at first called New Liverpool, was but newly founded. It presented itself to me as one great advantage of Morecambe Bay in having these two ports of Barrow and Fleetwood as harbours of refuge and alternate ports to each other. Fleetwood was, however, then capable of much improvement, and I proposed to Colonel Landmann to get a scour by cutting through the neck of the western headland, which would have given greater advantages, but other counsels prevailed, and Fleetwood is relatively dwarfed.

At first I had contemplated dealing with the small estuary of the Wampool and the Waver, on the south shore of the Solway, so as to get across the great frith to the west, and obtain a shorter line into Scotland with a larger extent of reclamations. The examination of the channels of the Wampool and Waver was, however, very unfavourable, and I was induced to propose a crossing of the Solway higher up. It is by no means certain that my determination, although then expedient, was without objections. At some after time, under more favourable auspices, the Solway may be advantageously crossed. At that period no one dared to contemplate such works as those over the Forth and the Tay.

With regard to the Solway, I should certainly have preferred an embankment, with provision for navigation to Carlisle—in fact, the same kind of work as Mr. Brunlees afterwards executed in Morecambe Bay. The ultimate extent of land to be reclaimed was at least 8,000 acres.

Although the practical examples are here taken from one district, and although that is an important one, sites suitable for the reclamation of land from the sea, the estuaries, and the rivers, are to be found in many parts of our islands. Our eastern coasts and our southern coasts have localities suitable for enterprise. The success which has attended some reclamation undertakings in Ireland should be an encouragement to further efforts in that direction.

* "Barrow-in-Furness; its Rise and Progress," by Francis Leach, B.A., editor of the *Barrow Times*, Barrow, 1872.

Such undertakings are, however, treated as matters for individual enterprise, or by joint-stock companies, and in all cases, private and foreshore claims are so dealt with as to embarrass the execution of every plan. If a landowner reclaims a tract, he should be in every way encouraged; but where the owner of land, or of manorial or of paramount rights, has not profited by his opportunities for centuries, then, suitable compensation being provided, his claims should not be allowed to stand in the way of those of the nation.

To increase the soil of the country, and thereby to provide employment and food for a larger number of the population, is truly a matter of national concern, and should be so regarded. In Morecambe Bay alone, food for 100,000 people might be grown. A Minister having charge of the national wealth—as a Minister of Agriculture in truth should be—would be able to confer permanent benefits on the country without throwing burthens on the treasury.

What is any one's business becomes no one's business, and this is fully illustrated by the history of a hundred years of Morecambe Bay, where a feasible work left to this day unaccomplished, is only one instance of the neglect of opportunities; and this paper has been brought forward to make the facts better known by an example so striking, and to stimulate public attention to the necessity for action.

APPENDIX.

Statement of Facts Relating to the Southport Foreshore.

1. The Southport Corporation have, for a long time, felt the desirability of acquiring both in the interests of the town and in that of the public who resort thither, the foreshore in front of the borough, and in the year 1880, approached the Duchy of Lancaster with that end in view.

2. In the month of September, 1881, an agreement was come to between the representatives of the Southport Corporation and the surveyor of the Duchy of Lancaster for the purchase of the foreshore by the former on certain terms and conditions, on the necessary Act enabling the purchase to be carried out being obtained. The corporation were given until August, 1884, to apply for the Act.

3. A draft embodying the terms so agreed upon was, at the request of the Duchy solicitor, drawn up and submitted to him for approval.

4. This draft agreement (which is still with the solicitor to the Duchy) has never been either formally approved of or rejected by him, although in the course of a tentative discussion of its provisions with him (when he intimated that the Duchy would prefer to deal with a public body, and would do so on easy terms), he suggested other terms than those embodied in it.

5. The riparian owners, when they became aware of the intention of the corporation to purchase the foreshore, through their solicitors and agents, endeavoured to prevent the negotiations proceeding. They threatened both the Duchy and the corporation with litigation, with a view of proving that the foreshore in question belonged to them, but instead of commencing such litigation, after a delay of nearly a year, they delivered an abstract of title which showed that their claims were groundless.

6. On Friday, the 6th of April, 1883, while both the corporation and the riparian owners were engaged before a Committee of the House of Commons in opposing a private bill, negotiations were opened by the said riparian owners with the Duchy authorities for the purchase of the foreshore.

7. The negotiations were on the point of being concluded when on the 9th of April, the representatives of the corporation, then in London, accidentally heard of them. They immediately sought an interview with the Chancellor of the Duchy of Lancaster, for the purpose of laying before him the facts relating to the arrangement come to between them and the Surveyor-General, and urging that it was one morally binding upon the Duchy. The Chancellor of the Duchy declined to grant them an audience, or even twenty-four hours' time for communication with their colleagues in Southport.

8. Thereupon some of their number, under protest, and in consequence of an absolute refusal both by the Chancellor and officers of the Duchy to grant time for deliberation or consultation with the town council of Southport, made on that day an enhanced offer, which the Duchy officials gave them reason to believe, would be accepted, and personally undertook a heavy pecuniary responsibility in order to avert if possible the disaster to the town of Southport, which would result from the foreshore passing into the hands of private individuals. A copy of this offer is sent herewith.

9. The offer of the representatives of the town council was refused and one made by the riparian owners considerably lower in amount accepted.

10. The arrangement entered into by the Duchy with the riparian owners is not, the corporation of Southport are adviced by counsel of eminence, legally binding upon or enforceable against the Duchy.

11. Since the arrangement come to with the riparian owners, the Chancellor of the Duchy has received a deputation from the corporation of Southport, which was introduced by Sir R. A. Cross, and accompanied by several members of Parliament. After hearing the statements of the deputation, the Chancellor tendered his good offices for the purpose of obtaining an equitable settlement, whereupon the corporation made a further offer, the most liberal

they felt justified in doing in the interests of the borough.

12. The Chancellor has not informed the corporation whether this offer will be accepted or not, but has suggested that the matter should be submitted to arbitration. The terms of the reference which the Chancellor has suggested are, in the opinion of the corporation, however, so onerous and inappropriate that they cannot, having due regard to the interests of their constituents, accept them, and they have caused an intimation to that effect to be forwarded to the Chancellor of the Duchy.

NOTE.—The corporation of Southport has been compelled to come to an arrangement which it feels to be very inadequate to the just claims of the public.

DISCUSSION.

The SECRETARY (Mr. H. Trueman Wood) said Mr. Clarke had alluded to a medal given by the Society for the reclamation of land, and at his suggestion he had referred to the past records of the Society to see what had been done in that way. He found that in the last fifteen years of the last century, viz., from 1785 to 1801, no less than eight gold and two silver medals were given for reclaimed various portions of land, mostly in Essex, though one plot was in Cornwall. The total acreage amounted to nearly 4,000, but it was mostly in small plots, and he found that one of the recipients was the Rev. Bate Dudley, whose portrait, by Gainsborough, was now to be seen in the Royal Academy Exhibition. Mr. Clarke had referred to the case of a man who had planted a crop of potatoes in a waggon which he sunk in the sands, with the view of testing the soil, but he had omitted to give the sequel, which was that when the potatoes came up, he dug up the waggon and drove it to London, as a valuable piece of evidence for a Parliamentary Committee. Such, at least, was the story as he had heard it.

Mr. WILLIAM BOTLY, having observed on the interesting character of the paper, said he was fortunate enough to hear a similar one at the recent meeting of the British Association, at Southport, where it excited a good deal of interest. It was very much to be regretted that the Duchy of Lancaster, the Crown, or any one else, should have the power to prevent or obstruct such great improvements which were national in every sense of the word; since they would increase the area of land, the supply of food, and the opportunity for useful labour. He had seen land in Norfolk, 50 years ago, which had been reclaimed from the sea, growing excellent crops of roots, and he saw no reason why the same thing should not be done elsewhere. He hoped that one result of this paper would be to awaken public interest and discussion, so that eventually some substantial progress might be made in the direction which had been described.

The CHAIRMAN said one of the greatest difficulties in the way came from the Duchy of Lancaster, but he thought the difficulty might be got over. He happened to be one of the trustees of Dr. Williams' Library, in Grafton-street, and he remembered that when they wished to purchase some land there they were told they could not do so; they must rent it on lease; but by giving some £300 above the value of the land, they got over the difficulty, and purchased the freehold. Possibly, the Duchy might be willing to treat in the same way.

Mr. H. J. WALDUCK said he must take a slight exception to what had fallen from Mr. Clarke as to the action of the Duchy of Lancaster, as he had found them willing to offer every facility for the reclamation of the land in Morecambe Bay. He had bought from them two tracts of land, one of 2,000 acres, and the other of 1,700, at a price of £2 per acre, and both parties were satisfied with the bargain. In the same way, when the Warton Land Company had partially accomplished its work, and the larger idea occurred to him of enclosing Cartmel Wharf, he again went to the Duchy and showed them what he proposed; their reply was that they would consult their own engineer, and if his report were favourable, they would be willing to treat with him, and the result was that another contract was entered into for 11,000 acres of land for £10,000, or less than £1 per acre for the freehold. In a work of that magnitude, the payment of £10,000 to the Duchy was not a matter which seriously affected the ultimate issue; the Duchy reserved certain important interests, and were bound to get the full value for what they had to sell. The Duchy, in that contract, however, made certain reservations; they sold the rights of the Crown subject to the authority of Parliament, because there were certain other rights which could only be dealt with by Parliament. One great difficulty was that you had to deal with the two rivers, the Kent and the Leven, on which there were navigable and fishing rights. He found that from two stations on the railway there 160 tons of cockles were sent in the month of January, representing a commerce of about £7,000 per annum, and those fishing rights were reserved. The cockles required to be covered twice a day with salt water, and therefore the estuaries had to be kept of sufficient width, in order to preserve the rights of the cocklers. Again, there were residential rights to be considered, and the works had to be so designed as not to interfere too much with the natural scenery. Apart from these matters, there were very great difficulties in reclaiming the land in Morecambe Bay. When he went to Parliament in 1874, everybody who had any conceivable right presented a petition against the Bill—the railway companies, lords of the manor, fishermen, and lodging-house keepers — thirteen petitions in all. In the result, they were all arranged with but one, but since then times had not been propitious for raising money, and active operations had been suspended for three years. Nature, however, had not suspended her operations, but, as narrated in the paper, had gone on silting up behind the embankment, and there were now three square miles covered with herbage. With regard to the larger question of the railway, other opposing interests came in. It was natural to suppose that the town of Barrow would be benefited by better railway accommodation, and he, therefore, laid the scheme before the principal landowner, the Duke of Devonshire, but after consideration he had declined to support it. The Midland Railway Company was next applied to, with the same result, and with the London and North-Western he had had no better success. When you had to deal with powerful Companies, who were interested in carrying coke and ironstone double the distance it need be carried, you required a good strong backbone to be able to combat them. That was the great advantage of bringing the subject before the Society of Arts, as it enabled public opinion to be brought to bear upon, and he had no doubt, in due time, the facts put forward would bring forth fruit.

Mr. Martin Wood thought it was by no means flattering to our national pride to think that such an important work had been allowed to languish so long. He could not help thinking that if such a piece of land belonged to the Dutch, they would not have taken so long before reclaiming it. There was a popular opinion that the Duchy of Lancaster was something like a dog in the manger, and this idea seemed to be countenanced by Mr. Clarke, though the last speaker did not quite agree with it. The engineering aspect of the matter was very interesting, especially considering the way in which natural forces were relied upon to assist in the work; but he rather doubted whether the straight line he saw on the map was the most likely to be successful as an embankment with which nature was to co-operate. Those works which were most successful generally adapted themselves more to the original formation of the coast line, the channels, and the currents.

Mr. Liggins said he had often been in sight of these sands when yachting, and it had occurred to him what a dangerous place it would be to be driven on by a westerly gale. If it had not belonged to the Duchy, he believed an embankment would have been run across years ago, and it would have been converted into fertile sheep pasturage. No doubt there were local difficulties, though he was not aquainted with them. A few years ago it was proposed to reclaim the Maplin Sands, just below Southend, which were now only used as an artillery range for Shoeburyness, and fertilise them with the London sewage, which would have had the double advantage of affording a valuable adjunct to the food supply of London, and preventing the filling up of the river with the sewage which was now poured into it, but so many difficulties cropped up, that the proposed company did not succeed. Barrow was a mushroom city, only equalled by Chicago in rapidity of its growth, owing to the development of the iron and steel trade; he knew one gentlemen who received as much as £70,000 in one year from royalties from the Barrow Steel Company; and there was a very fine harbour there, but he feared there was little hope of getting assistance from the Duchy or any Government department for improving it. He saw that only last night the President of the Board of Trade rejected a suggestion for doing something to a port in the vicinity, Port Patrick. In former times, this was used for mail communication to Ireland, and was now largely used by fishermen, but it was now falling into utter decay for want of a little timely repair.

Mr. Dipnall remarked that the reclamation of land was not necessarily confined to that now covered by the sea, and there were large tracts of moorland in Yorkshire and elsewhere, to which capital could be more readily applied than to Morecambe Bay. He thought, perhaps, Mr. Clarke had valued the land at £40 an acre at a time when wheat was 100s. a quarter, and that the same estimate might not be correct at the present day. In past years a great deal of land had been enclosed and planted with larch and Scotch fir, and afterwards brought under cultivation; but with very poor results. It cost from £12 to £15 an acre to bring it into cereal cultivation, besides a considerable period of time. The Chairman had alluded to the possibility of iron ore being found under these sands, but no definite data had been given on which such an opinion could be founded. At the same time, seeing that land was constantly being lost on Essex and Sussex coasts, it was important that wherever possible the balance should be made good by reclamation.

Mr. Walduck explained, in reference to a remark of Mr. Martin Wood, that the plan he proposed was exactly such as that gentleman suggested, following the lines of the river channels, but the indications were too faint to be seen on the map. With regard to the question raised by the last speaker, as to the probability of the land coming into cultivation, he had with him a report from a gentleman who had been cultivating some of the land taken in by the Furness Railway, near Grange, in which he says:—"When this marsh is enclosed, cultivation can be proceeded with at once, and the produce will be much greater than on the sandy marshes alluded to. Clover seeds can at once be sown, and will produce large crops. What this description of land will do is best proved by my own experience on the Grange marsh, which I rented from Mr. Maude, when reclaimed by the Furness Railway Embankment. I took 180 acres at the annual rent of 45s. per acre, and the following statement of the stock I put upon it and fed off, during the first year of my occupation, will no doubt be interesting, as showing the early return this description of marsh land will make, before draining or other permanent outlay had been made. I find from my books that I fed off for market during the first year 811 sheep and lambs, and 110 beasts. Land capable of carrying this weight of stock per acre should be worth to rent from 45s. to 50s. per acre. This result, I should also state, was obtained without a plough entering the land, it was merely scarified and harrowed, and sown down with clover seeds." With regard to minerals, hematite ore was found both east and west of Cartmel Wharf, and the finest quality of ore was found at Morton Crag, nearly pure peroxide of iron.

Mr. HYDE CLARKE, in reply, said Mr. Dipnall's remarks had been in part met by Mr. Walduck, but he might add that his estimates of the value were not based on an excessive price of wheat, but on actual experience. He was much indebted to Mr. Walduck for the practical contribution he had made to the discussion, but he must still beg leave to differ from him as to the action of the Duchy, and he thought what Mr. Walduck had advanced had rather tended to strengthen the view which he (himself) had put forward in the paper. The Duchy had certainly shown to Mr. Walduck a larger amount of favour than to anyone else, but with all that, it seemed to him that the great obstacle was the Duchy of Lancaster. He thought it monstrous to require £10,000 for the Cartmel Embankment, on the ground that the Duchy was bound to get full value for what they had to sell. His position was that the Duchy had no right to such a payment, because they had nothing to sell, and the main question was whether the Duchy and those who took advantage of its obstructive position, should stand against the national interests. Mr. Walduck had certainly narrowed the case against the Duchy, but he (himself) had said nothing about the other causes of obstruction, except in general terms. His contention, however, was that it was this attitude of the Duchy which enabled the landowners and others to interpose these obstacles at every point. There could hardly be a stronger instance of this than what were called the fishing rights. They came simply to the right of cockling, the gross amount involved being £7,000 a year. Surely it was possible to give compensation for those rights, on a moderate scale; the idea that this small amount of shell fish was to stand in the way of the wholesale growth of food for the population, was a thing which he was quite certain neither the Society nor the public would countenance. The great obstacle had always been the residential rights. One large landowner wanted to see the water in the Bay when the tide was out, and obstructed the scheme on that ground. Again, the railway companies, which had carried a line in a circuitous way all round the Bay, were now trying to prevent direct communication with Barrow, and thus to impede the access of all the people of England to that town, and to Scotland. But after all, the Duchy of Lancaster was a public department, and he was not without hope that, when the matter had been carried a stage farther, it would be discussed in the Press, and in Parliament, and that, having got rid of the Duchy, they would be able to deal with the other enemies of the community. The whole point was the necessity of national action in matters of national interest, such as this. He agreed that it was very desirable to reclaim waste land wherever possible, and to attend to harbours. There should be a Minister to attend to such matters, which should be constantly and consistently carried out. This question would gain wide publicity through the columns of the *Journal*, and he had no doubt it would be taken up. He had no professional or pecuniary interest in the matter; but looked upon it as one with which that Society had been connected for more than a century, and he had great hopes that before long Mr. Walduck would be able to carry out his plans to complete success, with the greatest possible advantage to the community, as well as to those who were associated with him.

The CHAIRMAN then proposed a vote of thanks to Mr. Hyde Clarke, which was carried unanimously.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

THE DWELLING HOUSE.—GROUP III.—
SUB-COMMITTEE B.

Wednesday, February 13th.—Present: Mr. George Godwin, F.R.S., in the chair; Mr. E. Hoole; Prof. T. Hayter Lewis; Dr. Thorne Thorne; Mr. Ernest Turner; Mr. K. D. Young; Mr. H. Trueman Wood.

SICK AND AMBULANCE.

Wednesday, February 13th.—Present: Inspector-General F. J. Mouat, M.D., in the chair; Deputy Surgeon-General Bostock, C.B.; Brigade-Surgeon W. G. Don, A.M.D.; Mr. V. B. Barrington-Kennett; Surgeon-General W. A. Mackinnon, C.B., A.M.D.; Dr. J. C. Steele; Sir Harry Verney, Bart., M.P.; Mr. H. T. Wood.

THE WORKSHOP.

Saturday, February 16th.—Present: Dr. George Buchanan, in the chair; Mr. W. Warington Smyth, F.R.S.; Mr. H. T. Wood.

THE DWELLING HOUSE.—GROUP III.—
SUB-COMMITTEE A.

Monday, February 18th.—Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Sir F. Abel, C.B., F.R.S.; Mr. H. H. Collins; Mr. Rogers Field; Mr. Baldwin Latham; Mr. Shirley F. Murphy; Mr. Samuel Osborn; Mr. E. C. Robins; Mr. H. Saxon Snell; Mr. H. T. Wood.

CREFELD TECHNICAL SCHOOL.

Technical schools have usually been arranged with the idea of affording instruction in the theory of the various mechanical industries comprised within their scope, the practical illustration of these fundamental ideas being, for the most part, reserved for the period during which the students actually entered the various branches of industry, with a view to which their theoretical studies had been carried on. Thus at Crefeld such means as existed of illustrating the actual practice of weaving were upon a scale calculated to represent the domestic industry, rather than the working of the modern system of factory production. The more extensive adoption of the latter principle in France necessitated similar measures in Germany, and the progress made in this direction has already been referred to in these columns.* With this modification of the general plan of working, a revision of the existing system of instruction became necessary, in order that students might acquire their technical knowledge under circumstances more closely resembling those of their future business career. The manifest need of the facility of illustrating on the spot the theories propounded by the various instructors led to the adoption of a scheme which necessarily comprised the principal features of a large manufacturing business.

Although the school has been established in its present shape mainly through the instrumentality of leading members of the Crefeld silk trade, its objects are by no means restricted to that branch of manufacturing industry. As the director (Herr Lembcke) remarked at the opening ceremony, the institution will, in all its various branches, pay attention to all kinds of weaving, dyeing, and finishing; keeping in view the idea of so bringing together the most varied results of the art of weaving, that manufacturers may acquire the facility of rapidly and with certainty utilising the effects of one material in connection with others, while refraining from being copyists in the ordinary acceptation of the term. The situation of Crefeld makes this programme quite appropriate, for the woollen manufacturing districts of Aix-la-Chapelle, Eupen, &c., are within a reasonable distance, while the important cotton industry of Gladbach is almost at its doors. There are in the immediate neighbourhood many factories engaged in various branches of the linen trade (which was at one time the staple employment of that part of Germany), and the Westphalian linen manufacturing district is not far off, so that the founders of the school have every reason to expect that the various centres of textile industry will be adequately represented amongst the students, the carrying out of their intentions on the subject as referred to being thus rendered possible.

The history of the foundation of the institution (lately opened by Herr Von Gossler, the Prussian Minister of Education), evinces the hearty co-operation of all concerned. The Crefeld Chamber of Commerce had, in the year 1878, given much attention to the question of remodelling the existing weaving school, and on the matter being submitted to the Minister of Commerce then in office (Dr. Achenbach), arrangements were made for sending an organised deputation to France, with a view of studying the operation of the technical educational institutions already existing in that country. This travelling commission included Herr Emil de Greiff, leading manufacturer, and Herr Heimendahl, President of the Chamber of Commerce. The invaluable and constant services of these two gentlemen, since that time, met with appropriate recognition at the inaugural festivities, and the success of the work now completed is attributed, in a great measure, to the practical knowledge of the requirements of the institution which are thus at the disposal of its founders.

The municipality of Crefeld gave the site (over an acre in extent), and contributed £7,500 to the work. According to a recent statement of the *Cologne Gazette*, the Prussian Landtag voted the amount of the cost of the building, which was upwards of £25,000. In addition to the necessary offices, class-rooms, lecture-rooms, &c., there is a shed building with an iron roof, containing eighty hand-looms and a number of power-looms. Electric light is used for illuminating purposes. Two large boilers supply the steam used as motive force. It is in contemplation to extend the present scope of instruction by fitting up a special department with the necessary machinery for testing the application of motive power to hand-looms, and thus allowing the domestic industry to share in the general manufacturing progress of the district. Amongst the incidents connected with the foundation of the school, is the action of the inhabitants of Crefeld, in establishing scholarships for young men wanting the pecuniary resources necessary for prosecuting their studies; this having been the form in which the golden wedding of the Emperor of Germany was commemorated at Crefeld. The maintenance of the school is provided for in the following manner:—One-half by the State, one-quarter by the municipality of Crefeld, and one-quarter by the Local Chamber of Commerce. The latter body has engaged to contribute a yearly amount of £750 from the proceeds of the silk condition house.

A notable addition to the educational resources of the school is afforded by the Krauth collection of tissues, embroidery, needlework, laces, trimming, wall-paper, &c., which was acquired by the State and presented to the school. The original school only had 21 students, while the new establishment has 140 in the weaving branch, and 30 in that devoted to dyeing and finishing.

The following summary indicates the principal features of the course of study at the new school:—
1. The instruction of foremen, designers and manufacturers for all branches of the weaving industry, and for mechanical engineering in connection with it.
2. The instruction of students who wish to learn

* Nov. 9th, 1883.

chemistry, by as thorough a training as possible in all branches of this science, and in its practical application. 3. The instruction of those students who wish to follow the dyeing, bleaching, printing, and finishing trades, in the manufacture of dyes and mordants, and in the methods of testing and valuing natural and artificial dyestuffs and chemicals. 4. The carrying out of practical operations in dyeing, bleaching, printing, and finishing in such a manner as to facilitate students carrying into practical effect the theoretical instruction they have received.

Herr Lembcke, the director of the school, had previously occupied an important position of a similar nature, at Chemnitz. The head of the finishing and dyeing branch is Dr. Lange, from Stuttgart.

THE SILKWORM DISEASE IN CHINA.

The gradual diminution of the exports of silk from Shanghai during the last few years is a subject which has been attracting interest, but of which a definite and consistent explanation has been wanting. From 1875 to 1880, the export of silk from the port in question varied between 65,000 and 85,000 bales a year. During 1881 and 1882, the annual quantity was only 50,000 to 55,000 bales; while the shipments for the season of 1883 will fall short of 35,000 bales; this limit (which was at one moment regarded as an exceptional one) not being even reached, on account of the complete failure of the second crop. The loss to the country is about £4,000,000 sterling, in addition to the diminution of customs receipts, valued at about £340,000.

These circumstances, and the facts which have brought them about, were detailed in a comprehensive manner by M. Paul Brunat, of Shanghai, in a letter addressed by him, on July 12, 1883, to his Excellency Li-Hung-Chang, Viceroy of Tientsin, and Minister of Commerce for the North of China. The district which is referred to is specially that which exports its products from Shanghai, and which (notwithstanding its important yield of silk) is of relatively small extent. M. Brunat has communicated to a Lyons journal a copy of his interesting statement, and explains the ignorance which has hitherto been general, as to the silkworm disease in China, by the fact that the foreigner is kept in the dark, as far as possible, by the natives of that country. The partial reduction alluded to in 1881-82 naturally pointed to the existence of disease, but it was not until the impending results of the present campaign became known, that microscopic research proved the existence of the malady known as *pebrine*, in a form resembling in gravity that which devastated at one time the silk-producing districts of France and Italy. That the disease existed in China in a latent form was well known to all concerned, but it was an equally recognised fact that the hardiness of the Chinese worm, and the favourable climate in which it was developed, kept in check any such grave consequences as would now seem to have resulted.

Attention is called to the fact that the diminution in shipments arises from no falling off in the foreign demand, as all the silk which arrives upon the Shanghai market is, as a rule, disposed of for export. The cultivation of mulberry trees has been on the increase, and the preliminary steps taken each season have been with a view to an augmented production. The reduced yield is attributed to the fact that a great proportion of the worms die before having made their cocoons, or make weak cocoons, poor in their quantity of silk. This season it would seem that, in certain localities, the production has only been 25 per cent. of the normal crop. Bad weather would, of course, exercise a certain influence, but the remark is pertinently made that bad weather is an accidental circumstance, the influence of which is proved to be unlikely by the regularity with which the diminution of yield has progressed of late years.

The facts quoted by M. Brunat, as to the silkworm disease in Europe, are of value in appreciating the situation of matters in China, as depicted by his further explanations. In 1853, the annual yield of silk in France was 40,000 bales, but the effects of a malady similar to that now existing in China gradually reduced the production, until a minimum annual quantity of 3,000 bales was arrived at. At first, it was thought that the disease was in the mulberry leaf, but subsequent investigations established the fact that the malady was hereditary in the silkworms themselves. It was attempted to import seed from lands where the disease had not yet appeared, but all the producing countries were gradually attacked, and although in China the disease only existed in a latent form, it manifested itself clearly in such Chinese seed as was imported into Europe.

During the period from 1865 to 1870, M. Pasteur was engaged (at the instance of the French Government) in carefully studying the causes of the disease, and in devising means of curing, or at least preventing it. His investigations allowed him to report to the following effect:—1. That the most destructive malady was *pebrine*, or disease of the corpuscles, which had caused the ravages of previous years. 2. That this disease is hereditary and contagious, and that it is developed by want of care in the rearing of the silkworms, &c. 3. That the distinctive character of this disease is the presence in the body of the diseased subject of small corpuscles, which can be seen with a microscope, and which increase in number as the malady develops itself. Further, that microscopic observation should be made use of in the selection of seeds or eggs for preservation.

This malady is compared with consumption in the human subject.

It is remarked that M. Pasteur's theories were at first met at times by disbelief, but it is upon the principles thus laid down that the measures were subsequently taken, which have resulted in the French and Italian yield of silk having recovered a good deal

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FRIDAY, FEBRUARY 29, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. Robert W. Edis, F.S.A., delivered the second lecture of his course on the "Building of London Houses," on Monday, the 26th inst., in which he dealt more particularly with sanitation, lighting, heating, and ventilation.

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR ESSAYS.

The Council of the Society of Arts have had placed at their disposal by Mr. William Westgarth, a member of the Society, a sum of £1,200, to be awarded in prizes for essays on "Dwellings for the Poor," and on the "Reconstruction of Central London."

The first prize will be a sum of £250 for the best practical essay upon the re-housing of the poorer classes, and especially of the very poorest classes, of the metropolis.

The second prize will be a sum of £500, for the best practical essay upon the whole subject of the sanitation, street re-alignment, and reconstruction of the central part of London.

In addition to the above, there will be three further prizes of £150 each:—1. For the best treatment of the engineering considerations. 2. For the best treatment of the architectural considerations 3. For the best treatment of the sanitary considerations. Any or all of these last-named prizes may be awarded to the same essay as that to which the £500 prize may be awarded, or they may be awarded separately.

The essays must be sent in to the Secretary of the Society of Arts, not later than December 31, 1884. No essays can be received in manuscript.

The Council reserve the right of withholding any of the prizes, or of awarding the amounts, or parts of the amounts, in any manner which may seem to them desirable. They also reserve the right of publishing any essay to which a prize may be awarded.

Further particulars can be obtained on application to the Secretary, John-street, Adelphi.

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FOREIGN AND COLONIAL SECTION.

Tuesday, February 26, 1884; B. Francis Cobb, Vice-President of the Society, in the chair.

The paper read was—

REFLECTIONS ON CHINESE HISTORY, WITH REFERENCE TO THE PRESENT SITUATION OF AFFAIRS.

By Demetrius C. Boulger.

The complication in Tonquin has not developed in the rapid manner that would have been in accordance with the habits of this continent. The crisis between France and China continues, but, to all appearance, it is less acute at this moment than it has been for some months past, although the imminent attack on Hunghoa and Bacninh may have decisive results one way or the other. France remains in actual possession of much of the northern province of Annam. Her arms have been victorious on every occasion. The enemies she has encountered have experienced the gallantry and discipline of her armies. Even the obstacles of the climate have been vanquished by science. On the other hand, China has done nothing to secure respect for her pretensions, to retain the sympathy of those who believed that she had the moral right on her side, and to convince her opponent, and the world at large, that she has the power and the disposition to enforce respect for those rights which both Prince Kung and the Marquis Tseng have defined with much force and clearness, as will be found on reference to the pages of the Yellow Book. Yet, slow and disappointing as, in a certain sense, China's diplomacy has been to those who thought that she had acquired the decision in council and the celerity in action of a European power, I shall be bold enough to say that those who were convinced that the Chinese would act in their own way, and not in servile imitation of the practice of this continent, never believed in the Chinese Government taking some open step of hostility against the French in the prompt and gallant manner that would have received the transitory admiration of this and some other countries, and that would have entailed defeat and disaster. The Pekin Government has placed on record, in the clearest possible characters, the rights it possesses in Tonquin. Those rights have been infringed, and some may consider that they have been surrendered. But a brief study of Chinese history would suffice to convince the most sceptical that the Chinese have acted on the present occasion exactly in accordance with their own fashion, and as they might have been expected to do, as well as to prove that dilatoriness in enforcing rights must not, in the case of China, be held to indicate the determination to abandon them.

The fact above all others which the study of Chinese history impresses upon the mind, is the extraordinary and undeviating persistency of the people, and the resolution with which the Government ever recurs to the pretension of paramount authority throughout a vast surface of the Asiatic continent. It is true that that claim has frequently been reduced to an empty pretence, that there have been long periods of the cessation not merely of all authority but of all intercourse between the central authority and its tributaries, and that the task of conquest has had to be resumed, on many occasions at great sacrifice and under extreme difficulties. It is mainly because it has been so, that the fact is of more than historical importance, that it illustrates the pertinacity of the Chinese, and that it serves as a key-note to their character. In dealing with other peoples and empires, the historian finds the progress of national character and dominion marked by regular and duly ordered stages, until the apogee of power is reached, and the decline, rapidly accelerating in its descent, follows as inevitably as the night does the day, until the people are extinct or enslaved, and their greatness has become a tradition. It has been the same in Asia as in Europe. The famous dynasties of India, Persia, and Central Asia, have passed away as completely as the empires of Greece and Rome. But China has been the exception, since the beginning of tangible as opposed to traditional history. With her, the necessary penalty of decay has not followed. She has sounded the lowest depths of misfortune; she has reached the last stage of decrepitude; and then, by some marvellous essence in her composition, exhaustion, instead of entailing destruction, has facilitated the recovery of vigour. The historian could point to more than twenty occasions, within the last 2,500 years of China's existence, when it would, to all seeming, have been justifiable to exclaim over the dismembered fragments of the Middle Kingdom, *Fuit*. Yet it has emerged from all these calamities with undiminished power and reputation, and seems to have acquired renewed strength from the closer knowledge of misfortune. Sometimes the re-invigorating influence has come from a foreign conqueror, such as the Mongol, and the Manchu; but more frequently the restorer has emerged from the ranks of the people themselves, in the garb of a religious devotee, or of a social reformer. But whether it was Taitsong or Hongwou, Kanghi or Kublai, the result has been the same for the Chinese people. They have been rescued from the evils of civil war, or relieved from the oppression of effete despotisms; and in return, they have, by their diligence and assiduity in peaceful pursuits, restored the prosperity of the State, and sustained an administration capable of asserting the dignity and privileges of the Dragon Throne. The history of China is composed of successive periods of greatness, decay, and revival, which would be wearisome to the student were it not so peculiarly distinctive of this one State and people, and so opposed to the power, decline, and fall of less stable countries and less favoured nations. The Chinese have a traditional saying, that "after long abiding union dis-union must come, when again union will revive," and, while it accurately illustrates the course of Chinese history, it appropriately expresses the self-confidence of a great people, whose first article of faith is that their kingdom has been established by Heaven.

These periods of dissension and deliverance have been followed not merely by the restoration of domestic peace, but also by the vigorous reassertion of all claims to exercise paramount authority over the minor states adjoining the immediate territory of China proper. The same idea which urged Tsin Chi Hwangti—in the 3rd century before our era—to send his generals into Central Asia, Tonquin, Burmah, and, perhaps, even India, actuated Wang Kue, a famous Chinese general, a century later, when he collected a vast host for the express purpose of destroying the Tartars of the desert. Wang Kue failed, and committed suicide; but his successors, Wei Tsing and Hokiuping, waged a successful war against the barbarian enemy. During fifty years, the struggle continued, and although the Emperor Vouti had frequently to complain of the inconstancy of fortune, he extended the influence of China far beyond the desert of Gobi. Another century passed before the supremacy of the Chinese was fully recognised, but at last it was stated, in B.C. 50, that all the peoples from Shensi to the Caspian acknowledged it, and the "troops of justice," as the Chinese were called, returned. After the lapse of yet another century, the greatest of all the Han generals, Panchow, led his army through Eastern Turkestan to Bokhara, planted his standards on the Oxus and Jaxartes, and for a moment contemplated the possibility of crossing the Caspian, and carrying the terror of Chinese prowess into this continent, then subject to the sway of Imperial Rome. Fifteen kingdoms were stated to have been subjected by Panchow, and to have accepted the authority of his Emperor. I am obliged to direct your attention to this remote period, for the reason that it was then that most of the claims of Chinese suzerainty originated, not only in the Turanian regions, but also in Cochin China, Corea, Burmah, and Tibet. Moreover, these campaigns had the most important influence on European history; for before the legions of Panchow fled those Hiongnou, or Huns, whose descendants, four centuries later, lowered the pride of the Cæsars, and debased the majesty of Rome.

It is not my wish to obscure the practical point by detaining you over the events of that remote period. We have only to recollect the antiquity of China's pretensions in the first place, and in the second to consider how vigorously they have been repeatedly asserted, in the face of dangers that would deter the timid, who dread the responsibility of their own acts. When the present reigning dynasty conquered China, and assumed the personal direction of affairs, the Empire had been long exposed, under the degenerate Mings, to the attacks of foreign enemies, and to the insults of its vassals. But it had redeemed some of its diminished character, and had at least demonstrated its consistency, by successfully defending Corea against the invasion of the great Japanese ruler, Fashiba. The Manchu conquest, followed by the formidable revolt of Wou Sankwei, covered a period of more than half-a-century. When peace had been restored within the eighteen provinces of China, it left the young Emperor Kanghi in face of those obstacles and difficulties with which a Chinese ruler will always have to cope. Neither the pacific inclination of the Chinese people, nor the pre-occupation arising from the formation of a new administration, could avail to avert the complications continually arising with turbulent neighbours and refractory dependents. The latter part of the 17th century found China engaged in dealing with the same problem which had forced itself upon her two thousand years earlier. It was not without reluctance that Kanghi felt himself compelled to establish the claims attached to his high office by recourse to the sword, both in Tibet and in Mongolia. Even he, great ruler as he was, and assisted by the talent of Feyanku and other able generals, failed to secure a durable peace. He overthrew his adversary Galdan, one of the most remarkable men the deserts of Asia have produced, but he did not obtain the enduring peace which was desirable, and even necessary, in the interest of China, and which could only be obtained on the basis of her supremacy. The full accomplishment of his designs was reserved for his grandson, Keen Lung, who extended the dominion of China to the Pamir, garrisoned Tibet, and defeated the mountaineers of Nepaul, and enforced her suzerain rights among all the neighbours, who had been accustomed, in times past, to ask investiture for their rulers, and to implore aid in adversity as suppliants to the Dragon Throne. For the practical meaning of claims which some would have us disregard or treat as illusions, the Chinese, therefore, have only to go back for a period of less than one hundred years. In 1792, Keen Lung sent an army of 70,000 men to defend the people of Tibet against the turbulent Goorkhas, who had plundered one of their chief cities. The Chinese gained several victories, advanced to within a short march of Khatmandeu, and imposed a humiliating peace. This was not the last occasion of China's interference, for in 1856, when the late Jung Bahadur had begun to encroach, the Chinese Amban then declared that unless he promptly desisted, he "would report all to the Emperor, and bring down a large army to recover the Tibetan lands and to invade Nepaul, promising—with an oath repeated seven times—that in such case he would ravage Nepaul, destroy its capital, and carrying off its malik, would send him to the Emperor at Pekin, to be presented to the Emperor in his most angry mood." Even as remarkable a man as Jung Bahadur was impressed by the power of China, and Sir Richard Temple has told us how he used to "feelingly recount the blows inflicted upon Nepaul by Chinese armies." Nor is there the least reason to suppose that the Chinese attach less importance than of yore to the policy of keeping, on the one hand the landmarks of the Empire as far removed from the centre as possible, and on the other of maintaining the buffer States which have separated China from India, and which have served to keep borders held by tribes more or less independent from falling away from their allegiance. The events of the last twenty years have shown that the Chinese attach no abated value to these possessions. In our own day, we have seen three great rebellions repressed within the limits of China proper. We have witnessed them followed by a campaign in the very interior of Central Asia, which, whether we like to sneer at some of the details or not, was triumphant, and triumphant over an opponent who had been considered by capable English officers likely to re-establish a vigorous dominion at the expense of China, and to offer a not ineffectual resistance to the progress of Russia. The effect produced by the campaigns of Tso Tsung Tang was increased by the bold attitude assumed towards Russia in reference to the province of Kuldja, and by the haughty refusal to accept a treaty that defrauded China of a portion of her rights. It is not in face of those events that the statement will be lightly accepted and believed that China is prepared to waive her rights in the States beyond her frontier. The whole lesson impressed upon us by her history is, that time fights on her side; because she has nothing to gain by being precipitate, therefore, her silence must not be construed as signifying an abandonment of her pretensions.

The history of China tells us much with regard to the past, but it may be said that it cannot inform us how the claims which originated at a remote period, and which were asserted by superior resources and determination, are to be made good in the face of the resolute aggression of a great military state like France. It is no use, it may be said, quoting the precedents of Keen Lung's campaigns—even that of the Goorkha overthrow in the passes of the Himalaya—for the simple reason that the French are different from those opponents, and that they seem to be as resolute as they have shown themselves to be formidable. There would be greater force in this objection if it could be assumed that the Tonquin question is one that France will be able to settle in a single campaign. Two years have elapsed since Captain Riviere planted the tricolour on the citadel of Hanoi, and the interval has been taken up with unceasing military operations. Yet the French do not now command the whole country, within even twenty miles of that town. It is not at all clear, therefore, that the old qualities of pertinacity and endurance are not the most important towards effecting the solution of the present difficulty; and in them it is reasonable to believe that China is as well equipped as ever she was. At the same time the dangers of the situation, not merely in Tonquin but wherever the Chinese claims to predominance come into contact with the tendencies of strong Governments to encroach, are aggravated by the uncertainty felt as to the degree of importance attached by China herself to any one of these possessions, which sometimes is little more than sentimental. The wish to respect them is hampered by the doubt on this point, while the designs of those who seek to ignore or dispute them are facilitated. The lessons of Chinese history are almost as instructive in this matter as they are on the subject of how the Empire acquired and retained the prizes of military prowess. The Pekin Government has evidently drawn a very nice distinction, although it declines to reveal the basis on which its judgments are formed, between those matters which are important and to be contended for, and those which are not worth a serious effort to retain. Thus we have seen it relinquish its hold upon Siam, acquiesce for the time in the loss of Loochoo, surrender the vast territory of maritime Manchuria, and facilitate the opening of the kingdom of Corea to all the trading nations of the world. Each one of these events involved an infraction of the rights of China as the paramount power. On the other hand, we have seen the Celestials clinging with tenacity to rights that are certainly of no greater practical value than some of those she has waived, and giving increased meaning to dormant claims, by embarking upon protracted and arduous campaigns. It still remains to be seen under which category the Chinese consider that the question of their invaded rights in Tonquin should be placed, and the balance of peace and war depends on the decision arrived at in Pekin, whether the operations of the French on the Songcoi are to be regarded with the calmness that acquiesced in the loss of maritime Manchuria, or with the indignation that decided the recovery of Kashgar and Kuldja.

While the history of the Empire affords precedents in support of both conclusions, the language of the Tsungli Yamen itself has revealed a certain amount of doubt upon the subject—not indeed with regard to the extent of the Chinese Emperor's rights in Tonquin, but on the point of whether the Empire would be seriously injured or not by the operations of France. There seems to have been a hope that even the loss of the Songcoi Delta might not deprive the southern provinces of Kwangsi and Yunnan of the protecting belt of independent territory which served to supplement the weakness and shortcomings of mandarin rule among turbulent subjects, and on a disturbed frontier. But the much larger form which French operations have assumed in the course of the campaign, both in Annam and in Tonquin, has precluded the idea that the solution of the Red River question will be anything short of the absolute contact of the two countries along a frontier which, so far as China's pretensions go, will be one that is very much curtailed. It is not permissible in this Society to pursue the inquiry any further; but there can be no question that such a climax of affairs is one most calculated to give the fullest weight to the original views of Chinese statesmen on the subject of their feudatories. Did the French only seek to found a second Hongkong at the mouth of the Songcoi, or were they even to be satisfied with a portion of the delta, the Chinese might, perhaps, acquiesce in an arrangement which averted the necessity of strong measures, and which left their relations with the Lolos and other border tribes undisturbed. If the situation be found to admit of a compromise, then possibly they will revert to the policy of concession which has been observed towards the chief foreign powers during the last twenty-five years. But if there be no middle course practicable, then, undoubtedly, the Chinese will revert to that mode of action which is most in accordance with their historical traditons, and with their own predilections.

A study of Chinese history teaches us something more than that the people and Government of the Celestial Empire have the instinct of superiority, and the great gift of governing subject races. It shows that they are not devoid of the power without which great pretensions approach the ridiculous. Notwithstanding their strong partiality for peace, their unconcealed and, let it be said, very foolish contempt for the profession of arms, and their consistently acting on the assumption that the best of all remedies is the one attained without violence—notwithstanding this unequivocal declaration in the interests of peace, the Chinese have engaged in a large number of wars, and of wars, moreover, in which they were uniformly successful, until they came into contact with the superior knowledge and resources of Europe. It is assumed by those who will not take the trouble to inquire into the facts, that the last foreign war with China was one of the simplest affairs possible, that victory was achieved, and the Pekin Government humbled, in a single campaign, and that the Celestials proved themselves contemptible soldiers. The facts were indeed different. During a war which continued for four years, the English naval and military forces, although always possessing a natural and well-deserved superiority, were frequently reduced, after some signal success, to impotency, by the impossibility of reaching any vital spot of this singular empire. The possession of Canton failed to produce any decisive effect at the capital; and when the Peiho forts were carried, and a treaty was concluded at Tientsin, the Chinese employed the twelve months intervening between its signature and its ratification in strengthening those forts, and preparing for a resolute defence of the metropolis. When the English envoy sought to make his way up the river with what seemed to be a sufficient force, he was rudely repulsed; and it required another twelve months to enable a strong expedition to be fitted out and despatched to the North of China. Then the Chinese were vanquished as much by superior strategy as by superior strength; while the unanimous decision of every military authority who went through the campaign and who has left his views on record, from Lord Wolseley downwards, was that the Chinese soldiers fought with great intrepidity, and only required better weapons and more skilful leading to have made a more stubborn and, perhaps, an effectual resistance. In face of their opinions, it would be hard to say that China does not possess the power and resources necessary to engage in war on a large scale. But the indications of history with reference to the present situation, do not cease with the campaign of 1860. We have the long wars with the Taeping rebels to assist our judgment towards a just conclusion. We have the struggle against the Mahomedans in Yunnan on the one hand, and of Kansuh and the Central Asian provinces on the other. There was much in those wars, carried on by Chinese generals and officers, to show that China was moving, and that her military efficiency was far from contemptible. But in each and all of these contests the Chinese acted as if they had no better ally than time, and that the enemies they could not overthrow in a single encounter they might vanquish out of sheer weariness. They afford no exact precedent, therefore, for the collision between China and a European power which would rely upon the celerity of its movements as the surest way of worsting a cumbrous and unwieldy antagonist. But we are, fortunately, provided with a more exact parallel for this higher mode of warfare, in the achievements of that remarkable man Chinese Gordon, who has proved himself, in more than one continent, the last support of enfeebled rulers and embarrassed administrations, and who now seems to have added a new chapter to the "Arabian Nights," by the spectacle of light and confidence which his mere presence has afforded in the midst of the dreary blackness of the Soudan. General Gordon's campaign in the country round Soochow, at the head of Chinese troops of whom a portion were led into action by Chinese officers, went very near to completely demonstrate the fact that a Chinese army might be made as mobile as a European. But it may be said that the excellence of the "ever victorious army" consisted in its foreign leading and in the genius of its commander. Of course, the whole credit of the victories which entailed the dispersion and flight of the rebels along the Grand Canal belongs to General Gordon, but he has himself placed on record his opinion that "Chinese troops, led by Chinese officers, will fight very well," and that, as a matter of internal policy for China, they are to be preferred to placing Europeans and Americans at the head of the national forces. Although the matter does not admit of decisive proof, there is a large quantity of evidence, both in the actual facts of history and in the opinions of those who had direct practical acquaintance with the Chinese as combatants, to show that they possess all the essentials to form an efficient army, and that the shortcomings of military discipline might be compensated for by superior numbers, the advantages of position, and the dogged determination of the people.

There is, consequently, no reason to suppose that there can be any better guide as to what China will do on the present occasion, in her dispute with France, than to ascertain by the light of history what she has done on similar occasions in the past. She has never been oppressed by any great feeling of timidity, although the threats used in her name are sometimes in excess not of her wish but of her sensible perception of what is possible. She has made some progress in military knowledge. She has less reason now to be afraid than at any time since the death of Keen Lung. Her dominions are at peace. There is no other burning question to distract her mind. With England and with Russia she is in accord. She has collected a vast quantity of munitions of war, and she has acquired the nucleus of a disciplined army. When she had none of these things, when, moreover, she was torn to pieces by internal dissension, she presented a bold front to the demands of England and the other nations, and proved herself capable of a protracted, if none the less vain, resistance. Is there much reason to believe from these facts that the Chinese Government, however tardy its action may be, will submit tamely and without a murmur to the infliction of an injury upon interests that it cherishes without the least attempt at concealment? A French writer has very truly called the Chinese "monopolisers," and history tells us that, where they have once been supreme, they are expelled only with the greatest difficulty. Their memory is most retentive, their patience is above proof, and they are not easily diverted from the main point of a dispute to any side-issue. They have, on the other hand, it must be admitted, a way of extricating themselves from situations in which the preservation of peace seems next to impossible, and not merely of adapting themselves to altered circumstances, but of actually extracting personal advantage from a situation that seemed sure to entail their discomfiture. The French may be able to convince the Chinese that the re-arrangement of Tonquin may yet be carried out without injuring their interests; but unless they can and will take the trouble to do so, there can be only one issue for the present complication. Chinese history of recent times contains, no doubt, instances of disagreeable surrender, but it is impossible to find one where the Chinese would have to withdraw more emphatic declarations, or to make greater concessions to an aggressor than in the case of a French conquest of Tonquin. For that very reason if the history of the past furnishes a sure clue to the events of the future, it must be said that China has gone too far to draw back, and that the decisiveness with which her opinions have been expressed betrays the absence of all inclination to retreat, and bow to the decrees of a harsh necessity.

DISCUSSION.

Mr. MARTIN WOOD said that Mr. Boulger had not traced to its root the remarkable tenacity and persistence of the Chinese people and State, as no doubt he could have done. He mentioned that to revive the remembrance of a remarkable article in the *North American Review*, in 1879, by Mr. W. Williams, probably an American missionary, who wrote on the social status of China. His object was to explain the durability of the Chinese State, and he went back to two or three of those revolutions, which showed how the Chinese commonwealth remained through all such changes, with its permanence as a State as assured as ever. All this accorded entirely with the conclusions of Mr. Boulger's paper. According to his recollection, Mr. Williams traced the State durability to the strength of family principle, and referred it to the ancient Hebrew and Biblical history. He explained how this had stood firm through many revolutions and disasters by virtue of the persistence of the family hierarchy. There had been lately some indications of weakness in their material condition, and he should like to ask whether famines and droughts had been more frequent within recent times than formerly, and whether they could be traced to any undue denudation of forests, and the demands of an increasing population.

The CHAIRMAN said there was the one peculiarity about the Chinese, that after a long period of apparent unchangeableness, during the last forty years, there had been a great change in the country, and especially in the military habits of the people. When the first opium war was fought, and our troops went up the coast to occupy Tientsin, they were met by some men with matchlocks, but the majority used bows and arrows and cross-bows, and the artillery was hooped round with iron. The guns in some of the forts were of a pattern which made them look like Armstrongs, but they were made in one casting, and were probably more dangerous to the Chinese than to their enemies. But all that was now changed; they knew the value of a Krupp gun as well as a European; they had Armstrong guns and rifles very similar to those with which the German army were provided. They made their own gunpowder, and they had depositories of ammunition, arms, and warlike materials at different parts of the kingdom. This change had taken place chiefly since the English and French troops marched to Pekin; and the last time he was in China, two or three years ago, he was amazed at the difference in the fortifications. For instance, forts which he first remembered as a series of earth works, with the guns open in the embrasures, were now of the most perfect kind, more nearly resembling our own at Portsmouth. Up the Yang-tsze-kian they had armories where they could cast large guns, had lathes for turning them, and where they could turn out anything required in the shape of warlike implements. These factories were originally established under the supervision of Europeans, but the Chinese had become so apt, that they could now dispense entirely with European assistance. He had no doubt that if, unhappily, war should ensue between the French and Chinese, there would be a very different force to deal with from that which there was at the time when the combined armies marched to Pekin. He would conclude by proposing a cordial vote of thanks to Mr. Boulger, for this very able paper, which had evidently been prepared with more than ordinary care.

Dr. LEITNER, in seconding the motion, remarked that, consciously or unconsciously, some passages in this extremely able paper reminded one of parts of Gibbon, which were not, perhaps, altogether inappropriate, especially that portion in which he spoke of Roman discipline confronting barbarian numbers, This would perhaps sum up the conclusions to which those who did not altogether share Mr. Boulger's views as to the possibility of an encounter between the French and the Chinese, would arrive. But on such a question, the reader of the paper was a greater authority than one like himself, to whom the Chinese fell under the vague head of Turanian, or, in other words, under the convenient algebraical form of x, the unknown. Amongst philologists, there should be a great division made between the known and the unknown families of language; the known being the Semitic and Aryan, and the unknown or Turanian, under which class was put the great mass of information they had yet to obtain. He was afraid that statesmen were very much in the same position, and that a good deal of what they had to do, if not altogether deserving the way in which Mr. Boulger had characterised Chinese Gordon, as "the last support of enfeebled rulers and embarrassed administrators," must certainly, by their own admission, come under the convenient x, or the unknown. In the case of Yarkand, they had, some years ago, an example which ought to be immortalised by those who worshipped red tape. The Chinese Governor of Yarkand had orders not to fight until the Chinese army came to relieve him, but to hold the fortress, though he was surrounded by the troops of Yakub Khush Begi. It seemed ungracious to object to any little circumlocution or difficulty of routine that might be encountered in this country, when they had that splendid example, followed by the most remarkable instance of heroism in the Chinese Governor of Yarkand. When the enemy approached he would not give up the fort, and he would not fight; but he constructed a mine of gunpowder under the Council-room and assembled his Council; and when the first enemy put his head into the room, he quietly dropped the ash from his opium pipe on to the train leading to the mine and blew up the fort. He hoped that "the spectacle of light" given by the fair complexion of General Gordon, and the confidence which he felt in himself, and inspired in others, would cause in the midst of the dreary blackness of the Soudan, not only the pacification of the Soudanese now, but also within the next few months, a satisfactory settlement of the question which would then have to be confronted. The Chinese army going to relieve Yarkand sowed their crops, and reaped them, and ate them, and then advanced next year, and sowed their crops again, and then advanced again to the relief of Yarkand. They certainly drove out, however, when they did come, by their crushing numbers, Yakub Khush Begi, and made an end of the matter. He hoped, therefore, that, in spite of the delays of English redtape, success would crown our efforts as it had those of the Chinese. Mr. Martin Wood had referred to the question of the famines, and asked what steps had been taken for their prevention in more recent times. The Chinese Government appeared to have taken the step of allowing the governors of their outlying Tartar provinces to do what they liked until famine actually occurred, and then, when grave complaints reached the capital, the governor was decapitated. The consequence was that within the last forty or fifty years, famines in Chinese Tartary had been exceedingly rare. He was glad to be the exponent, however feebly, of the gratitude which he was sure all who had heard the paper read must feel to Mr. Boulger.

The motion having been carried,

Mr. Boulger, in reply, said with regard to the material condition of the Chinese, and the question whether famines were more or less frequent than of old, it was hardly possible to give an exact answer. It must be remembered, however, that these famines, of which they had heard so much during the last 20 years, had always followed in the train of rebellion. They had heard of famines decimating the provinces of China, but they were the results of the Mohamedan and Taeping rebellions; there were no famines in the provinces which were not disturbed. Another cause of material injury to China was the periodical inundations of the yellow river, which had always occurred since its course was diverted a thousand years ago. Beyond those two facts, there was really nothing known of the material condition of China to make one suppose that she was less prosperous than she has ever been; the state of her trade, however doubtful it might be for Europeans, was certainly most favourable to the Chinese.

TWELFTH ORDINARY MEETING.

Wednesday, February 27th, 1884; E. A. Cowper, M.Inst.C.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Capper, Robert, Westbrook, Swansea.
Crossley, William J., Glenfield, Altrincham.
Curtis, Richard, Limehurst, Altrincham.
Grindley, John, Millfield, Highgate, N., and Upper North-street, Poplar, E.
Kerr, James, Church, near Accrington.
Kirkpatrick, Andrew J., 179, West George-street, Glasgow.
Lloyd, Frederick James, 4, Lombard-court, Gracechurch-street, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Barker, Richard, Morialta, Forest-hill, S.E.
Binns, Edmund Knowles, The Rosary, 3, Montgomery-road, Sharrow, Sheffield.
Chester, Henry, 2, The Elms, Clapham-common, S.W.
Crossman, Colonel William, R.E., C.M.G., United Service Club, S.W.
Duncan, David John Russell, 32, Queen Victoria-street, E.C.
Habgood, William, 20, Farringdon-street, E.C.
Howard, Frank Geere, Oaklands, Cricklewood, N.W.
Humber, Thomas, Beeston, Notts.
Immisch, Moritz, 119, Torriano-avenue, Camden-town, N.W.
Jármay, Gustav, Winnington-park, Northwich.
Jones, Edward, 145, Strand, W.C., and Holmdale, Wimbledon.
Mills, Percy Batt, Belmont, Chigwell, Essex.
Parkes, Dr. Louis C., 51, Cadogan-square, S.W.
Sharp, Sidney, Millmead, Guildford, Surrey.
Wilson, Miss Lillian, Boston-house, Chiswick.

The paper read was—

INTERNAL CORROSION AND SCALE IN STEAM-BOILERS.

By G. Swinburn King.

In presuming to offer any remarks on corrosion and scale in steam-boilers, I have no thought of instructing eminent engineers and chemists in a matter concerning which it would better become me to listen to instruction from them. But, profiting from that which they have already taught me, my desire is to call renewed attention to an important subject, and to endeavour, in popular language, to interest the philanthropist and the economist, to whom it especially appeals, and to lay before the owners of steam-power, and their superintendent engineers, the results of my researches; pointing out what I believe to be the surest methods of overcoming evils which are known to cause a considerable loss of life, and an enormous annual waste of property.

Further discussion and inquiry may result in the discovery of better methods, but, in the meantime, those that have proved effectual cannot be too widely made known.

A former connection with the Admiralty led me to reflect on the importance of this question, and to take a great interest in it. Since that period I have made personal investigation into the subject in the great shipping ports of London, Liverpool, Cardiff, Hull, and other places; and in the manufacturing centres, such as Warrington and the neighbouring towns.

From an economic point of view, the subject affects the widest interests in this country: the birth-place and home of steam-power. Besides its relation to the Navy and the shipping world generally, it is of vital importance to every owner of factory, mill, or mine; and, as it must ultimately affect the cheapness of production, it should concern every class and every consumer.

Since the days of James Watt, now a century ago, when the giant steam was finally subjugated to the will of man, there has been a constant cry for more power.

In the earliest days of steam as a motive power, boilers were sometimes made of wood and afterwards of stone; and these primitive materials were followed by the adoption of cast iron, generally in a spherical or hemispherical form, as being best calculated to hold in bonds the expansive force. Copper was found to be inferior in tensile strength, and too expensive for the purpose. Cast iron has now been discarded for wrought iron and steel, and the spherical form of boiler has given way to the tubular or cylindrical, with tubular furnaces and flues running through and within it. The Cornish, the Lancashire, the Galloway, and marine boilers are all constructed after this fashion; and the greatest efforts of our ablest engineers have been directed, not in vain, to construct a boiler strong to resist, strong to drive, and strong to meet the cry for more power.

But, from the moment one of these structures is mounted into its position, insidious foes are working, which, sooner or later, will compass its destruction; and among the foremost of these must be placed corrosion and incrustation, or scale. These, while constantly reducing the strength of the boiler, appear to be the most common cause of explosion.

The Boiler Explosions Act came into force on the 12th July, 1882, and from that time to November, 1883, fifty-seven explosions had been reported to the Board of Trade. This Act, however, has only a limited scope, and does not apply to steamships having certificates from the Board of Trade, nor to H.M. ships, &c., nor to boiler explosions on railways, nor to those investigated under the Mines Regulation Act of 1872. The total number of deaths resulting from these particular catastrophes was thirty-nine, and in addition, forty-six persons were injured. Such fatal explosions —happily rare—as that on board the Royal Mail steamer *Severn* last November, by which nine persons lost their lives, are excluded from this return.

Mr. Gray, in his report to the President on the explosions occurring in the twelve months ending July, 1883, states that—

"The prevailing cause of explosion is the unsafe condition of the boilers through age, corrosion, wasting, &c.; and [he adds] a noticeable feature in many cases is the absence of any effort on the part of the steam user to ascertain the condition of the boiler, and, consequently, of any attempt to repair defective plates or fittings."

The report of the Registrar-General for 1881, for England and Wales alone, shows that the total number of deaths in that year, directly attributed to boiler explosions, was 51; but, besides these, no fewer than 652 persons were killed by scalding in various and unstated ways; and though it cannot be stated as a fact, it is fair to assume that at least a proportion of these deaths by scalding, from ungiven causes, arose from boiler explosions. These, it must be remembered, are the bare official returns of the killed. Add to them only an equal number of wounded, and it needs no vivid imagination—no affectation of word-painting on my part—to picture to your minds the greater suffering, unrecorded, of mutilated men and women, of bereaved families, and homes made desolate.

If some of these terrible disasters can be traced to their cause, and a remedy found—if life can be saved—as I am fully convinced it can be, this paper will not have been read in vain. Such is the humanitarian side of the question—but the loss of property, arising from decay, is not indicated by the number of explosions, and is far in excess of that which is thus suddenly occasioned. Every steam user knows the heavy annual outlay necessitated by rapid deterioration of boiler plates and tubes, the amount of fuel wasted by reason of scale encrusting the interior, the injury it inflicts on the boiler, and the labour and expense of chipping it out with the scaling hammer.

Mr. Robert Wilson, in his valuable "Treatise on Steam Boilers," says—

"As a rule steam-boilers explode from one cause alone—over-pressure of steam." "It often happens," he says, "that boilers are too weak for the pressure they are worked at, and no accumulation of pressure beyond this is requisite to bring about their destruction."

A boiler may be unfit to bear its working pressure from four causes, which he enumerates:—(1) Its original design and strength not being understood by those who fix the pressure; (2) the strength, although originally sufficient, having been gradually reduced by wear and tear; (3) by a sudden overtaxing as by unequal contraction; (4) by bad workmanship or material.

I propose to confine my remarks to the second of these causes, and to inquire whether the aggregate of casualties which are attributable to wear and tear cannot be reduced; and whether a remedy cannot be found for the weakening of the various parts of a boiler by corrosion and "pitting," and by the over-heating of furnace plates and tubes, consequent upon the formation of lime scale upon them.

Internal corrosion is a trouble from which few boilers entirely escape; but marine-boilers are the greater sufferers. Land-boilers are subject also to very serious and often rapid decay from external corrosion, but I do not propose to make more than a passing remark on external decay. The principal causes arise from undue exposure to the weather, unscientific mounting on possibly damp brickwork, leakage consequent upon faults of construction, or negligent management on the part of the engineer in charge. These sources of corrosion are commonly known, and the measures necessary to prevent them are now well understood; although it must be admitted they have been often culpably neglected.

Internal corrosion may be divided into ordinary corroding (or rusting) and pitting.

Ordinary corrosion is sometimes uniform through a large part of the boiler, but it is often found in isolated patches, which have been difficult to account for.

Pitting, which is still more capricious in the location of its attack, may be described as a series of small holes, often running into each other, in lines and patches—eaten into the surface of the iron to a depth sometimes reaching a $\frac{1}{4}$ of an inch. Pitting is the more dangerous form of corrosion, and the peril is increased when its ravages are hidden beneath a coating of scale or fur which may have gathered over it. For without great watchfulness this insidious canker may go on unsuspected, until a catastrophe reveals it.

Ordinary corrosion has been commonly accounted for by the presence of acids in the water, but the mysterious ways of pitting have been an enigma to engineers; and although a variety of theories have been advanced to explain its capricious and peculiar methods, none were conclusive until recent scientific investigation discovered the true agency.

It was long suspected that galvanic action, or electricity in some form, had to do with both corrosion and pitting. One theory was that voltaic action was set up between the iron shell and brass tubes, and another that differences in the quality of the iron plates produced the same result. Experiments were made, from time to time, to test these hypotheses, but they seem to have ended, for the most part, in the conclusion that electricity was inoperative either as a cause or a cure. Considered as a cure, it was set aside by some eminent engineers as mere empiricism; but most thoughtful men admitted that the action of electricity, if it really existed, was not understood. New light has since been thrown upon the subject, and altered views now prevail, but I will not anticipate.

There is another form of decay in boilers known as grooving. This also comes under the head of wear and tear. It may be popularly described as a kind of surface cracking of the iron, caused by its expansion and contraction under the influence of differing temperatures. It is attributable generally to the too great rigidity of the part of the boiler affected, and may be looked upon as resulting from faults of construction. It is, therefore, outside the scope of this paper, except in so far as it may be, and frequently is, aggravated by internal corrosion, which fastens upon the cracks and eats them more deeply into the iron.

The hard calcareous scale which is deposited by the water on the internal surfaces of the boiler, may be taken roughly as identical with the fur which forms on the inside of a tea-kettle. It is composed chiefly of salts of lime, and is known by many names in different districts. I have collected a few specimens for inspection, recently taken from both land and marine boilers, which will give a more definite idea to what it really is. (Specimens produced.) On the whole, it is perhaps a greater enemy than internal corrosion, especially in land-boilers, as it brings in its train so many destructive agencies, and involves so many expenses. As of fire, it may be said that it is a good servant but a bad master—for a thin covering of about the substance of a coat of paint is found to protect the iron from rust, and is therefore favoured by all engineers.

Beyond this point, however, it is an unmitigated evil. In the first place, it necessitates a great waste of fuel, varying according to the thickness and character of the incrustation; but the waste of coal may be fairly put down at an average proportion of not less than 100 per cent. The reason is this, that scale is a very efficient non-conductor of heat, and when it is interposed between the furnace and the water, the latter is unable to take up the heat, which, by consequence, goes away unused up the flues. Then again the iron, or other metal, of the furnace and tubes, being no longer protected by contact with the water, becomes red hot, and is burnt and twisted to the imminent danger of the boiler; while a heavy expense is incurred for renewing the plates and tubes so affected.

When the scale is thick and hard, the proper examination of the parts beneath it is impossible until it has been entirely removed. Indeed, if it were not removed, the boiler would become unworkable. Scale, therefore, being so great a foe, has to be periodically chipped away with hammer and chisel; and the process of chipping is so severe that it tends very greatly to wear out the boiler. The cost of chipping is, in itself, a heavy item; and it should be borne in mind that a factory boiler must, during the process, perhaps every six or eight weeks, be put out of work for several days at a time.

Scale will stop the feed pipe, which supplies water to the boiler; or hardening over the fusible plug in the furnace crown, which is intended to melt and give warning when the water is dangerously low, will nullify this precaution; and it has thus caused both collapse and explosion.

To dwell on the nature and detail of all the various deposits that afflict steam-boilers would occupy too much time, and it is not necessary for my purpose; but concerning carbonate of lime, which is often a source of danger, I must offer here a few remarks.

This is deposited as a pulverent body; and under certain conditions, chiefly of neglect on the part of the engineer in charge, will form a hard scale similar to that we have been considering, but by proper attention a great deal of it may be got rid of by blowing down, or emptying the boiler to the extent of a few inches day by day, by the scum cock, while it floats near the surface, or by the blow-off cock when it has settled at the bottom. If, however, this floury deposit is allowed to accumulate, and thicken the water, it will produce priming, which may be described as "boiling over," the same process which is apt to take place in boiling a saucepan of milk, or of water thickened with flour. The water is driven with the steam into the machinery, and may knock off the cover of a cylinder, or blow out the bottom of it. The second great danger which it involves is, that lying in a mass upon the furnace plates, it may prevent the steam from rising, and thus the water being lifted on the top of the deposit by the steam held beneath it, the furnace is left without protection, and is liable to be overheated, and to collapse by the pressure of the steam.

However, these particular dangers may be averted, as already indicated, by due care, without which no scientific appliance is of any avail; and touching this point, I may quote Mr. Michael Reynolds, the author of several excellent engineering works. After inculcating care in various ways, he says, in his practical and significant style:—"Any boiler can be made sensitive and hard to manage. Fire it on no system, feed it with water just as the lead plug is in danger, and fill it to the whistle; and your boiler will one day give a big kick." Many a big kick, it may be added, has been occasioned by want of ordinary attention to well-known rules.

The difficult problems that corrosion and scale have presented to engineers and chemists are evinced in the number of patents that have been taken out for chemical compounds to solve them. Hundreds of these compositions have been put into the market, and the number is still increasing; a proof, perhaps, that no panacea has been discovered; although many preparations are still in use by different engineers. These compounds have in truth become so numerous, that every new one is looked upon as another nostrum, and perhaps by the majority of interested persons it is not credited even with the virtues it may really possess.

The chemical laboratory has been ransacked in vain for an absorbent of oxygen that will stop corrosion, or an alkali that can be applied without the risk of causing priming.

With regard to the inutility of boiler compositions, I cannot do better than quote Mr. Hannay, of Glasgow, of whose invention I shall have to speak later on :—

"Boiler compositions [he says] can be classified under two distinct heads. First, there are compounds of the nature of precipitants, which are intended to render the incrusting material pulverent instead of coherent. But these do not at all prevent corrosion, and the best compouuds only partially prevent incrustation. The second class, called solvents, are chiefly ammonia salts, which form soluble double salts with lime, and so prevent incrustation. They are, however, very dangerous, as they dissociate under high-pressure steam, and act rapidly on iron, thus increasing the corrosion. Besides, in marine-boilers, under great pressure, the presence of even a minute quantity of ammonia salt causes violent 'priming,' that is, sudden ebullition, driving the water of the boiler over into the cylinders of the engine, and sometimes causing the fracture of the cylinder or piston rod. Experiments were made with nearly every possible form of chemical boiler composition, and they were all found wanting."

If further condemnation is required, it will be found in a report of Mr. Lavington Fletcher, of the Manchester Steam Users Association, an engineer of acknowledged and leading authority in such matters. He is reported as saying :—

"The number of anti-incrustation compositions was very numerous. Their component parts were veiled in mystery. Many of them proved injurious to the boilers on actual trial. Some lined the plates with a glutinous coating which, while it had the desired effect of keeping off the scale, unfortunately at the same time kept off the water, in consequence of which the furnace crowns became overheated, strained, and bulged out of shape. The members, therefore, were warned not to adopt any of these boiler compositions without the greatest caution. As the incrustation compositions were costly, blowing out was too often given up when they were used. The practice of neglecting blowing out was strongly objected to, and an explosion that occurred at Bury from that cause was referred to as an illustration."

Mr. J. A. Rowe, an able engineer and officer of the Board of Trade, observes with regard to compositions, that some of them may be useful to prevent the formation of hard deposit, but the "objection to the very best of them is that their acids tend to injure the boiler. . . . The majority of them have passed into oblivion, and those that survive seem doomed."

The superintendent engineer of a Bristol company told me of an instance in which, after careful trial, he had adopted a compound which was strongly recommended. It was used in the boiler of a ship on a voyage to America, and it answered its purpose admirably; but, on the return voyage, the engineer in charge put too much of the fluid into the boiler, and the feed-pipe was consequently stopped. The openings into the water gauges being also stopped, they continued to indicate a sufficiency of water until it had fallen to the level of the furnace crowns. The consequence was, the furnaces burned and collapsed, and the ship was seriously disabled on the high seas.

Some compounds cure one part of the evil, and do not touch others, while some again are extremely dangerous to use in a boiler under steam pressure.

Among the many inquiries directed upon the general subject, some of the most exhaustive and minute have been those instituted by the Admiralty, extending from 1874 to 1880. They were carried out by committees appointed to inquire into the causes of decay in the boilers of H.M. ships. The committees were invested with very abundant powers, and were directed to propose measures tending to increase the durability of boilers.

The results of their labours are contained in very able reports, full of valuable information and practical suggestion; but for the purpose of the present inquiry, they may be briefly summarised as follows :—

1. With regard to a prevailing belief that the presence of particles of copper in a boiler was a source of injury, they state, first, that the quantity carried into the boiler is extremely small; and, second, that no injurious effect of importance can be produced by it.

2. That fatty acids resulting from the use of vegetable and animal oils for lubrication were a source of injury, and they recommend the use of mineral oils.

3. Moist air, or water containing air, are powerful corrosive agents. They recommend increased density in the water, especially in boilers fed from surface condensers, and that the boiler should be emptied as seldom as possible.

The main conclusion, however, at which the committee arrived—the great principle that they asserted and demonstrated—was that galvanic action, induced by the contact of zinc with the iron of the boiler, was the best and only trustworthy remedy for corrosion; and that, so long as the metallic contact was maintained, little or no corrosion would go on.

They adopted a plan of hanging slabs or plates of zinc by iron straps from the stays or rods within the boiler, the zinc being held in a clip in which it was tightly bolted. The theory was perfect, but the weak point in practice was found to be in keeping up electric contact between the two metals. The zinc and the iron not being metallically connected, but only mechanically pressed together, were liable to be so far separated—by the corroding of the surface of the zinc—that the galvanic current was soon weakened and destroyed.

The committee endeavoured to circumvent this difficulty, first, by fixing in each boiler an excessive number of plates, so that (apparently) if electric contact should cease even in many plates, it might chance to be maintained in some; and, secondly, they directed a frequent examination with the view of renewing the contact, and putting in fresh plates in lieu of those destroyed by corrosion.

This system was the best they were able to arrive at, but it could be maintained only at such a cost that, to use the words of the report:—"The expense of the zinc necessary for efficient protection is undoubtedly an important element in determining how far it should be adopted." For besides the expense of fitting, examining, and renewing the excessive number of plates already referred to, the committee go on to say that "the actual waste of zinc is much greater than that due to the protection of the boiler; and it becomes important to ascertain whether that waste cannot be avoided."

With great care, however, this system was found to prevail against the inroads of corrosion; and herein was a distinct advance, although it still left the question of incrustation by lime-scale comparatively untouched. Indeed, it is stated that the scale which formed in some of the boilers in which slabs or plates were used became "harder and more adherent," and it was therefore suggested that the zinc should be periodically removed altogether, for a limited time, in order that a slight corrosion forming under the scale might enable it to be separated more readily from the iron.

Under the Admiralty system, then, it must be presumed that the bad effects arising from scale, such as the burning of the iron, the waste of coal, and the injury caused by severe chipping, are still a source of trouble and expense; and such I believe is the case. I have before me a specimen of the scale which formed in two months in one of H.M. steam vessels. It was recently taken from a boiler treated on the Admiralty method, and considered to be in very good order.

The committee's report attributed this hard scale to the action of the excessive quantity of zinc which was found necessary for protection when used in the form of slabs or plates. This, however, is now shown to have been an erroneous conclusion, the real cause being that the galvanic current set up under the Admiralty system has not sufficient intensity. I hope to explain this point a little more fully later on.

Now, having pointed out where the Admiralty method fails, I must give credit to the inventor, *per contra*, for the large amount of success it has, nevertheless, achieved. Experience teaches us that few inventions cannot be improved upon, and Mr. Weston himself, of whom I am about to speak, would be the last to claim perfection for his particular plan of protecting boilers by means of zinc.

Mr. William Weston is the Admiralty chemist at Portsmouth, and was a member of the Boiler Committee, whose collective labours are worthy of all praise. It is due to him, however, to state that the system of protection finally adopted in the British Navy was initiated and worked out by him, with indefatigable pains and assiduity; and that his method, whatever may be its shortcomings when viewed in the light of later discovery, has worked so well that near half-a-million of money must have been saved to the Navy and the British tax-payer since its introduction.

Before the application of the galvanic principle, it was not an uncommon occurrence for the boilers of H.M. ships to be worn out in one commission, or, at least, to become so unsafe as to render their renewal necessary; and, as a case in point, I may mention the *Bellerophon*, whose boilers had to be renewed, after serving only one commission of three or four years, at a cost of some £30,000.

A man who serves the Queen is content to do his duty, and must often do so without being singled out for praise or reward even for special services; but in this paper I am at liberty to mention the name of Mr. Weston with honour, and to claim for him the personal credit which is his just due.

The mercantile marine has in a great measure followed in the wake of the navy; and zinc is now very largely employed in the fleets of all the large companies. Every possible method of fixing it in the boilers has been adopted, with more or less success. Engineers who understood the principle of its action in forming with the iron a galvanic battery, have sought to secure metallic connection by many mechanical devices, while others, convinced of its efficacy, but not understanding its methods, have even thrown it loose into the boilers, to waste and crumble away to no purpose.

Zinc, indeed, had long been used with the object of depositing any minute particles of copper that might find their way into the boiler. It was useless for this purpose, as the Admiralty inquiry fully proved; but wherever it happened to be connected with the iron, it became protective, by setting up electric action, which would continue for a short time, until oxidisation of the zinc had broken the electric contact.

A superintendent engineer who was using zinc in his boilers, fixed to the iron, told me he did not believe in the galvanic theory, while in practice he was profiting by it; and when I pointed out this fact, and asked him to explain on what other principle the zinc could be protective, he was unable to answer me.

Another engineer to an important company told me he had a theory of his own, that what was called corrosion and pitting was nothing of the kind, but was solely the result of friction from the circulation of water in the boiler. On the other hand, the majority of superintendent engineers who have some knowledge of electricity and chemistry, are quick to appreciate the truth of the now ascertained cause, and the scientific remedy.

Among the numerous methods adopted for fixing the plates in boilers, the plan patented by Mr. Phillips (formerly a member of the Admiralty Committee), was considered one of the best. It consists in attaching a plate of zinc to a stud or peg, 3 or 4 inches long, projecting from the shell of the boiler, the plate being screwed on tightly by a nut, to ensure close contact with the iron. This system, however, is liable to failure, like all other modes of mere mechanical attachment, as I shall be able to show; and the only means whereby it can be made at all successful is by introducing an excessive number of plates, at great expense, and by constantly examining, cleaning, and renewing them. I have known as many as thirty-eight plates fixed in each of six boilers in one ship on this system, and as many as fifty-six in one boiler of a ship of war on the Admiralty system.

Now, it often happens that when one mind is moved to investigate in a particular direction, another, at a distance, is working to the same end; and men unknown to each other are working out the same problem, and arriving at similar conclusions. So it was in the application of zinc to steam boilers. While Mr. Weston was working up, step by step, to his present system, Mr. Hannay, of Glasgow, an electrician and chemist, alone in his laboratory, or watching experiments in steam factory or sea-going ships, was building up fact upon fact, and coming about the same time to the same conclusion in principle. In the application of that principle he made an important advance on other methods.

I will endeavour, as briefly as possible, to narrate his proceedings, and describe his invention. The investigation was commenced for the Allan Line of steamers, from Glasgow, at the request of Messrs. Allan Brothers, who, like all owners of steam power, were deeply interested in the boiler question.

The common theory held at that time was that free oxygen and carbonic acid in the water were the active causes of corrosion, and Mr. Hannay's first experiments were directed to absorb the oxygen by the ordinary methods known to chemists, with the result, however, that corrosion continued. When an alkali was added to absorb the carbonic acid, priming was caused to such an extent as to be dangerous to the safety of the machinery. He may be said to have exhausted chemistry in his endeavour to find a means of stopping the decay; but, although he succeeded in removing every trace of free oxygen and carbonic acid, the corrosion still continued after six months of patient trial. He concluded, therefore, that, while free oxygen and carbonic acid might help to corrode the boilers, they were certainly not the chief causes.

It next occurred to him that certain parts of the boiler more highly heated might, for reasons familiar to science, have their surfaces so altered as to cause them to become electro-negative to the colder parts. This view was particularly impressed upon him from the fact that corrosion so often took place along certain well defined lines, as, for instance, along the sides of the fire tube. Sometimes the corrosion was so deep that there was reason to apprehend collapse of the furnace. The cold blast going to feed the fire kept the part where the corrosion was quite cool, while the flames kept the top very hot.

Starting, then, from these facts, he deduced the theory that thermo-electric currents were set up between the colder and hotter parts of the boiler, and that the colder part, forming the positive pole, corroded by the natural law of galvanic action.

To test this theory, experiments were made with a boiler specially constructed to allow it to be heated in sections, and to stand a pressure of 200 lbs. to the square inch. Two iron plates were fixed in the boiler, one near the top, and the other near the bottom, and both were connected with a galvanometer, so that a current of electricity passing from one plate to the other could be detected and measured. The boiler was heated alternately more strongly at the top or the bottom, with the constant result that whenever the temperature rose above the boiling point, as in a steam-boiler, the cooler plate became positive, and wasted away. Thus the theory was lifted into the region of ascertained fact.

Attempts were made to keep boilers in actual use more uniformly heated, but if corrosion were stopped in some places, it was sure to break out in others.

It appeared, therefore, that the only way to prevent this corrosion was by making the iron all negative by a current stronger than that set up in the iron itself by differences in temperature. The current was estimated and found to be very small; a weak battery was fitted up, and the positive electrode, or wire, passed into the water of the boiler, the negative electrode being soldered to the outside of the boiler.

After six months' trial with this arrangement, it was found that corrosion had entirely ceased.

Two important facts, therefore, were now made clear; natural electric currents, so to speak, caused corrosion, and a stronger artificial current could be made to cure it.

The experimental boiler was then again tried with the same arrangement as before, but it was first filled with dilute acid. The current was kept going for three months, when it was found that the interior of the boiler was still quite free from corrosion, the acid having been powerless to injure it.

The actual natural current between the metals being so very small, it was thought that, instead of a battery, a simple galvanic couple, formed by a mass of zinc within the boiler, properly connected with the iron, might be sufficient to overcome it.

Now, the theory of zinc in contact with iron preventing corrosion may be illustrated thus:—

Take two pieces of metal, one of zinc and one of iron, and immerse them in a solution of water diluted with acid, both will suffer from corrosion; but connect them with a wire, and you make them at once into a galvanic couple. A current of electricity is set up between them—the corrosion is directed entirely upon the zinc, which crumbles away, while the iron is no longer injured. The zinc is the positive, and the iron the negative pole. Now you have only to continue the plate of iron till it extends all round the zinc and encloses it, and you have a perfect illustration of the manner in which an iron boiler, enclosing a block or mass of zinc, is made as a whole into the negative pole of a galvanic couple, and is thenceforward absolutely protected from corrosion. It will also become evident that if the connecting wire be broken, or the contact between the zinc and the iron made imperfect by the intervention of any foreign matter, the galvanic current will cease, and the iron of the boiler will corrode as well as the zinc—just as the two pieces of metal were seen to corrode before they were joined by a wire.

The theory, then, of the protection of iron by contact with a more electro-positive metal being unassailable, and experiment corroborating it, inquiry was next instituted to discover the cause of failure in zinc as ordinarily employed.

It was found that, as zinc had been previously used, no proper arrangements were made for ensuring a true and lasting metallic contact. To show how this fact was demonstrated, and at what pains it was ascertained, a narration of one of the numerous experiments made will be interesting:—A boiler was fitted with rolled zinc plates attached to studs, on Mr. Phillips's principle, as previously described. Every precaution was used to give perfect metallic contact. The stud was filed bright and made slightly conical, the hole in the zinc plate made to fit tightly, and the nut on the stud screwed home so as to drive the plate into thorough contact with the clean iron. An insulated wire was fixed to the plate, and led, through a stuffing box packed with india-rubber. Another wire was soldered to the outside of the stud. When a small battery and a galvanometer were put in circuit, the current passed from the zinc to the stud, and so round again to the battery, proving that the contact was perfect. There were six plates put in on trial altogether, and the result was that, after three days' boiling, two of the plates had become metallically disconnected from the boiler—that is to say, no current could pass through the circuit. After five days, another plate became useless, owing to the same cause. At the end of twelve days, only one plate was in electrical contact with the boiler. The boiler was opened after thirteen days' steaming, and it was found that none of the plates were really used up, but that a layer of oxide of zinc had formed between the plate and the stud, and the zinc was thus rendered useless. It must be remembered that these six plates were all specially fitted, and ought to have acted thoroughly well if anything could. The sixth plate was sent away with the ship again, but only remained active two days. It was eaten through when the boiler was again opened.

By this and other experiments it was proved that no mere mechanical attachment of the zinc will suffice to ensure continued maintenance of the galvanic current, because, no matter how closely the zinc is fitted to the stud, or bolted to the iron, the water creeps in between, and soon destroys the metallic contact.

It was also found that the use of plates was faulty. If they are cast, they split up and fall to pieces in a few days, and if rolled, they are only about a quarter of an inch in thickness, and they soon dissolve away.

To meet the various defects in the use of zinc plates, Mr. Hannay designed a ball of zinc, with a copper conductor cast through the centre of it, the copper being so combined and amalgamated with the zinc at the junction of the two metals, as to form brass, and thus no corrosion could form between them to stop the galvanic current. The zinc is well hammered at a certain temperature, ensuring long existence in an efficient condition.

This ball of zinc is called an "electrogen;" it is fitted in any convenient part of the boiler by a simple device, and a wire from each end of the copper conductor is soldered firmly to to the iron. From this moment the electrogen keeps up an uninterrupted galvanic current, and the whole of the interior of the boiler is absolutely protected from corrosion so long as any of the zinc remains.

It was ascertained, by further experiments, that a very small surface of zinc was sufficient to afford protection for a radius of twenty-five feet from the point of contact, and the spherical form of the zinc was adopted because it would maintain perfect protection with a minimum of waste, the large surface exposed by plates, in proportion to their bulk, being quite unnecessary. Herein, therefore, was the means of avoiding that waste which the Admiralty Committee stated was "much greater than that due to the protection of the boiler," and for which they sought a remedy.

Two electrogens are found in practice sufficient to protect an ordinary "single-ended" marine-boiler in which, by some engineeers, forty or fifty plates would have been considered necessary. The electrogens will last for about six months, while the plates would probably corrode away in as many weeks.

The advantages that Mr. Hannay claims for his system, as compared with any employment of zinc plates, are that it is less expensive and more effectual, and that the protection it affords does not depend upon a chance contact that may be destroyed at any moment. But a further gain, perhaps even greater than these, is that it does not allow scale to form in a boiler at any time to a much greater thickness than that of an egg shell, or a coat of paint.

The zinc ball, with its perfect contact, generates a current of greater intensity than zinc plates mechanically fitted, and the consequence is that a portion of the water is slowly decomposed, and the hydrogen that is evolved at the negative pole, all over the surface of the iron and underneath the scale, forces off the scale in thin flakes by mechanical action, as soon as it becomes thick enough to be impervious to the hydrogen. In this way the scale is kept forming and re-forming, hanging in loose flakes, or falling off as it becomes detached from the iron.

Thus all the evils attending incrustation, which have been before enumerated, are avoided. Fuel is saved, burning of the iron is prevented, and chipping becomes no longer necessary.

The reason why scale becomes more hard and coherent under the zinc-plate method as used in the navy, is that while the galvanic current set up acts in retarding corrosion, it has not sufficient intensity to decompose the water and deposit a layer of hydrogen on the iron; so the scale grows on a firm surface, and is not pushed off by gas evolved beneath it.

When zinc is merely pressed against iron, the two metals really touch each other at minute points only, and thus great resistance is introduced. Resistance in this case means that the current is destroyed to a certain extent as electricity, and converted into heat; just as the resistance of the break destroys the motion of a train and converts it into heat. Then the water creeping in between the two metals, and forming a non-conducting oxide between the two surfaces, increases the resistance, and ultimately prevents the passage of the current altogether.

When resistance is prevented, and the full intensity of the current is allowed to pass from the zinc to the iron, and back through the water, hydrogen is slowly accumulated at the iron surface, yielding protection from corrosion, and, at the same time, loosening and throwing off the scale.

The value of any discovery that will prevent the formation of hard scale in land-boilers can scarcely be over-rated. These boilers in which fresh water is used, do not suffer so much from internal corrosion; but the calcareous scale, which forms in them, has been always a great source of trouble. Compositions have failed, and zinc plates are ineffectual to remove it.

The electrogen, however, seems to have solved the problem; and to make it sufficiently active in fresh water, the homœopathic principle is applied of *similia similibus curantur*. A small quantity of salt, which is the active corrosive agent in sea water, is made, not only to cure the disease of corrosion which it actuates, but to stimulate an electric current which entirely disposes of incrustation.

Sea water contains on an average 32 to 38 parts of salt in 1,000. Mr. Hannay's homœopathic dose is ½ an ounce to a gallon, or 4 parts to a 1,000; and, as no proportion less than 8 times this amount has any effect on iron, no harm can be done to the boiler, even if it were not protected by the zinc. Into brewers' "tanks" and other boilers, the water from which is used for manufacturing purposes, salt, of course, cannot be admitted; but this difficulty is overcome by a simple device, by which the salt is kept separate from the body of the water.

Land-boilers, in many districts, would become quite unworkable through the accumulation of scale, if it were not chipped off every five, six, or eight weeks—of course at considerable expense—the boiler lying idle during the process. With electrogens it has been proved that boilers will work more than twice the usual time without any necessity for opening them, and that then the loose flakes of scale may be cleared out in a short time with a hose and a broom. Meantime, no thick scale being allowed to form, it becomes perfectly harmless; the coal consumed does its full work, and steam is made more freely.

Engineers, who have witnessed the results in several recent trials, have stated their opinion that the discovery will revolutionise the treatment of land-boilers.

In conclusion, a further and valuable addition has been made to the marvellous applications of electricity, which have pre-eminently distinguished the last decade of scientific discovery.

But there is no finality in human invention. More light will dawn, and with it new marvels will arise. It may be that, before another decade has run its course, electricity or atmospheric power will have superseded steam, and the huge iron boiler of to-day will be looked upon as the clumsy expedient of an ignorant generation.

Till then, while the evils we have been considering exist, and are potent for the destruction of life and property, inquiry into their nature and origin is both desirable and necessary, and time will not have been wasted in seeking to discover the most effectual remedies.

A number of models and diagrams, illustrating boiler explosions, were lent for exhibition by Mr. E. B. Martin.

DISCUSSION.

Mr. E. B. MARTIN said he had endeavoured to collect materials to illustrate the subject of boiler explosions, and had published the results of his investigations over a period of twenty-one years. The last time the subject was before the Society, Mr. Walford and other speakers made use of his statistical returns to base their calculations upon. When asked to give the result of his investigations to the Parliamentary Committee in 1870, he arranged all the results of explosions under general heads. First, the faults in boilers due to constructional materials, faults which might be prevented by careful periodical inspection, such, for instance, as corrosion, and faults attributable to want of care on the part of the men. To-night they were dealing with the evils which might be protected against by periodical inspection. By the tables, a total was given of 1,258 explosions, killing or injuring 385 persons; out of that number internal corrosion was the cause in 115 cases, causing the death or injury of 238 people. It should be remembered that those figures represented only a very small portion of the risks of internal corrosion, because thousands of boilers must have been found corroded, and had been renewed before they came to the stage of bursting. Internal corrosion took several forms. One was the corroding of the whole of the interior of the boiler very gradually, and that was a very difficult thing to detect, because there was then no part which could be particularly detected more than the rest. The next case was pitting—a very puzzling kind of corrosion. In pitting, the plate was perfectly sound everywhere except in certain places. The holes were very deep, and larger in the interior than at the front, like those in granite rocks, as if they were scooped out from the inside. Another form was what is called channelling, where it looked as if the plate had been chiselled out with a gouge. That was very seldom seen in the inside of a boiler, unless the boiler had been left without any water in it. Another most formidable form was furrow, where a nick was cut in the edge of the plate. That was because the plate was not only subject to corrosion, but to bending backwards and forwards, when any corrosive action of the water would attack it very fast. That was found chiefly in the tubes of locomotives and in the ends of Cornish boilers; it was owing to the strain at that part of the boiler between the flue and the shell, and if there was not sufficient play that peculiar furrow was produced. Another evil was scale—that was found in every variety. He had found it varying from a substance almost like flannel to quite hard scale, and from an almost impalpable scale to balls as big as one's fist. The scale slipped down in cylindrical boilers, and formed in the bottom a very hard agglomeration. He might also refer to the description of corrosion known by the formation of a "pocket," and that was another form which must be guarded against, if the result of the electrogen was to bring down the scale in flakes to the bottom of the boiler. Then as to the remedy generally suggested for all those evils of internal corrosion, the one he had advocated most strongly was to get better water It was a great pity to use an antidote, and to continue the poison. The author of the paper had pointed out that this could be comparatively easily done. It was better worth while to spend a great deal in doing something with the water itself, than to do anything with the water afterwards in the boiler. Those evils were mostly met with in connection with the use of sea water in sea-going boilers. The introduction of electricity as affecting corrosion and scale was not exactly new. He had tried an apparatus to prevent the deposit of scale, an apparatus with prongs pointing in all directions, which were supposed to collect the electricity of the steam as it was formed, and to convey it away, but he could not find the slightest alteration, though he had tried it month after month. Those who started that idea, he thought, went on a wrong principle, because they began by saying that electricity was formed by the conversion of the steam. They knew that Faraday had said that was not true, and there was no electricity, as far as hey knew, in the formation of steam, but that it was formed very rapidly by the friction of the globules against the edges of the outlet. He had tested this by a model hydro-electric boiler, in which the steam was caused to produce frictional electricity, and the result of his tests showed that it was not the electricity of the steam that had anything to do with the scale forming. It was no good, therefore, to do anything in that direction to prevent it. The author, however, seemed to have started on quite another principle in using galvanism, but from what he had seen in the plates of boilers, he thought it had no effect at all, because, as had been explained, the contact with the outer shell was not made sufficiently good. The author had shown them, however, how to get over that difficulty by the electrogen, and that looked as if it was at least a start on the right principle. Without the test of experience, it was difficult to say whether or not the apparatus would succeed, but there was enough in it to make it well worth while to try its application to land-boilers. There was one danger to be guarded against. When an antidote was put into people's hands to guard against a particular evil, they sometimes would not take the trouble to remove the evil itself, and it was to be hoped people would not, therefore, become careless in getting fresh water, which he thought was the very best of remedies. These were temporary matters after all, for before long they must get their direct power from the fuel that was burnt, so as to make their engines rather fire than steam-engines.

Mr. Loftus Perkins had only the experience of using perfectly pure distilled water in his boilers, and he found that it did not affect the iron at all. When at sea they carried the requisite fresh water with them, and if distilled fresh water were used, boilers would never wear out at all. He found it was no use attempting to distil sea water, the salt was carried over mechanically. Distilled fresh water alone was used in his boilers. Of course he was excluding grease and everything, except pure water. By pure water he meant water distilled a great number of times, and that should be done of course before it was put into the boiler. That was very easily done with proper arrangements. He had had boilers and heating apparatus working 50 years, and they were just as good as the day they were made. In the heating apparatus distilled water was not used, and the result was that there was a very small quantity of sediment which could easily be got rid of.

Mr. King sketched the apparatus which Mr. Hannay suggested could be introduced into Lancashire boilers between the flues. The apparatus might be put any where. A wire came from each end of this electrogen, and was fastened on to the iron where most convenient. That was soldered firmly to the iron of the furnace on both sides, and as long as that contact remained perfect there was a continuous electric current between the whole surface of the iron, wherever the iron was exposed, and the zinc. The electrogen was a ball of zinc, through the middle of which a strong bar of copper passed as a conductor; at each end of the copper was a wire, then the electrogen was dropped into a cup, and the ends fastened on to the iron wherever the greatest amount of intensity of current was required, for instance, under the furnace, where the greatest amount of corrosion took place, would be best.

Mr. Henry Maudslay said the principal subject of the discussion had been land-boilers, with which he had not so much acquaintance as with marine boilers. In the early days of steam navigation, some large copper boilers were made for vessels employed in the Bay of Naples, where they had to lie for some time, and would have been exposed to the corroding action of the water there, which was strongly impregnated with salt and sulphur, and they answered very well. In high-pressure boilers, of course, other difficulties would occur; and in the days when chemical science was not so far advanced, and so much was not known with regard to the antagonism which would occur between the materials used and the impurities contained in various waters, a variety of chemicals were recommended for the purpose of preventing deposit. In the case of locomotives which had to make long journeys, there would be so much difference in the quality of water obtained in various districts, that the whole question became very difficult, and there was quite room for another paper, showing the different conditions which would prevail in marine and locomotive boilers as compared with those of a stationary engine, where the chemical properties of the water used could be exactly ascertained. For instance, the water at Epsom was impregnated with Epsom salts, and though it would seem pure when put into the boiler, the moment it was heated, chemical substances would be deposited, which would have a material effect on the iron. Water from the chalk, and from other sources, would leave deposits of a very different character. It would be very useful if a tabular statement were prepared showing the components of various waters, and their effects on the iron or steel of which the boilers were made. A remedy might then be devised in the shape of some electrical or other apparatus by which those effects could be counteracted.

The Chairman said he could confirm what had been said as to the great difference of water in different parts of the country. In some places it was so bad that it could not be used at all; in one district it contained salt and soda, and in others it was very hard. On some lines the difference was so great, that when an engine got furred up, it was sent to another locality and there got cleaned out.

Mr. Porter said the water at Camden-town Station of the London and North-Western Railway was formerly taken from a deep well, but it struck Mr. Webb that it would be better to get a purer water, and it was now brought from Bushey to Camden-town, and was there treated by Dr. Clarke's process, with the aid of such mechanical means as he had devised for carrying out that system on a large scale; the object being to deprive it of the calcareous matter in solution.

Mr. Wavish asked whether the author considered it was more important to keep up a rapid circulation in the boiler than to use other means. He found that by securing a rapid circulation he could keep the boiler clean, and also get an equalisation of the expansion of the boiler-plates. Of course he was speaking of land-boilers, and he would show the meeting a pipe which had been four years in work, and had never been cleaned. He kept up the circulation by means of a tube from the bottom, supported by vertical bars from the furnace.

The Chairman said there was only a scale of from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch on the pipe exhibited. The Galloway tubes, commonly put into boilers passing up from the bottom, were very useful in promoting the circulation in Lancashire and Cornish boilers, and it was very important to keep them at the same temperature at the bottom as the top. He had known some so badly constructed that, when there was steam up at the top, you could bear your hand in the water at the bottom. The condition of the plates when such was the case could easily be imagined.

Mr. W. Haworth asked what means Mr. Wavish adopted for getting rid of the lime and other deposit in the boiler, which would increase from day to day unless there were some means of blowing it out.

Mr. Wavish said it was blown out occasionally; but it was reduced to such a small quantity that there was very little to take out.

The Chairman remarked that the stone did not go away with the steam, and must fall into the bottom of the boiler. He should imagine that Mr. Wavish was favoured with very pure water.

A Member asked if any means were taken to purify the water before using it.

Mr. Wavish replied in the negative. It was the East London Company's water. The boiler had not been scaled for four years; and he only blew out once in three months.

Mr. Porter remarked that the East London Water Company's engineer, who had six boilers under his management, had adopted the Porter-Clark process for purifying the feed water for those boilers.

Mr. NELSON pointed out that in many steam-boilers, when the water was in ebullition, it was continually rising to the surface, and the deposits which were made were enamelled on by the heat of the boiler. His remedy would be not to let the enemy get in at all. It was not possible to use the scum-blower to advantage, unless it was used continually, and until the boiler was almost emptied, there would not be a particle of sediment run out. Of course that was seldom done, because, if so, steam could never be got up at all. In conclusion, he proposed to show the working of a small model which he had constructed.

Mr. J. J. EASTICK asked how the small quantity of salt spoken of was proposed to be kept from the body of water in the boiler in Hannay's system, and also how, when the pieces of scale were sent round, there could be any water behind them to become decomposed, because he thought the scale would be perfectly dry.

The CHAIRMAN said that the stone formed was sufficiently porous to become damp. He thought the water would get to the plate, although in small quantities; at least that was his own observation.

Mr. LAYCOCK said that a very valuable discovery had been brought before them, its adoption by the Admiralty having led to a very large economy. It was not merely a question as to whether pure water in a particular boiler would give the same result as in others, or would cause no corrosion. They knew, as a matter of fact, that corrosion did exist, and that it was one of the greatest difficulties which had to be contended against. If Mr. Hannay's system was an improvement upon that of the Admiralty, that was a matter which was surely worthy of better attention than had been given to it. He thought an important question such as this should be brought forward at another time, so that the Society might see whether this was a good invention or not.

Mr. A. J. MAGINNIS said with regard to marine boilers, of which he had a number under his superintendence, that he had some time ago tried the "electrogen," and the results at that time were not satisfactory; but he must do Mr. Hannay the justice to say, that the steamers in which they were tried, afterwards passed out of his superintendence. He was only told that no throwing off the scale could be seen. For aught he knew, it may have had the protective qualities of the zinc he had previously used in the boilers. Up to the present time, with everything that chemists and scientific men had brought forward, those who had charge of marine boilers had discovered no better way of keeping down scale than the old method of chipping it away by hand labour. With regard to compounds, one great question to marine boilers was the length of time that vessels were in port. He knew of marine boilers now working continuously in first-class steamers, which had been 14 years in existence carrying high pressure, and those boilers were very recently subjected by the Board of Trade to double the working pressure; he could not, however, say whether zinc was used in them. He was acquainted with some boilers ten years old, in which zinc had been used almost from the first. He had tried the boilers in two steamers, using the compound in one and not in the other, the vessels being in the same trade and using the same water, and he found that he could scale the boiler in which the compound was used in two or three days less time. That result was more particularly observable in the narrower portions of the boilers. One difficulty, however, referred to was that the compounds attacked the iron or steel, as the case might be, of the boilers. He had not been able to try that with boilers carrying 80 lbs. or 90 lbs. pressure, but he had placed some borings, filings, and rivets, and had them suspended for six years in the compound in a cold bottle, and to the present day nothing of the kind could be seen. Time was money to owners in those matters, and £20 or £30 expended in putting a compound into a boiler was a trifle if a steamer was thereby enabled to get away several days sooner than she otherwise would. Vessels had, of course, to sail to all parts of the world, and good scalers could not always be found—even engineers were not always qualified to look after the scaling of boilers. Though desirous of giving credit where credit was due, he thought Mr. Weston was getting more praise than he ought in this matter, because in the mercantile marine, zinc had been used for years before the Admiralty ever thought of it; to his own knowledge it had been used ever since 1867. Metallic connection was the important point to be attended to. Scaling was a most expensive process, and would cost sometimes more than £100 in a foreign port, but still it was money well spent. As to the use of distilled water, new steamers generally made their first run with salt water, for the purpose of getting a coating on the boilers, and preventing the formation of red rust, which would lead to very bad corrosion indeed. He had found plates which had been allowed to get into that condition pitted through and through in three months, where no protective scale had formed on the tubes. With regard to the use of scum-cocks and blow-off cocks, he quite agreed with the Admiralty instructions in doing away with them, but there were occasions when they might be used with advantage, so as to get out the grease and other things which had come in from the machinery, by blowing down the boilers to the level of the furnaces. Another point was to secure the proper circulation of the water from the time the fires were lighted. That was in fact the salvation of boilers, and for that purpose he always took care to connect his boilers with a donkey-engine, and by other means to ensure that the water should flow in continuously at the top of the boilers until they were filled up.

Mr. J. Green said that notwithstanding the expense of rolled zinc, the Admiralty were employing it. He desired to know whether the wires were altogether contained within the boilers or not.

Mr. King said they were entirely inside.

The Chairman said—I quite agree with Mr. King, that England, being the home of the giant steam, thanks to Newcomen, Watt, and Trevithick, we do right in spending some time in thoroughly mastering an apparently slight fault, which really is but a slight fault now that we know what it is; but it may, I think, be taken as a lesson not to try carelessly, and give up rashly, a promising invention, without first thoroughly investigating all points, to see that we are not deceiving ourselves. Thus, if we lose the electrical contact that we need, and do not know it, we ought to thoroughly examine and discover whether all the circumstances really are what we wish for, and whether all contacts are perfect; this Mr. Hannay seems to have done, and, of course, with the immediate result of maintaining the galvanic current between the zinc, now commonly used in marine boilers, and the iron or steel of the boiler. One of the first applications of zinc, as a "protector" of other metals, was that of Sir Humphrey Davy, who put large blocks of zinc into a ship's side, in contact with the copper sheathing used in his time for wooden ships, and with the effect of preserving the copper from corrosion. The result was very curious, as the weeds and barnacles thought it was done for their comfort, and they forthwith clung all over the copper sheathing, which no longer poisoned them off; this, of course, made the ship so foul that the plan had to be abandoned. The true hard scale, spoken of by the author of the paper, composed chiefly of carbonate of lime, is deposited in a neglected boiler in a crystalline form, and if allowed to become very thick, as we see in some samples of "Sunday stone," may ruin a boiler; in fact I have known of a set of tubes being taken out of a ferry boat in one solid mass, with the stone between them; and in some few cases, where the stone was chipped away, there was found to be no boiler-plate left at particular places, so that the stone had been the only boiler-plate for some time at that spot. But these are rare cases of thorough neglect. If a proper composition is regularly added, the carbonate of lime does not deposit in a crystalline condition, but in what chemists call "an amorphous condition," and in such form it falls as mud or fine sand to the bottom of the boiler, where it can be blown out. A boiler thus attended to, and fed with fresh water, does not corrode or scale heavily; this I say from experience of many boilers, and I have never had a blow-up or anything approaching one, or in fact any trouble with any of them. I have known many copper boilers, in past times, and they were very satisfactory, except in first cost; and I have pulled out two old low-pressure copper waggon boilers that had holes in them plugged with wood. I have only a few years since taken down what I believed to be the last low-pressure copper "haystack boiler" in London, and which was in very fair working order; the copper was excellent. It was, of course, replaced by a double-flued high-pressure Cornish boiler. Many years ago, at the request of a friend, I tried a composition containing ammonia, but although it brought off some of the scale, it was very bad for the boilers and for the engine, which it rusted all over, inside and out. Mr. King has spoken of the idea, now exploded, of small particles of copper being carried over from surface condensers. This is a mistake, and the pitting of iron boilers that took place when surface condensers were first introduced, was from the grease and oil then used becoming converted into acid grease, by long boiling with the water at pressure. I mention this because, having put up boilers to work at 220 lbs. per square inch, for the purpose of forming acid grease, I found that $4\frac{1}{2}$ hours was quite sufficient for the purpose. However, for some time now, salt water has been used in marine boilers, and as that is changed from time to time, there is lime enough in the water to neutralise the acid grease if any is formed, and the use of mineral oil in place of vegetable oil has pretty well cured the evil. The author has spoken somewhat of undue expansion and contraction of the metal of a boiler due to unequal heating. Now, in certain cases the strains induced are most severe; for instance, a single-flued Cornish boiler, full of cold water (and particularly if the brickwork is damp and cold), may, if heated quickly, have 20 lbs. pressure of steam in it, and yet have the bottom so cool that a person can bear his hand on it. In such case the top of the boiler, at and above the water line, is longer than the bottom, and the strains are very severe. If several boilers are used in one works, it is easy to arrange a small pipe to take steam from one boiler at work into the bottom of the cold boiler, and thus heat it up fairly. Bad effects are often produced by the mistaken notion of feeding cold water to the bottom of the boiler; this I have known done with a number of Cornish boilers in London, and the boiler repairs were excessive. The right plan was, I think, first suggested by Mr. Lavington Fletcher, viz., to run a long and perforated feed-pipe into the boiler, above the crown of the furnace (so that, if the valve leaked, it would not leave the crown dry), but below the waterline; then the cold water distributed itself amongst the hot water that already contained steam, and no violent cooling of particular plates or of the bottom of the boiler occurred. In conclusion, I think the thanks of the meeting are due to the author for his paper.

The vote of thanks proposed by the Chairman was accorded unanimously.

Mr. King, after thanking the meeting, said in answer to observations made, that the salt was kept from mixing with the water by a contrivance enclosing the "electrogen." As to the doubt of the hydrogen getting underneath the scale, and peeling it off, the best answer was that it actually did so. Whether it got through the cracks or through the pores of the scale, he was unable to add, but he should think it was a little of both. In 99 cases out of 100, this apparatus had been successful in preventing scale from gathering to any thickness beyond that of an egg-shell, which was the thickness engineers liked to have in their boilers. He might add that the chippers, finding their interest going, had sometimes cut the wires and thus stopped the electric current, and at other times these were found not to be properly fitted by the men, and that instead of seeing that they had positive metallic contact, the men had soldered the wires on to rusty iron, thereby, of course, stopping the galvanic current. As to the credit due to Mr. Weston, until he introduced the zinc system into the navy, the boilers were wasting away to a very great extent, and credit was at least due to him, from an economical point of view, for bringing that system into use in the navy.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

School and Education.

Wednesday, February 20th.—Present: Lord Reay, in the chair; Mr. Alfred Bourne; Mr. J. G. Fitch; Rev. T. Graham; Mr. T. E. Heller; Mr. A. C. King; Lieut.-Col. W. R. Lewis, R.A.; Mr. Philip Magnus; Dr. R. J. Mann; Inspector-General F. J. Mouatt, M.D.; Mr. T. Nordenfelt; Mr. W. Woodall, M.P.; Mr. H. Trueman Wood.

India.

Wednesday, February 20th.—Present: Sir Joseph Fayrer, M.D., F.R.S., in the chair; Sir George Birdwood, M.D., C.S.I.; Deputy Surgeon-General N. Chevers, M.D., C.I.E.; Mr. R. A. Dalyell, C.S.I.; Surgeon-General C. A. Gordon, M.D., C.B.; Colonel J. Michael, C.S.I.; Mr. W. G. Pedder; Mr. H. A. Perry; Mr. J. R. Royle; Mr. R. Stewart; Mr. A. Stirling; Surgeon-General Townsend, C.B.; Mr. Frederick Young; Mr. H. T. Wood.

Education Congress.

Tuesday, February 26th.—Present: Mr. B. St. John Ackers; Rev. T. Graham; Mr. Philip Magnus; Rev. T. W. Sharpe.

Laboratory.

Tuesday, February 26th.—Present: Sir Joseph Lister, Bart., F.R.S., in the chair; Mr. W. Watson Cheyne; Dr. W. H. Corfield.

Obituary.

John Hullah, LL.D.—This distinguished musician, who had been for many years intimately connected with the Society of Arts, both as member and examiner, died on February 21st, in the seventy-second year of his age. Throughout a long life of hard work he has figured as one of the most conspicuous and energetic advocates for the extension of musical culture amongst the masses. Born at Worcester, June 27, 1812, John Pyke Hullah came at a very early age to London, which thenceforth became his home. He did not, however, enter upon any course of musical training until 1829, when he became a pupil of William Horseley. Three years later he studied singing under Crivelli, at the Royal Academy of Music, and made his *debût* as a composer in 1836, when his opera, *The Village Coquettes*—the libretto by Charles Dickens—was produced at the St. James's Theatre. The first training school in England was founded by Dr. Kay (afterwards Sir James Kay-Shuttleworth) and Mr. Edward Carleton Tufnell; and Mr. Hullah accepted the post of musical instructor. In 1841 he organised a school at Exeter-hall for the education of schoolmasters of day and Sunday schools, on a system founded upon that of Wilheim. On June 21st, 1847, the first stone of St. Martin's-hall was laid. The building was opened, in an uncompleted state, on February 11th, 1850, and there Mr. Hullah continued to hold his entertainments, until it was destroyed by fire in August, 1860. During the twenty years from the foundation of his class to the destruction of St. Martin's-hall, it is estimated that no fewer than twenty-five thousand vocalists received tuition at Mr. Hullah's hands; and many vocalists of prominence were introduced to the public, amongst whom may be mentioned Mr. Santley, Mr. Lewis Thomas, Miss Palmer, and Madame Lemmens-Sherrington. Mr. Hullah held from time to time many official appointments. From 1844 to 1874 he was Professor of Vocal Music at King's College, and occupied similar posts at Queen's College and Bedford College, London, since their foundation. He was examiner to the Society of Arts in the Theory of Music from 1859, when the examinations were commenced, until the time of his death. In 1876, he suggested the examinations of the Society in the Practice of Music, and these were commenced in 1879 under his superintendence. In March, 1872, he was appointed Inspector of Training Schools for the United Kingdom. In 1875, the University of Edinburgh conferred upon him the honorary degree of LL.D.

General Notes.

Wheat Production in New South Wales.—The development of the wheat-growing industry in New South Wales has been uniformly steady of late years, as shown by the following returns:—

1874	2,273,620	bushels.
1875	2,148,394	,,
1876	1,958,640	,,
1877	2,391,979	,,
1878	2,445,507	,,
1879	3,439,326	,,
1880	3,612,266	,,
1881	3,717,355	,,
1882	3,405,966	,,
1883	4,042,395	,,

It will be seen by these figures that the wheat crop of 1883 was considerably in excess of those of previous years.

Acoustic Indicator for Spindles.—Professor R. Escher, of Zürich, has invented an apparatus for remedying an inconvenience which has been found to exist in the ordinary appliances by means of which the number of spindle-revolutions is indicated. He remarks, in a communication to the *Centralblatt für Textil Industrie*, that by the present system a relatively large expenditure of power is required, while, for various mechanical reasons, the records arrived at cannot, in all cases, be taken as correct. He has found a simple means (by using a spool with glued paper fastened round it, and with four holes cut in the paper at equal distances) of obtaining a distinct musical sound from the pitch of which the exact number of revolutions is found. F (first space in treble clef) represents 2589·4, and an octave higher exactly double (5178·8). The difference between each semitone is graduated; thus, between F and F sharp, there is a difference of 154, while between E and the next F the difference is 290·6. The table annexed to the communication in question is based on the French normal pitch. For the benefit of those whose musical knowledge is defective, the suggestion is made that a pitch-pipe might be constructed, bearing on it the necessary indications of the number or revolutions appertaining to each chromatic interval. By this means it is believed errors would be rendered improbable, it is considered.

Amber.—Natural amber must be regarded as a mineral resin, though probably derived from an extinct coniferous tree. Its ultimate constituents are: carbon 78·82, hydrogen 10·23, and oxygen 10·95; and its specific gravity varies from 1 to 1·1. It becomes negatively electric by friction, and melts at a temperature of 550° to 750° Fahr. Amber is found on the shores of the Baltic and Adriatic seas, and to a smaller extent in Sicily; generally near the surface of the ground, but also at the bottom of the sea. Its yellow tint varies in depth, while it is sometimes transparent and sometimes opaque; but the clouded variety is the more highly esteemed. The demand for this substance, especially in the East, has led to the manufacture of an artificial amber; but the true may be distinguished in many ways from the false, and also from gum copal, which somewhat resembles it. Real amber is never perfectly uniform in tint, as are both artificial amber and copal; it is also harder and less easily scratched or crushed. It is slightly brittle, and breaks with a regular conchoidal fracture Amber may be cut, sawn, filed and polished; but the pieces will not stick together again, as they wil with its substitutes. The warmth of the hand wil cause it to exhale an agreeable aromatic odour, which is not the case with either copal or artificial amber. Finally, amber, covered with grease and held over a flame, may bend, which the other substances will not do.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

March 5.—"The Progress of Electric Lighting." By W. H. Preece, F.R.S. Sir Frederick Abel, C.B., F.R.S., Chairman of Council, will preside.

March 12.—"Water Regulation, in regard to Supply, Floods, Drainage, and Transit." By General Rundall.

March 19.—"The Elephant in Freedom and Captivity." By G. P. Sanderson, Superintendent of Government Elephant-catching Operations in Bengal. Sir Joseph Fayrer, K.C.S.I, M.D., F.R.S., will preside.

March 26.—"Vital Steps in Sanitary Progress." By B. W. Richardson, M.D., F.R.S. Sir Robert Rawlinson, C.B., will preside.

Foreign and Colonial Section.

Tuesday evenings:—

March 18.—"Borneo." By B. Francis Cobb, Vice-President of the Society.

April 1.—"The Rivers Congo and Niger entrances to Mid-Africa." By Robert Capper.

Applied Chemistry and Physics Section.

Thursday evenings:—

March 13.—"The Upper Thames as a Source of Water Supply." By Dr. Percy F. Frankland.

March 27.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. Alder Wright, F.R.S., D.Sc.

April 24.—"Economic Applications of Sea weed." By Edward C. Stanford, F.C.S.

Indian Section.

Friday evenings:—

March 7.—"The New Bengal Rent Bill." By

W. Seton-Karr. Sir George Campbell, M.P., K.C.S.I., will preside.

March 28.—"Trade Routes in Afghanistan." By Griffin W. Vyse. Lord Aberdare, F.R.S., will preside.

April 25.—"The Existing Law of Landlord and Tenant in India." By W. G. Pedder.

Cantor Lectures.

The Third Course will be on "Building of London Houses." By Robert W. Edis, F.S.A.

Lecture 3. Mar. 3.—Fittings, Planned Furniture, Constructive Decoration.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Robert W. Edis, "Building of London Houses." (Lecture III.)

Central Chamber of Agriculture (at the House of the Society of Arts), 2 p.m.

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. Woodward, "Fruit Farming."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Geikie, "The Origin of the Scenery of the British Isles." (Lecture VI.) 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. A. C. Engert, "The Defects of Steam-boilers and their Remedy."

Chemical Industry (London Section), Burlington-house, W. 8 p.m. 1. Dr. C. R. A. Wright, "The Manufacture of Cupro-Ammonium and Zinc-Ammonium, and their Technical Adaptation." 2. Mr. S. H. Johnson, "The Filtration of Potable Waters." 3. Paper on "Some Applications of Keiselghur."

British Architects, 9, Conduit-street, W., 8 p.m. General Meeting. Report of Council on award of Medals and Prizes.

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. W. B. Tegetmeier, "The Production of Poultry for the Table."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arthur Severn, "Beach Studies."

Tuesday, March 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gamgee, "Animal Heat." Lecture I.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Sydney W. Barnaby's, "Hydraulic Propulsion."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. Dr. S. Louis, "Handicrafts and Artisans mentioned in Talmudical Writings."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. W. R. Ogilvie Grant, "A Revision of the Fishes of the Genera *Sicydium* and *Lentipes*, with Descriptions of Five New Species." 2. Mr. F. Moore, "Descriptions of New Asiatic Diurnal Lepidoptera, chiefly from Specimens in the Calcutta Museum." 3. Count T. Salvadori, "Note on *Anas capensis*."

Wednesday, March 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Preece, "The Progress of Electric Lighting."

Geological, Burlington-house, W., 8 p.m. 1. Mr. E. Wethered, "The Structure and Formation of Coal." 2. Mr. Frank Rutley, "Strain in Connection with Crystallisation and the Development of Perlitic Structure." 3. Mr. W. H. Penning, "Sketches of South African Geology.—No 1. A Sketch of the High-level Coal-fields of South Africa."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p m.

Archæological Association, 32, Sackville-street, W., 4 p.m. Mr. H. Syer Cuming, "Finger-nail Lore."

Obstetrical, 53, Berners-street, W., 8 p.m.

Shorthand, 55, Chancery-lane, W.C., 8 p.m.

Thursday, March 6...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. St. G. Mivart, "The Relation between Instinct and other Vital Processes." 2. Mr. C. B. Clarke, "Indian *Cyperus*." 3. Dr. P. Manson, "Metamorphosis of *Filaria sanguinis hominis* in the Mosquito." 4. Dr. J. Schaarschmidt, "Afghanistan Algæ."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Armstrong and Dr. Miller, Studies in Sulphuric Acids (No. I.):—"The Hydrolysis of Sulpho-Compounds, and the Recovery of Benzenes from their Sulphuric Acids." 2. Mr. G. Watson Smith, Note on "The Behaviour of the Nitrogen of Coal during Destructive Distillation, and comparison of amount of Nitrogen left in Cokes of various origin." 3. Mr. Thomas Farrington, Note on "Some Experiments to determine the Value of Ensilage as a Milk and Butter-producing Food."

London Institution, Finsbury- circus, E.C., 7 p.m. Prof. Schuster, "The Aurora Borealis."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "The Older Electricity, its Phenomena, and Investigators." (Lecture II.)

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Friday, March 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p m. (Indian Section.) W. Seton-Karr, "The New Bengal Rent Bill."

United Service Institution, Whitehall-yard, S.W., 3 p.m. Mr. Robert Main, "The Cost of the Navy."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. C. V. Boys, "Bicycles and Tricycles in Theory and in Practice."

College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. Clifford Allbutt, "Chapters on Visceral Neuroses." (Lecture I.)

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Rev. E. Maclure, "Personal and Place Names."

Saturday, March 8...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Shelford Bidwell, "Experiments Illustrating an Eplanation of Hall's Phenomena." 2. Prof. S. P. Thompson and Mr. Colman C. Starling, Note on "Hall's Phenomena."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Captain Abney, "Photographic Action considered as the Work of Radiation." (Lecture II.)

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FRIDAY, MARCH 7, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and last lecture of the course on the "Building of London Houses," was delivered by Mr. Robert W. Edis, F.S.A., on Monday, 3rd inst., when the lecturer treated more particularly of fittings, planned furniture, and constructive decoration.

On the motion of the Chairman, a cordial vote of thanks was accorded to the lecturer for his interesting course of lectures.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, February 28th, 1884; W. H. Preece, F.R.S., Vice-President of the Society, in the chair.

The paper read was—

RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.

By Professor Silvanus P. Thompson, B.A., D.Sc., M.S.T.E. University College, Bristol.

Fifteen months ago, I had the honour of delivering in this place a course of three Cantor Lectures on "Dynamo-electric Machinery." In the first of those lectures, the endeavour was made to trace out a physical theory of the action of dynamos, and to follow the theory into its bearings upon the construction of such machines. In the second lecture, a large number of actual machines were considered and compared with one another and with the theory; and in the third lecture, the dynamo was considered in its functions as a mechanical motor.

As the present paper may be considered supplementary to the Cantor Lectures, it will be convenient to treat of the features of progress which come to-night under review in a similar order of topics. I, therefore, take up first the theory of the dynamo.

There are, in fact, three distinct theories of the dynamo: (1) a physical theory, dealing with the lines of magnetic force and lines of current in which these quantities are made, without further inquiry into their why or how, the basis of the arguments; (2) an algebraical theory, founded upon the mathematical laws of electric induction and of theoretical mechanics; and (3) a graphical theory, based upon the possibility of representing the action of a dynamo by a so-called "characteristic" curve, in the manner originally devised by Dr. Hopkinson, and subsequently developed by Frölich, Deprez, and others. The last of these three methods, though it has not received any great or striking development during the past year, has proved itself to be the most invaluable aid in the practical construction of dynamo-machines. One has only to refer to the use made of characteristics by Mr. Kapp in his articles on the winding of "compound" dynamos, and, still more recently, by Dr. Hopkinson, in solving certain problems in the electric transmission of energy, to see how invaluable the method is.

In the algebraic theory much progress has been made during the past year; and there certainly was room for it. Monsieur Joubert has published, in the *Journal de Physique* for July, 1883, a long mathematical article, the object of which is to deduce the equations of the dynamo, taking into account not only the action of self-induction in the circuit, but also some of the terms of the second order usually neglected in first approximations. It is a question whether he has not still omitted some terms of quite as great an importance as those retained in the complicated formula deduced by him. But the matter can hardly be discussed in the present paper. Still more recently, Professor Clausius has published in Wiedemann's *Annalen*, for November last, a paper expounding a mathematical theory of dynamo-electric machines far more comprehensive, and, I venture to say, far more true, than any other yet put forward. Without shirking any of the mathematical difficulties presented by the complications of mutual induction between, and self-induction in, the various organs of the machine, and by the admitted incompleteness of all our formula for connecting the magnetism of an electro-magnet with the strength of its exciting current, Prof. Clausius has succeeded in putting the equations into a shape, not only far more satisfactorily from the point of view of completeness, but in framing those equations in a manner that must commend itself to every engineer. The relative simplicity attained by Clausius is, in fact, due to his lavish introduction of a set of arbitrary constants, each one of which having values that must be determined by experiment, for each machine or type of machines. The number of new symbols thus introduced is considerable; and it would be very desirable to find names for the separate constants to be determined. An excellent translation has appeared in the *Philosophical Magazine* of this year, and another is in process of publication in *The Electrician*, in which journal the series of articles on the theory of dynamo-electric machines from the pen of Professor O. J. Lodge is still continued. It cannot be said even yet that the mathematical theory of the dynamo is near completion. A further paper by Professor Clausius is promised; and it remains to be seen whether this article will deal with some of those points in which the graphic method has been so useful in practice, for example, in determining the proper quantities of wire for the coils in "self-regulating" or "compound" machines, and in finding the best shape to give to magnets and pole-pieces.

Turning to the physical theory of the dynamo, there is much to record. Our knowledge of the inductive actions which go on between the field-magnets and armatures of dynamos, has received considerable additions during the past year from the researches of Isenbeck,

FIG. 1.

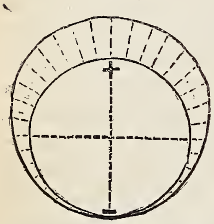
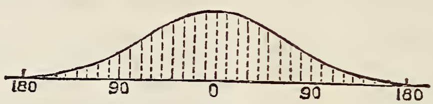


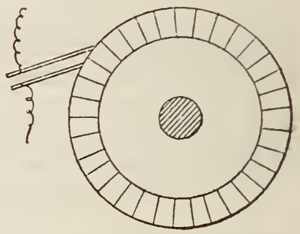
DIAGRAM OF POTENTIAL ROUND THE COLLECTOR OF GRAMME DYNAMO.

FIG. 2.



HORIZONTAL DIAGRAM OF POTENTIALS AT COLLECTOR OF GRAMME DYNAMO.

FIG. 3.



METHOD OF EXPERIMENTING AT COLLECTOR OF DYNAMO.

Cunnynghame, Pfaundler, and others. There is a good deal to be said on this head, and I have several new results to announce as the result of my own observations. Let me take as my starting point a matter mentioned in my Cantor Lectures, namely, the distribution of potential round the collector or commutator of a dynamo. Mr. W. M. Mordey, who first drew my attention to the fact that this distribution was irregular in badly designed machines, had devised the following method of observing it. One terminal of a voltmeter was connected to one of the brushes of the dynamo, and the other terminal was joined by a wire to a small metallic brush or spring, which could be pressed against the rotating collector at any desired part of its circumference. I then made the suggestion that these indications might with advantage be plotted out round a circle corresponding to the circumference of the collector. Figs. 1 and 2, which are reproduced rom my Cantor Lectures, serve to show how the potential in a good Gramme machine rises gradually from its lowest to its highest value. The same values as are plotted round the circle in Fig. 1 are plotted out as vertical ordinates upon the level line in Fig. 2. I made the remark at the time that if the magnetic field in which the armature rotated were uniform, this curve would be a true "sinusoid," or curve of sines; and that the steepness of the slope of the curve at different points would enable us to judge of the relative idleness or activity of coils in different parts of the field. About the same time, I developed this method of observation a little further, and used two small metal brushes, at a distance apart equal to the width between the middle of two consecutive bars of the collector of my little Siemens dynamo, for the same purpose.* As the collector rotated, these two little brushes

* Dr. Isenbeck has also independently used a similar arrangement to investigate the induction going on in a Gramme dynamo.

(see Fig. 3 p. 320) gave on the voltmeter an indication which measured exactly the activity of the induction, in that section of the armature which was passing through the particular position in the field corresponding to the position of the contacts. I found, in the case of my Siemens dynamo, that the result was fairly satisfactory, for the difference of potential indicated was almost *nil* at the sections close to the proper brushes of the machine, and was a maximum about half way between. In fact, the differences of potentials was rising most markedly at 90° from the usual brushes, or precisely in the region where (as seen in Fig. 2 p. 320) the slope of the curve of total potential was greatest. One immediate result of Mr. Mordey's observations on the distribution of potential, and of my method of mapping it, may be recorded. I pointed out to Mr. Mordey that in a dynamo where the distribution was faulty, and where the curves of total potential showed irregularities, the fault was due to irregularities in the induction at different parts of the field; and that the remedy must be sought in changing the distribution of the lines of force in the field by altering the shape of the pole pieces. I am able now, after the lapse of fifteen months, to congratulate Mr. Mordey on the entire and complete success with which he has followed out these suggestions. He has entirely cured the Schuckert machine of its vice of sparking. The typical bad diagram given in my Cantor Lectures was taken from a Schuckert machine before it received from his hands the modifications which are so signally successful to-day.

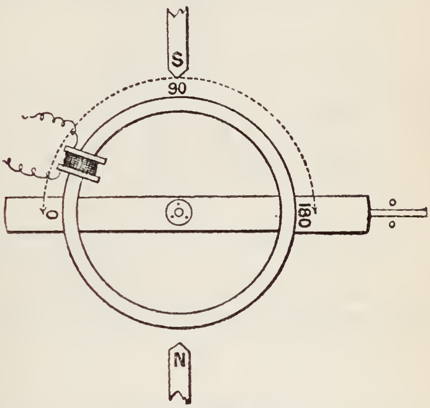
Since the experiments above detailed, I have experimented on my Siemens dynamo in another way. The machine was dismounted, and its field magnets separately excited. Two consecutive bars of the collector were then connected with a reflecting galvanometer having a moderately heavy and slow moving needle. A small lever clamped to the collector allowed the armature to be rotated by hand, through successive angles equal to 10°, there being thirty-six bars to the collector. The deflexions obtained of course measured the intensity of the inductive effect at each position. The result confirmed those obtained by the method of the two wire-brushes.

I mention these methods, which have been used in my laboratory at Bristol, and have not been published before, because they relate strictly to the physical theory of the dynamo as developed in my Cantor Lectures, and also because of their practical application to all dynamos in which any such defect appears. They are also very closely related to the researches of Dr. Isenbeck, which next claim attention.

Dr. Isenbeck described, in the *Electrotechnische Zeitschrift* for last August, a beautiful little apparatus for investigating the induction in the coils of a Gramme ring, and for investigating the influence exerted by pole pieces of different form upon these actions.

Isenbeck's apparatus (Fig. 4) consists of a circular frame of wood placed between the poles of two small bar-magnets of steel, each 25 centimetres long, lying 25 centimetres apart. On the frame, which is pivotted at the centre, is carried a ring of wood or iron, upon which is placed at one point a small coil of fine wire. This corresponds to a single section of the coils of a Pacinotti or of a Gramme ring, of

FIG. 4.



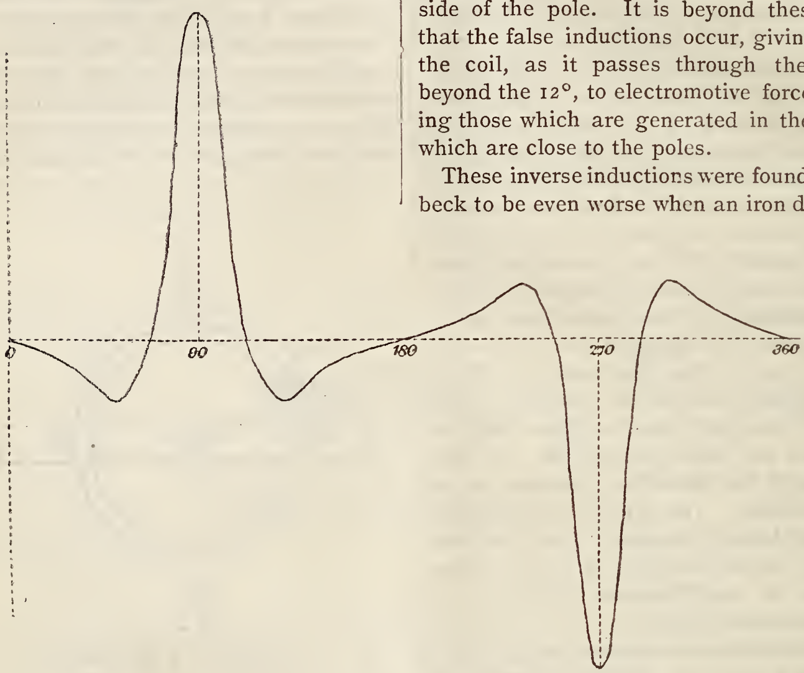
ISENBECK'S APPARATUS.

which the ring of wood or iron constitutes the core. The coil can be adjusted to any desired position on the ring, and the ends communicate with a galvanometer. On vibrating it isochronously with the swing of the needle of the galvanometer, the latter is set in motion by the induced currents, and the deflexion which results shows the relative amount of induction going on in the particular part of the field where the coil is situated. The vibrations of the frame are limited by stops to an angle of 7° 5'. Pole-pieces of soft iron, bent into arcs of about 160° so as to embrace the ring on both sides, but not quite meeting, were constructed to fit upon the poles of the magnets. In some of the experiments a disc of iron was placed internally within the ring; and in some other experiments a magnet was placed inside the ring, with its poles set, so as either to reinforce, or to oppose, the action of the two external poles. In Dr. Isenbeck's hands this apparatus yielded some remarkable results. Using a wooden ring, and poles destitute of polar expansions, he observed a very remarkable inversion in the inductive action to take place at about 25° from the position nearest the poles.

Fig. 4 is a sketch of the main parts of Isenbeck's instrument, and shows the small coil mounted on the wooden ring, and capable of being vibrated to and fro between stops. When vibrated at 0°, or in a position on the diametral line at right angles to the polar diameter, there is no induction in the coil; but as the coil is moved into successive positions round the ring towards the poles, and vibrated there, the induction is observed first to increase, then die away, then begin again in a very powerful way, as it nears the pole, where the rate of cutting the lines of force is a maximum. This powerful induction near the poles is, however, confined to the narrow region within about 12° on each side of the pole. It is beyond these points that the false inductions occur, giving rise in the coil, as it passes through the regions beyond the 12°, to electromotive forces opposing those which are generated in the regions which are close to the poles.

These inverse inductions were found by Isenbeck to be even worse when an iron disc, or an internal opposing magnet, was placed within the ring; but a reinforcing magnet slightly improved matters. Of course such an action in a Gramme armature going on in all the coils, except in those within 12° of the central line of the poles, would be most disastrous to the working of the machine; and the rise of potential round the collector would be anything but regular. In Fig. 5 I have copied out Isenbeck's curve of induction for the consecutive four quadrants. From 0° to 90° the exploring coil is supposed to be vibrated in successive positions from the place where, in the actual dynamo, the negative brush would be, round to a point opposite the S pole of the pointed field-magnet. From 90° to 180° it is passing round to the positive brush; from 180° to 270° it passes to a point opposite the N pole; and from 270° to 360° returns to the negative brush. Now, since the height of this curve, at any point, measures the induction going on in a typical section as it moves through the corresponding region of the field, and since in the actual Pacinotti or Gramme ring the sections are connected all the way round the ring, it follows that the actual potential at any point in the series of sections will be got by adding up the total induced electromotive force up to that point. In other words, we must integrate the curve to obtain the corresponding curve of potential corresponding with the actual state of things round the collector of the machine. Fig. 6 (p. 323) gives the curve as integrated expressly for me from Fig. 5 by the aid of the very ingenious curve integrator of Mr. C. Vernon Boys. The height of the ordinate of this second curve at

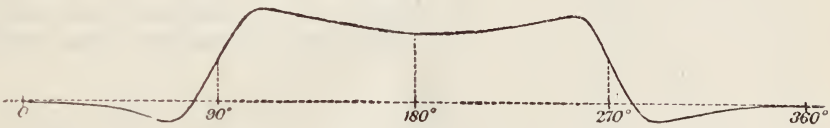
Fig. 5.



any point is proportional to the total area enclosed under the first curve up to the corresponding point. Thus the height at 90° in the second curve, is proportional to the total area up to 90° below the first curve. And it will be noticed that though the induction (first curve, Fig. 5) decreases after 90°, and falls to zero at about 102°, the sum of the potentials (second curve, Fig. 6) goes on increasing up to 102°, where it is a maximum, and after that falls off, because, as the first curve shows, there is from that point onwards till 180° an opposing false induction. If this potential curve were actually observed on any dynamo, we might be sure that we could get a higher electromotive force by moving the brush from 108° to 102°, or to 258°, where the potential is higher. Any dynamo in which the curve of potentials at the commutator presented such irregularities as Fig. 6, would be a very inefficient machine, and would probably spark terribly at the collector. It is evident that the induction in some of the coils is opposing that in some of the adjacent coils.

Two questions naturally arise—Why should such detrimental inductions arise in the ring; and how can they be obviated? The researches of Dr. Isenbeck supply the answer to both points. Dr. Isenbeck has calculated from the laws of magnetic potential the number of lines of force that will be cut at the various points of the path of the ring. He finds that the complicated mathematical expression for this case, when examined, shows negative values for angles between 12° and 90°. The curves of values that satisfy his equations have minima exactly in those regions where his experiments revealed them. This is very satisfactory as far as it goes. But we may deduce a precisely similar conclusion in a much simpler manner, from considering the form and distribution of the lines of magnetic force in the field. These are shown in Fig. 7,

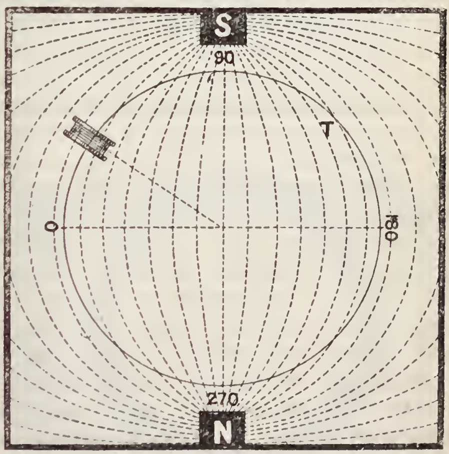
FIG. 6.



together with the exploring coil situated as in Fig. 4 (p. 321). A simple inspection of the figure will show that at 0° a certain number of lines of force would thread themselves through the exploring coil. As the coil moved round toward the S pole, the number would increase at first, then become for an instant stationary, with neither increase or decrease; after that a very rapid decrease would set in, which, as the coil passed the 90° point, would result in their being no lines of force through the coil. But at the very same instant the lines of force would begin to crowd in on the other side of the coil, and the number so threaded through negatively, would increase until the coil turned round to about the position marked T, where the lines of force are nearly tangential to its path, and here the inversion would occur, because, from that point onwards to 180°, the number of lines of force threaded through the coil would decrease. We see then that such inversions in the induction must occur of necessity to a small coil rotating in a magnetic field in which the lines of force are distributed in the curved directions, and with the unequal density which this disposition of the field-magnets presents. The remedy is obvious; arrange a more uniform field, in which the lines of force are more equally distributed, and are straighter.

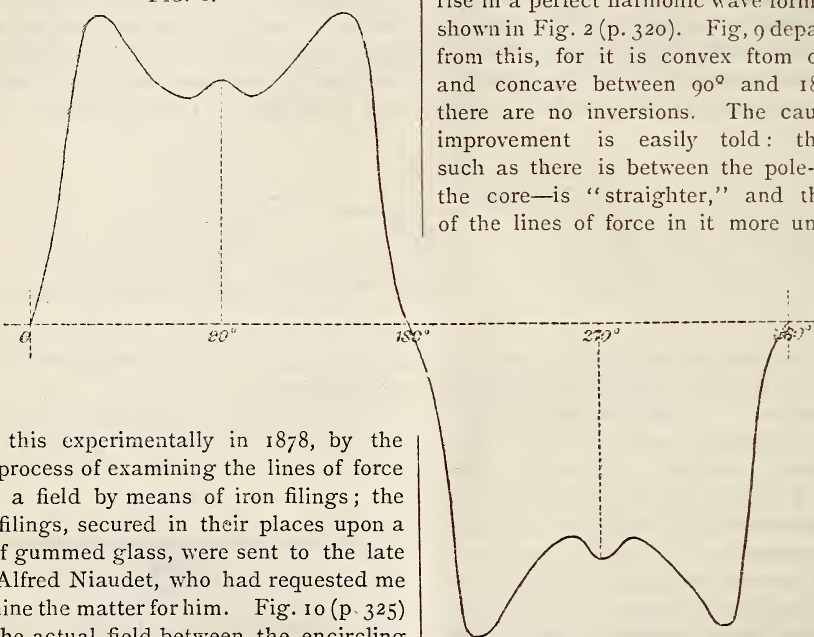
If an iron core be substituted for the wooden core, the useful induction is greater, and the

FIG. 7.



false induction less; there is still an inversion, but it takes place at about 25° from the pole, and is quite trifling in amount. The introduction of iron pole-pieces extending in two nearly semi-circular arcs from the magnets on either side has, if the wooden ring be still kept as a core, the effect of completely changing the induction, so that the curve, instead of showing a maximum at 90° from starting, shows one at about 10°, and another at 170°! If, however, we make the double improvement of using the iron pole-pieces and the iron core at the same time, the effect is at once changed. There are no longer any inversions. though the induction shows some peculiarity still. Fig. 8 shows the curve of induction adapted from Dr. Isenbeck's paper, and Fig. 9 (p. 325), the curve of potential, which I have had integrated from it. Looking at Fig. 8, we see that on starting from 0° induction soon mounts up, and becomes a maximum at about 20°, where the coil is getting well opposite the end of the encircling pole-piece. From this point on, though the induction is somewhat less, it still has a high value, showing a slight momentary increase as the coil passes the pole at 90°, and there is another maximum at about 160°, as the coil passes the other end of the pole-piece. My integrated curve (Fig. 9) tells us what would go on at the collector, if this were the action in the connected set of coils of a Pacinotti or Gramme ring. The potential rises from 0° all the way to close upon 180°. Still this is not perfect. In the perfect case the potential-curve would rise in a perfect harmonic wave form, like that shown in Fig. 2 (p. 320). Fig, 9 departs widely from this, for it is convex ftom 0° to 90°, and concave between 90° and 180°. But there are no inversions. The cause of the improvement is easily told: the field—such as there is between the pole-piece and the core—is "straighter," and the density of the lines of force in it more uniform. I

FIG. 8.

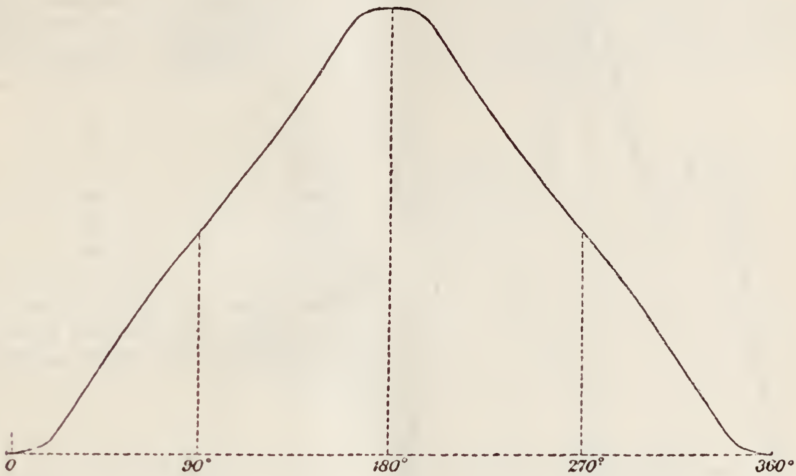


proved this experimentally in 1878, by the simple process of examining the lines of force in such a field by means of iron filings; the actual filings, secured in their places upon a sheet of gummed glass, were sent to the late Mons. Alfred Niaudet, who had requested me to examine the matter for him. Fig. 10 (p. 325) shows the actual field between the encircling pole-pieces and the iron ring. It will be seen that, though nearly straight in the narrow intervening region, they are not equally distributed, being slightly denser opposite the ends of the pole-pieces. One other case examined by Dr. Isenbeck, we will glance at. The effect of introducing within the ring a interior magnet, having its S pole opposite the external S pole, and its N pole opposite the external N pole, was found to assist the action. The induction-curve is represented in Fig. 11 (p. 326). As will be seen, there are two maxima at points a little beyond the ends of the pole-pieces, as before; but in between them there is a still higher maximum, right between the poles. This case also has been integrated on Mr. Boys' machine, and shows the potential curve of Fig. 12 (p. 327). This curve is a still nearer approach to the harmonic wave-form, being concave from 0° to 90°, and convex from 90° to 180°.

I pass from Dr. Isenbeck's researches, and the integrated curves of potential which I have deduced from them, to some further researches of my own, which were undertaken with the view of throwing some light on the question whether the Pacinotti form of armature, with protuding iron teeth, or the Gramme form, in which the iron core is entirely overwound with wire, is the better. It has been assumed without, so far as I am aware, any reason assigned, that the Gramme ring was an improvement on that of Pacinotti. Pacinotti's was of solid iron, with teeth which projected both outwards and inwards, having the coils wound between. Gramme's was made "either out of one piece of iron, or of a bundle of iron wires," and had the coils wound "round the entire surface." Now the question whether the Gramme construction is better than the Pacinotti or not, can readily be tested by experiment. And experiment alone can determine whether it is better to keep a thickness of wire always between pole-pieces and the core, or to intensify the field by giving to the lines of force the powerful reinforcement of protruding teeth of iron. The apparatus I have constructed for determining this point is now before you. It is sketched in Fig. 13 (p. 328).

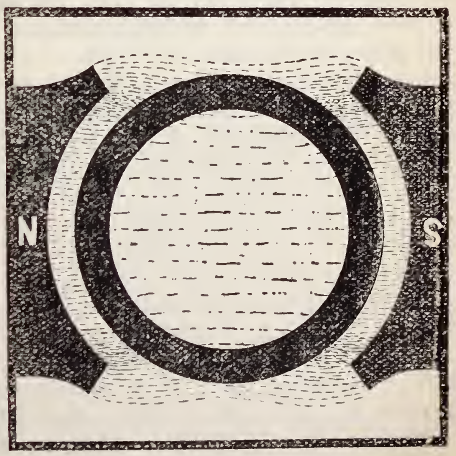
First, there are a couple of magnets set in a frame so as to give us a magnetic field, and there are pole-pieces that can be removed at will; in fact, there are three sets of pole-pieces for experimenting with different forms. Between the poles is set an axis of brass,

FIG. 9.



upon which the armatures can be slid. These armatures are three in number. One is shown in Figs. 14 and 15 (p. 328), and consists of two coils of fine wire wound upon a wooden ring; another armature is exactly like this, but is built up on a ring of iron wire; a third (shown in its place in Fig. 13) is constructed upon a toothed ring made up of a number of plates of ferrotype iron cut out and placed flat upon one another. On each of the armatures are wound two coils at opposite ends of a diameter. The coils contain precisely equal lengths of silk-covered copper wire, cut from one piece. The cross section of the core within each of these coils is in each case a square, of one centimetre in the side, so that the number of turns in each coil is as nearly equal as possible. I can slip any one of these armatures into the field, and connect it with a galvanometer. There is a lever handle screwed to the armature, by means of which it can be moved. I have used two methods of proceeding in order to compare the coils. One of these methods is to turn the armature suddenly through a quarter of a revolution, so that the coils advance from 0° to 90°, when the "throw" of the needle of the galvanometer—which is a slow-beat one—gives me a measure of the total amount of

FIG 10.



IRON RING IN THE MAGNETIC FIELD.

induction in the armature. The results are as follows:—

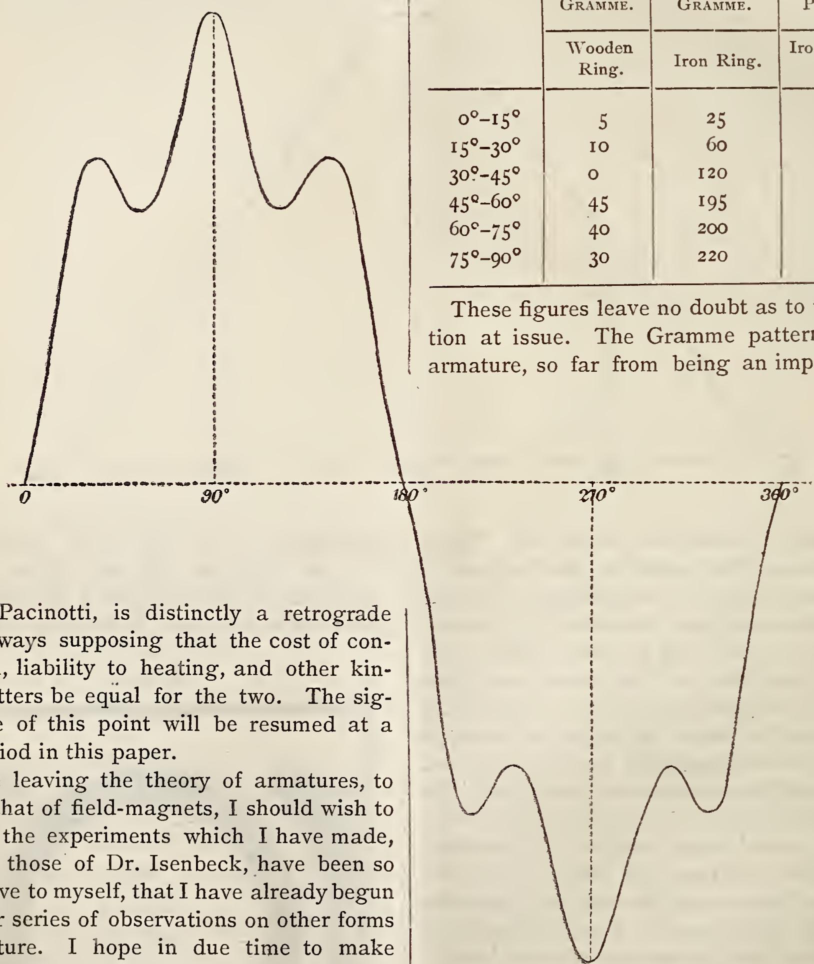
Gramme.	Gramme.	Pacinotti.
Wooden Ring.	Iron Ring	Iron Toothed Ring.
5	24	50

My second method of using these armatures consists in jerking the coils through a distance equal to their own thickness, the coils being successively placed at different positions in the field. The throw of the galvanometer being observed as before. Each of the coils occupies as nearly as possible 15° of angular breadth. Accordingly, I have two stops set, limiting the motion of the handle to that amount, and at the back, there is a graduated circle enabling me to set the armature with the coils in any desired position. If we move the coils by six such jerks, through their own angular breadth each time, then starting at 0°, the sixth jerk will bring us to 90°. I have plotted out in Fig. 16 (p. 329), the three curves thus obtained, and the corresponding numbers are given in the following table:—

	Gramme.	Gramme.	Pacinotti.
	Wooden Ring.	Iron Ring.	Iron Toothed Ring.
0°–15°	5	25	30
15°–30°	10	60	70
30°–45°	0	120	140
45°–60°	45	195	320
60°–75°	40	200	380
75°–90°	30	220	360

These figures leave no doubt as to the question at issue. The Gramme pattern of ring armature, so far from being an improvement on the Pacinotti, is distinctly a retrograde step; always supposing that the cost of construction, liability to heating, and other kindred matters be equal for the two. The significance of this point will be resumed at a later period in this paper.

Fig. 11.



Before leaving the theory of armatures, to pass to that of field-magnets, I should wish to say that the experiments which I have made, and also those of Dr. Isenbeck, have been so instructive to myself, that I have already begun a similar series of observations on other forms of armature. I hope in due time to make known the results of my investigations.

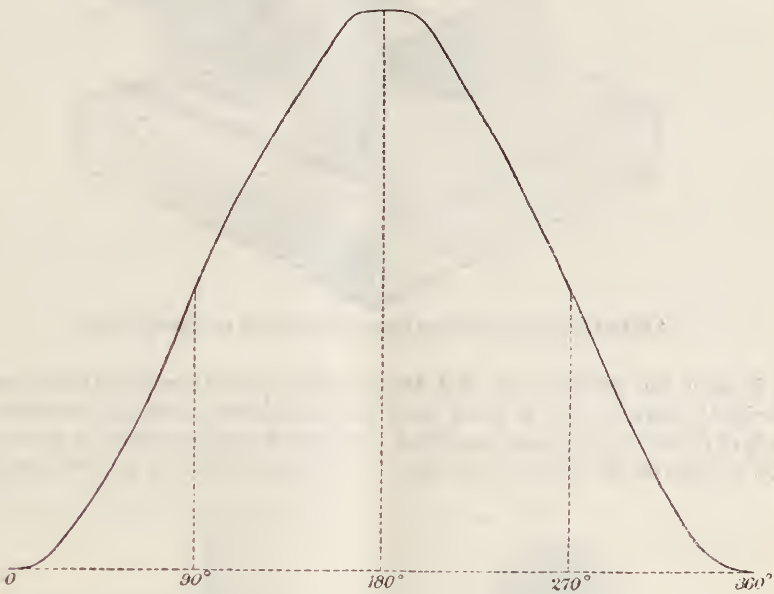
But little advance has been made in theory so far as relates to the field-magnets. The law of saturation of an electro-magnet remains still an empirical law. It is satisfactory, however, that such widely differing authorities as Professor Clausius, M. Marcel Deprez, and Professors Ayrton and Perry, agree in accepting the empirical formula of Fröhlich as a sufficiently accurate expression for the law of saturation.

Some progress has been made in the theory of the lead that must be given to the brushes of the dynamo. Formerly this was ascribed to a sluggishness in the demagnetisation of the iron of the armature; but in 1878, the late

M. Antoine Breguet suggested as a reason the influence of the actual current circulating round the armature coils, which would tend to produce in the iron of the armature a magnetisation at right angles, to that due to the field-magnets.

Breguet showed that there would be a resultant oblique direction of the lines of magnetisation in the field, and therefore, since the "diameter of commutation" is at right-angles to this direction, the brushes also must be displaced through an equal angle. Clausius accepts this view in his recent theory, and adopts for the angle of the resultant field that whose tangent is the ratio of the two magnetising forces due to the field-magnets, and the current in the armature respectively. Professors Ayrton and Perry have also pointed out that there will be an additional displacement of the resultant pole of the armature, consequent upon the self-induction going on in the armature coil between its different sections. In their paper on the government of motors, in which they have brought out this point, they, however, take the view that part of the displacement of the pole is due to the sluggishness of demagnetisation of the iron. I do not think, however, that this can be maintained. No experimental proof has ever been given that there is any such thing as a true magnetic lag; the apparent magnetic sluggishness of thick masses of iron is demonstrably due to internal induced currents; and no one uses solid iron in armature cores for this very reason. Neither has it been shown that thin iron plates or wires, such as are used in armature cores, are slower in demagnetising than magnetising. Indeed, the reverse is probably true; and, until further experimental evidence is forthcoming, I shall assume that there is no magnetic lag in properly laminated iron cores.

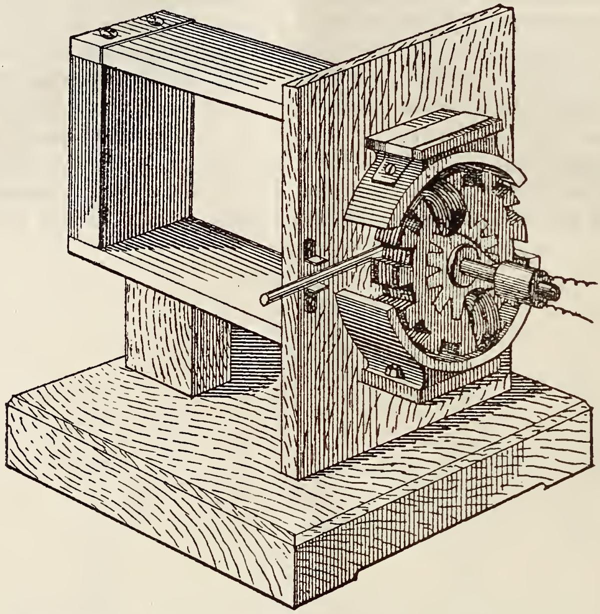
Fig. 12.



It may here be pointed out that, assuming as a first approximation that the rule that the tangent of the angle of lead represents the ratio between the magnetising power of the field-magnets and of the armature coils, the lead may be diminished to a very small quantity, by increasing the relative power of the field-magnets, a course which is for many other reasons advisable. All practice confirms the rule that the magnetic moment of the field-magnets ought to be very great as compared with that of the armature. Further than this, there ought to be so much iron in the armature as to be just saturated when the dynamo is working at its greatest activity. If there is less than this, it will become saturated at a certain point, and when any currents greater than this are employed, the lead will alter, for then the magnetic effect due to the current in the armature will be of greater importance, relatively to that due to the field-magnets. For the same reason, the lead will be more constant when the field-magnets are under their saturation point, than when quite saturated. In short, every cause that tends to reduce the lead, makes the lead more constant, and therefore tends to reduce sparking at the brushes. And the best means to secure this is obviously to use an unstinted quantity of iron—and that of the softest kind—both in the field-magnets and in the armature, for then the currents circulating in the armature will have less chance of perturbing the field.

In relation to the magnetisation of field-magnets, it may be pointed out that the "characteristic" curves, now so much used for the study of the action of dynamo machines, which show the rise of the electromotive force of the machine in relation to the corresponding strength of the current, are sometimes assumed, though not quite rightly, to represent the rise of magnetisation of the field-magnets. Now though the magnetisation of the magnet may attain to practical saturation, it does not, under a still more powerful current, show a magnetisation less than saturation. But the characteristics of nearly all series-wound dynamos show—at least, for high speeds—a decided tendency to turn down after attaining a maximum; and for some machines, for ex-

Fig. 13.



Apparatus for investigating Induction of Armatures.

Fig. 14.

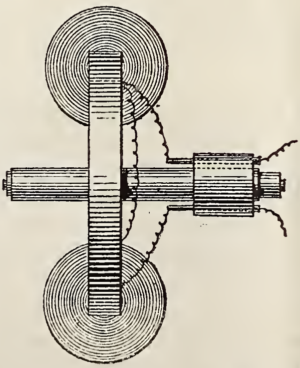
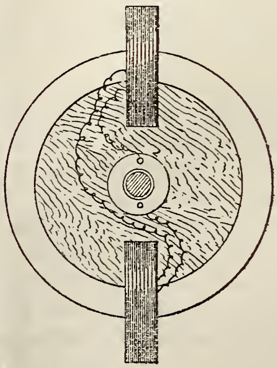


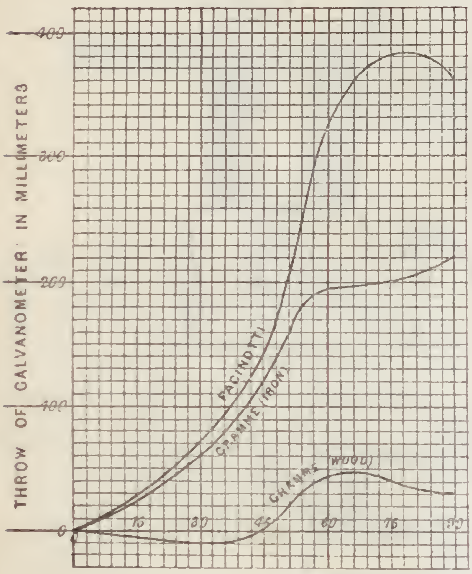
Fig. 15.



Experimental Armature.

ample, the Brush, this diminution of the electromotive force is very marked. The electromotive force diminishes, but the magnetism of the field-magnets does not. An explanation of this dip in the characteristic has lately been put forward by Dr. Hopkinson, in his lecture on "Electric Lighting," before the Institution of Civil Engineers, attributing this to the reaction of self-induction and mutual induction between the sections of the armature. No doubt this cause contributes to the effect, as all such reactions diminish the effective electromotive force. I am inclined, however, to think that the greater part of the effect is due to the shifting of the effective line of the field in consequence of the iron of the field-

FIG. 16.



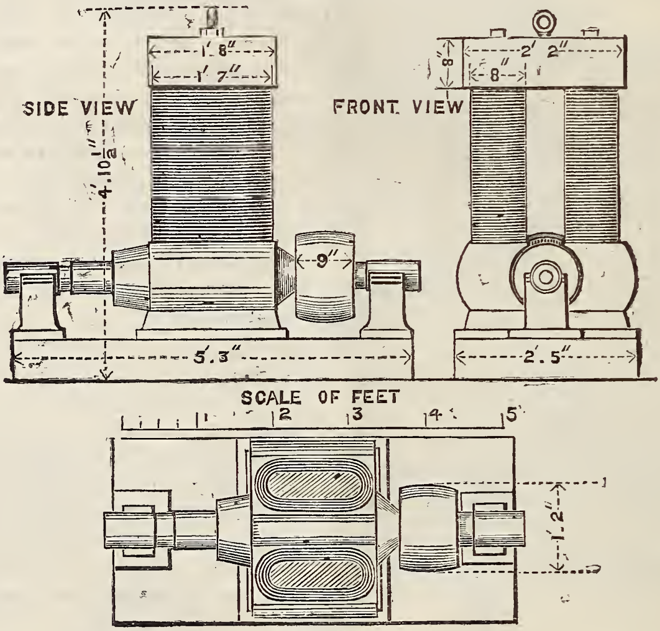
magnets becoming saturated before the armature is so. It is at least significant that in the Brush machine, where the reduction of electromotive force is very great, there is also such a mass of iron in the armature, and so variable a lead at the brushes.

Another point in which theory has for long been ahead of practice, is in the advantage to be gained by working as nearly as possible with closed magnetic circuits; that is to say, with a nearly continuous circuit of iron to conduct the lines of magnetic force round into themselves in closed curves. The enormous importance of this was pointed out so far back as 1878 by Lord Elphinstone and Mr. C. W. Vincent, whose dynamo embodies their idea. Every electrician knows that if a current of electricity has to pass through a circuit, part of which consists of copper, and part of liquids—such as the acid in a battery, or the solution in an electrolytic cell—the resistance of the liquid is, as a rule, much more serious than the resistance of the copper. Even with dilute sulphuric acid the resistance to the flow of the current by a thin stratum is 200,000 times as great as would be offered by an equally thick stratum of copper. And in the analogous case of using a field-magnet to magnetise the iron core of an armature, the stratum of air—or, it may be, of copper wire—in between the two pieces of iron, offers what we may term a relatively enormous resistance to the magnetic induction. If we take the magnetic permeability of iron as 1, then the permeability of air is something like $\frac{1}{20000}$, and that of copper is not very different. Or, in other words, a stratum of air or copper offers about 20,000 times as much resistance to the magnetic induction as if the space were filled up with soft iron. Obviously, then, it would be a gain to diminish as much as possible the gaps between the portions of iron in the circuit. The values of the magnetic permeability for iron, air, and copper, have been known for years, yet this simple deduction from theory has been set at defiance in the vast majority of cases. We have had, a few minutes ago, an experimental proof that the Pacinotti ring, so far from having been "perfected" or "improved" by Gramme, as some very high authorities say, is vastly inferior to it. It will perhaps be intelligible now why Pacinotti's design was essentially right.

I now pass on to the progress recently made in the practical construction of dynamo-electric machines. Thanks to the kindness of several of those by whom this progress has been achieved, I am able to put before you their very latest results.

The Edison dynamo has, during the past eighteen months, received very material improvements at the hands of Dr. Hopkinson, F.R.S. Some of these improvements relate to the field-magnet; others to the armature. Dr. Hopkinson has, in the first place, abolished the use of the multiple field-magnets, which in the Edison "L" "K" and "E" machines were united to common pole-pieces, and instead of using two, three, or more round pillars of iron, each separately wound, he puts an equal mass of iron into one single solid piece of much greater area of cross-section and somewhat shorter length. One such iron mass, usually oval or oblong cross-section, is attached solidly to each pole-piece, and the two aer united at the top by a still heavier yoke of iron. The machines have, consequently, a more squat and compact appearance than before (FIG. 17). It may be remarked, in passing, that the use of multiple pillars of iron used by Edison in the "L," "K," and "E" machines must have been prejudicial, because the currents in those portions of the coils which passed between two adjacent iron pillars must have been opposing each other's magnetising effect. Dr. Hopkinson has also introduced the improvement of winding the magnets with a copper wire of square section, wrapped in insulated tape. This wire packs more closely round the iron cores than an ordinary round wire. In the armature the following change has been made. The iron core in the older Edison machines was made of thin iron disks, separated by paper slipped on over a sleeve of *lignum vitæ;* and held together by six longitudinal bolts passing through holes in the core-plates, and secured by nuts to end plates. These bolts are now removed, and the plates are held together by great washers, running upon screws cut on the axle of the armature. The size of the central hole in the plates has been diminished, thus getting into the interior more iron, and providing a greater cross-section for the

FIG. 17.



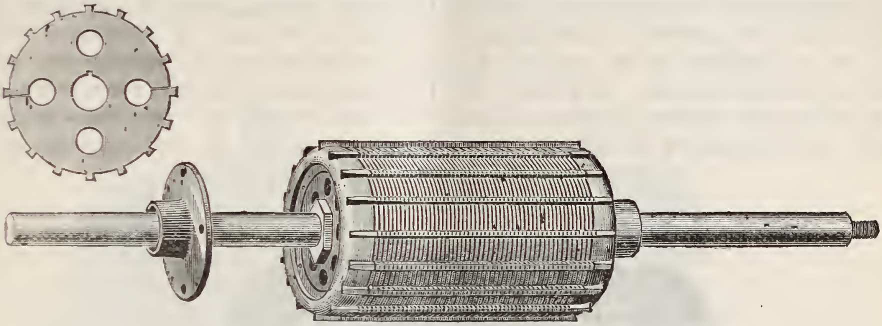
EDISON-HOPKINSON DYNAMO.

magnetic induction. By these improvements, a machine occupying the same ground space, and of about the same weight as one of the older "L" 150-light machines, is able to supply 250 lights, the efficiency being at the same time improved. In the new 250-light machine, the diameter of the armature is 10 inches; its resistance, cold, is 0·02 ohm; that of the magnets is 17 ohms. The characteristic curve of the machine shows that even when doing full duty, the field-magnets are far from being saturated. It will be remarked that, in the older construction, the bolts and their attached end-plates furnished a circuit in which idle currents were constantly running wastefully round, with consequent heating and loss. An Edison 60-light "Z" machine of the older pattern, tested by the committee of the Munich Exhibition, was found to give an efficiency which, if measured by the ratio of external electric work to total electric work, exceeded 87 per cent.; but its commercial efficiency—the ratio of external electric work to the mechanical energy imparted at the belt—was only, at the most, 58·7 per cent. In a recent test made by Mr. Sprague, at Manchester, on an improved dynamo (a 200-light machine), the efficiency of electrical conversion exceeded 94 per cent., and the commercial efficiency 85 per cent.*

The Edison Company states that "the weight and cost of the machines per lamp are greatly reduced," but they add a table from which it appears that the old 250-light machine costs £250, whilst the new 250-light machine costs £265, if made as a fast-speed machine, and £425 if constructed as a slow-speed machine.

The Siemens' machines have not been much altered during the past year; and it is a little difficult to describe the improvements which have been made, as the firm of Siemens Bros. decline, for commercial reasons, to furnish data for publication. Progress has, however, been made by this firm, especially with their compound-wound machines, of which some account has been given by Herr E. Richter, in the *Electrotechnische Zeitschrift*. It appears that three methods of combination have been tried. The shunt and series coils have been wound on different arms of the magnets; they have been wound on separate short frames, and slipped on to the cores side by side; and they have been also wound over one another. In the latest machines, the series coils are wound outside the shunt windings. The regulation judging by the curves given by Herr Richter, is not perfect. The best regulation was from a "*g* D 17" machine, of which two of the magnet limbs were wound with shunt coils of 29 layers of a 1 millimetre wire, and the other two with two layers of a 3·5 millimetre wire. The potential varied from 64 to 69 volts when the number of lamps was reduced from 20 to 9.

Fig. 18.



Core of Weston Armature.

Fig. 19.

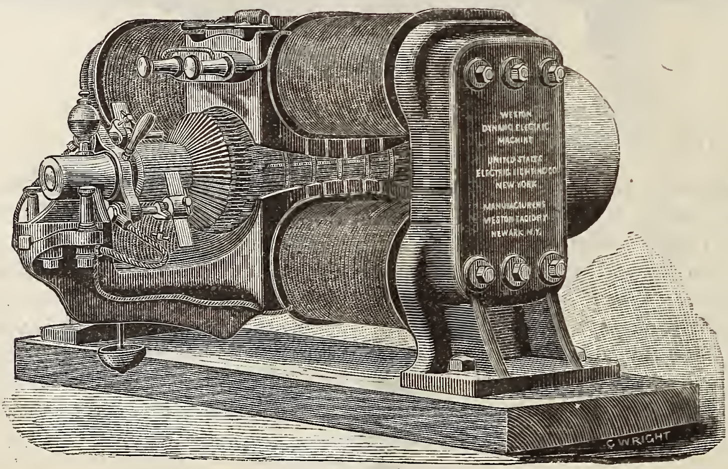
Weston Armature.

The Weston machine has an armature more or less resembling those of the Siemens' machines. The core is built up of disks of iron, of the form shown in Fig. 18, strung together, and presenting projecting teeth all along the surface of the cylinder. Fig. 19 shows the armature when completed. In this machine, as is also evident from Fig, 20 (p. 332), the pole-pieces are laminated, to obviate eddy currents and heating. Recently, Mr. Weston has adopted a method of winding the armature with two circuits, so that an accident to one section shall not completely break down the machine. The latest of the Weston machines show substantial design, and many improvements in detail upon the older forms.

* These values assume the B. A. unit as the true ohm, and are, therefore, probably about 1½ per cent. too high.

The machines of the Gramme type next come in for consideration. In those of the actual Gramme pattern I cannot learn that any important improvement has been made in this country; but in the States, the Fuller Electrical Company, which holds the Gramme and Wood patents, has brought out several improved forms of machine, in which mechanical engineering skill of a high order is apparent. The field-magnets, frames, and pole-pieces are very substantial, the ring is better built than the European types, and the collector bars are prevented from flying to pieces by the addition of an insulated ring shrunk on over their ends. In France, too, the machine has received important modifications at the hands of M. Marcel Deprez. M. Deprez's dynamo has two Gramme rings upon one axle, which lies between the poles of two opposing field-magnets, each of the two-branched, or so-called horseshoe form. These are laid horizontally, so that the north pole of one is opposite the south pole of the other, and *vice versa;* the poles being provided with curved pole-pieces between which the rings revolve. M. Deprez, who has given much attention to the question how to design a machine which, with the least expenditure of electric energy, gives the greatest actual couple at the axle, is of opinion that the horse-shoe form of electro-magnet is the most advantageous. The iron cores and yokes of the field-magnets are very substantial; but the pole-pieces are not very heavy. M.

Fig. 20



Weston Dynamo.

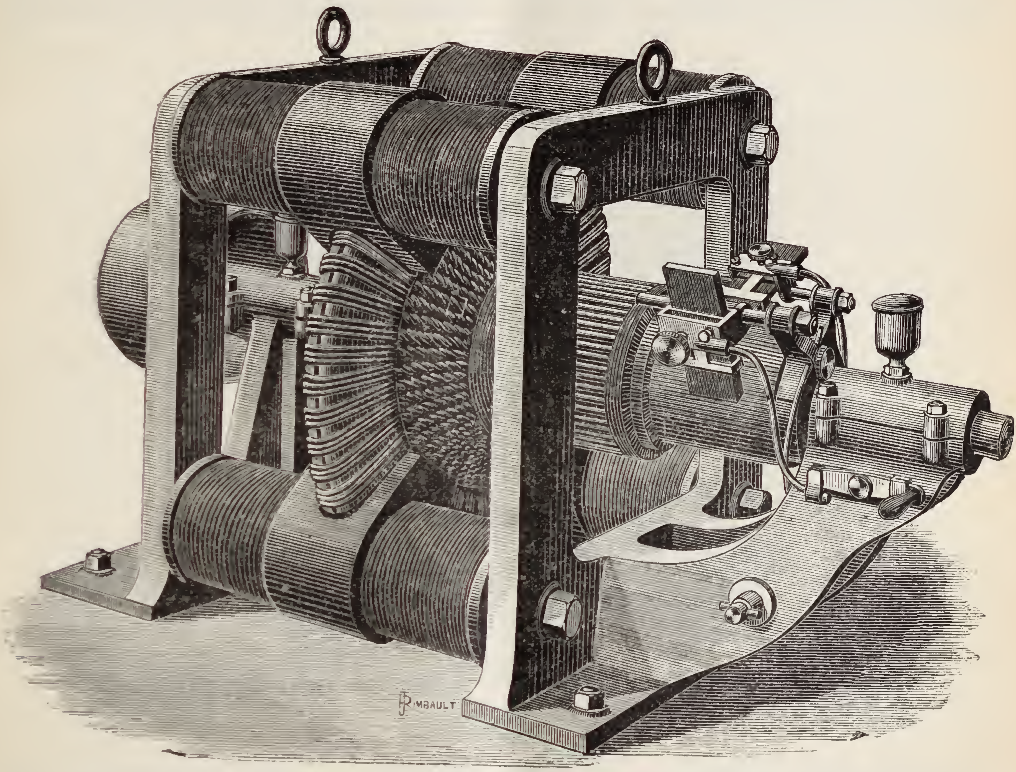
Deprez's machine has a very elaborate system of sectional windings of the field-magnets and a switch-board, enabling him to couple up the connections in various ways. The circuits of the two rings are quite distinct, and each armature has its own collector and brushes. M. Deprez has also constructed other Gramme machines, with armatures of very fine wire, for his experiments on the electric transmission of power.

Another machine, having as an armature an elongated ring somewhat like that of the Maxim dynamo, was shown during last autumn at the Fisheries Exhibition, under the name of the Hockhausen dynamo. The field-magnets of this machine are very strangely disposed, the ring being placed between two straight electro-magnets placed vertically over one another; the upper magnet being held in its place by curved flanking-pieces of iron, which run down the two sides of the machine, and connect the topmost point of the upper magnet with the lowest part of the lower. This arrangement, which strikes the eye as being both mechanically and magnetically bad, is claimed as one of the virtues of the machine, which, in spite of its magnets, appears to be a very good working machine. Its armature is constructed of four separate curved iron frames, upon which the previously wound coils are slipped, and which are then bolted together and secured to strong end-plates. I have not seen any report on the efficiency of this of machine.

We next come to the class of machines in which a flattened Gramme ring is used, and of which the machines of Fein, Schuckert, and Gülcher are the best known types.

Mr. Gülcher has been steadily at work improving his dynamo in its various mechanical and electrical details. In particular, he has devoted attention to the winding of the field-magnets, so as to secure a constant potential at the terminals. After experimenting with various methods of compounding, he finds that the best results are arrived at in the following way:—In his four-pole dynamo there are eight cores to be wound. Each of these receives a shunt coil of fine wire, and outside this a main coil of stout wire. The eight fine wire coils are then joined up in series with one another, and connected as a shunt to the terminals; whilst the eight main circuit coils are joined up in parallel. In proof of the degree of accuracy attained by this method Mr. Gülcher has given me many numerical data from actual tests. All of them show a very fair approximation to a constant potential, and an actually attained constancy for a con-

Fig. 21.



Victoeia (Schuckert-Mordey) Dynamo (4-Pole).

siderable range. For example, a 4-pole machine, intended to give 65 volts, gave that figure exactly, when the external current varied from 30 to 88 ampères; and gave 64 volts at 5 ampères, 63·5 volts at 130 ampères. With one ampère only, the potential was 61·5 volts. Mr. Gülcher adds that, in spite of all possible care in manufacture, very large machines do not give results as satisfactory as those given by machines of somewhat smaller dimensions, though the machines are of identical type, and their parts calculated from the same formulæ. He thinks this, to indicate that to obtain the same ratio of out-put and efficiency to weight, there ought to be a corresponding increase made in the electromotive force of the machine. In other words, the means taken in large machines to keep down the electromotive force to equality with that of the smaller machines are detrimental to the action of the machine.

The Anglo-American Electric Light Corporation has been manufacturing during the past year a dynamo of the flat-ring type, under the patents of Schuckert and Mordey, to which the not very apt name of the "Victoria" dynamo has been given. By the kindness of Mr. F. Wynne, general manager of the Corporation, and of Mr. Mordey, and Mr. P. Sellon, I have been able to learn a great deal about this machine, and to test personally its capabilities. There are two types of the new Schuckert-Mordey dynamo, one having 4, the other 8 poles arranged round the ring. As mentioned earlier in this paper, Mr, Mordey has given great attention to the form of the pole-pieces. These pole-pieces, in the earlier Schuckert machines, consisted of hollow iron shoes or cases which occupied a large angular breadth along the circumference of the ring. Similar hollow polar extensions are still used in the Gülcher machines (see Fig 26 of my Cantor Lectures). Mr Mordey has found my opinion, based upon the diagrams of potential at the collector, to be correct, that these wide-embracing pole-pieces were responsible for false inductions, giving rise to opposing electromotive forces and setting up secondary neutral points at the collectors. He has, therefore, by long extended experiments, arrived at a form of pole-piece which completely obviates these effects. As will be seen from Fig. 21 (p. 333), which represents the 4-pole Victoria dynamo, the pole-pieces, though they embrace the ring through its whole depth, from external

FIG. 22.

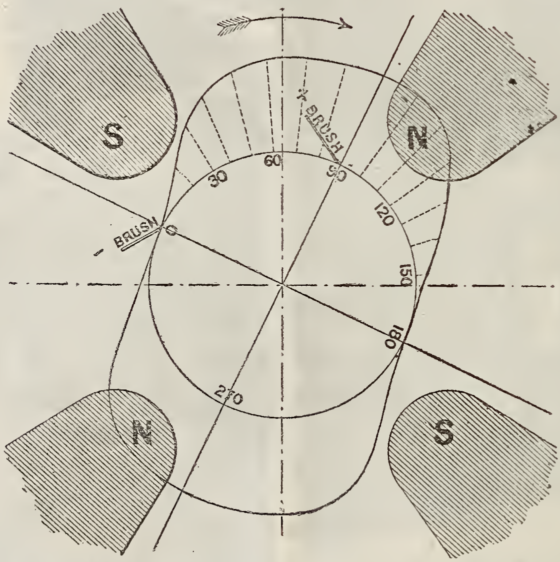


DIAGRAM OF POTENTIALS AT COLLECTOR OF 4-POLE SCHUCKERT-MORDEY DYNAMO.

to internal periphery, are quite narrow, and do not cover more than 30° of angular breadth of the circumference of the armature. They are of cast-iron, and are cast upon the cylindrical cores of soft wrought-iron which receive the coils. It may be mentioned that, in the 4-pole Gülcher machines, the wide box-like pole-pieces are also cast on wrought-iron cores. The armature of the Victoria dynamo resembles in its structure the Pacinotti rather than that the Gramme type. Its core is built up of rings cut from sheet charcoal iron, and Mr. Mordey has taken special pains to ensure that there are no electric circuits made in the bolting together of these cores, each plate being both electrically and magnetically insulated from the adjacent plates. Eddy currents in the core are thus almost entirely obviated. This was far from being the case with some of the earlier machines, in which, as in the Edison machine until Dr. Hopkinson improved it, the bolts holding together the cores constituted an available path for wasteful inductions. The core rings of the Victoria dynamo are toothed, as in the Pacinotti ring, and the wires are wound in the intervening gaps. There is, moreover, ample ventilation in this armature, a point not to be overlooked. Formerly, in a four-pole machine, four brushes were necessary—as in the Gülcher dynamo and the four-

	[illegible] Company [illegible]	[illegible]		[illegible]		£50,000, half cash, and half shares in the Gulcher Company.
Nov. 4, 1882	Lancashire and Yorkshire Electric Lighting Company	100,000		£5 shares	...	
„ 9, 1882	North-Eastern Electric Light and Power Company	100,000		£5 shares	...	
Jan. 10, 1883	Liverpool Electric Supply Company	10,000	...	£5 shares	...	
Mar. 8, 1883	Consolidated Electric Company (Limited.)	100,000	...	£1 shares	...	An agreement to be made between J. S. Beevan, Wm. Taylor, Frank King, the South Eastern (Brush) Company, the Provincial (Brush) Company, and the present Company; all shares taken up and considered as fully paid (Consolidated Electric Company.)
Mar. 27, 1883	Liepmann Carbon Company (Lim.)	30,000	...	£100 shares	...	To purchase the British and foreign patents of Henry Liepmann, for improvement in the manufacture of carbon for electric lighting.
April 11, 1883	Gerard and Company	40,000	...	£10 shares	...	To introduce into the United Kingdom the inventions of M. Jean, Gerard-Lescuyer and Co., of Paris, and to acquire the English letters patent relating thereto; to manufacture electric lamps, and to purchase and generally carry on the business of an electric lighting company in all its branches. 568 preference and 2,543 ordinary shares taken up; £5,430 considered paid up on the former, and the full amount on the ordinary shares. Aug. 23rd, 1883.
„ 14, 1883	Chamberlain and Hookham	100,000	...	£10 shares	...	To apply electricity to lighting and other purposes, and to acquire a license to manufacture meters and other apparatus, under letters patent. 1,000 A and 5,000 B shares taken up; £1 10s. called and paid upon the former, the latter being considered as paid. August 27th, 1883.
„ 24, 1883	Mexican Gas and Electric Light Company	100,000	...	£20 shares	...	To acquire contracts from the Government, &c., in Mexico, for gas and electric lighting. Whole of the capital taken up and fully paid.
May 10, 1883	Ferranti-Hammond Electric Light Company	100,000	...	£10 shares	...	To supply electricity for electric lighting and other purposes, in Hampstead and adjoining parishes. &c. Name changed to "Hampstead Electric Lighting Company." Return to Sept. 14, 1883, states only shares taken up, seven subscribed by signatories.
„ 30, 1883	South Kensington Mutual Electric Lighting and Supply Company	230,000	...	£10 shares	...	To supply electricity for lighting in South Kensington and elsewhere.
June 29, 1883	Economic Electric Company, Limited	...	...	...	...	Formed to purchase the debts, debentures, and shares, of the Duplex Electric Light, Power and Storage Company. Registered without nominal capital. Every member guarantees to contribute £1 to the assets in the event of winding up.
Aug. 16, 1883	Continental Maxim-Weston Electric Company	50,000	...	£1 shares..................	...	To supply electric light and power on the Continent.
„ 22, 1883	West London Electric Light Company	60,000	...	£10 shares	...	To carry on the business of an Electric Light Company in all its branches.
Oct. 26, 1883	Edison and Swan United Electric Light Company	1,000,000	...	£5 shares..................	...	To acquire the business and properties of the Edison Company and of the Swan Company, excepting only foreign and colonial patents.
Nov. 28, 1883	Simplex Electric Light and Plant Company	40,000	...	£5 shares..................	...	To purchase patents from the Protector Lamp and Lighting Company, of Worsley, near Manchester. Did not proceed to allotment.
Dec. 1, 1883	Atlas Electric Appliance Company	2,000	...	£1 shares..................	...	To purchase the invention of J. R. P. Wallis and F. W. Cherry, relating to improvements in electric lamps. Purchase consideration, £25 cash, 40 fully paid preference shares, and 150 founders' shares.

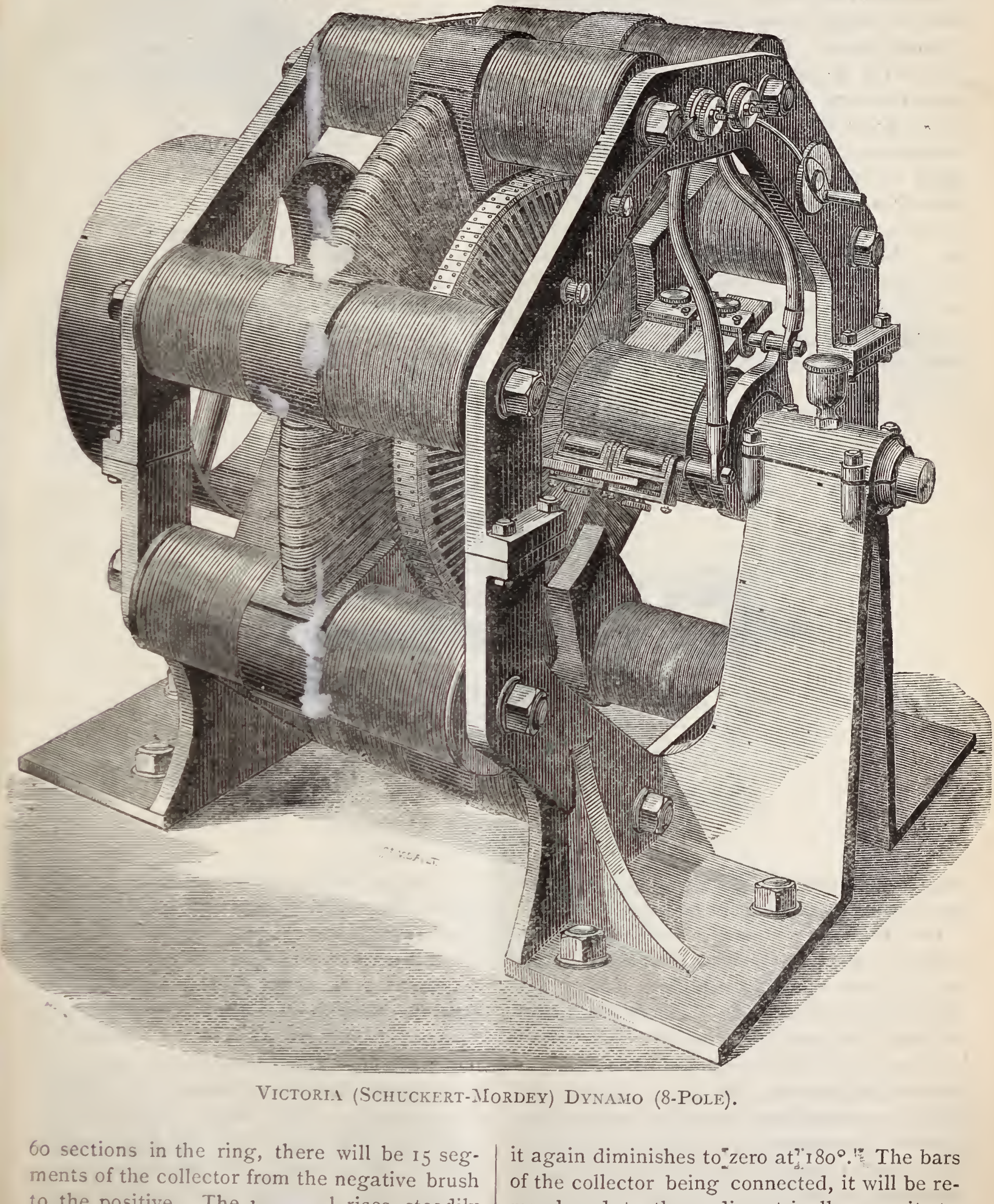
TABLE OF THE ELECTRIC LIGHT COMPANIES

Registered from May 31, 1875, to December 1, 1883.

Date of Registration.	Company.	Capital. Amount.	Capital. Issued.	Capital. Particulars of Shares.	System.	Remarks.
		£	£			
May 31, 1875	Charles Ball & Company	6,000	...	£10 shares	...	In possession of Gramme patents.
Oct. 4, 1878	British Electric Light Company	100,000	...	£10 shares	Gramme machine	Sole licensees. Patents acquired from Charles Ball & Co. for £6,250, and £2,500 in shares, &c. 7,241 shares taken up, and the full amount called and paid up thereon, Sept. 1883.
Jan. 8, 1879	Anglo-American Electric Light Company	15,000	...	£10 shares	Wallace-Farmer	Wound up, and business sold to new company bearing the same name.
Dec. 12, 1879	Anglo-American Electric Light Company	60,000	60,000	£5 shares	C. F. Brush	Wound up 20th Aug., 1882.
July 29, 1880	Electric and Magnetic Company	500,000	250,000	250,000 £10, & 25,000 ordinary	Jablochkoff.	
Dec. 4, 1880	Anglo-American Brush Electric Light Corporation	800,000	400,000	£10 shares	Brush and Lane-Fox incandescence	Brush patents purchased from the Anglo-American Company for £40,000 in cash, 10,000 fully paid shares, and 15,900 £4 paid. Share capital reduced to £400,000 = 80,000 £5 shares, Feb. 6th, 1882. 13,701 £5 shares fully paid; 26,999 shares £3 paid.
,, 28, 1880	Siemens and Company	...	400,000	£100 shares, £75 paid	Siemens	Manufacturing and lighting.
Feb. 7, 1881	Swan Electric Light Company	100,000	...	£10 shares	Swan incandescence	Patents purchased from J. W. Swan for £50,000, £25,000 in cash, and 2,500 in fully paid shares. Amalgamated with the Edison Electric Light Company, June 30, 1883 (except as to foreign and colonial patents), under the name of the Edison and Swan United Electric Light Company.
April 1, 1881	Maxim-Weston Electric Light Company	172,500	172,500	£1 shares	Weston-Maxim	Capital increased to £500,000, May 18, 1883.
July 15, 1881	Eastern Electric Light and Power Company	250,000	150,000	£5 shares	Brush-Lane-Fox	India patents. 20,000 shares taken up, upon 20,000 of which £4 was called, and the remainder in full; £123,045 paid, Nov. 14, 1882. Difficulties experienced in carrying out installations, in consequence of the prohibition by the Indian Government of overhead wires.
Aug. 9, 1881	Anglo-Colonial Electric Light Company	8,000	...	£1 shares	Laing	Formed to purchase the Laing patents for England, India, and the Colonies [illegible]
October [illegible] 188[illegible]	North [illegible]					

pole Gramme. Mr. Mordey has reduced the number to two, by the device, firstly, of connecting together those segments of the armature coils which occupy similar positions with respect to the poles; and secondly, of connecting together, by me llic connections, those bars of the collector which are at the same potential. In the four-pole machine opposite bars are thus connected. Two brushes only are then necessary, and these are 90° apart. Fig. 22 (p. 334) gives the actual diagram of the potentials at the collector. There being

FIG. 23.

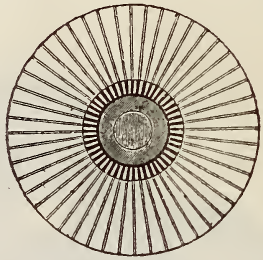


VICTORIA (SCHUCKERT-MORDEY) DYNAMO (8-POLE).

60 sections in the ring, there will be 15 segments of the collector from the negative brush to the positive. The p l rises steadily from the negative brush, nd becomes a maximum at the positive brush, at 90°, whence it again diminishes to zero at 180°. The bars of the collector being connected, it will be remembered, to those diametrically opposite to them, it follows that the potential will rise from 180° to 270°, precisely as it rose from 0° to

90°, and will again fall to zero in passing from 270° to 0°. If the curve from 0° to 180° were plotted again horizontally, we should clearly see how nearly regular the rise and fall is. If from this curve we were to construct another one, in which the heights of the ordinates should correspond to the tangent of the angle of slope of this potential curve—in other words, if we were to differentiate the curve—we should obtain a second curve—the curve of induction. It would show a positive maximum at about 30°, and a negative maximum at about 120°, where the slope up and slope down are steepest in the potential curve. These maxima of induction are situated very nearly opposite the edges of the pole-pieces, on the side toward which the armature is rotating. Apparently the lines of force of the field are the thickest here. In this displacement of the maximum of induction we have, I think, the explanation of the inferiority of the earlier machines with broad polar expansions. In those machines the maximum position of induction was displaced to the very edge of the broad pole-piece, and, therefore, the induction was sudden and irregular. It is a singular result that while

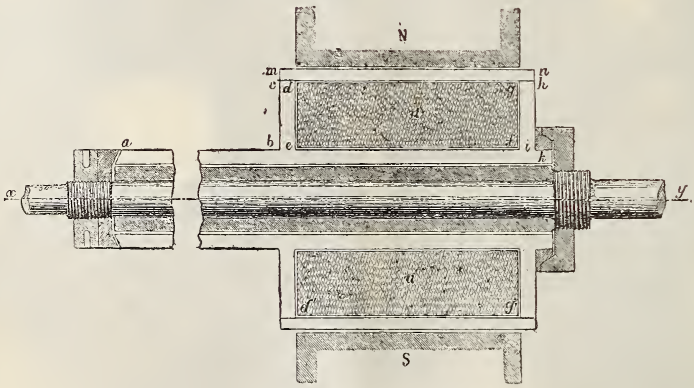
Fig. 24.



Cabella Armature.

in those machines in which the ring armature is extended cylinderwise, there must be wide-embracing pole-pieces, in those in which the

Fig. 25.

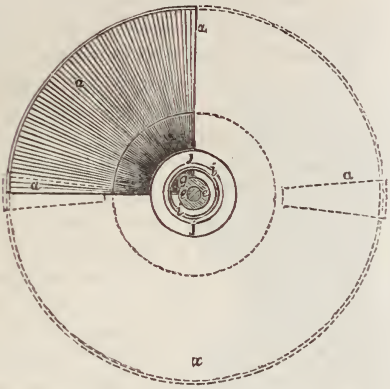


Cabella Armature. Section.

ring is flattened into a disc shape, the pole-pieces must on no account be wide.

The Victoria dynamo is self-regulating, having all the eight field-magnet coils doubly wound, with main circuit coils inside, and shunt coils outside. The characteristic of this machine is wonderfully straight. In a "D^2" machine, wound for a potential of 60 volts, the following values were obtained. Open circuit, 58 volts; 10 ampères, 58·5 volts; 20 ampères, 59 volts; 60 ampères, 59·7 volts; 90 ampères, 59·9 volts; 120 ampères, 60 volts. It will be seen that for small loads the potential drops a little; but it is under these circumstances that the engine speed usually rises slightly in practice, so that the constancy of the potential between the mains is somewhat better than the figures would show. In actual practice, the regulation is marvellous. I have myself opened the circuit of a Victoria dynamo which at the time was feeding 101 lamps, 100 being at a distance, 1 lamp attached to the terminals of the machine. On detaching the main wire from the terminal, the 100 lamps were suddenly extinguished. The solitary lamp on the machine did not even wink, and there was no flash at the brushes. The sparking was so slight it was impossible to tell whether the machine was an open circuit or whether it was doing full work. The lead was the same under all loads. There are not many dynamos that can show a result of this kind. According to measurements made by the Anglo-American Corporation's electricians, who have published

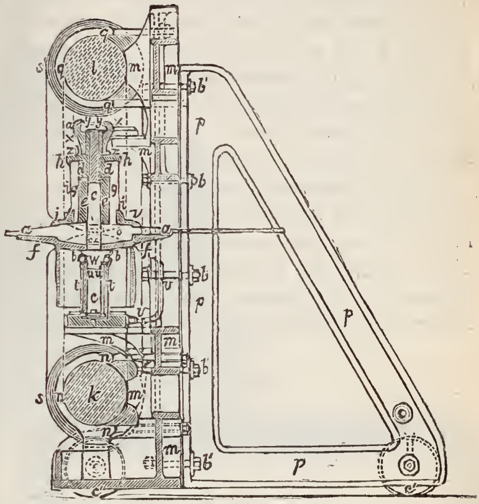
FIG. 26.



ARMATURE OF SIR W. THOMSON'S WHEEL DYNAMO.

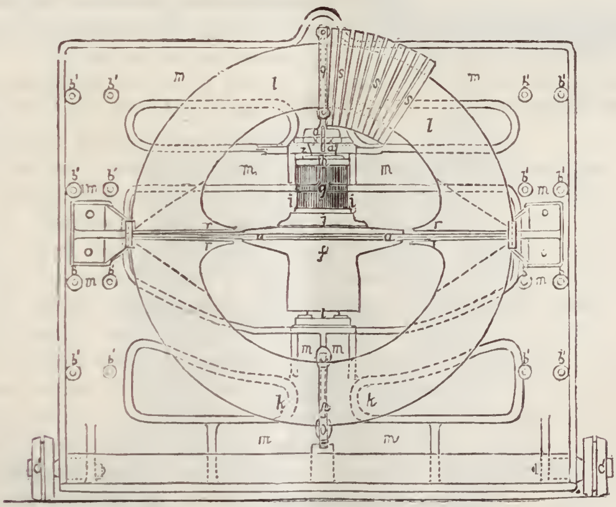
the figures entire, the factor of conversion of this machine is 96·15 per cent., the electrical efficiency 85·68 per cent. These values assume the B.A. unit of resistance as the true ohm, and are, therefore, probably about $1\frac{1}{2}$ per cent. too high. Some of these machines are wound for low speeds for ship lighting. These machines have an electrical activity slightly higher, and an efficiency slightly lower, than the high speed machines. They also have field-magnet cores

FIG. 27.



SIR W. THOMSON'S WHEEL DYNAMO. VERTICAL SECTION.

FIG. 28.



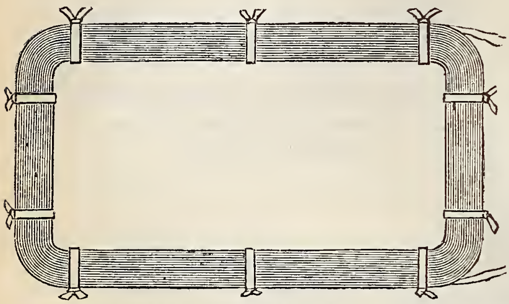
SIR W. THOMSON'S WHEEL DYNAMO. FRONT ELEVATION.

slightly heavier, requiring, therefore, the expenditure of rather more electrical energy in maintaining the field. These remarks refer, of course, to a comparison between machines wound to light an equal number of lamps, and to work at an equal electromotive force.

A larger type of Victoria machine having 8 poles, alternately north and south, set round the ring, has also been constructed by the Anglo-American Corporation. This machine (Fig. 23, p. 335) illuminates 750 incandescent lamps. The ring has 120 sections, there being 15 sections, therefore, between each pole and the adjacent pole of the surrounding set. As each segment of the collector is connected with those situated at 90°, 180°, and 270° distance round the set, only two brushes are required.

A rather singular commentary upon the real superiority of multipolar dynamos having rings of the flattened type, over the more compact ring armatures to which we have been accustomed in the ordinary Gramme machines, is furnished by the announcement within the past month of a new and improved dynamo designed by M. Gramme himself, in which there is a flat-ring armature rotating within a crown of 12 poles. Elaborate illustrations and a detailed description of this latest of dynamos are given in the *Revue Industrielle*, of January 9th, 1884. From this article it appears that in the opinion of M. Gramme the new machine still requires some modifications to make it quite a

Fig. 29.



Parallelogram Coil from the Elphinston-Vincent Armature.

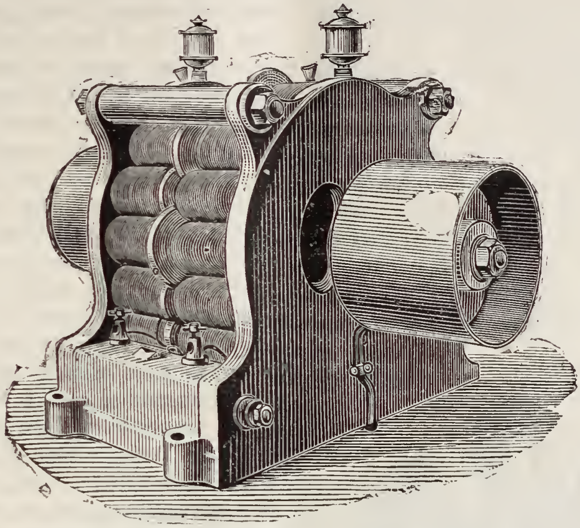
practical machine. A glance at this drawing is quite sufficient to enable one to hazard a guess at the reasons. The pole-pieces are broad, nearly meeting one another. I should confidently predict from such a design the vice of sparking at the brushes and heating of the collector segments. Moreover, there are no fewer than 24 brushes! Think of the friction of 24 brushes, and the labour of making the complicated holders. It appears that in England we are at least a few steps a-head of France in the matter of designing dynamo-machines.

Another 4-pole flat-ring dynamo has been designed by Herr Schuckert, of Nürnberg, and was exhibited at the late Vienna Exhibition. This machine, which had many excellent points in its design, was compound wound, and was calculated to give, at 450 revolutions, a current of 320 ampères at 100 volts.

The present drift toward multipolar dynamos of this type is very significant. There is little difference save in detail between the 4-pole machines of Gülcher, Schuckert, and the newer "Schuckert-Mordey" dynamo, albeit these differences are not unimportant. But all these constructors agree in adopting the flat-ring. The advantage originally claimed for this construction, namely, that it allows less of the total length of wire to remain "idle" on the inner side of the ring, is rather imaginary than real, for the total resistance of the armature is but a small fraction of the whole resistance of the circuit; and it is possible to spread the field so as to make all parts of the wire active without any gain whatever, if, by this spreading, there is no increase on the whole in the total number of lines of force in the field. The real reasons in favour of multipolar flat-ring armatures appear to be the following:—First, their excellent ventilation; second, their freedom from liability to be injured by the flying out of the coils by the tangential inertia (often miscalled centrifugal force) at high speeds; third, their low resistance, due to the fact that the separate sections are cross-connected either at the brushes, or in the ring itself, in parallel arc. To these may be added that, with an equal peripheral speed, the armature rotating between four poles undergoes twice as much induction as when rotating between two poles; since it cuts the lines of force twice as many times in the former case as in the latter.

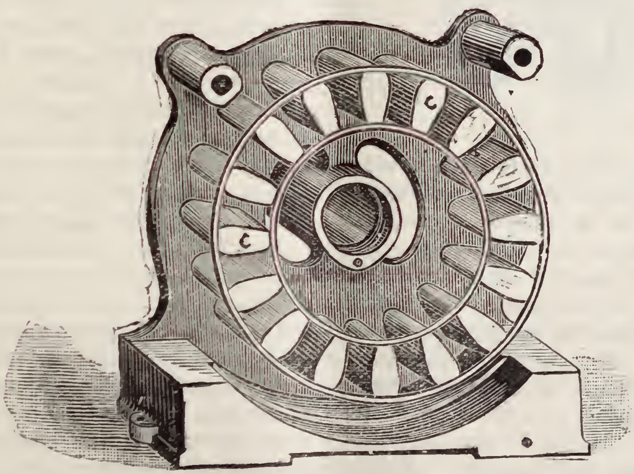
I pass on to the improvements made in the dynamo by Messrs. R. E. Crompton and Co. To describe the course of development which the Bürgin dynamo has undergone in Mr. Crompton's hands would alone occupy a whole evening. The armature of the original machine, as it came from Switzerland, consisted of several rings set side by side on one spindle, these rings being made of iron wire wound upon a square frame, and carrying each four coils. In this form it is described in Professor Adams's Cantor Lectures on "Electric Lighting" in 1881. Mr. Crompton changed the square form to a hexagon having six coils upon it, and increased the number of rings to ten, so that the armature consisted of sixty segments. He then found it advisable to alternate the positions of these, instead of placing them in a regular screw-order on the spindle as shown in most of the published drawings of this well-known machine. The next step was to increase the quantity of iron in the hexagonal cores, and to ascertain by experiment what was the best relative proportion of iron and copper to employ. At the same time, Mr. Crompton and Mr. Kapp introduced their system of "compounding" the windings of the field-magnets. Another change in the armature followed, the rings being made much broader and fewer in number, four massive hexagonal rings, united to a 24-part collector, replacing the ten slighter rings and their 60-part collector. Quite recently Mr. Crompton and Mr. Kapp have again remodelled the style of armature, and have produced a machine which, though it is not yet quite completed, shows what may be done in the way of improvement by careful attention to the best proportions of parts and quality of material. The new dynamo weighs 22 cwts. Its field-magnets are of the very softest Swedish wrought iron, compound-wound. The armature is a single ring of the elongated or cylindrical pattern, and its coils are wound upon an iron core made up of toothed discs of very thin soft iron fixed upon a central spindle, the coil being wound between the teeth as in a Pacinotti ring. In fact, the

FIG. 30.



THE FERRANTI THOUSAND-LIGHT DYNAMO.

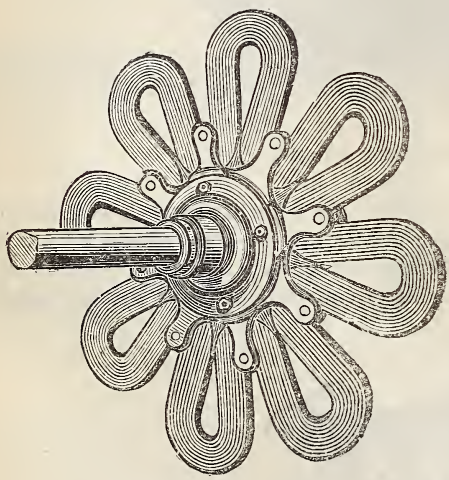
FIG. 31.



HALF-CARCASE OF FERRANTI DYNAMO.

armature may be described as a kind of cross between those of Weston and Pacinotti, having also something in common with the Bürgin armature; at least, so I understand, for though I have, by the kindness of Mr. Crompton, been allowed to see the machine, I have had no opportunity as yet of examining the armature. Mr. Crompton's great aim has been to have as complete a magnetic circuit as possible, and that of the best quality. He has sought to increase the intensity of the field by having plenty of iron in the armature, and bringing that iron as close as possible into proximity with the pole-pieces by means of the projecting teeth. The result is an extraordinary increase in the "output," or, as Sir William Thomson terms it, "activity" (*i.e.*, amount of work done per second) of the machine The machine is

Fig. 32.



Feeranti Armature.

only 3 ft. 4 in. long, 12 in. high, and 2 ft. wide. The armature is 17 in. long, and 8 in. diameter. At 1,000 revolutions per minute it gives 110 ampères at 145 volts, or its "activity" is 15,950 watts; but at this speed it heats too much. The power of the field-magnets is such that, at all speeds, and under all conditions of the external circuit, the intensity of the field overmasters the magnetising action of the currents in the armature coils. There is, therefore, hardly any lead at all at the brushes, and what lead there is, is absolutely constant. There is no sparking at the brushes, and it is impossible to tell by looking at the brushes whether the current is off or on. Mr. Crompton is now constructing another machine of the same general design, but larger, to drive 1,000 Swan amps. This machine, together with its engine, is only about 8 ft. long, 6 ft. high, 2 ft. 4 in. wide, and complete, with its bed-plate, will weigh only about 8 tons.

It may be mentioned that in Messrs. Crompton's compound dynamos, as also in those of the Anglo-American Corporation, the series coils are wound direct upon the iron-cores, and the shunt coils outside them, thus reversing the practice adopted by Messrs. Siemens, and by Mr. Gülcher. It might have been expected that theory would have something to say in determining which practice is preferable. If the shunt coils of thin wire are outside, the prime cost for an equal magnetising effect will probably be greater. If the series coils are outside, the loss by heating in producing an equal magnetic effect will probably be increased. It might have been expected that, as with galvanometer coils, so with the coils of field-magnets, it would be advantageous to get as many of the turns as close as possible to the core, and, therefore, that the thinner wire should be wound on before the thicker. But, on the other hand, it is advisable to keep down the resistance of the series coils, as they will form part of the main circuit; whilst the additional resistance necessitated by winding in coils of larger diameter is not altogether a disadvantage in a shunt coil. If this proves to be the right way of regarding the problem, we shall wind the shunt coils outside those that are in series with the main circuit.

Before leaving the subject of ring-armatures I should like to refer to a form recently devised by Signor B. Cabella, which I think might be recommended to amateur constructors of dynamos as being easily made. The Figs. 24 and 25 (p. 336) show its general arrangements. The armature resembles that of the Edison dynamo in being built up of copper strips. These are separately cut out, and consist each of a straight piece having two arms, and projecting at right angles. A sleeve of insulating material is placed over the axle, and round this these copper pieces are arranged to the number of some 240 or so, having their arms projecting symmetrically round in two radial sets, one near one end and the other near the other. The channel formed thus between the two sets is lined with insulating material, and then entirely filled up with soft iron wire wound round. Then straight strips of copper, eight millimetres broad and two millimetres thick are screwed across the outside (like the bars of the Edison armature) from the ends of one set of radial projections to the ends of the others, forming the parallelogram section. But, in order to connect the ring all round in a continuous circuit, these external strips of copper are connected at their two ends to pieces which project not from the same internal copper strip but from adjacent strips. Thus an external bar will connect the anterior end of the first strip with the posterior end of the second; and so on. Every third strip is carried along the axle and connected to a segment of the collector. This construction is certainly simpler than that of the Edison armature, and might be adapted to many different types of machines. According to Professor Ferrini, one of Cabella's armatures placed between the poles of a 60-light Edison ("Z," old pattern) instead of its ordinary armature, increased its power so that it could be used over 100 lamps.

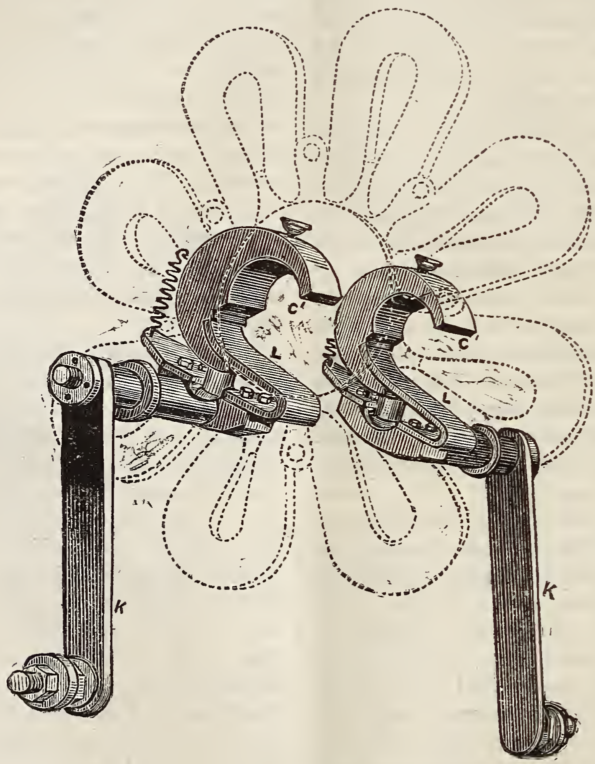
Passing from ring-armatures, I come to another type of machine having disc armatures. The earliest machine of this type was due to the indefatigable Mr. Edison, who built up his disc of radial bars connected at the outer ends by concentric hoops, and at the inner by plates or washers. Each radial bar communicates with the one opposite to it; and the disc thus built up is rotated between the cheeks or pole-pieces of very powerful field-magnets, which very nearly meet, and which therefore yield an enormously powerful field I cannot hear of any of these disc dynamos having yet come into practical use.

Another type of disc-dynamo has been invented by Sir W. Thomson. In this case, the armature is a flat wheel, very like a flattened bicycle wheel. It is shown at *a* in Figs. 26, 27, and 28 (p. 337). The radial arms or spokes of the wheel, in which the currents are induced, are all connected at their external ends to the copper rim, but at their internal ends are carefully insulated and connected each to a segment of a collector or commutator, *g*. As in Edison's disc machine, so also in this, the thin disc rotates between the poles of very powerful field-magnets, which, in the case of Sir W. Thomson's machine, are semicircular in form. Sir W. Thomson also pivots his armature with its axis vertical, and spins it like one of his gyrostats. Unfortunately, the machine has not shown itself to be in practice a success. Its construction necessitates a very high speed, else the electromotive force would be small. If the radial bars, instead of being all joined to one rim, were united by overlapping insulated rims, each one to the one next to that diametrically opposite, and a connection brought round again at the hub to the next but one from that at which the outer rim started, then, applying similar connections all round, the radii would all be connected in circuit, and a much higher electromotive force might be obtained. I am not aware that any disc so connected has yet been tried.

Some improvements have also been made in the Elphinstone-Vincent machine. The sections of the armature of this machine are wound separately in parallelogram forms like that shown in Fig. 29 (p. 338), and the separate sections are then fixed upon the periphery of a papier-maché cylinder which is mounted so as to rotate between powerful field-magnets and internal field-magnets whose poles reinforce the field. In the improved machines the parallelograms of wire are so arranged that the overlapping ends lie outside the ends of the polar surfaces of the field-magnets, which, therefore, can be brought very close to the surface of the rotating cylinder. Amongst other improvements, also, segments of the collector are internally cross-connected, so that only two brushes are needed instead of six as formerly. Several improvements in mechanical details have also been made.

In alternate current machines something has also been done. The Ferranti - Thomson machine, which, at the date of my Cantor lectures, had just made its appearance, has been considerably perfected. By the courtesy of Mr. Hammond, I am enabled to show Figs. 30 to 33 (pp. 339, 340), illustrative of the "1,000-light" dynamo, and of its working parts. Externally, the machine is scarcely charged at all; the driving pulley being a little larger in proportion. Internally, considerable changes have been made, and in these the hand of the experienced mechanical engineer is apparent. The frame-work of the machine is now cast in two halves, which are afterwards bolted together. Fig. 31 (p. 339) shows one-half of the carcase of the machine with its projecting circle of magnet cores, C, which receive the field-magnet coils. The armature, originally a single zigzag piece of copper, has assumed the form shown in Fig. 32 (p. 340), in which it may be seen that the convolutions are multiplied, and are held in their places by bolts through a star-shaped piece of brass which also serves to carry to one of the two collectors the connexion with one of the zigzag copper strip. There are in fact three complete circuits of copper strips in the armature connected in parallel arc. They begin at three of the alternate four bolts of the star-shaped piece, and, folding ound one another, they all eventually unite with a second and inner star-shaped piece, which communicates with the second collector. Each strip makes ten turns round the zigzags, so that there are thirty layers, all well insulatd from one another by strips of vulcanised fibre. This armature is 30 in. in diameter, and a little more than ½ in. thick in the upper convolutions, so that the opposite poles of the field-magnets can be brought very close together, and a very powerful field produced. The entire armature weighs only 96 pounds. The most extraordinary part of the machine is, however, the arrangement adopted for conveying the currents to the external circuit. The axle carries on either side of the armature an insulated collector ring of bronze, to which the afore-mentioned star-shaped pieces are respectively connected. Instead of brushes, solid pieces of metal, shown at *C′ C′*, Fig. 33, are employed to collect the current. These collectors hook on over the collecting rings, and bear against about 180° of the periphery of each ring. They are fixed on universal joints, and

Fig. 33.



Collectors of Ferranti Dynamo.

held by springs from rotating. Copper strips connect them to the terminals of the machine. The arrangements for lubricating the bearings are extremely perfect. The machine requires a speed of 1,400, and weighs 1½ tons. Mr. Ferranti has also designed a slow-speed dynamo to run at 300 revolutions per minute, and feed 500 lamps.

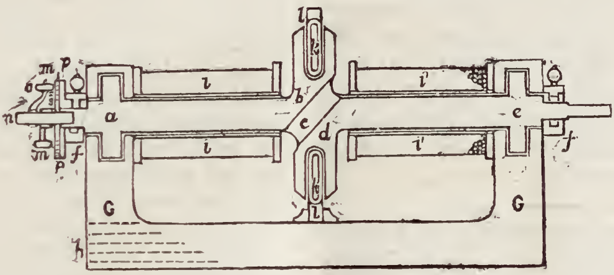
A very large alternate current machine was shown at the late Electrical Exhibition at Vienna, by Messrs. Ganz, of Buda-Pesth. It was capable of furnishing light for 1,200 Swan lamps (20 candle-power each). This dynamo, which in some points resembled Gordon's well known machine, was constructed according to the Mechwart - Zippernowsky system. The thirty-six bobbins of the field-magnet were set concentrically on an iron frame, and rotated within an outer circle of thirty-six armature bobbins. The field-magnet coils were, in fact, the fly-wheel of the high-pressure compound engine which drive the machine and its exciter. The diameter of the rotating part was 2½ metres. A salient feature of this machine is the fact that any one of the coils, either of armature or field-magnets, can be removed from the side of the machine, in case such are needed. The whole fly-wheel can, in this way, be taken down by one man in a few minutes. An electrical efficiency of 85 per cent. is claimed for this machine.

Of one other class of machines—the unipolar dynamo—I had intended to say something. It is a remarkable thing that, though to my knowledge a great deal of attention has been paid lately to machines of this type, no one has yet succeeded in designing a practical unipolar dynamo. There seems to be some hiatus in the theory of this class of machine, for the very singular fact remains that those which are designed in defiance of precautions to avoid wasteful internal eddy currents will work, though badly, and those designed with such precautions will hardly woık at all.

There are two or three other new designs for machines which, at present, can hardly be called anything but curiosities. There is, for example, a design for a dynamo (a drawing of which is given in Fig. 34), by Sir Charles Bright, in which the field-magnet coils and armature stand still, but in which the iron cores and the brushes rotate. There is another design by Professor G. Forbes, in which part of the field-magnets rotate. Mr. C. Lever has designed a machine on somewhat similar principles to the foregoing. I have myself essayed an alternate - current machine, in which both armature and field-magnets stand still, while laminated pole-pieces alone revolve. I hear also of a dynamo designed in the States in which there are no field-magnets only two revolving armatures.

And now I have left myself no time to deal with the third branch of my subject, namely, the dynamo in its functions as a mechanical motor. In this branch also much progress has been made. If time permitted I would speak of the motors designed by Professors Ayrton and Perry, which are successful to a very remarkable degree in yielding a great mechanical power in proportion to their weight. I might have been inclined to say something of the attempts made by the same able electricians to produce a self-governing motor by various devices of centrifugal and periodic governors, and also by using an ingenious differential winding. I might tell you how I have myself worked at the question from a different point of view, and have sought to govern motors so that they shall run at a uniform speed, by devices which will not wait until the speed changes before they act, but by devices depending upon the variations in the load of the machine, in short, upon dynamometric governors instead of centrifugal ones. These things must, however, wait until some more convenient season. Time will only admit of my showing you here, in conclusion, a model designed by Mr. C. Dorman to illustrate the graphic law of efficiency of motors, which I put forward in my Cantor lectures, and which I am happy to learn has since been largely used in many different countries.

FIG. 34.



SIR C. BRIGHT'S SUGGESTED DYNAMO.

To sum up then, it may be observed that in every department under review, the story of the past fifteen months is one of solid progress. It has been, it is true, progress of a quiet and perhaps of a commercial rather than a scientific order, yet, as I have shown you, one in which practice and theory have gone hand in hand. It is true that in some few points theory is a-head of practice, but in a still larger number practice is a-head of theory. It would be a great boon to us if our theoreticians could bring up theory to the level of practice in some of the simplest facts. We do not even know the exact law of the saturation of iron in electro-magnets, and content ourselves with formulæ, which we *know* to be incorrect. Of the laws of induction of magnetism in circuits partly consisting of iron, partly of strata of air, or of copper wire, we know very little. We want some new philosopher to do for the magnetic circuit what Dr. Ohm did for the voltaic circuit fifty years ago. There is ample room for progress yet in theory as well as in practice; and the perfection of theory means the deliverance of practice from arbitrary rules of thumb, and from the blunders of inexperience which have so retarded progress in the past. The history of the past fifteen months, however, gives great encouragement for the future, because it shows how much may be done, even in the face of great commercial depression, by those whose knowledge and experience give them a deliberate faith in the future, and whose efforts are directed toward no uncertain end. A steady development toward the yet far distant goal of perfection is going on unceasingly. The progress of which I am permitted to be the chronicler to-night is progress of the good and substantial kind, that owes nothing to the excited rush of Stock Exchange speculations, and which, not having been nurtured at an unhealthy fever heat, is destined to be of permanent value.

My thanks are due to the publishers of the *Electrician* for permission to reproduce Fig. 17; to the publishers of the *Electrical Review* for Figs. 26 to 29; to Mr. F. Wynne, of the Anglo-American Electric Light Corporation, for Figs. 21 and 23; to Mr. R. Hammond, of the Hammond Electric Light Company, for Figs. 30 to 33; and to Mr. Hugh Watt of the Maxim-Weston Company, for Figs. 18 to 20.

DISCUSSION.

The CHAIRMAN said they were much indebted to Professor Thompson for the extremely clear and able manner in which he had brought forward the progress of dynamo-electric history, and he was very much pleased to find that in that progress he had given the first place to practice, and the second place to theory. He had always found theoretical men rather inclined to look with a certain amount of disdain upon practical men, and to think that practical men knew nothing about their subject unless they followed the dictates of theorists. But a change seemed to be coming over the spirit of the dreams of philosophers, and they were now paying much more attention to the teachings of experience than they used to. Professor Thompson had shown how, during the past 15 months' progress, the lead had been taken by practical men; and he had been rather amused at this, because not much more than a week ago he heard him make similar remarks upon a paper brought before the Royal Society by Professor Hughes, one of the most wonderful experimenters and discoverers of the present day. Professor Hughes succeeded, with pins, bodkins, bonnet wire, match boxes, tin kettles, and similar pieces of apparatus, in extracting from nature some wonderful secrets, and he had brought out some very beautiful instruments, which had been the result of incessant toil and constant experiment in every shape and form. Professor Thompson, at the Royal Society, gave the theory after Professor Hughes had shown his instruments, and at the end of the paper expressed surprise that Professor Hughes' instrument accorded with his theory. This was much what he had told them now, though not quite in the same words, that, after all, experience was the only safe guide in teaching one how to make instruments for real practical work; and theory was a very good servant indeed when it came afterwards, and gave a plain, simple, unvarnished tale, which all could understand, to enable them to understand the peculiar action which had taken place. Professor Thompson had alluded to the theory of the dynamo machine, and divided his theories into three—the physical, the algebraical, and the geometrical; and he was bound to say that his own diagramatical representation of the action of dynamo machines, and of the performance of magnetic fields, were perhaps the most interesting part of his paper. The way in which he had worked out the magnetic field had taught everybody more about this subject than they knew before. But he must say that he objected *in toto* to this application of the term theory to explanations which Professor Thompson had given of the action of the dynamo machines. Theory was neither algebraical, nor geometrical. What Professor Thompson called theory was an explanation—a mode of representing what took place. But a theory was more than that; it was an explanation—a mental picture—of what took place in nature which placed it beyond mere hypothesis. For instance, the theory of light was an explanation of a certain physical action which took place in the universe, which enabled the vibrations of the sun to be represented in our eyes. The theory of heat was something which enable dus to conceive of matter itself vibrating and the space around it also vibrating in unison; but he objected to applying the term theory to either an algebraical or geometrical description of the actions of the dynamo or any other machine. He, and all other electricians, wanted to have some idea conveyed to their minds of what took place in a wire, in iron, and in the space occupied by the iron and the wire, which produced those marvellous results which they saw in the electric light and in the transmission of force, and to this sense he would confine the word theory.

Mr. LIGGINS said he was not qualified to speak on the scientific aspect of the question, but he was much interested in hearing of the progress which had been made during the last sixteen months. He was glad to find that some of the bubble companies were going to the wall, and when some of the systems which had very little merit were out of the way, there would be a chance for some simple and practical method to come into use. One day last week, at the Edgware-road Station, he noticed that the electric arc light was wonderfully steady, and the superintendent informed him that an improvement had just been introduced, which reduced the cost from £200 to £8. That was all he heard about it, for he had not time to inquire further particulars, but he hoped the time was not far distant when the public would derive a benefit from some of these improvements.

Mr. PERCY SELLON then gave some particulars of the Victoria machine. He said that taking an original Schuckert machine, capable of giving 60 incandescence lamps of a certain power, by substituting four poles for two, the mass of which, both in iron and copper, was very little in excess of that in the original two, and using identically the same ring, they obtained 100 lights, and a much better result in the commutator. From the old Schuckert machine they got a very similar diagram to that which had been shown, among those integrated from Isenbeck's as a bad one with false inductions (Fig. 6), the output of the machine being crowded into two bobbins, and on the other side there was a back electromotive force which caused considerable sparking. This was almost entirely removed by the use of four poles, and at the same time the internal resistance was brought down to about one-fourth what it was before. In constructing large dynamos for 500 lights and upwards, they were increasing the number of poles to 6 and 8, and eventually, probably, they would go to 12 for very large machines. The great advantage of this was that when you brought the poles together you had a given number of lines of force crowded into a very much smaller space; the distance of the centres between north and south polarity were much less, and whilst the number of poles increased, the intensity of the field remained the same, and, therefore, a given length of wire and iron, revolving at a certain speed, would give a decidedly higher result. With regard to the system of compound winding, he should say that a great deal of the credit was due to an *employé* of the firm, Mr. C. Watson; and it was applied without any formula or mathematics, and the very first machine constructed without any experiments gave as good a curve as the one shown on the diagram. It gave a difference of potential of only about 3 per cent. when the whole number of lamps was at work, and when the armature was simply working on the shunt. That showed that theory was not always necessary.

Professor THOMPSON, in reply, said that he did not agree with the Chairman's criticism on his use of the word theory. He thought that he had indicated that these three methods were really three aspects of the theory. The number of lines of force which he had been dealing with, might be expressed by a certain length of line, geometrically, or by the symbol n alphabetically, or when viewed optically, by a mere pictorial demonstration. What some people wrote n for, other people indicated by drawing a line in a certain direction. It was only another way of arguing about the things themselves. He wanted them not to ignore those essential considerations which constituted the true theory, and which underlay the mere mere facts of observation. They were approximating to that theory by one process or another; sometimes by algebra; sometimes by geometry; sometimes by diagrams; and it made all the difference between working intelligently and unintelligently, to have a principle to guide one. He had been trying to discover, both from *à priori* considerations, and from the teachings of experience, what the principles were which ought to guide practice; and he thought he might claim to have vindicated the claims of theory. It was quite true that theoretical men had been sometimes loth to allow any consideration to practical men; but on the other hand, practical men would often refuse to have anything to do with theory. The vindication he wanted to put forward was this; in his Cantor lectures and since, he had been working diligently at the curves of potential round the commutator, and to-night he had connected them with the curves of Isenbeck. Part of the improvement he had noticed in the Schückert machine was directly due to the advice he had given Mr. Mordey, and to the world at large, on shaping of the pole-pieces to that form which would give the best result on the commutator in respect to the rise of the curve of potentials. Originally the Schuckert machine had great shoes of iron, as pole-pieces, round it, now they were narrowed and tapered. It was found that where you had pole-pieces on the two sides of an ordinary cylindrical Gramme ring, it was better to have them curved round through a large arc, because it gave a flatter field, and the cutting of the lines of force was more regular. Now they were finding that practice was leading in an exactly opposite direction for flat ring machines with the poles at the sides; the shoes were being cut down into little narrow pole-pieces. Theory had led practice to that; and theory, too, had pointed out the relation between the curve of the potential, and the induction due to the pole-pieces. After theory had indicated the source of error and a possible means of remedy, they had gone on experimentally cutting down the pole-pieces until they got the proper curve on the commutator. He might further claim, as a vindication of theory, that M. Gramme, who had had fourteen years' experience in constructing Gramme machines, and to whom they owed an enormous debt of gratitude, had not yet arrived at the real point which had been reached in England. M. Gramme confessed that this 12-pole machine of his was not yet perfect; and he (Professor Thompson) had little doubt that the reason was that he had great flat pole-pieces nearly meeting each other. He would stake his opinion on the fact that if he had only made the poles narrower, he would have had a better curve of potential, and a machine that did not spark so much. That was the deduction he should draw at once from the potential curve. He claimed that it was entirely admissible to call a generalisation from which deductions of that kind might be drawn, theory; it was theory in the truest sense of the term, because it pointed the way for practice to follow. He did not require to know what electricity was, or what magnetism was in a piece of iron, or what was the ultimate form of the transfer of force across the space between them, before he used the word theory. He regretted that cold water should have been thrown on his attempt to raise the construction and design of dynamo-machines above mere rules of thumb, which were the essence of practice when unenlightened by theory. Practice without theory went on blundering in the dark, and though it was possible to blunder into success it was much more easy to blunder into failure. With regard to the invention which had been mentioned which would reduce the cost from £200 to £8, he need hardly say he should be much interested in further details; he believed it was the first instance on record in which an inventor dared to claim to have reduced the cost more than 50 per cent., that being the usual reduction claimed in the stock phrase of company promoters.

The CHAIRMAN, in proposing a vote of thanks to Professor Thompson, said he did not apply the word "theory" in the sense he objected to. He thought that certain geometrical and algebraical investigations were essential in carrying out any practical question, but he objected to the use of the word "theory" to explain what was really better expressed by the word "principle." Professor Thompson himself used the word "principle," and had detailed the principles that governed the action of the dynamo machines, and it had been in following these principles that such vast improvements had been made. He should like to have heard some description from Professor Thompson of a class of dynamo machine which was now coming into use daily very largely for the production of copper by the deposit of the metal from its salts. This was being done both at Swansea and at Birmingham. Mr. William Elmore, a hard worker in this field, who had works at Blackfriars, was setting up very large works at Swansea for the extraction of copper from impure ores by this method and when next Professor Thompson brought the subject before this Society, as he was sure the Council would insist upon his doing next year, he hoped that he would pay a little attention to those dynamo machines that were met with in other fields besides the production of electric light and the transmission of power. Again, he was rather disappointed to hear him pass by very lightly the performance of the Hockhausen machine, which was certainly the most distinguished feature of the Fisheries Exhibition. He did not think that that machine had received the attention it deserved, or been studied so carefully by Professor Thompson as others. Its performance was simply wonderful, and though he had not yet seen the Victoria machine, his own impression was that of all those he had seen the Hockhausen was decidedly the best. Perhaps Mr. Crompton's was an exception, for he had this advantage over Professor Thompson that he had seen the performance of the Crompton machine. It was certainly a wonderful little thing. You saw before you apparently a lump of iron which was motionless and silent; it appeared motionless because it went so quickly, and it was silent because it was so beautifully made, but with that machine currents of electricity were produced that had increased the output of the form known as the Crompton-Burgin machine exactly 100 per cent. The great lesson to be learnt was this; advance was being constantly made in all these machines, an advance whose future they could scarcely see an end to, and everyday they could perceive how, by the combination of theory and practice, they were developing the power of producing electricity to an extent which no one had dreamed of. What with the improvements such as had been mentioned that evening, with improvements in electric lamps and various other appliances, he did not think there was any chance of that end being reached which gas shareholders were so anxious to see.

The vote of thanks was carried unanimously, and the meeting separated.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 5, 1884; Sir FREDERICK ABEL, C.B., D.C.L., F.R,S., Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Allen, Mrs., 18, Ashchurch-park-villas, Shepherd's-bush, W.
Bowick, Thomas, Stafford-lodge, Southend, Bedford.
Davey, Henry, Rupert-lodge, Headingley, Leeds.
Davies, William J., Gunterston-road, West Kensington, W.
Fielden, Edward Brocklehurst, Nutfield Priory, Redhill, Surrey.
Kinglake, Robert Alexander, Rushmere, Wimbledon.
Larnach, Donald, 21, Kensington-palace-gardens, W.
Moseley, Charles, Manchester.
Playster-Steeds, John, Grosvenor-gate, Twickenham.
Rose, Frederick, 28, Page-street, Westminster, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Brown, Henry, B.A., 10, Phillimore-gardens, Kensington, W.
Dewar, Prof. James, M.A., F.R.S., 19, Brookside, Cambridge.
Hogg, Stapleton Cotton, 68, Warwick-square, S.W.
Mitting, Ebenezer Kennard, Rye, Sussex.
Preston, Edward, 35, Cornwall-gardens, South Kensington, S.W.
Rivington, Rev. John Alfred, M.A., 32, Eardley-crescent, West Brompton, S.W.
Smith, Harry Fryer, 13, Albany-st., Regent's-pk., N.W
Venner-Morris, A. A., Ivernolen, Ammanford, R.S.O., Carmarthenshire.

The paper read was—

ON THE PROGRESS OF ELECTRIC LIGHTING.

By William Henry Preece, F.R.S.

At a recent meeting, held in the City, to determine the future of a prominent electric lighting company, the principal speaker is reported to have said*:—"Electric lighting was at present a failure, and the sooner the public were made aware of it, the better for their pockets." This statement (if made) is not only an egregious fallacy, but an absolute untruth. Electric lighting is a most pronounced success. What has proved a disastrous failure is, electrical company-mongering, and electric lighting finance. The money-making world has been too eager to reap the benefit of the patient student, the ingenious inventor, and the observing engineer.

The progress of electric lighting, from a financial point of view, has been disgraced by the commission of every possible crime that commercial immorality could invent, and every foolish act to which insane speculative mania could lay itself open; but from a practical point of view it has been steady and sure. At one time, I contemplated in this paper, entering somewhat largely into the commercial side of the question. I had prepared a list of every company that had been promoted, floated, or wound up, but on further consideration I saw no advantage in crying over spilt milk. The ravenous promoter, the thoughtless investor, the disappointed speculator would care little for what would be said here. The evil that has been done could not be undone. History would soon again repeat itself. If any other fresh invention were to spring up, to threaten the prosperity of some well established interest, stockholders would be frightened, mania would set in, financiers would flourish, and money would freely change pockets.

There is no doubt, however, that the disgraceful financial operations, and remarkable gullibility of the investing public, of the past two years have materially checked the progress of electric lighting by destroying confidence in its success, and thereby withholding the sinews of war by which alone ultimate success can be secured. With millions thrown in the gutter, it is not to be wondered at that investors button up their pockets when the words electric light is mentioned; but leaving aside the question of the gross mismanagement which has allowed immense sums to be squandered, I propose briefly to indicate some of the progress made, both in a scientific and practical sense, and to show that electric lighting is a real true success.

On August 18th, 1882, an Electric Lighting Act, promoted by the Board of Trade, received the Royal Assent and became law. Its effect has been to add considerably to the expenses of those who are struggling against difficulties. Its object was to prevent the possibility of the formation of such a gigantic monopoly as that of water and gas. It has effectually done this, but by strangling the babe. The Act provides that an electric lighting undertaking should be carried out under a provisional order or under a license. The former covered a period of twenty-one years, the latter a period of seven years only. Provisional orders required that those who supplied the electric light, should, within a given time, compulsorily light, for public and private purposes, some portion of the district they wished to supply, while other portions should be lighted only on requisition and by agreement, or failing either, the order was to be withdrawn. These relative areas were to be determined upon jointly by the local authority affected, and the undertakers. The capital to be expended in every separate case was to be allotted, and a certain portion deposited with the Board of Trade, to prove the *bona-fides* of the undertaking.

Very carefully prepared regulations were issued, controlling the mode of supply, and securing the safety of the public. These regulations are sufficiently elastic to be modified with the advance of electrical knowledge, and with the teachings of experience.

Provision is made for the purchase by the local authority of the undertaking, if promoted by a company, at the end of the twenty-one years' period, and restrictions are inserted

* *Electric Review*, February, 16, 1883, p. 139.

preventing the possibility of any claim to monopoly, or to exclusive rights. Moreover, the limitation of profits and the revision of prices are left to be controlled by the fear of competition from rival electric light companies, and from the existence of gas, and by the exercise of public opinion through the medium of the Board of Trade. The tenure of the order is dependent on faithful discharge of its obligations. The Board of Trade remains a species of arbitrator between the public and the undertakers of light. It has effectually checked the establishment of a monopoly, but at what price?

One hundred and six provisional orders were applied for last year, sixty-nine were granted, but at the present moment deposit has not been paid on one single undertaking, and, therefore, not one single installation has been carried out under the provisions of the Act. Of the sixty-nine provisional orders granted, fourteen were given to local authorities themselves, but not one has been carried out.

Ten applications for licenses were received by the Board of Trade, but none were persevered with, and, therefore, none have been granted. No form of license has yet been issued. It is intended that their restrictions shall be less onerous, and their operation shall be more tentative in their character than those of provisional orders. They will be granted for seven years, to be renewable at the end of that period.

Some modification will have to be made in this Act. It is all in the interest of one class, viz., the local authority. The fear of the repetition of the gas and water monopoly has evolved restrictions that render commercial enterprise difficult. No cautious inventor would embark his capital in business which, if successful, will at the end of twenty-one years be confiscated, and, if unsuccessful, will be thrown on his hands, while no local authority will take the bull by the horns and do the work itself while there is the prospect of someone else doing it for them. Ever changing local authorities are very chary of investing ratepayers' money in tentative schemes, and cautious speculators will not risk money in what must be either practical confiscation or doubtful gain. The City of London has gone so far as to ignore the Act, and to invite tenders to light the streets, and to supply houses without any restriction whatever. Other corporations will, perhaps, do the same. Capital can be attracted only by gain. If the gain is to be thickly spread over a few years, the public will suffer. If it be only thinly spread, the capital will not come, and the public will equally suffer. Hence the operation of the present Act is detrimental to the public good.

As regards the scientific progress little has to be said. We had learnt nearly all we wanted to know before electric lighting had entered its practical stage. In reality, the very fact that it had entered its practical age was a proof that it had passed through its infancy of scientific tuition. The conditions that determined its production, the laws that regulated its behaviour, the means that were available for its control, had all been thoroughly investigated and laid down, before practice stepped in to show us what could be done.

Electricity can be produced, currents can be distributed, light can be generated, but we have yet to learn how all this can be supplied economically, profitably, and with safety to person and to property. Practice alone can determine these points, and it is well to make a rapid survey of the extent to which practice has up to now enabled us to solve these points. The future of electric lighting is now in the hands af practical men.

It has been well said that a want has only to be announced to prompt inventive genius at once to supply it. Electric lighting has called for motors of a class not hitherto in demand, and steam, gas, and water engineers have rushed to the front to meet the demand. Nothing can surpass the perfection of this class of apparatus; where everything is excellent, it would be invidious to single out examples. The production of electric currents means the expenditure of power; and when the extent of the installation is known, it is a simple calculation to specify how much horse-power is needed. Some employ a fall of water to urge a turbine, others employ steam, many use gas to obtain the power requisite to convert the energy of mechanical motion into that of electric currents. Gas-engines are being very largely used, and since the expenditure of a given amount of gas as power, will produce more light through the agency of electricity than by direct combustion in air, it is clear that we have here an evidence of the true function of gas. The perfect gas-engine has not yet been produced. Those in use are too noisy, too irregular, and sometimes uncertain, but the advances made are very marked and very encouraging. The hall in which we are is, as you see, brilliantly illuminated by a gas-engine. Those little lamps, though electric glow lamps, are in fact lighted by gas, though the gas itself is consumed in the cellar. The light we enjoy is only a form of the energy which has been brought into this building by the Gas Light and Coke Company. In all cases of electric lighting, electricity is merely the agent which transforms the pent-up energy contained in water, steam, or gas, into that of light. Hence it is that so much of the efficiency of electric lighting apparatus depends upon the instrument called the "dynamo," by which the conversion of this energy is brought about, and here it is that so much inventive skill has been expended, and so much real progress has been made.

The dynamo is the machine by which mechanical energy is converted into electric currents. Rings, or bars of copper-wire, forming a portion of the electric circuit, are forced through a space subject to strong magnetic influence, and the result is the formation of electric currents, whose intensity is dependent primarily on the magnetic strength of this space, and of the velocity with which the wire is made to pass through it, and secondarily, on the dimensions of the conductors, and of the size of the machine. The tendency of recent improvements has been to improve the mechanical details and to increase the out-put of the smaller machines. Thus by increasing the quantity and quality of iron, by better winding, and by rearranging some parts of the machines, Dr. Hopkinson has succeeded in doubling the out-put of the Edison dynamo. Mr. Crompton, by somewhat similar means, and by using the purest iron obtainable, has succeeded in making his Bürgin dynamo light up 210 lamps, instead of 90. Sir William Thomson and Mr. Ferranti have turned out a little machine, which succeeds in lighting up 1,000 lamps by a mass of metal, which two years ago would not have illuminated 100 similar lamps.

Thus we have a process which is still actively going on, by which the economical out-put of a given weight of material is vastly increased.

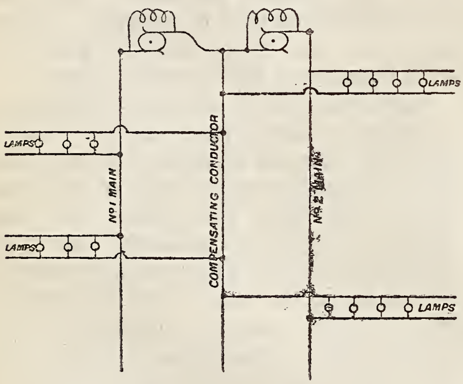
One of the most interesting objects at the Fisheries Exhibition last year was the Hochhausen dynamo, which is one of the most remarkable yet brought into the market. Those who visit the forthcoming Health Exhibition will have an opportunity of inspecting it. The main features of this dynamo are the extreme simplicity and the mechanical accuracy of its parts, the automatic mode of governing, its great adaptability, so that it can be varied at will either to high or low tension, and the remarkably low velocity for such high electromotive force.

The distribution of the currents through conductors is one of the problems that demands the highest skill of the engineer, not alone for the efficient working of the system, but for its economy. It is not sufficient to convert our useful energy into electric currents, we want to distribute them with the least possible waste. Conduction means waste, and this waste can be controlled only by using the purest metal, and by so regulating the electromotive force and dimensions of the conductor as to obtain the maximum effect with the minimum means. It is an exceedingly difficult problem to solve. The metal universally used is copper, but very few people take the precaution to test its purity. Contractors go to the cheapest market, and the result is they get the nastiest material. I know of conductors that give only 70 per cent. of the conductivity that they should give. This means largely increased waste, and greatly enhanced cost of working. Impure copper not only means needless waste, but waste means heat, and, therefore, danger.

But wasted energy may also take the form of leakage, or direct loss of current. This is cured only by good insulation. Good insulation unfortunately means expense; and here again competition has forced too much economy. I have not examined one single case of the failure of an electric light that has not been traceable either to crass ignorance, or to needless economy. Perfectly well insulated copper conductors are within the reach of all who choose to pay for them; but when proper specification, proper inspection, and proper tests are neglected, we must expect, as has too often happened, failure and expense.

A marvellous improvement has been made by Dr. John Hopkinson and by Mr. Edison, independently of each other, by which the weight of copper necessary for central station working has been diminished 60 per cent., and this is due to the use of two dynamos connected in series, and a third, or compensating conductor, placed between them as shown in the accompanying diagram. (See next page.) The weight of copper necessary for a conductor can also be diminished by the use of high tension currents, and this has led to various suggestions by which high tension currents shall be used for charging secondary batteries, and for exciting induction coils, but the use of high tension currents for household purposes is at present regarded as dangerous.

High tension currents are, however, available for public street lighting, and are very satisfactorily employed for this purpose. There is a very senseless crusade being conducted just now in certain quarters against overhead wires. Overhead wires, if properly constructed, are most desirable, especially for electric lighting. It is the terrible abuse of this mode of construction that has caused the present onslaught upon them. They have been erected recklessly, and they disfigure our streets; they are maintained carelessly, and they endanger traffic; they have been run up without method or control, and they have damaged property. But overhead wires can be made absolutely secure, they need not be a disfigurement nor an injury; they are far more readily maintained than underground wires; they facilitate the economy of electric lighting, not only by affording better conductors, but by radiating away



the waste heat generated, and by requiring fewer joints and connecting points.

I do not in the least object to overhead wires through our streets for public lighting, though I strongly object to the cloud of wires that now obstruct the sky line in many of our thoroughfares. When ugly objects form an essential function of utility, it is wonderful how their unsightliness is condoned. Who complains of the ugliness of gas lamp-posts, and what is there in the necessary adjuncts of town life more ungraceful or hideous?

I do not, however, advocate overhead wires for general lighting. The conductors in that case must go underground, and with the great demand for telegraphs, telephones, and electric lighting, it is a pity that our Corporations do not extend that useful system of subways, that has been partially carried out in the City of London, for easy fixing and inspection. The present mode of laying pipes in trenches is not only costly but dangerous, and it has led to many more accidents than have been occasioned by the falling of overhead wires. Our streets are almost always open for either gas, water, telegraphs, or telephones, and the evil is increasing, and will continue to increase, with electric lighting. The cure is proper subways.

The progress made during the past two years in the form and character of lamps, whether arc or glow, has not been very marked. In arc lamps the tendency has been to simplify the working parts, and to increase their steadiness of action. The Crompton, Pilsen, and Fyfe-Main lamps leave little to be desired in this respect. At the Vienna Exhibition, there was a remarkably steady lamp in the French Section, the Abdank lamp, but it has not been seen in England yet. The arc lamp has many serious defects, which circumscribe its value very considerably, but it is eminently adapted for workshops, railway goods yards, and for large spaces where high masts can be fixed.

For general domestic illumination the glow lamp, as made by Swan and Edison, is, in my opinion, the only proper one. At the Munich and Vienna Exhibitions, a remarkable lamp by Cruto, of Turin, was shown. It was said to be a carbon tube of high resistance. It gave very good results, and absorbed a very small current, but it is not in the market yet. At Vienna, the Bernstein lamp attracted much attention. It also was a thin carbon tube made by carbonising a hollow silk ribbon, but it had low resistance, and required much current. It gave a considerably higher candle power than we are accustomed to. For instance, one lamp requiring 5 ampères and 30 volts, gave 60 candles; and another, with 8·5 ampères and 35 volts, gave 100 candles. Its normal efficiency of 2·5 watts per candle was very low, the efficiency of the Swan lamp being 3·5 watts per candle, and that of the Edison 4 watts per candle. Its duration is said to be very great. All glow lamps can be made to give economical results when we use large currents, but, unfortunately, their life is much curtailed by doing so. The filament is disintegrated, and the inside of the glass is, in consequence, covered with a dark deposit. Hence we are obliged to be satisfied with low efficiency to obtain reasonable durability.

The Bernstein lamp is, however, of an inconvenient power, and while it may do for street lighting, and for large spaces it is not adapted, in its present form, for our rooms and offices. It is, therefore, a lamp that is more likely to replace arc lamps than the present glow lamps, as made by Edison and Swan. It has, however, shown us a direction in which economy can be effected, and we may reasonably hope that the workers in this field will soon find a means to improve the present efficiency of the small glow lamps, and thus reduce the cost of working them.

A good many private houses, as well as public establishments, have been recently fitted up, and their experience has developed many difficulties and dangers which have only to be found out to enable them to be overcome. There is no use ignoring the fact that the admission of electric currents into our homes means the admission of a new danger—a danger that is only to be surmounted by the dictates of experience. Careful rules and regulations have been drawn up for the guidance of those who are executing installations, but the true remedy is to employ none but skilful and experienced contractors, and to have premises properly inspected by recognised professional men. Under such guidance electric light leads can be made absolutely harmless and devoid of all danger. The same cannot be said of gas, oil, or candle, for they involve the use of matches, and are always in a condition of potential danger. 2,041 persons in England alone, in 1881, met with violent deaths from burns, scalds, and explosions (not in mines). In one week, not long ago, six deaths from explosions of gas were recorded in the *Times*. Hence, while electricity is certainly accompanied by its own dangers, these dangers can be neutralised, and other infinitely more serious ones can be completely expelled from our houses.

Mr. Killingworth Hedges has devoted a great deal of attention to safety catches, and he certainly has produced the most efficient that are in the market. No electric light lead should be without its safety plug, or cut out. It is a precaution of a cheap and simple character, efficient, and reliable in action. A bar or sheet of lead, or alloy, is inserted in the circuit, which is instantly fused when from any cause the current exceeds its proper amount. It is a nuisance to be left in the dark, which must happen when the safety catch is fused, for the circuit is broken; but one can submit to this when the result is safety gained, or some source of danger eliminated. The remedy is a little barbarous, but it is efficient. A less crude contrivance was shown in Vienna—the invention of Mr. Anderson—but I have not seen it in practice.

It is most desirable that we should have, in every electric light installation, instruments to measure the current flowing and the electric pressure present. Am-meters, or current measures, and volt meters, or pressure indicators, are very numerous. I have always used Sir William Thomson's well-known instruments, but the greatest novelty in this direction are the instruments of Capt. Cardew, R.E., which are exhibited to-night. They indicate current and potential, or pressure, by the expansion of a platinum wire due to the heat generated by the current that flows through it.

Another important economical feature is the proper distribution of light. Trotter's dioptric system is very ingenious and useful. Several are shown.

I scarcely think that the true solution of isolated house lighting will be secured until we can obtain reliable, effective, and economical secondary batteries. Planté's original accumulator, as improved by Faure, Sellon, and Volckmar, has not yet reached that stage of perfection that one would wish to see, but the progress towards this desideratum is steady and promising. Planté has himself made a decided improvement by preparing his lead plates in nitric acid, and the experiments that I have made with his cells, as supplied by Elwell and Parker, of Wolverhampton, are so encouraging that I am about to use a set of them in my own house. A secondary battery has this advantage, that your electricity is stored up to be used when you want it, by day or night, without the constant use of machinery. In ordinary houses, such as mine, there ought not to be required more than one day a week for charging—a day set apart for the purpose like washing day—when sufficient electricity should be stored up for a week's work. I scarcely hope to do this yet, but it is well within the bounds of possibility.

I have indicated to you the direction in which progress has been made. The output of the apparatus has been greatly increased, and, therefore, the capital required for installation reduced, the expenditure on conductors has been considerably diminished, the efficiency of the lamps—especially in their durability—has been improved, and all these steps in advance have the tendency to economise the production of the electric light. But the progress is being continued, and there is vast room for this improvement. Nothing approaching finality has yet been reached.

I see no reason whatever why our public streets should not be as efficiently lighted by electricity as they are now by gas, and for the same price. But the public are not satisfied with the same illumination; they will have more light. They are spoilt by the dazzling splendour of the arc lamp, and they treat with contempt the less showy glow lamp. Nevertheless, the best lighted street in the City of London is Holborn-viaduct. The Thames-embankment and Waterloo-bridge have now been lighted by fifty arc lamps for over five years by the Jablochkoff Company. Blackfriars-bridge, Bridge-street, Ludgate-hill, St. Paul's-churchyard, and Cheapside have been lighted by thirty-eight Brush arc lamps for three years. We are now engaged in a very interesting series of experiments at Wimbledon, to determine the best and most efficient way of lighting public streets, and much value in an economical sense will, it is hoped, accrue from these trials.

It is remarkable how the use of electricity is growing in favour with theatre managers. Supported by the success of the Savoy, the Criterion, and the new Prince's Theatre in London, the Prince's Theatre in Manchester, the Prince of Wales and the Royal Theatres in Birmingham, two theatres in Glasgow, and many others are following Mr. D'Oyley Carte's spirited venture, and who can refrain from wishing that all would follow his example? Cool and pure air, absence of headache, and cheerfulness of mind are experienced at the Savoy, while the reverse is felt elsewhere where gas is used. I have recently examined the estimates for lighting up the Opera house in Vienna, and I have every reason to believe that less than 30s. per lamp per annum will brilliantly illuminate that beautiful house, and give a handsome return to those who have undertaken the contract.

There are many small central stations at work in England, but none on a large scale. At New York there are several. The Edison Company's first station lights 431 houses, and 10,300 lamps, and they are now erecting two new ones for 50,000 and 70,000 lamps, respectively. We have, in London, one at work on the Holborn-viaduct, another at Brixton, and another for 5,700 lamps will shortly be opened at Victoria-station. There are small central stations at Godalming, Chesterfield, and Colchester. The Hammond Company have one at Brighton, which works over an area of seven miles. This company maintains 900 arc lamps, and 5,500 glow lamps in different places in England. There is a central station at the Edgware-road station of the Metropolitan railway, whence Notting-hill-gate, Gower-street, King's-cross, and Aldgate stations are lighted over a length of fifteen miles long. One hundred and fifty-one glow and five arc lamps are illuminated by the distributing system of Goulard and Gibbs. Lord Salisbury, an amateur electrician of no mean type, has established quite a system of his own at Hatfield. The *Times*, ever in the van of progress, has for four years lighted up its printing and compositors' room.

Our new Law Courts are admirably lighted, and some of the judges have said that the electric light is the only good thing in this new Palace of Justice. The House of Commons has gradually been fitted up, and the Colonial Parliament Houses in Cape Town and New South Wales are following the examples. Indeed, restaurants, hotels, and public buildings, are all testifying to the fact that I am so anxious to bring before you, that electric lighting is a decided success, for they are using it. But we want to see it in our homes. An excellent little book on this point has recently been published by Mr. Hammond, which is well worth your perusal. He has given there a table so striking and convincing, that I have had it copied and suspended for your information:—

The following table shows the oxygen consumed, the carbonic acid produced, and the air vitiated, by the combustion of certain bodies burnt so as to give the light of 12 standard sperm candles, each candle burning at the rate of 120 grains per hour:—

Burnt to give light of 12 candles equal to 120 grs. per hour.	Cubic feet of oxygen consumed.	Cubic feet of air consumed.	Cubic feet of carbonic acid produced.	Cubic feet of air vitiated.	Heat produced in lbs. of water raised 10° F.
Cannel Gas......	3·30	16·50	2·01	217·50	195·0
Common Gas ...	5·45	17·25	3·21	348·25	278·6
Sperm Oil.........	4·75	23·75	3·33	356·75	233·5
Benzole............	4·45	22·30	3·54	376·30	232·6
Paraffin	6·81	34·05	4·50	484·05	361·9
Camphine.........	6·65	33·25	4·77	510·25	325·1
Sperm Candles	7·57	37·85	5·77	614·85	351·7
Wax	8·41	42·05	5·90	632·25	383·1
Stearic	8·82	44·10	6·25	669·10	374·7
Tallow	12·00	60·00	8·73	933·00	305·4
Electric Light...	none	none	none	none	13·8

There you see why the electric light is so pure and so healthy. There is no consumption or pollution of air. There is the smallest possible production of heat. There are none of the existing dangers from fire or suffocation, but all is pure, healthy, and safe.

Our homes on the sea—those ocean palaces that render voyages to America and our colonies a pleasant yachting picnic—are being gradually fitted. Over sixty are already so fitted, and all will soon be done. None but those who have tumbled and tossed on the angry ocean in a pitch-dark confined crib for the seemingly never-ending night, can appreciate the peace and comfort of the soft and gentle little glow lamp that is now supplied.

Efforts are being made to introduce primary batteries for the generation of electric-light currents, but not as yet with marked success. Unless the products of combustion can be sold profitably, primary batteries must necessarily be costly, and their constant renewal, and the amount of personal supervision they demand, militates much against their use, but some admirable batteries for small and temporary installations have been brought out, notably that of Mr. Holmes. Our railway trains are being lighted. Very satisfactory experiments are being made on the Brighton, South Western, South Eastern, Metropolitan, Midland, and Great Northern railways, with dynamos, primary and secondary batteries, and there is no doubt whatever of their ultimate success. There is no reason why the energy of the moving train itself should not produce currents of electricity to illuminate every compartment with the light of day.

Exhibitions have been both banes and antidotes. They have had much to do with the cause of the late mania, but they have also encouraged invention, and stirred up emulation. Last year's Fisheries Exhibition did much to educate Londoners to the advantages of the light. This year's Health Exhibition will do more; and I venture to prophecy—a foolish practice, unless you know—that this Exhibition will, as an electric light display, be the best we have ever seen.

There have been a good many failures in electric lighting, as there must be in the introduction of every new enterprise, but every failure can be traced to imperfect apparatus, or to the employment of inexperienced contractors—in fact, to bad engineering. It is not long since that the wiring of a large building was let to one firm, and the lighting to another, with the necessary consequence that the whole thing "burst up," to use an Americanism, on the night of opening.

It is difficult to express any opinion on the economy of the electric light. We have not had the experience of any central lighting station of sufficient magnitude to justify the formation of such opinion. Any comparison between gas and electricity on this basis is unfair, because gas is produced in quantities sufficient to supply hundreds of thousands of lamps, while the largest electric light station yet erected does not light up 10,000 lamps. In New York, the price is the same for electricity as for gas, but then gas costs 12s. per 1,000 cubic feet, as it did in London, in the memory, perhaps, of some present. Nevertheless, the cost of supplying electricity now is far less than was the cost of supplying gas in the early days of its introduction.

But why draw a comparison? People do not compare the cost of gas with that of candles, nor the price of a pheasant with that of a mutton chop. If we want a luxury we must pay for it, and if the price of the luxury is not too great, people will have it. People will have electric light, if it can be supplied to them, not because it is cheap, but because it is safe, healthy, pure, soft, and natural. And, moreover, they will not object to pay any reasonable price for it, whatever may be the price of gas. Gas is most destructive, unhealthy, and objectionable when used for artificial illumination. The proper function of gas is the production of heat, and we see in this room how this production of heat can be utilised to form electric currents which diffuse about us a real luxury—pure light. When the electric light can be supplied, questions of sanitation, ventilation, and decoration will determine its use, and not questions of price. At present, for household purposes, it is a luxury for which we must pay; but the progress made is so rapid, and the room for improvement so great, that the day is not far distant when we shall cease to regard it as a luxury, and shall demand it as a necessity.

[An Appendix, consisting of a Table of the Electric Light Companies, is printed as a Supplement.]

DISCUSSION.

The CHAIRMAN said the paper had quite borne out his expectations, that it would show immense progress to have been made in electric lighting since Mr. Preece read a paper on the same subject some three years ago.

Mr. E. CROMPTON said he could not make a long speech, as he had been suffering all day from a bad headache, arising from a nine hours' argument with a recalcitrant Corporation Committee, who seemed bent on putting wires into a public building of such a size as would have certainly set it on fire; and he was going back again by the 12 o'clock train to try and put the matter right. The paper was a most able and much needed contribution to public knowledge on this subject, for there was no doubt an impression abroad that the electric light was waning, and that it was not the light of the future, but after that evening he hoped such a delusion would vanish. He would endeavour to say a word or two from his own experience; and first of all, with regard to the question of economy, he might say that in the minds of practical men there was no doubt whatever about the economy of the electric light. They knew that the cost of producing it had steadily decreased, and now the cost of producing so much electricity, and using it in lamps, was as easily calculated as the cost of gas, if they were furnished with the data which all gas engineers must have in dealing with gas-works, and that was, the consumption required. If they were to go to any fresh country and compete with gas for lighting a town, with coal at a fair price, they could compete on even terms, and if coal were dear, more easily still. In fact, the dearer the fuel the better for electricity, because the fixed charges, the cost of production and labour, would remain constant for the two, but electricity had the advantage in producing a greater number of units of light per ton of coal consumed. One point which Mr. Preece had forgotten to emphasise was, that in the future they must look less to electric systems and more to the men who carried them out. What had now to be done was the working out practically of the many inventions which had been brought out. Hitherto, the men had been kept in the background, and the systems put in front; but the gentlemen, such as he saw there, who had the foresight to gather around them a staff of young men, whom they had thoroughly trained in all the details of the science, were those who would carry electric lighting to a successful issue in the future. In one sense, as Mr. Preece had said, the electric light was a luxury, but in another it was a necessity, and any man who had once had it in his house, especially if he were the father of a family, would, he was sure, say that it was necessary. Those who had seen children's faces in a nursery after a dull winter's day, when the gas had been lit all the time, and compared them with children in a house blessed with electric lighting, would say that he who was content with gas when he could get electricity was simply poisoning his children. The reason why electric lighting spread so slowly in private houses was the almost insurmountable difficulty in finding a place to put the motive power. They had to put the machinery in cellars, and often part in one cellar and part in another, and the men in charge had to work underground—in fact, such difficulties were never thrown in the way of engineers before, owing to the enormous value of property in towns. These difficulties were so great, that it was wonderful the failures had not been more numerous, and very great credit was due to the sub-engineers—whose names never came forward—who worked out these details.

Mr. GEORGE OFFOR wished to correct one statement in the paper, with regard to licenses under the recent Act. A license for lighting the town of Colchester was being persevered in, and would be granted as soon as certain slight modifications had been arranged between Major Armstrong and the Company. Again, with regard to the danger of distributing of electricity by currents of high tension, that had been got over at Colchester by the engineers in charge, in the following manner. Storage batteries were employed, which were charged in series from a central station by a high tension current; but to avoid the taking of that high tension current into the houses, each stack of batteries was divided into two parts, connected by a rocking switch, by means of which, while one-half the battery was being charged by the high tension current, the other half was in supply, and as soon as the electromotive force was reduced in the supply half to a certain point, it automatically threw the supply half into charge, and the charging half into supply. Under that arrangement, the potential carried into the houses was that of lamps used, and by that means the condition of the Board of Trade, that the potential should never exceed 200 volts, was complied with. This installation at Colchester was of peculiar interest, because it was the first practical attempt to supply electricity on similar lines to those adopted by gas companies. The current being distributed from a central station gave a constant supply, and the consumer had none of those difficulties to which Mr. Crompton had alluded in finding space for the machinery; he was charged so much per thousand, or per lamp per hour, as the case might be. With reference to the great question of economy, he could endorse all that Mr. Preece had said with regard to readiness with which the electric light would be taken irrespective of the price of gas; but from his experience with a small installation of only 2,000 lamps, he found they could compete with gas at the same price. They were able, however, to obtain a higher price very readily, viz., ½d. per lamp of 20 candles per hour, which was equivalent to 5s. per 1,000 feet of gas. The reason they could do so was readily explained. A large linendraper remarked to Major Armstrong that he found his goods very much damaged by gas, and that the saving by electricity in that way alone more than paid for the whole cost. There was an impression abroad that the electric lighting business was played out, simply because certain gambling transactions on the Stock Exchange had brought the shares to a discount; but they knew not only that the means of supplying electricity had marvellously improved, and that the demand for electric lighting was increasing in at least equal proportion.

Mr. HAMMOND agreed with the preceding speakers that such a paper as they had listened to was much needed at the present time. Those engaged in electric lighting had often to listen to most unpleasant remarks, such as had been referred to, and in many cases were plainly told that the whole thing was a swindle; but he maintained that the progress already made had been such as to warrant them in believing that some day electric lighting would triumph over all obstacles, and have as great a future as the railway system, or the water or gas supply. He believed they were on the eve of as great an era in lighting as their forefathers who had stood on the threshold of the railway era. Many people thought the details given in the table to which reference had been made were only of interest to chemists; but on the contrary he was convinced that the public would, ere long, come to the opinion that it was quite as dangerous to take in poison with the air as in their food or water supply. What was the position of England, only twenty years ago, with regard to water? and there was an almost exact analogy between pure water and pure air. Twenty years ago, the people of England were perfectly indifferent as to what water they were drinking, but they then woke up suddenly to the importance of the subject; and when he was a member of the Corporation of Middlesborough, that body, in conjunction with Stockton, were willing to pay £800,000 to secure pure water. What had happened with regard to water would also happen with regard to air. In their houses of business they had to put up with many inconveniences; but when they went home, if they could ensure having the air as pure as that which existed outside, they would be willing to pay something for it. In the case of water, they were now willing to pay any price to secure purity, as in the case he had mentioned, where £800,000 was paid for what a few years before could have been secured for half the money, but it was not then deemed of sufficient importance. Mr. Preece had mentioned the great progress which had been made in the construction of dynamos and lamps, and the question was what had been the great obstacle during the last few years to the progress of electric lighting; for numerous as were the installations at the present time, they had to face this fact, that, with the one exception mentioned by the last speaker, no absolute house to house installation was at present in existence. It was all very well to say you had a machine which would run a thousand lights at a slow speed, and that the lamp was slightly improved; the question put to him by a friend of his was, how soon are you going to supply it in Pembridge-square? He said that he knew where electric lighting was introduced he had not to breathe poisoned air, that it was perfectly under control, and so on, but why was it not offered to the public at large to take advantage of? There were all sorts of reasons advanced. Some said it was the Electric Lighting Act which stood in the way, but he did not believe it. He thought the twenty-one years tenure was quite sufficient. It was not the intention of the framers of the Act, or the Board of Trade, that at the end of that time the property of the company should be confiscated, but that it should be sold at its then value without calculating anything for prospective profits, such as had been demanded hitherto in the case of gas and water companies, and he did not believe such a provision would prevent capitalists investing. Then it was said that the frightful speculation which had occurred was the great bar; and, no doubt, shares in electric lighting companies had been treated like counters in a game at vingt-et-un or écarté; but the great bar after all was something different. They had heard of different kinds of energy, but, after all, the most powerful kind of energy was what Americans called the almighty dollar. There was upwards of 150 millions of money invested in the gas industry; and the shareholders in this industry were to be found in every town throughout the kingdom, and they were all working dead against electric lighting, which they feared might depreciate their property. What encouragement was there to men to put their money into electric lighting? The very same people whose money they wanted for this purpose were gas shareholders. He was lately in Birmingham, and there he was told that they had a million and a-half in gas; that they lived on gas; and what was the use of his coming to them and talking of electric lighting. He told them that they would have to put as much into electric lighting, and why was it not done? The great obstacle was, in this case as in every other, that unless the best work was always put into it, any new thing took years to make its way. It was because every installation had not been a success that people who looked into it said they would wait a bit, and see what better could be done. As a man said to him the other day, he was at some place where all the lights went out. When Mr. Crompton had to spend nine hours in persuading people not to use wires which would burn the place down, they could understand the difficulties which had to be encountered. They had not yet recognised the fact that those who had to do this business must be men who never turn out bad work. He had had to suffer from this cause himself, having, as Mr. Preece had mentioned, to put machinery costing £5,000 to £6,000 into a building which had been fitted up with wires by people who had put up the electric bells. But better views were now beginning to prevail, and when it was generally recognised that good work had to be done in every direction, they would go a-head. He had yet to meet with the mother who, for the sake of cheapness, would give her child food which had a modicum of poison in it, and they would yet live to see the day when there would be as much aversion to breathing poisoned air as there was now to eating poisoned food or drinking impure water.

Mr. Preece said he had omitted one point in his paper, and that was the fittings in the house. He had lately dined with Mr. Tayler Smith, a well-known architect, who had devised such beautiful fittings for his house, that he had induced him to bring some of them there, and he hoped he would explain them.

Mr. TAYLER SMITH said he hardly agreed with Mr. Hammond as to the great obstacle to the general introduction of electric lighting. In his opinion one very great obstacle was that companies did not care to supply a house that only required 20 or 30 lights, they wanted you to have 40, 50, or 60, and charged for the whole when only a part were in use at the same time. In order to avoid paying for the maximum when he only used the minimum, he had arranged all his lights so that they could be removed from one room to another as required, having "shoes," as he termed them, inserted in the skirting of the rooms into which the wires could be readily inserted. He then exhibited and explained various forms of candelabra and bracket lights of very elegant design, all of which were readily detached and placed where required, the most striking and original of all being a hanging light, which could be raised or lowered at pleasure, like a telescopic gaselier. A two-light bracket could be put in the place of a single one, if more light were required, and for reading lamps there was a very ingenious arrangement by which the wire conveying the current was wound on a wheel under the lamp when a short distance only was required, and paid out when the lamp had to be moved to a greater distance from the connection. If any one's foot caught in the wire leading from the socket, it simply slipped out, and was easily replaced. Another very beautiful design was intended for a pianoforte lamp, which threw the light on the music, and not into the eyes of the player.

The CHAIRMAN said the discussion might usefully be continued to much greater length if time permitted, but unfortunately it did not. There was no doubt some truth in what Mr. Hammond had said with regard to the powerful interests which were arrayed against the cause of electric lighting, but it was to be hoped that as the use of gas was rapidly extending in many directions not contemplated until recently, that opposition would by degrees die out. If time allowed him to go into the various uses of electric lighting, he should have had to mention several points which Mr. Preece had omitted; but he hoped that gentleman would bring the subject before them again at no very distant date, and give further details.

Mr. PREECE said, if he had one regret, it was that they had not had an opportunity of hearing something said from the gas companies' point of view. He was a gas shareholder himself, and held a portion of the 150 millions to which Mr. Hammond referred; but he was not at all afraid of his investment, nor of the future of gas, notwithstanding what he had brought forward with regard to the progress of electricity. He believed that the same era which Mr. Hammond anticipated for electric lighting was also awaiting gas as a motive power, and as a store of energy to be used principally for the production of electricity. A very important point had been mentioned by Mr. Crompton, that they must look more to men than to systems, and Mr. Crompton himself was an example of the sort of men who were bringing electric lighting into the front rank. In preparing that paper he had visited Mr. Crompton's factory at Chelmsford, where 250 men were busily employed in the manufacture of these things; and he regretted that he had not been to Colchester, as he should not have made the mistake which Mr. Offer had corrected. He had visited a great many private houses, however; he had breakfasted in Glasgow, and dined in Manchester, under the electric light; but of all the places he had visited none had afforded him so much pleasure as the house of Mr. Tayler Smith, where every detail was carried out in the most perfect manner, as they could judge from the specimens which had been exhibited. On the next occasion he would promise gas a chance, and see what could be said in its favour as against electric lighting.

The CHAIRMAN, in proposing a vote of thanks to Mr. Preece, remarked that one important element in the development of every practical application of science was to find a clear exponent of the subject, who was at the same time honest enough to say frankly all he thought, either for or against the subject he was dealing with, and such a man they had in Mr. Preece.

The vote of thanks was carried unanimously, and the meeting separated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings recorded in last week's *Journal*:—

SICK AND AMBULANCE.

Wednesday, February 27th.—Present: Director-General Crawford, A.M.D., in the chair; Surgeon-Major G. J. H. Evatt, M.D., A.M.D.; Mr. John Farley; Inspector-General J. D. Macdonald, M.D., C.B., F.R.S.; Surgeon-General W. A. Mackinnon, C.B., A.M.D.; Dr. J. C. Steele; Mr. J. S. Young.

THE DWELLING HOUSE.—SUB-COMMITTEES A AND B.

Thursday, February 28th. — Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Sir Frederick Abel, C.B., F.R.S.; Dr. Alfred Carpenter; Mr. C. N. Cresswell; Mr. W. Eassie, C.E.; Mr. Rogers Field, C.E.; Dr. E. Frankland, F.R.S.; Mr. G. Godwin, F.R.S.; Mr. Charles Heisch; Mr. Malcolm Morris; Mr. Shirley F. Murphy; Mr. Samuel Osborn; Major-General Sir Richard Pollock, K.C.S.I.; Sir Robert Rawlinson, C.B.; Dr. R. Thorne-Thorne; Mr. Ernest Turner; Mr. Frederick Young; Mr. H. Trueman Wood.

The Library.

Tuesday, March 4th.—Present: Dr. W. Ogle, in the chair; Rev. T. Graham, D.D.; Mr. A. C. King; Mr. C. M. Kennedy; Mr. J. L. Clifford Smith; Mr. D. Williams.

NOTES ON THE REARING OF SILK-PRODUCING BOMBYCES IN 1883,

By Alfred Wailly

(Membre Lauréat de la Société Nationale d'Acclimatation de France).

General remarks.—By referring to my report on the rearings of 1882, which appeared in four numbers of the *Journal of the Society of Arts* (19th and 26th January, and 2nd and 23rd February, 1883), it will be seen that during the very mild winter of 1881-1882, a considerable number of moths emerged from cocoons of Indian wild silkworms. During the last winter only six moths emerged from the 1st to the 16th of January, 1883, after which no more emerged till May. As I have observed, and stated in previous reports, moths from tropical species are apt to emerge during the winter when the weather is mild, while moths of native or northern foreign countries seldom, if ever, emerge before the spring. This irregularity in the emergence of the moths of tropical species is one of the difficulties in the way of their reproduction and acclimatisation; it may take place at any season, though the greater number emerge in the summer and autumn. Hence the necessity, to have a fair chance of success, of having a large number of live cocoons.

I bred, or attempted to breed, in 1883, about the same number of silk-producing bombyces as in previous years, such as *Attacus Pyri*, of Central Europe, *Attacus Cynthia* and *Antheræa Pernyi*, originally imported from North China; *Telea Polyphemus*, *Samia Cecropia*, *Samia Promethea*, *Saturnia Io* and *Actias Luna*, from the United States of North America; *Actias Selene* and *Antheræa Mylitta*, from India. *Attacus Atlas*, as will be seen further on, could not be attempted. I reared, besides the above-named species, a number of lepidoptera, which, as they have no connection at all with sericiculture, cannot find their place here. My notes on the rearings of 1883 being very numerous, covering some 28 pages of my note-book, I shall not reproduce them *in extenso*, as details on most species have already been given in previous reports. Although it is sometimes necessary to repeat former statements, I shall confine myself principally to new facts.

As yet, only a few of my European and American correspondents have sent reports of their success or failure in rearing the various species of silk-producers. Of British correspondents, Mr. John Ball, of Macclesfield, has obtained a very great success in 1882 and 1883 with *Antheræa Pernyi*, *Actias Luna*, and *Actias Selene*, and he wishes me to record it. With respect to the rearing of *A. Pernyi*, in 1882, Mr. Ball says he found this most valuable silkworm as easy to rear as any of the British lepidoptera, and quite hardy, and he succeeded in obtaining two broods during the year. The moths began to emerge from the 1st of May, and the first larvæ hatched on the 16th of the same month; the larvæ spun up from the 20th to the 24th of June. On the first of August a female moth emerged, and on the 3rd a male, from the pairing of which ova were obtained on the 4th, which hatched on the 16th of August. Larvæ formed their cocoons from the 1st to the 7th of October.

Of *Actias Luna* reared in 1882, Mr. Ball says:—With the 24 ova you sent me I obtained 22 larvæ, four of which died in first stage. The other larvæ thrived splendidly; they had hatched on the 15th of June from ova laid on the 2nd of June. The larvæ spun up from the 13th to the 17th of July. From the 18th of August to the 22nd all the moths emerged from the cocoons, and all were fine perfect specimens. In 1882, Mr. Ball was equally successful with this species, the rearing having taken place about one month later.

With respect to *Actias Selene*, Mr. Ball says:—The larvæ from the ova you sent me on the 8th of July, hatched on the 15th of July, spinning up from the 18th to the 19th of August, and the moths emerged from the 21st to the 24th of September. Mr. Ball's rearing of *Selene* in 1882 was also a great success; it took place at the same period, the moths emerging from 21st to 25th of September, all splendid specimens. Both *Luna* and *Selene* were fed exclusively on walnut.

Wild Silkworms.

Of late years, wild silk culture has attracted much attention in various quarters, and there is no doubt that the rearing, on a large scale, for commercial purposes of such silkworms as *Pernyi*, *Cynthia*, *Mylitta* (tussah), *Polyphemus*, *Cecropia*, and others, would be a very profitable enterprise, if these wild silkworms were bred in climates suitable both to the worms and the plants they feed upon. These two indispensable conditions could easily be found. *Attacus Cynthia* is not only acclimatised but naturalised in France, and it can be reared even in England, in the open air, with the greatest success. *A. Pernyi* (oak silkworm) can also be reared in the open air, and it is reared, on a large scale, in Guipuscoa, a north-eastern province of Spain, where two crops of cocoons are obtained every year. *Telea Polyphemus*, introduced by me in this province, thrived equally well, and became acclimatised. Some years ago, I sent large quantities of *Cynthia* and *Peryni* live cocoons to the United States of North America, and both species are now found wild in many parts. The acclimatisation of these wild silkworms is, therefore, an easy matter when a suitable country is chosen.

I lately received from Paris a letter dated 31st October, from a gentleman who, together with some of his friends, intend to entrust a rather considerable capital to one of my correspondents in French Guiana, for the purpose of cultivating on a large scale the *Attacus Aurota*, a wild South American silkworm common in Brazil, the Guianas, and other parts of South America. No doubt, if the project is carried out, the rearing of this species will be easy, and the quantity of cocoons obtained will be enormous, for this silkworm has six generations every year in French Guiana. But I was asked before anything was done respecting that enterprise to give advice, and state what would be the commercial value of the silk, which was a difficult question to answer.

Cocoons, as is well known, are of two sorts: the closed cocoons like those of *Pernyi*, *Yama-Maï*, *Mylitta*, *Polyphemus*, and others, and those cocoons which are naturally open at one end, such as those of *Cynthia*, *Atlas*, *Cecropia*, *Aurota*, &c. The *open* cocoons, and *Aurota* is one of them, remain exactly the same after the moth has emerged, as they were before, and no opinion on the quality of the silk can be formed till these cocoons have been carded. The *closed* cocoons, on the contrary, are cut open (or are apparently *cut)* by the moth when it emerges from it; then the threads can be pulled and the silk examined and appreciated to a very great extent. Such is not the case with the open cocoons, the silk of which cannot be pulled by hand.

For the last ten years my work has been the reproduction, rearing, and study of the various wild silkworms of China, Japan, India, and America, of which I could obtain live cocoons or ova. Many persons in Europe and America, through my exertions, have also been able to rear and study them. But this work has occupied all my leisure hours. I have had, therefore, no time left to study the quality of the silk of the various species. All I know is that the silk of *Pernyi Yama-Maï* and *Mylitta* is valuable, and, if well worked, is almost equal to that of the *Bombyx Mori;* the silk of *Polyphemus* seems equally fine. I had always thought, and I still think, that the silk of these species, with closed cocoons, is superior to the silk of those with open cocoons, and my opinion also was that reeled silk was of more value than carded; but from a letter lately received from Mr. T. Wardle, of Leek, a great authority on such a subject, I see that carded silk is as good as reeled silk, a very important fact to know, as it would make some of the open cocoons as valuable as the closed ones, if the thread obtained by carding were as fine as that obtained by reeling. In his letter of the 5th of November last, on the subject of sericiculture, Mr. T. Wardle says:—"Have you visited No. 71, New Bond-street, London, where all my Tussur (*Mylitta* or *Paphia* of India) developments are? My partner, Mr. Brough, would be glad to explain anything to you. I think, if anyone went to India to collect Tussur cocoons and any other wild silks, that it would pay, and I think any enterprise of that kind would receive some Government encouragement. . . . To cultivate any cocoons would be a good speculation, if they could be produced in sufficient quantity; because, if they cannot be reeled, they can be carded, and, of the two, there is more demand for carded yarn than reeled, and a carded yarn fetches more money than a reeled one."

I twice visited Mr. Wardle's place in New Bond-street, and I examined with the greatest interest the splendid and various articles manufactured with the Tussur silk, and I would recommend all persons taking an interest on this subject to visit the place. A visit to Mr. Wardle's would show of what importance would be the cultivation, on a large scale, of the Tussur and other equally valuable wild silkworms in such countries as would be suitable to them.

The collecting of wild silk cocoons in the forests of India, or other parts, would be profitable to reproduce and rear the various species, but I do not think sufficient quantities of these cocoons could be collected in this way for manufacturing purposes, and for the latter, rearing in the open-air and on trees must be resorted to.

Worms reared in a state of domesticity in warm rooms, or in "*magnaneries*," as the mulberry silkworm, would be liable to the terrible contagious diseases which, for years, have attacked the latter, to such an extent as to make the supply of mulberry silk very much smaller than it used to be. In France, some fifty years ago, one of the most terrible of these diseases (which fortunately has now, it is said, disappeared) was the "*muscardine*," a white vegetable parasite which was developed inside the worm or in the chrysalis. Whilst the *muscardine* preyed on the mulberry silkworms, the other epidemics had disappeared; but, from 1845, two other distinct diseases made their appearance one after the other. The first was the "*pébrine*" (pepper disease), a very ancient affection of the worms, which, when attacked by it, are covered with black spots, and grow smaller and smaller till they die. Later on, a second, very distinct from the first, and a worse disease, made terrible ravages among the worms; this is the "*flacherie*." The *flacherie* is worse than the *pébrine*, because, after all the expense and the labour of rearing the worms, which eat and grow well, showing apparently no signs whatever of disease, they die within a few days before the spinning period; hence, a great loss and disappointment. These contagious diseases may co-exist, but when they are intense, it often happens that one excludes the other, according to the ordinary law of epidemics. These diseases, created by the overcrowding of worms in hot rooms, may also be the consequence of rearing from eggs containing the germ of disease, for, it must be remarked, that a certain number of diseased worms live and procreate in spite of that germ of disease in them. On the contrary, silkworms reared in the open-air, on trees, and in suitable climates, could not be attacked by these contagious diseases. Since the deficiency in the production of mulberry silk, the cultivation in India of the Tussur silkworm has been considered of the highest importance. As yet, it does not seem that the rearing of the Tussur worm has been attempted on a large scale, though, no doubt, it will be so before long.

Major G. Coussmaker published, in 1873, a most useful and interesting pamphlet on "The Tussur Silkworm," and every year, in spite of the difficulties in his way, Major G. Coussmaker reared this valuable silkworm in a state of semi-domestication in the neighbourhood of Poona, with a success which increased every year, as may be seen by reading his annual reports. In his last report to the Secretary of the Bombay Government, dated Poona, 14th February, 1883, previous to his final departure for England, Major Coussmaker, however, says that he regrets he cannot recommend Government to continue these experiments in that part of India, owing to three causes, the principal one being that the climate there was an insurmountable obstacle.

On a visit I paid to Major G. Coussmaker last October, I had the pleasure to converse with him at length on the subject of sericicultnre in India, and I have since read the many letters which were sent to him on the subject by correspondents in various parts of India. A perusal of these letters shows that the rearing of the Tussur silkworm could be successfully carried out on a large scale, if assistance were given to an experienced sericiculturist.

From the knowledge acquired by the reading of numbers of reports and letters, I think that a warm, moist temperature, such as that of Ceylon, is the best for the Tussur and some other wild silkworms.

I have also examined Tussur cocoons sent from Calcutta, Madras, Ceylon, and Bombay, the last having been kindly brought for me by Major Coussmaker. Major Coussmaker complains in his last report of the small size of the Bombay cocoons, as compared with those of other parts of India. Now, those from Ceylon are quite as small, if not smaller, than the Bombay cocoons, but the silk of the Ceylon cocoons, in my opinion, is finer and softer; they are, for the most part of a yellowish white, and similar in shape and texture to the Japanese oak silkworm (*Yama-maï*) cocoons.

In January, 1883, I saw in the offices of the Société d'Acclimatation de France, in Paris, cocoons which had been sent when alive from Cochin-China. These cocoons seemed to me exactly like those of the Ceylon Tussur in size, shape, and colour; but the moths varied in their shades of colour, just as those of the Tussur found in various parts of India. The moths of the Ceylon species, on the contrary, as far as I have observed, are all of the same colour, the male being dark reddish brown, the female bright yellow. An interesting article on the Cochin-China silkworm, which I saw in Paris, written by M. J. Fallou, may be read in the June number, 1883, of the "Bulletin" of the Société d'Acclimatation. The species was at first considered as being *Antheræa mylitta* (the Indian Tussur), but subsequently it was found to be *Antheræa Frithii* (Moore), a species described in the "Proceedings of the Zoological Society," 28th June, 1859.

By comparing the species which I have considered as the Ceylon *A. mylitta* with the other Indian *Mylitta*, an entomologist might be lead to give the Ceylon race a differant name than *Mylitta* as the cocoon is more oval and somewhat different in other respects, and so are the moths to a certain extent.

But, is it not possible that these differences are due to a difference of climate, and that the Ceylon species and *A. Frithii* are only southern species or varieties of *A. mylitta*. At any rate, whether or not the Ceylon silkworm is the same species as the *A. mylitta* of the more northern parts of India, it seems evident that the moist and warm climate of Ceylon is very suitable to the rearing of that species of *Mylitta*. In all probability other species would succeed as well, and the introduction of the more northern *Mylitta* into Ceylon would, in course of time, show whether it is the same as the Ceylon silkworm.

Coming now to the rearing of the *A. mylitta* and other wild silkworms in various parts, and on a large scale, the plan adopted by the Japanese for the rearing of their valuable oak silkworm, *Yama-Maï* and very probably also by the Chinese, who are expert sericulturists, might be followed. Many papers have been written on the culture of the Japanese *Yama-Maï*, two published as far back as 1864, one of which had been translated from the Japanese into Dutch, by Dr. Hoffman, and then from the Dutch into French, by M. F. Blekman, interpreter to the French Legation in Japan. According to the pamphlet translated from the Japanese, the plan adopted for the rearing of the *Yama-Maï* consisted of three different operations. I say "consisted," because the first and second systems of rearing may, perhaps, not be adopted at the present time. Now, let us see what these three systems of rearing the *Yama-Maï* are :—

1. On branches, *en baquets*, in tubs.
2. On branches, *à fleur de terre*, at a level with the ground.
3. On trees, *en libre nature*, in the open air.

A note following these three headings says: The first mode is employed for the rearing of the worms till after the third moult; after that period the second and third modes become applicable.

The first mode of rearing is this: tubs, placed under a shed, are filled with water and covered with lids in which holes have been bored, four, five, or six, according to the size of the tubs. The oak branches which are to feed the worms are plunged through these holes into the water, taking care to plunge the stalks of the branches into the holes which are opposite to one another, using only half of them, and corking or stopping the holes which have not been used, till the foliage has been eaten by the worms, or has become too old or faded. Then fresh branches are introduced into the tubs through the holes left vacant for that purpose. The fresh branches being placed so as to touch the old ones, the worms quit the old branches to go to the fresh ones. If the space is too wide between some parts of the old branches and the new ones, the old branches are cut in small pieces, which are placed, or pinned, on the new branches. A tap is placed at the lower part of the tub, so that the water can be drawn out and renewed every other day, or every day, as the purity of the water is of the utmost importance. This plan of rearing may be adopted till the worms form their cocoons, when the rearings are on a small scale.

COMMERCIAL MUSEUMS.

The above subject has been recently discussed in the *Deutsches Handelsblatt*, in connection with the progress made in the direction indicated by England as well as by other European countries. In France the idea has found an energetic defender in M. Felix Faure, who advocated it in his proposal for the budget of 1884. According to the project of a so-called *Musée Commerciale Consulaire*, it would contain—1. A collection of raw material from foreign countries. 2. A collection of objects which are required in various foreign markets, accompanied by details as to prices, duties, &c. M. Faure's opinion is that private enterprise could not successfully carry out such an idea, and he therefore proposes a museum of this kind to be established at the Ministry of Commerce, and for a committee of manufacturers, exporters, and commission merchants to be formed under the presidency of the Minister. The establishment of such a museum in Paris would be followed by similar museums in other business centres.

In Germany, the formation of a museum of commercial geography was proposed in December, 1881, when (with promises of support from the German Foreign-office and Admiralty), the Central Association for Commercial Geography of Berlin sent out a formal request for co-operation to persons likely to promote the idea either by subscriptions or by exhibits. The responses to this appeal have been numerous and valuable as to the latter portion of the subject, but the funds available are not sufficient to cover the expense of arranging the collections. In Wurtemburg, however, the efforts made have been much more successful, private enterprise having established at Stuttgart a so-called "depôt of export," samples in which every branch of Wurtemburg industry is represented in a systematic manner. A catalogue has been printed, 4,000 copies of which have been distributed amongst various consulates, hotels, &c., in different parts of the world. It is printed in German, French, English, and Spanish. About 450 firms have joined in this enterprise.

The idea thus successfully carried out at Stuttgart has been partially adopted at Vienna, where the Oriental Museum deals with Eastern trade.

Belgium inaugurated a Commercial Museum at Brussels in April, 1883. This is not only a collection of Belgian industrial products, but much care has been taken in suitably classifying the samples, forwarded by Belgian consuls in all parts of the world, for the purpose of illustrating the articles capable of being imported by Belgium from various countries. The Belgian Parliament supplied the necessary funds for this undertaking.

Although not having made such an advance as Belgium in the solution of the question at issue, Italy has made progress of a satisfactory character, the Government having decided to open such institutions at Milan and Turin. The first contributions towards the Museo Commerciale Consolare were exhibited by the Minister of Agriculture at the Milan Exhibition, and at its conclusion, the claims of both Milan and Turin were brought forward in such a prominent manner that the collections were divided. Since then, the various Italian consulates have been invited to furnish articles for exhibition.

SCHOOLS OF ART.

An Exhibition, to illustrate the operations and influence of Schools of Art, will be arranged by the Science and Art Department of the Committee of Council on Education, South Kensington. It will consist of school studies, works of ornamental and decorative art produced from designs by students in schools of art, works of ornamental and decorative art, woodcuts, lithographs, and etchings designed or executed by those who have been students in schools of art.

The following particulars have been issued:—

1. My Lords consider that it will be of advantage to the art education of the country if an exhibition of works of art manufacture designed and executed by students of schools of art, be held during the present year, in connection with and forming part of the International Exhihition at South Kensington.

2. The works will consist of carvings in all materials, furniture, decorations, metal working of all kinds, jewellery, goldsmiths' work, pottery, glass, woven and printed fabrics, &c.

3. All articles exhibited must be the work of past or present students of schools of art, or executed from designs by such students, the works themselves having been executed since the year 1862. The articles must be certified by the manufacturers, by the master of the school of art in which the student has received instruction, or by the student himself. The name of the manufacturer, of the school of art, and of the student will be published.

4. The decision as to the acceptance of any work for exhibition will rest entirely with the committee of selection.

5. The works must be sent to the department on or before 31st March. They must be addressed to the secretary and accompanied by a note (written only on the first and third pages) describing them as they are meant to be inserted in the catalogue. The note should also state the names of the manufacturers,

the designers, and the artisans; the names of the schools of art attended by any of them; and the periods for which they attended. The prices of each article may be given if it be desired.

6. Every possible care will be taken of the works sent for exhibition, but the responsibility for loss or damage in transit, and during the period of the Exhibition, will rest with the exhibitor. By order, W. D. DONNELLY, Col. R.E., Assistant Secretary.

Correspondence.

MR. SWINBURN KING'S PAPER ON BOILER CORROSION.

Mr. J. H. Porter writes with reference to his remarks in the discussion, laying stress upon the fact that the modification of Dr. Clark's process, invented by him and known as the Porter-Clark process, purifies the water before it is pumped into the boiler, thereby carrying out the views of Mr. E. B. Marten, that it was better to improve the water before use than to treat it within the boiler itself. Mr. Porter quotes, from a report of Mr. Lavington Fletcher, a paragraph to the same effect. The number of boilers under the charge of the East London Water Company's engineer is 60, not 6, as given in the report. Mr. J. J. Eastick also writes to say that the view he had intended to put forward in the discussion was that the removal of scale from boiler-plates was effected by the sudden conversion of water into steam behind the scale, rather than by the decomposition of water which had soaked through the scale, and the formation thereby of hydrogen, which is supposed to force off the scale by mechanical action.

General Notes.

EXHIBITION IN URUGUAY. — An Uruguayan National Exhibition is to be opened at Montevideo, on the 19th of April, 1885. It is to be organised by the General Board of Agriculture and Immigration, and will include all sorts of foreign farming apparatus and cattle. Special importance will be attached to woods and forests, and the necessity for their cultivation. Exhibitors must be registered before March 1, 1885.

CHAMBERS OF COMMERCE IN FOREIGN COUNTRIES.—The French Consul at Mexico, M. Coutouly, has reported to his Government the acceptance by the club of French residents, of his proposal for the establishment of a local French Chamber of Commerce. A similar arrangement is projected at Guatemala. It is intended by means of such bodies to afford French agents useful guidance, and to transmit to the Home Government all information affecting French commerce and industry, as well as to elucidate questions bearing on French trade, whether local or general.

NEW TEXTILE PLANTS.—In the French journal *La Ramie*, M. Pailleux calls attention to a Japanese plant named *Kusu (Pueraria Thunbergeana)*, the roots of which contain starch, while the leaves and shoots are used as food. Its fibrous portions are adapted for use in the manufacture of cordage. It is a lofty and hardy plant, attaining within a year a height of from 12 to 25 feet. It yields fruit, and grows upon the most unfruitful dry ground where nothing else would thrive, provided there is a sufficiency of warmth. It requires no care, and can be propagated by seeds or by planting. A plant named *Kappe* was shown at last year's Amsterdam Exhibition. It is indigenous to Java, and when its fibres are carefully prepared they resemble wool, and when curled, at a moderate cost, can be used for stuffing mattresses. It can also be spun and dyed, but the fibrous appearance it retains shows that a radical improvement in the method of treating it has still to be discovered. All who examined the fibre at Amsterdam were satisfied of its contingent importance as a textile material.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock :—

MARCH 12.—"Water Regulation, in regard to Supply, Floods, Drainage, and Transit." By General RUNDALL. THOMAS SALT, M.P., will preside.

MARCH 19.—"The Elephant in Freedom and Captivity." By G. P. SANDERSON, Superintendent of Government Elephant-catching Operations in Bengal. Sir JOSEPH FAYRER, K.C.S.I , M.D., F.R.S., will preside.

MARCH 26.—"Vital Steps in Sanitary Progress." By B. W. RICHARDSON, M.D., F.R.S. Sir ROBERT RAWLINSON, C.B., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings :—

MARCH 18.—"Borneo." By B. FRANCIS COBB, Vice-President of the Society. Admiral RYDER will preside.

APRIL 1.—"The Rivers Congo and Niger entrances to Mid-Africa." By ROBERT CAPPER.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

MARCH 13.—"The Upper Thames as a Source of Water Supply." By Dr. PERCY F. FRANKLAND.

The Rt. Hon. Sir LYON PLAYFAIR, K.C.B, M.P., F.R.S., will preside.

MARCH 27.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc.

APRIL 24.—"Economic Applications of Sea weed." By EDWARD C. STANFORD, F.C.S.

INDIAN SECTION.

Friday evenings :—

MARCH 7.—"The New Bengal Rent Bill." By W. SETON-KARR. Sir GEORGE CAMPBELL, M.P., K.C.S.I., will preside.

MARCH 28.—"Trade Routes in Afghanistan." By GRIFFIN W. VYSE. LORD ABERDARE, F.R.S., will preside.

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 10...Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. M. Lupton, "Lupton Bey's Notes on the Bahr Ghazal Province, in the Soudan." 2. Mr. E. G. Ravenstein, "The Somal and Galla Countries."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. Bernard Dyer, "Some Scientific Aspects of Cheese-making."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Harrison, "London as a Historical City."

TUESDAY, MARCH 11...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Animal Heat, its Origin, Distribution, and Regulation." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. Sydney W. Barnaby's Paper, "Hydraulic-Propulsion."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. A. L. Lewis, "The Longstone and Other Prehistoric Remains in the Isle of Wight." 2. Admiral F. S. Tremlett, "The Cromlec of Er Lanic." 3. W. J. Knowles, "The Antiquity of Man in Ireland." 4. Mr. H. Prigg, "A Portion of a Human Skull of supposed Palæolithic Age from near Bury St. Edmunds."

Colonial Inst., St. James's Banqueting-hall, Regent-street, W., 8 p.m. Mr. Charles S. Dicken, "The Mineral Wealth of Queensland."

WEDNESDAY, MARCH 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Lieut.-General F. H. Rundall, "Water Regulation in Regard to Floods, Drainage, and Transit."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. 1. Professor Abbe, "The Distance of Distinct Vision." 2. Mr. T. B. Rosseter, "Further Observations on *Stephanoceros Eichhornii*."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.

College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. Clifford Allbutt, "Chapters on Visceral Neuroses." (Lecture II.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. J. Gale "American Construction."

THURSDAY, MARCH 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical and Physical Section.) Dr. Percy F. Frankland, "The Upper Thames as a Source of Water Supply."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury- circus, E.C., 7 p.m. Prof. E. Pauer, "Romanticism in Music."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. William H. Cope, "Jade—its Peculiarities and Mode of Treatment, Artistic and Mechanical, illustrated by Numerous Specimens."

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 5 p.m. Dr. Henry Veale, "Organisation and Management of Field Hospitals."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "The Older Electricity, its Phenomena and Investigators." (Lecture III.)

Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Massey, "Notes on a Train-lighting Experiment."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Professor Larmor, "The Direct Application of the Principle of Least Action to Dynamical Analogues." 2. Professor M. J. M. Hill, "The Closed Funicular Polygons, belonging to a System of Co-planor Forces, having a Single Resultant." 3. Mr. J. W. L. Glaisher, "The Square of Euler's Series." 4. Mr. J. Griffiths, "Further Results of a Theory of Transformation of Elliptic Functions."

FRIDAY, MARCH 14...United Service Inst., Whitehall-yard, 3 p.m. Capt. J. T. Bucknill, "Automatic Artillery Fire."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. J. N. Langley, "The Physiological Aspect of Mesmerism."

College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures.) Dr. Clifford Allbutt, "Chapters on Visceral Neuroses." (Lecture III.)

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C , 8 p.m. Mr. A. A. Ader, "Shakespeare's Use of Alliteration."

SATURDAY, MARCH 15...Geologists' Association, 2 p.m. Visit to the Natural History Museum under the Direction of Dr. Woodward.

Royal Institution, Albemarle-street, W., 3 p.m. Captain Abney, "Photographic Action considered as the Work of Radiation." (Lecture III.)

CORRECTION.—In the report of the Chairman's remarks in the discussion on Mr. Boulger's paper on "Chinese History" (see ante p. 301), it should have been stated that the fortifications referred to were at Woosung (col. 2, line 4); also for "Tientsin" (col. 1, line 15 from bottom) read *Chusan*.

Journal of the Society of Arts.

No. 1,634. Vol. XXXII.

FRIDAY, MARCH 14, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SOCIETY OF ARTS PRIZES.

The Council of the Society of Arts are prepared to award the following prizes in connection with the International Health Exhibition :—

John Stock Prize.

Under the John Stock Trust, a Society's Gold Medal or £20, for the best example of sanitary architectural construction, in the following classes of the Exhibition :—

Class 20.—Dwellings, models and designs for the same, and specimens of buildings erected in the grounds. Fittings and accessories for dwelling-houses. Completely-fitted apartments.

Class 28.—Materials for sanitary house construction—roofs, walls, damp-courses, solid floors, damp-proof wall-coverings, cements, &c.

Class 29.—Materials for sanitary house decoration, non-poisonous paints and wall papers, floor coverings, washable decoration, &c.

Class 30.—Objects for internal decoration and use in the dwelling. Fittings and furniture.

Class 32.—Publications and literature, models, pictures, diagrams, &c., relating to Group III.

Shaw Prize.

Under the Shaw Trust, a Society's Gold Medal or £20, for the most deserving exhibit in the following Classes :—

Class 41.—Designs and models for improvements in the arrangement and construction of workshops, especially those in which dangerous or unwholesome processes are conducted.

Class 42.—Apparatus and fittings for preventing or minimising the danger to health or life, from carrying on certain trades. Guards, screens, fans, air-jets, preservative solutions, washes, &c.

Class 43.—Objects for personal use — Mouth-pieces, spectacles, dresses, hoods, &c., for use in certain unhealthy and poisonous trades.

Class 45.—Sanitary construction and inspection of workshops, factories, and mines—(*a*) New inventions or improvements for ameliorating the condition of life of those engaged in unhealthy occupations; (*b*) means of economising human labour in various industrial operations.

North London Exhibition Prize.

Under the North London Exhibition Trust, a Society's Gold Medal or £20, for the best set of specimens illustrating the handicraft teaching in any school in the following Classes :—

Class 49.—Domestic economy and other forms of technical and industrial education for girls — (*a*) Models and apparatus for the teaching of cookery, housework, washing and ironing, needlework and embroidery, dressmaking, artificial flower - making, painting on silk, pottery, &c.; (*b*) specimens of school work.

Class 50.—Handicraft teaching in schools for boys—(*a*) Apparatus and fittings for elementary trade teaching in schools; (*b*) specimens of school work.

Fothergill Prizes.

Under the Fothergill Trust, Two Gold Medals (or two sums of £20), one for the best exhibit in Class 27, and one for the best in Class 26.

Class 27.—Fire prevention apparatus—Extincteurs, portable engines, domestic fire escapes, &c.

Class 26.—Lighting apparatus — (*a*) Electrical apparatus for illumination and domestic use, secondary batteries, electroliers, accumulators, &c.; (*b*) apparatus for lighting by gas, gas producers, gas meters, gas fittings, chandeliers, &c.; (*c*) oil and other lamps; mineral oil, wax and other candles, vegetable and animal oils.

Trevelyan Prizes.

From the Trevelyan Prize Fund, Five Gold Medals (or five sums of £20), for the best exhibit in each of the following Classes :—

Class 2.—Prepared vegetable substances used as food, including tinned, compressed and preserved fruits and vegetables. Bread, cakes, and biscuits of all kinds. Tobacco.

Class 3.—Prepared animal substances used as food in a preserved form—tinned, smoked, salted, compressed and prepared animal foods of all kinds; food produced by insects, such as honey, &c.

Class 6.—Cookery practically demonstrated.—Economical cooking, workmen's and other kitchens, cheap restaurants, bakeries, cafés, foreign cookery, &c.

Class 7.—The chemistry and physiology of food and drink. The detection of adulteration, materials used as adulterants, analyses, food constituents and equivalents, tables, diagrams, &c.

Class 11.—Apparatus and processes for conserving, storing, conveying and distributing fresh food of all kinds.

Each prize will be a Gold Medal, or the sum of £20, at the option of the recipient.

The Council propose to ask the juries in each class to recommend for their consideration either two or three exhibits which they might consider deserving a prize.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1884, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and or his other reforms in the postal system of this country, the benefit of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, in the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufectures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measure and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which, for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal servicсs rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the

University of Berlin, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture, have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and a Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce, by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

The Council invite members of the Society to forward to the Secretary, on or before the 19th of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

INDIAN SECTION.

Friday, March 7, 1884; Sir GEORGE CAMPBELL, M.P., K.C.S.I., in the chair.

The paper read was—

THE NEW BENGAL RENT BILL.

By W. S. SETON-KARR.

The subject on which I have the honour to address you this evening is wide, important, capable of consideration under various aspects, and certain to lead to much divergence of opinion. It is usual, in similar cases, for the lecturer or speaker to begin by saying that, in his treatment of the question, he will avoid all political controversy. I think it preferable to say that I shall avoid irritating remarks, or disparagement of the motives and opinions of those who have particular views, whether of the rights of the tenantry or of the position and privileges of the Zemindar; for, in truth, it is impossible to treat this subject properly without reference to its political scope and effect. Agriculture is not only a great, but it is the greatest, interest in India. A good system of revenue, rent, and tenure lies at the bottom of all its social advancement. In every one of our numerous annexations, nothing goes on at all until the claims of the Government are laid down with equity and precision. And though revenue in Bengal and Behar has long been settled on a basis accepted and well understood by the people, and although my present paper will deal with rent and occupation rather than with revenue, it is quite obvious that, unless the respective rights and claims of Zemindar and ryot are fairly adjusted, chronic warfare will not cease, and Oriental society, so far from progressing, will be threatened with something not very unlike disintegration and decay.

Now, I apprehend that most of my audience are more or less familiar with the prominent and characteristic features of the Zemindary systems of Bengal, Behar, and a small part of Orissa; therefore only a brief recapitulation of the events which have led to the present state of antagonism will be necessary. When, rather more than a century ago, the Government of the East Indies passed from the speculations of commerce to the responsibilities of empire, its administrators mostly adhered to the various systems—revenue, police, and judicial—established by their predecessors, the Mohammedan viceroys of Bengal. They were eminently cautious and conservative. The revenue was collected from various contracting parties, just as it had been by Nawabs who reigned with absolute power at Dacca or Moorshedabad. A good deal of time has been taken up in discussions whether those responsible for the collection and payment of the Government revenue were hereditary Zemindars, or mere tax collectors and farmers of the public dues. But—as any one familiar with the records and writings of the last century, especially with that storehouse of information, the Fifth Report of the House of Commons, dated 1812, will admit—the first Zemindars were of various classes. There were the heads of ancient houses, some older than the Mogul Empire itself— Bishanpore, Tikari, Bettia, Nuddea, Nattore, and others, with whom it was natural that the ruling power should contract; there were farmers who contended for the privilege of collecting the Government dues and making their own profits; there were some in whose families the office of tax gatherer had a tendency to become hereditary; there were others who contracted one year and defaulted in the next. There were, in short, ancient Rajas, Mohammedan upstarts, wily and supple Hindus, and even adventurous Englishmen of resolution, skill, and knowledge of the native character. But about the time of the great debate on paper between Shore and Lord Cornwallis, and certainly at the epoch of the Decennial Settlement, all the various parties were generally comprehended under the term Zemindars, and in the not, perhaps, scientific phraseology of the Legislature of the day, were sometimes styled landholders or proprietors of land. In considering their attributes, duties, responsibilities, and rights, it is, above all, essential to divest oneself of the idea that a landholder in Bengal corresponds to the English squire or owner in fee simple. Nothing can be further from the truth. And, indeed, this attempted analogy, arising out of loose language, misleading translations, and forcible introduction of the English law of real property, though productive of some confusion and error, has long been abandoned by all but a very few, and forms no part of the Zemindars' case. Doubtless, on the other hand, the Zemindar of Bengal, whether he owns a whole *chuckla*, two or three pergunnahs, or is a Talukdar with only a couple of villages, always enjoys certain rights and privileges which give him much importance, which it is not easy to formulate or define, and which rest partly on legislative enactment, partly on judicial decision, but most on the custom and common law of the country. He is, in one sense, the owner of an estate, but that estate means technically nothing more than a certain area of the land of Bengal on which is assessed a fixed portion of the Government revenue. As responsible for that portion of revenue, the Zemindar has certain clear rights over the whole area. He can establish or induct ryots into any part of it, or he may cultivate the land by his own hired servants. His dues may be collected from the cultivated land, as well as from the swamp and the jungle. He has rights in fishing, in the natural products of the forest, in honey, wax, wild fruits, and timber. He can vary the rent claimable from each cultivator according to the character of the cultivation, and no one ever, in theory at least, disputes the Zemindars' claim to a far higher rate for sugar-cane, tobacco, garden or homestead, than for early or late rice. All lands or plots vacated by ryots, owing to death or desertion, revert, *ipso facto*, to the Zemindar. He can assign the vacant homestead to a new ryot; can establish new villages; found new bazaars, or *hauts;* cut roads, drain swamps, and dig splendid reservoirs. The theory which regulates all these acts of lordship is not, I hold, that the soil belongs to him, but that these successive operations tend either to increase or to diminish the rent-paying power of the land; and as rent must be the basis of land-revenue, no one but the Zemindar has the right to say how fresh land is to be taken up, and by what ryots; under what terms the waste or jungle is to be reclaimed; to what extent the existing acreage of rent may be diminished in order to supply the general community with such solid benefits as a road from one cluster of populous villages to a crowded bazaar; or a tank of pure water, a quarter of a mile in length and some thirty feet in depth. Time prevents me from pursuing this topic further, or proving my position, as I might do, by judicial record, by the testimony of experts, or by the writings and opinions of officials who have made the Zemindary system the study of a life.

A similar brief sketch must be given of the rights and titles of the ryot. It is useless, for any legislative or practical purpose, to inquire at what period, or under what political convulsions, those village communities, so familiar to us elsewhere in India and so admirably illustrated and expounded by Sir Henry Maine, disappeared from off the face of Bengal and Behar. No doubt acute writers may find traces of this system in the tendency of men of one caste, or one religion, to occupy whole villages, or particular *mahallas* or quarters of villages. Fishermen in one tract; outcasts or *chandals* in another; Brahmins in a third; Mussulmans in a fourth—are instances familiar to every district officer. But liability to Government in Bengal and Behar never goes beyond the liability of the Hindu family of cultivators, while undivided in mess and estate, for the rent of their holding. We must take, then, the ryot as an individual, one of a cultivating class, but not one of a coparcenary community. If the Zemindar had his privileges, his prestige, his legal and equitable rights, and his able partisans, the ryot has had also his friends and defenders, the custom of centuries to back him, the practical connection with the soil which revolution could not alter, which high-handed oppression could not terminate, which legislative enactment did not fail to recognise, and which statesmen, from Shore and Cornwallis down to Canning, Grant, Lawrence, Campbell, and Eden, have exerted themselves to maintain and protect. To quote one sentence from the Legislature of 1793, which has been referred to scores of times since this agitation began, the Governor-General, Lord Cornwallis, reserved for himself and his successors the right "to enact such regulations as he may think necessary for the protection and welfare of the dependent Talukdars, ryots, and other cultivators of the soil." A *jotedar*, or proprietary tenant, in early days, depended for security, freedom from annoyance and oppression, no doubt quite as much on the character of the Zemindar and his agents, as on the protection of the English executive authority or the safeguards created in his favour by the law. He was liable, as we have seen, to rates of rent which rose with the character of his produce. His plot might be measured at any time by his Zemindar, who could resort to this operation without recourse to any Court. He might be bullied by the Amin, harassed by collecting agents, called on to contribute extra cesses to the extravagance or necessities of the Zemindar who had lost a big law suit, married an eldest son, dedicated a temple, or received a title from the hands of Government. But no superior landlord dictated to him about the rotation of crops, if such an agricultural operation was thought of, or required him to erect fences or little embankments, and keep them in repair. There were no conditions as to repairs or alterations in buildings. The ryot built his house of bamboo posts, wattles, and thatch of grass or reeds, and carried it off bodily or sold it, if he thought of changing his village. If his holding was too big to manage, or if he rose from the status of a *jotedar* to something resembling a dependent Talukdar, he could sub-let any portion, without asking any one's leave, to cultivating sub-tenants. Indeed, this authority was tacitly recognised in his *potta* or title-deed of occupancy, whereby he bound himself to urge no plea of abatement on account of death or desertion. And while no interference with any one agricultural operation was ever attempted by any Zemindar, the ryot had two safe-guards and two proofs of some distinct proprietorship, which, in this discussion, can never be put aside. In the first place, for nearly one century in Bengal Proper, no enhancement of rent has been possible without resort to the Courts. The judicial rent, so familiar to us from recent Irish legislation, has prevailed more or less in the Lower Provinces since the days of Lord Cornwallis, and long before Act X. A high-handed Zemindar, or a lessee of some thirty villages under such a Zemindar, has doubtless often claimed extra payments, as I have explained, known as *abwabs;* but for the additions to the *jumma*, or rent proper, as it is termed, there is nothing for it but taking the recusant ryot into Court. Sometimes a prominent and wealthy ryot is selected, and sometimes it is necessary for the landholder to dragoon half a village in succession, through three Civil Courts. This fact alone, so patent, so universal, so clearly recognised by every class connected with the land, either as Zemindar, dependent Talukdar, substantial tenant-proprietor, or sub-cultivator, ought to dispose of the last shred of argument in favour of the absolute, unqualified dominion in the land, ever claimed for the superior holder. The second safe-guard is, perhaps, less known and it is very often disputed, but it is none the less capable of satisfactory legal and authoritative proof. It is that the *jote* of the ryot has a distinct marketable value, and is absolutely essential to the performance of certain acts, or to the appropriation of lands to some one specified use. For instance, a rich Zemindar wants a piece of land on which to erect a temple, or a summer or garden house, or a *kucherry* for himself and his agents. If there is a vacant plot within his Zemindary, he can appropriate it to this object. But if there is none such vacant or suitable, the Zemindar is compelled by custom having the force of law, to get a piece of land by assignment from one of his own ryots. And any district officer conversant with his business and the people will give you scores of instances of this practice. I will go further, and say that it is not only usual for a Zemindar to become his own ryot as it were, or to take an assignment of land from one of his own tenants for a practical, beneficent, or philanthropic purpose; but it is quite as common for a Zemindar, for purposes of annoyance or revenge, to gain a footing in the Zemindary of a rival by an exactly similar process. If a ryot is unable to stand the oppression of his own Zemindar, he often surrenders his holding to the neighbouring Zemindar, who will be quite able and willing to fight the ryot's battle for him; and I have known instances in which an able and unscrupulous landowner, having gained a footing in the estate of a rival in this way, has ended by purchasing, annexing, or in some way, legal or illegal, appropriating all the similar and all the superior rights, and ousting his rival from the complete estate. Ryotty tenures, again, are often put up to public auction, in execution of decrees, and sold for what they are worth. They are also disposed of privately, though I own that the power of a ryot to sell or convey away his tenure, without first obtaining the leave of the Zemindar, is constantly called in question, and is just one of those points on which much diversity of opinion exists in different localities. But still, as a fact, the sale does often take place, whether the power to sell be recognised or denied; and at any rate the ryot, it has been legally settled as a rule, holds by custom and not by contract. His rent cannot be varied except by formal suit and judicial decision. His *jote* is something so tangible, so valuable, so necessary for those who wish to deal practically with the soil, that it becomes an object for competing Zemindars, and is recognised as a separate asset under the decrees of Courts.

Such is just an outline of the position of Zemindar and ryot since the legislation of 1793, and I have not time to support and illustrate my position by a review of the various laws, limiting, expounding, or defining the power of the Zemindar between that legislation and the era of Lord Canning, to show how the recovery of rent was facilitated to the Zemindar, in 1799, by power to distrain crops, with certain reservations to the ryot, and to bring summary suits before the Revenue authorities; to explain why Zemindar was, for years, prevented from giving leases of large tracts for more than certain periods; to show how the partition of estates, under the Hindu law of inheritance, had to be jealously watched and circumscribed, in order to prevent detriment and loss to the Government revenue; or to enter on the vast and fertile subject of the resumption of invalid rent-free tenures, which caused such agitation between the years 1828 and 1840.

It is sufficient to say that while the interests of the ryots was often obscured and neglected, they were never wholly lost sight of before the law of 1859, which, in spite of the distraction caused by the Sepoy revolt, the Government of Lord Canning found time to pass, and which, for some years at least, was deemed to have secured the position of the ryot, and to have redeemed the pledges recorded by Lord Cornwallis in 1793. To three important provisions of that celebrated statute I need only just allude. It recognised the permanent occupancy of a ryot who had cultivated land for twelve years, and secured him or his successors against eviction. It protected him from judicial enhancement, unless he was paying a less rent than the same class of ryots in his neighbourhood, or unless the productive powers of the soil had been increased otherwise than by his agency, or unless he held more land than his deeds could cover; and it supplied him with other securities against oppression and extortion, while it defined more strictly the acknowledged position and superior claims of the Zemindar. For some years things went much better. The ryot began to understand what the law gave him. The well-known rent case of the High Court of 1865 still further elucidated the Act. But, about the year 1873 matters altered. Agrarian disturbances, as they are called, were frequent. In some places Zemindars could not collect their lawful dues. In others their extra cesses were intolerable. Ryots learned the art of combination. It became clear, after divers attempts to cope with the difficulty, that something must be attempted on a larger scale. A Rent Commission, composed of some very able gentlemen, English and native, was appointed. Their labours resulted in a report. The report was followed by an exhaustive correspondence of the Government of Bengal, and by the draft of a new rent law, which was followed by another draft from the hand of Mr. Ilbert, the legal member of council; and this brings me, not *per saltum* but by short steps, to the important part of my address, the Tenancy Bill for Bengal. Some previous acquaintance with my whole subject, the perusal and reperusal of the Fifth Report of the House of Commons, a careful study of the recent Blue-books published by the Government of Bengal and the Government of India, to say nothing of a large quantity of independent literature, in magazines, and reviews, and unpublished documents, have quite satisfied me that Lord Ripon's Government had no option in the matter. It was not a case of deferring legislation to some distant season, or for hoping that the agricultural agitation would subside owing to the spread of education, the weight of judicial decisions, the increased power of an active executive, or any other plausible reason for putting off till to-morrow which ought to be done to-day. Very likely the draft Act has excited active opposition, has offended the feelings of a powerful class, and may call forth, even from those most qualified to judge fairly, a wide diversity of opinion. But after nine years of disturbance, copious reports, and the concurrent testimony of some of the ablest administrators, there was nothing for it but fresh legislation. A Government which has always boasted of its anxiety for the welfare of the speechless part of the native community, would have failed in its first duty, had it not tried to grapple with this intricate, this controverted problem, the rents and tenures of Bengal and Behar.

So now to the specific measures proposed for the relief of the ryot, and, to a certain extent also, in the interest of the Zemindar. I have sometimes thought whether the Bill, with its seventeen chapters, two hundred and thirty sections, besides schedules and appendices, might not be too comprehensive; whether the object in view could not have been obtained by re-casting and improving Act X of 1859. Intelligent natives are perplexed and harassed by our ceaseless flow of legislation. I remember a Bengal Zemindar of large estates and conspicuous ability, whose outlay for stamps used in litigation and agricultural business averaged £7,000 per annum, telling me that he and his agents were perfectly bewildered by supplementary, amending, and explanatory laws. The scope and object of one, and its main sections and clauses, had only just been mastered, when they were ruthlessly swept away. Yet when I recollect that the Rent Commissioners, the late Lieutenant-Governor of Bengal, and the Viceroy and his Council are all in favour of one new comprehensive enactment, I waive my own objections, even though I am aware that the new Bill consigns to oblivion many of the best known Regulations and Acts well understood by the Zemindar, not too complicated for the tenantry, and endeared by long practice to the official mind. The main subjects dealt with by the new Bill are:—

1. The distinction between land known as *khamar*, or *nij*, and that known as ryotty; or, in loose English language, the land cultivated by the superior landlord as a home-farm, and the land given over to ryots who pay him rent. In the times of the Tudors the *khamar* would have been known as demesne lands.*

2. The limitation on the power of the Zemindar to enhance his ryot's rent.

3. The acquisition and the incidence of the right of occupancy by ryots.

4. The treatment of sub-ryots, or other ryots not hitherto having an occupancy right.

5. The framing of tables of Pergunnah rates all over the country, to serve as a guide to the Civil Courts or to supersede or anticipate their action altogether.

6. The sale of ryotty or occupancy holdings, or sub-tenures.

There are divers other provisions for the issue of processes, the payment of rent at proper times of the year, the distraint of standing crops, the correct keeping of accounts, the delivery of receipts for rent, and the powers of the Courts, which, however important, are not so radical or essential. I have only time to allude to these latter in one lump.

The distinctions between *khamar* or home-farm and ryotty land has long been familar to all residents in the interior. Indigo planters, in most factories, have always had a quantity of the former land, which they cultivated with their own servants, bullocks, and ploughs. Many of the Zemindars do the same. According to my experience, the cultivation of the *khamar* land was generally slovenly; the various operations of ploughing, harrowing, weeding, and watching, was carelessly performed; and the result was far inferior, as regards the crop, to what would be attained by a Kaivert, a Kopali, a Pode, a Teor, or any one of the Hindu agricultural castes. Still, variety in cultivation and tenure has not been without its uses. There is always a chance that some energetic Talukdar, or it may be an Englishman, may arise and set the fashion of a more careful agriculture; that he might try new kinds of produce, or get greater returns from such valuable crops as *pan*, sugar-cane, tobacco, jute, and others. I cannot say that I recollect more than two or three instances of this improved or model cultivation on the part of Bengali Zemindars. But still it is not desirable to exclude the possibility of the appearance, among the Zemindars and Talukdars of Bengal, of some wealthy magnate, who, like Lord Tennyson's agricultural Baronet, should be—

> "A breeder of fat oxen and fat sheep,
> A pamphleteer on guano and on grain,
> A patron of some thirty charities."

I see no great harm in the provision for effecting a survey and register of these *khamar* lands in the collectorate. The plan was once proposed by Sir J. P. Grant. I myself introduced a Bill for the purpose, in the year 1861, and I note especially that, in Behar, Zemindars, for some years past, have been in the habit of converting large stretches of ryotty into *khamar*, and annexing them to the indigo factories. But I gathered from one of the discussions on this subject that it was proposed to compel the Zemindar who became possessed of a ryotty tenure, vacated for some cause or other, to settle some other tenant upon the land. He (the Zemindar) was

* See an excellent article on this subject in the *Quarterly Review* for January last.

not allowed to use it for his home farm, or to convert it into a garden, or otherwise to keep it for his own enjoyment. Whatever may be the danger against which the authorities wish to guard, I sincerely trust that no such compulsory clause will be inserted or retained. Let the occupancy, hereditary, *khoodkhast*, *chapparband*, or *kadimi* ryots have what security of tenure you think fit, but avoid these despotic and obligatory clauses. Tyrannical or unfair appropriation of ryotty lands by wholesale ought to be met in divers other ways. And even in Behar, where this plea of wholesale usurpation is most pleaded as a reason, it is stated that three-fourths of the land are still held under occupancy tenures. If land does revert to the Zemindars by death, flight, or failure of heirs, as I have always maintained it must do by the common law of the country, the Zemindar ought to be left to deal with each plot as he thinks fit. There should be no legal interference with what has long been recognised as an hereditary privilege of the superior landlord. Otherwise, for a small object in favour of the ryot, you present the Zemindar with a tangible grievance. Mr. Ilbert says distinctly, in his reasons and objects, "that the existing stock of *khamar* land cannot hereafter be increased." But suppose large tracts to be laid desolate and drained of inhabitants, by an epidemic, a famine, or an inundation, or the jungle and swamp to be reclaimable, surely it is not politic or equitable to say that no Zemindar or landlord shall appropriate any portion of such tract for his own *khamar* land and cultivate it, if he likes, as what we should call a home farm.

The next point is the limitation of the Zemindar's power of enhancing rent, and I will consider this in connection with the equally important matter of the preparation of tables of Pergunnah rates. As usual, in our Anglo-Indian administration, the venue and jurisdiction of suits for rent and enhancement has been repeatedly shifted. Sometimes the duty has been divided between the Revenue and the Civil Courts, that is between the Courts of the Collector and his deputies, and those of the Native Subordinate and the English Civil Judges. But, in truth, Courts of any kind, however admirable, are not the best sort of machinery for ascertaining generally the qualities of the soil, the varieties of the produce, and the increase in the productive powers of the land, whether due to the ability of the cultivator or to great social or economic causes. The best plan for the ascertainment of the customary or local rate would be to entrust the inquiry to a Revenue or a special Commission. I have seen it stated that Pergunnah rates are not now ascertainable. Within my own experience of twenty years ago, they were not only ascertainable but ascertained. In the districts with which I was practically most familiar, Jessore, Pubna, and the Twenty-four Pergunnahs, and other metropolitan districts, these rates varied slightly in each Pergunnah, were perfectly well known, and could be got at with comparatively little trouble. Major Ralph Smith got them in his report on the Twenty-four Pergunnahs, and so has Mr. W. W. Hunter. I cannot but think that resolute and intelligent officers, conversant with the people and going about the country in camp and on circuit, could easily make out tables of rates for rice, garden, homestead, sugar-cane, jute, &c., in several of the largest districts. And even if they did not exist everywhere, or were fluctuating and uncertain, it would be quite possible to take districts in which they had not been obliterated as guides and types for the others. Many a retired civilian, when he reads of these agrarian quarrels, would, I believe, wish himself thirty years younger, in order that he might have the chance of spending the cold season on such a special duty. Also I entirely approve of the provisions whereby a ryot, subjected to a suit for enhancement, shall not be liable to be sued again on the same account for a period of ten, twenty, or even thirty years. It is intolerable to think that a substantial tenant-proprietor, to whom, as a class, is owing all the wealth and diversity of cultivation in Bengal, should, after going through an ordeal of two or three Courts in the year 1884, be again subjected to the same annoying and expensive process, at the caprice of the Zemindar and his agents, in the year 1887. It is also perfectly equitable and proper to fix a reasonable rate of enhancement beyond which no Court shall go. In the end this will save all parties a deal of trouble, and the Pergunnah rates would be guides and aids to the Civil Courts.

The subject of Permanent occupancy is a more difficult, a more perplexing, and yet a very essential part of the Rent Law. The law of 1859 fixed twelve years as the period which entitled a ryot to consider himself immovable as long as he paid his rent. I shall not stop to discuss at length whether the legislators of that day conferred a new status on the twelve-year tenant, or only stereotyped the already existing customs and ideas. My own deliberate opinion is, that Act X, in this respect, was in full conformity with the experience and the just expectations of a large class of ryots, and with a correct appreciation of revenue, rent, agriculture, and social life. But it has been found that Zemindars and their agents have resorted to various expedients in order to defeat this law. They shift their tenants from one plot to another just before the twelve years expire. They get the ryot to contract himself out of his rights, and they resort to various artifices well known to collectors and magistrates. It was at one time proposed to reduce the limit still more in favour of the tenants, by cutting it down to three years. But at present it is proposed to retain the older and higher limit, and to stipulate that any resident ryot holding any plot or plots in any village, whether he has been shifted or not, shall acquire this occupancy right. I could wish that the Government of India had adopted the test of distance suggested by the Government of Bengal, and required the plots so held to be within two miles, or one *kos*, of the ryot's residence. With regard to other ryots and to sub-tenants — that is to say, the ryots of the ryot—I agree with a remark of one of the district officers consulted, that the less we try and legislate for this particular class the better. The object of the paternal care of the Government should be the well-known *jotedar* or tenant proprietor, who resides in his ancestral home, who owns a tract of fifty, thirty, or twenty acres, and who occasionally, by holding an entire village, rises almost to the dignity of a sub-tenure. Let him sub-let his land to the cultivating or labouring classes who are variously termed *shikmi*, *korfa* or *koljana* tenants. Let such come and go, like the men in Lord Tennyson's "Brook," as in a fluctuating and populous community is natural and right. If they manage to acquire occupancy rights under the broad law which you are about to lay down, they will do so by the action of national causes, which you ought not either to hinder or to accelerate. I should despair of providing for all contingencies, or embracing all classes and all agricultural rights by a code which would be in advance of the needs or capacities of the community.

Lastly, comes the free sale of these occupancy rights, to whomsoever they may belong. Less has been made of this part of the subject in the report of such sterling ability than might have been expected. I mean by this, that I find little or no mention in this voluminous official literature of the practice whereby an over-reaching Zemindar buys up the *jote* or tenant-right within his own estate, or in that of his adversary. It is true that the practice and legality of such sales is constantly questioned and discussed; but my own conclusion is that, whether the Zemindar liked it or not, whether he was too weak or too careless to interfere effectively, tenures were sold by private bargain, were made over by private arrangement, were put up to auction by Civil Courts, and possessed a sort of marketable value all over the country. It is not necessary to say more on this head, than that the Nazir of any Civil Court puts up to public auction every day the *jumma* of Thakur Dass Mandal, in the village of Gharibpur, being ten rupees nine *annas* and four *pie*, at the suit and decree of Baboo Kalachand Dutt. But while the draft Act proposes to recognise this practice authoritatively, it takes no notice of the other practice I have alluded to, by which a powerful Zemindar buys up two or three *jummas* or *jotes* in a neighbouring Zemindary, and ends, as I said at the commencement of the lecture, in getting a firm grip of the whole estate. Neither does it cope with that prominent and glaring evil so familiar to district officers, namely, the acquirement of the tenure by a powerful litigant in the name of some one else, usually a dependent or mere man of straw. It is called *benami* in Bengal and *ism-farzi* in Upper India. It is productive of more confusion, antagonism, and annoyance than any other bad agrarian device that I can recall. Admistrators have deplored it. Civil Courts have tolerated it. Legislators have tried to grapple with it. The remedy that I have always proposed is, that no person should be entitled to plead in any Court of the country, or in pursuance or defence of any right whatever, that he is the real and legal owner of what is put forward ostensibly in another's name. He ought to be bound to register his own purchase or possession in his own name.

The above are the main provisions of the Bill to which I think it desirable to draw your attention, and to some of which I should be prepared to give support. There are others which I think uncalled for and unpolitic. It was a mistake, as one of the native members of the Viceroy's Council pointed out, to drag into the Bill such a phrase as "compensation for disturbance or for improvements." These are terms drawn from the Irish Land Act, and the very phrase, "compensation for improvement," seems to me to be based on a very erroneous apprehension of the relations to each other of the rent payer and the rent receiver. Nothing in all this long history is better understood practically in Bengal then the course of agriculture, the foundation of new villages, the draining of swamps, the reclamation of lands covered with brushwood, grass, and jungle. All provisions for the landlords requiring improvement, and calling on the ryots to make them, are quite foreign to the state of rural society. As I have said already, the landlord may be left to drain the morass, to cut the canal that lets out the water of the great Hanspukria mere, to build the temple, to make the bathing ghaut, and to establish the new bazaar. The ryot, with his own plough and his own capital, plants his date garden, turns the swamp into rice land, and the rice field into garden land, without the aid of the legislature or the Zemindar.

I do not wish to apply harsh terms to those who drafted or amended this part of the Bill on its original lines; but the sections 126 to 132 really, to my mind, evince a complete ignorance of the kind of improvements on a large scale which a Zemindar has been in the habit of encouraging or carrying out himself, and of the uses to which the substantial ryot puts his ploughs and his two or three pairs of bullocks, his manual labour by *dao* and *kodali*, on the house and the land which he is accustomed to call his own. Neither do the authors of these provisions appear to have dreamt of the delicate questions which will infallibly arise out of the proviso that a ryot may make certain improvements, and if he refuses, that the Zemindar may come in and make them himself. It is easy to imagine cases in which the opening of a Mahommedan burial-ground, the building of a Mahommedan mosque, the erection of a Hindoo temple or a serai, might afford endless opportunities of collision between Zemindars and ryots of opposite religions. The common law and practice of the country is quite sufficient to meet these contingencies, and both parties may be perfectly well left to make their own arrangements on all these matters, subject, as a last resort, to the ordinary tribunals. These schemes, which seem designed to foster village fights, caste rivalries, and endless litigation, can only be compared to Cloud-Cuckoo city in the play so well illustrated recently by a body of Cambridge undergraduates, out of which indistinct atmosphere they ought never to have emerged.

In discussing the Permanent Settlement of Bengal, we are somewhat apt to lose sight of the fact that this Permanent Settlement was extended, in the year 1795, to the important province of Benares. Yet we do not hear in that quarter of these disturbances, or of the necessity for the revision of Regulations I. and II. of that year. I have no practical knowledge of the working of the system in Benares; and, in reference to the laws in question, I perceive that the Bengal Settlement was introduced there with certain modifications. The rights of the village Zemindars, who, of course, are very different persons from the large Zemindars of Bengal, were ascertained and defined. Some of them, when dispossessed, were reinstated. The Puttidars, or co-parceners, descended from the same common stock, were allowed to establish their rights. Care was evidently taken that the more powerful Talukdars, corresponding to the Zemindars of Bengal, should not override the rights of the village proprietors; and, somehow, difficulties were obviated or anticipated. This may have been owing to the greater experience of the British authorities; or to the sturdier character of the ryots in Benares, Ghazipore, and Juanpore; or, as I have heard from a civilian of great Revenue experience, now deceased, owing to the fact that the Resident at Benares, Mr. Jonathan Duncan or his successor, went in, under the Perpetual Settlement, as it were, and secured the rights of the inferior proprietors, or to some other cause. But there is the fact that we have no disturbances in Benares; and I do not exactly see why what has been done for the tenant in one province may not be done in another.

I understand, however, that the present Lieut.-Governor of Bengal is in favour of a general cadastral survey and record of all holdings whatever, all over the Lower Provinces. To this I would reply that this greater proposal comes too late; that it would only be accomplished by an enormous and an incommensurate expenditure; that it would excite violent passions, and probably cause grave outrages in many districts; and that the object contemplated ought to be attainable by other less expensive and less harassing modes. In short, if I could offer a word of advice to intending legislators on this tremendous subject, it would be couched in the following terms:—"Beware of attempting too much, or trusting that all difficulties will disappear before the serried array of sections and clauses. The more minute your provisions, the greater the opportunities for craft and cunning to evade the law, or turn what is meant for the ryot's advantage to his detriment and loss. It is the story of the old usurer in Horace:—

> "Scribe decem a Nerio: non est satis, adde Cicutæ
> Nodosi tabulas centum: mille adde catenas;
> Effugiet tamen hæc . . . . vincula Proteus."

I purposely omit the offensive epithet that would complete the line. Grapple, I would say, with the most prominent of the evils brought to light in this interminable discussion. Make Zemindars register their *khamar* or *nij* lands, but allow the same to be increased or diminished by natural causes, and without interference or compulsion; surround the substantial tenant-proprietor, who has done so much at his own expense for higher cultivation, with all reasonable security for his possession, and guarantee him against vexatious enhancement at recurring intervals. Leave the sub-ryots entirely alone. Do not attempt to prescribe to either Zemindar or *jotedar* the limits or the terms of their respective improvements, whether affecting the course of agriculture, or the erection of houses, or the general convenience of the community. Be satisfied with legislation on broad lines and on existing customs, and give to Magistrates, not Collectors, a power to award a summary and reasonable compensation to any ryot who has been forced to pay extra harassing cesses, however dignified by precedent or tradition. But take nothing from the Zemindar of manorial right, equitable privilege, or ancient custom, which the Perpetual Settlement gave him, or which, however feudal in it its character, is not absolutely inconsistent with the well-being of a proprietary class of tenants. Remember that the Zemindary system of Bengal, at various times, has stood a severe strain, and has not failed. In the trying time of the Mutiny, the revolted Sepoys in Eastern and Central Bengal melted away before the impassive demeanour and, in some cases, the active loyalty of the Zemindars; and the same class in times of scarcity and famine, have not been unmindful of their duty to a starving an enfeebled population. Record the Pergunnah Rates, and be not discouraged by any assertions that such cannot be traced. If in any one district they are difficult of ascertainment, then let the State step in and create the precedent which its officers cannot find. By this and similar means may this long standing controversy be mitigated, if not concluded, and the proposed legislation, shorn of its excrescences, tempered by reason, and possibly aided by compromise, may be accepted as a relief or a boon by the Zemindar, while it will conduce at the same time to the consolidation of a valuable class of existing peasant proprietors, as well as to the honour and credit of the British name in India."

DISCUSSION.

Rajah Rampal Sing said he had heard the paper with much pleasure; but, although it was very able and instructive, he feared those who were not well acquainted with the circumstances of India, and especially of Bengal, would not thoroughly understand the subject. He had the honour of representing the poor tenants of Bengal, and would endeavour to put their case before the meeting. It was the case in India, as all over the world, that the conquerors of the country had secured the land to themselves, and the tenants' interests were but little considered. He was not speaking in any way as a party man, for he was himself a landlord, having about 200,000 people on his estates, and he would therefore be affected by the new law; but he knew that unless the poorer people were protected, India could never prosper. He maintained that the passing of this Bill was not in any way inconsistent with the terms of the Settlement made by Lord Cornwallis, because he reserved to himself and his successors the right of making improvements or alterations if it should be found necessary, and since the state of India had improved, the terms of the Settlement might properly be changed. The tenants of Bengal had, at present, in reality no rights; the landlords exercised almost despotic power, and rack-rented them to an extent. By passing this law, the Government would not only secure the comfort of the tenants, but also the interest of the landlords, because, selfish as they were, they ignored their own interests. The tenants, at present, having no security, had no inducement to improve the land, and if there seemed no likelihood of a good crop, they would go away, and thus the landlord, in the end, suffered loss. With a permanent occupancy the land would be improved, and the landlord would be sure of getting his rent.

Mr. Robert Cust had been very much pleased with the paper, particularly as he knew that Mr. Seton-Karr had not only had a quarter of a century's experience amongst the people whose condition he had described, but had also conscientiously perused all the papers connected with the subject. He was glad to say that he agreed with the conclusions he had arrived at, and coming from the North-West Provinces he, perhaps, looked at the question more impartially, as an outsider. It was perfectly true that this Bill had not been introduced unnecessarily. In some respects the Zemindars, perhaps, were hardly used, in limiting their demesne land, but, on the whole, he must say he was an uncompromising advocate of the tenant; and should not be worthy of being a disciple of Lord Lawrence if he were not. His own training and experience had brought him to the firm conviction that the welfare of India depended on the Government supporting the masses, who cultivated the land. It was rather remarkable that, in Benares, there had always been quiet and contentment, while in Behar, an adjoining province, there had been so much trouble, the two provinces being almost precisely similar both in the character of the population and in the soil, and both being under the permanent Settlement. The Benares Settlement was made by Jonathan Duncan, two years after the Settlement of Bengal, and was almost identical with it. The reason for the difference was simply this; that forty years after that Settlement the Government of the North-West Provinces went boldly in and made a sub-settlement, by which not only the rights of the superior landlord, but also of the occupying tenants, were safe-guarded; and that was found to be good for both landlord and tenant. He could see no solution for the difficulty in Bengal except by doing something of the same kind; half the expense to be paid by the landlords, and half by the State. He said this all the more freely because he was sorry to see that in Calcutta two parties who had recently been in open controversy with each other on another question were now united in opposing this measure. He would remind his hearers that, when Herod and Pilate became friends, it was to do an act of injustice.

Mr. LETHBRIDGE said he had followed the paper closely, and had learnt much from it, and with most of the conclusions he agreed, but on others he ventured, with some diffidence, to differ from Mr. Seton-Karr. He had said that in his opinion Lord Ripon's Government had no option but to proceed with this legislation, and he expected to hear some very good reasons for that statement, but the only one adduced was, that there had been nine years' disturbance, with copious official reports, together with the opinions of some of the superior officers of the Government. With regard to the nine years' disturbance, he had, during part of that time, been resident in the centre of Bengal, and since he left the Kishnagur district, he carefully followed the current politics of every part of the province. He was acquainted with the incident of the Pugna riots and some other disturbances, but so far as the whole of one part of Bengal was concerned, he believed it was acknowledged by everyone acquainted with the province that, so far from disturbances having occurred through the oppression of the ryot by the Zemindar, the fact was quite the contrary, and the Zemindars had not been able to obtain their own rights from the ryots. He did not think there was anything which could be called a serious disturbance ever heard of in that part of Bengal. In Behar, which was generally supposed to call for this legislation most strongly, for a considerable part of the nine years referred to, a large quantity of land had been under the direct management of the Government, owing to long minorities, and it was stated by the Zemindars, especially the Maharajah of Durbungah, after the estate had been many years under the management of the Government, that whatever had grown up in the course of time to which objection might be taken, they had been started or followed by the Government officials who had charge of the land. The early part of the paper, which was purely historical, seemed to be mainly of academical interest, as connected with the Land Bill, and the most important part contained in it was the statement that a great mistake was often made in supposing the rights of the Zemindar corresponded in any degree to the rights of an English freeholder. He was not prepared to dispute that, because there were certain rights which attached to a landowner in England which a Zemindar had possibly never possessed; but on the other hand, there were rights which had been possessed before the permanent settlement by the Bengal Zemindar, that no English landowner ever possessed since the feudal times. Up to the permanent settlement, the Zemindar had rights of police, and could try offenders summarily. That was quite sufficient to show that these rights were not coterminous, but it did not follow that one right was not as great as another, and it seemed to him that the historical rights of the Bengal Zemindar were as large, if not larger, than those of any landowner in England. With regard to the rights of the ryot, there was very little said from which anyone need dissent. Mr. Seton-Karr had swept away the fallacy, which had been put forward of late, that there was any trace to be discovered in Bengal of the old village system, and, therefore, it was absurd to talk of going back to the rights of the ryot, or any other persons' rights at the time when that village system existed. He was glad to hear the reader of the paper deal with such force with the monstrous proposals of the present Government with regard to the khamar rights of the landlord. It seemed to be interfering almost with the fundamental notions of property of any sort, to tell the nominal owner of land that he could not take land into his own hands and cultivate it. That he should have his khamar surveyed at his own cost seemed to him to be grossly unjust in every way.

Sir JAMES CAIRD said he would not have presumed to take any part in the discussion, seeing so many gentlemen of much greater experience of India present, but he was glad to bear testimony to the great value of the paper, and he thoroughly agreed with Mr. Seton-Karr that the question had come to the front in such a fashion as to be impossible to be resisted. When in India, as a member of the Famine Commission, he found when they came to Bengal that at that time this question was of most pressing importance. They made many inquiries on the subject, and came to the conclusion that legislation was necessary. He was also glad to hear from Mr. Seton-Karr that the Cornwallis Settlement not only gave certain rights to the Zemindar, but reserved the power to the Government at any time when necessary to protect the rights of the ryot. What was the cause of this question coming to the front so prominently? It was simply that in the rich provinces of Bengal, where the population had increased so greatly, and where five-sixths of the people were entirely dependent on the land, the competition for land had become so excessive, and the temptation, therefore, to raise rent upon the small cultivator was so great, that it had been necessary for the Government to come forward to protect the interests of the cultivators. He regretted to hear that Mr. Seton-Karr thought it desirable to except the sub-tenants, the very men who it seemed to him were most helpless, and that he reserved his sympathies for those who were better able to take care of themselves. What a picture did Mr. Seton-Karr draw of the Zemindar? He described them to be bad cultivators—the crops they produced were not comparable to those of the small tenants who surrounded them, and yet he seemed surprised that any law should be passed to prevent these men having greater facilities for acquiring an additional extent of land. He did not see why any man who could afford it should not buy land, but it was undesirable for India, where people were pressing on the means of subsistence, that the land should fall into the hands of those who had proved unable to make a good use of it. The excessive pressure of the population of Bengal should be considered; about fifty millions out of the total of sixty, were entirely depeudent on the cultivation of the land, and of those fifty millions nearly two-thirds occupied from two to three acres a-piece. They were the very smallest cultivators, the very people over whom he was sorry to say Mr. Seton-Karr had not extended the ægis of his protection. He trusted that all-important point would be kept in view. A few nights ago he had the pleasure of sitting next to M. Clemenceau, and on inquiring about the small occupying owners in France, he was glad to hear that, notwithstanding the law of sub-division of land there, the plots were not becoming too small, because very often the cultivating occupier had as a neighbour an owner who was not a cultivator, and from whom he hired the land, and by great thrift and frugality acquired the means of gradually buying out his neighbour, and in that way keeping a workable extent of land. The result was, as M Clemenceau assured him, that these small cultivating owners were doing well. He should be glad to see something of the same system adopted in India—to see the small men there becoming owners of their own land, and independent of the Zemindar altogether.

Mr. Maclean said this was a very difficult subject, and he having no practical acquaintance with Bengal, should not have ventured to address the meeting, but for one circumstance. He had taken considerable interest in the subject, having had to discuss Indian affairs for many years past, and he thought one of the great evils with regard to Bengal was this, that for the last 25 years, to his own knowledge, the Zemindar had been perpetually worried by fresh legislation. Now a great attempt was to be made apparently to pass one comprehensive measure, and he did hope that something would be done to settle the respectlve interests of the Zemindar and ryots once for all. The provision which Sir James Caird had referred to, which allowed the Government to interfere from time to time for the protection of the ryots, might be a good one, but it might have its mischievous side also if Government felt itself justified in upsetting every settlement made after five or ten years, and in harassing and doing occasional injustice to the Zemindar. The Zemindars had been eminently loyal, and had always stood by the Government of India, and their rights ought to be respected, the tenants' rights being duly provided for too.

Mr. Charles Campbell said it was a great pleasure to an old Bengaller, like himself, to hear Mr. Seton-Karr descant in his vivid manner on Bengal things. With regard, however, to the statement that the Zemindar of the permanent settlement was not intended to be made into a prproietor like an English squire, he must join issue. Nothing could be clearer to his mind, from the regulations of 1793, and the recorded opinions of Lord Cornwallis, Mr. Shore and many others, that the Zemindar was constituted the full and actual proprietor of the soil (as much and in many things far more than any Yorkshire or Leicestershire squire), so far as such proprietorship did not interfere with the rights of certain tenantry, which rights were clearly specified at the time, but, unfortunately, were never registered or recorded. Mr. Seton-Karr assumed that this Bill was urgently required, but, in his opinion, it was in many of its main points as uncalled for, unjust, and impolitic measure as was ever conceived. What could be more unjust to the Zemindar or useless to a ryot than to give a ryot who had acquired a right of occupancy under the proposed statute, power to sell that right to any one he pleased. As to the jotedar of Jessore, whom Mr. Seton-Karr and he (Mr. Campbell) knew well, he could look after himself very well, and did not need assistance. What was much more wanted was fair protection for the petty cultivating ryots, who were as 1,000 to 1 as compared with the big jotedars. Further, the Bill contained provisions for the Board of Revenue to declare what was to be looked upon as the staple produce of each locality; and it was suggested that there should be a roving kind of commission to fix ratcs for rent in every locality, after consideration of what is known as the Pergunnah rate. In his (Mr. Campbell's) opinion there was no such thing as a Pergunnah rate in actual practical operation. The only possible test of a fair rent in Bengal was what the neighbours willingly paid and throve under. By Act X of 1859 it had been found totally impossible for the Courts to fix fair and equitable rents with reference to the fluctuating values of produce. In parts of Bengal land was often cultivated on the half-and-half system; the cultivating ryot carrying out at his own expense the entire cultivation, and dividing the produce on the spot with the superior ryot (who sometimes did, and sometimes did not, provide the seed). If it were intended to provide against famines by new-fangled legislation, he (Mr. Campbell) considered the Zemindars should at least have some compensation for the confiscation of their guaranteed rights.

Mr. Seton-Karr, in reply, said he had benefited very much by the remarks of his critics. Mr. Charles Campbell, he thought, rather forgot what the *barga* system really was. One man had the plough and bullocks and the other had the land, and then they divided the produce in half. He had cultivated land on that system himself. He gave the land and the ryot gave the plough and bullocks, and they stood over the crop and divided it between them, the ox treading it out at the same time, according to the Scripture, not being muzzled when he did it. As had been said by Sir James Caird, there might be some difficulty in ascertaining to what particular class the ryot belonged; but he thought the best thing was not to encumber legislation with a vast number of minute provisions, because if they attempted too much, they would probably fail in everything. It had been said, with some point, that he had not given sufficient reasons for the Bill being brought forward, but he thought the reasons were so patent to anyone, who had read the reports of Sir Ashley Eden, Sir George Campbell, Mr. Rivers Thompson, and all the best officers in Bengal, that something must be done, that it was unnecessary to dilate upon them. He could have given reasons for half-an-hour, but to those who would take the trouble to read the Blue-books, he thought there was very little room for argument on this point. He was very glad to hear the way in which his attempts at description of the system had been received, and should carry away with him for future guidance many useful hints from what had been said.

The Chairman, in proposing a vote of thanks to Mr. Seton-Karr, said the greater part of his remarks had his hearty concurrence, though some points had been raised by Sir James Caird and other speakers, with respect to which he should be more inclined to agree with them. He believed there was no man connected with India who had a more intimate knowledge of Central Bengal than Mr. Seton-Karr, but in Behar, perhaps, more even than in Bengal, was there a crying necessity for legislation. The commission appointed to inquire into the subject there, which comprised men of various classes, not only officials but Zemindars and indigo planters, came unanimously to the conclusion that legislation was absolutely indispensable. There was scarcely a ryot in Behar who could prove and maintain the rights conferred upon him by the Act of 1859. As regards the general question, he was glad justice had been done to the great Settlement of 1793. As had been shown, that was a Settlement not only in favour of the Zemindar, but also of the ryot; and for his part, he believed that great as the loss to the Revenue might be from a permanent Settlement, on the other hand, the advantage was so great, that there was a great deal to be said in its favour, provided that it was for the advantage of the people, and not of one class only, amounting to the withdrawal of Government protection for the great mass of the people. He must admit, without going into details of the Bill, he was much inclined to think with Mr. Seton-Karr and others that this Bill was a great deal over-loaded with detail. No doubt there was a great deal to be said in favour of combining into one Act the whole law on a complicated subject; but, on the other hand, those who had to deal with legislation were apt to find great difficulty in combining codification with an amendment of the law. He had read that Bill with a great deal of care, and while there was a great deal of codification, amendment, and elaboration of old principles, he thought the only really important new principle in it was one which for his part he might have wished the Bill had been confined to, namely, that the right given by the Act of 1859 to twelve year tenants should also be given to those who, from circumstances, had not held the same land continuously, but had been chopped and changed about by superior powers. That was the essential feature. and if that reform had been effected, perhaps the codification and other amendments might have come afterwards. With regard to the sub-ryots, he was inclined to agree with those who differed from Mr. Seton-Karr, if he understood him aright, that he would leave them unprotected altogether. With regard to the unlimited right of sale, a great deal was to be said on both sides. Imprudent people having rights to which they were unaccustomed, might be tempted to make an improvident use of them. There was one point on which he must express his difference from Mr. Seton-Karr, and that was with regard to the survey; he thoroughly admitted the difficulties, the magnitude, and the expense of the undertaking, but after a wide experience of different provinces he came to the conclusion that you could not expect to settle the question permanently until there was a survey and record of rights. It was the want of that survey, and record of rights which had caused the Settlement of 1793 to fail, and made the Settlement of 1859 fail. The only other point he need refer to was the statement in the paper as to the assistance given by the Zemindars of Eastern Bengal at the time of the Mutiny.

Mr. Seton-Karr said he only spoke of their passive demeanour.

The Chairman said his impression was that the ryots were not only passive but very active in Eastern Bengal in defeating the Sepoys. It was very much by a popular movement that they were defeated. That showed the immense advantage of settled ryots who had well ascertained rights to protect. A great deal was said about the ryots of Eastern Bengal, who were extremely well off, and had been able to hold their own, and that was the fact. They were mostly Mohammedan, and that was a democratic religion; it got rid of the worship and tyranny of caste; that might have something to do with it. At any rate that prosperous population in Eastern Bengal was almost entirely a Mohammedan population, perhaps the greatest in the world, and the British Government had been able to hold that country for 100 years with a single sepoy regiment, because the people were contented and prosperous. That was a striking example of the advantage of a well-satisfied peasantry. There was no fear of Mohammedan or any other fanaticism so long as justice was done to the people.

The vote of thanks was carried unanimously to the reader of the paper.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 12, 1884; THOMAS SALT, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Bratty, William, Sandford-street, Manchester.
Byrne, Charles Pitt, B.A., 52, Bedford-gardens, Campden-hill, W.
Fletcher, Thomas, United Telephone Company, Oxford-court, Cannon-street, E.C.
Francis, E. G., 59, Fulham Palace-road, S.W.
Griffith, R. W. S., Eyeworth-lodge, Lyndhurst, Hants.
Johnson, Samuel H., West Ham-hall, Forest-gate, E.
Johnson, George Stillingfleet, 11, Savile-row, W.
Lethbridge, Roper, C.I.E., 19, Clanricarde-gardens, W.
Nightingale, E. W., 139, Denmark-road, Camberwell, S.E.
Rawes, Francis Bristow, Bowbridge Works, Newark-on-Trent, and 13, Brunswick-ter., Newark-on-Trent.
Smith, Surgeon-Major Samuel, Wyndham-house, Kingsdown Parade, Bristol.

The following candidates were balloted for and duly elected members of the Society:—

Capper, Robert, Westbrook, Swansea.
Crossley, William J., Glenfield, Altrincham.
Curtis, Richard, Limehurst, Altrincham.
Grindley, John, Millfield, Highgate, N., and Upper North-street, Poplar, E.
Kerr, James, Church, near Accrington.
Kirkpatrick, Andrew J., 179, West George-street, Glasgow.
Lloyd, Frederick James, 4, Lombard-court, Gracechurch-street, E.C.

The paper read was—

A SYSTEM OF NATIONAL WATER REGULATION NECESSARY IN REGARD TO SUPPLY, FLOODS, DRAINAGE, AND TRANSIT.

By LIEUT.-GENERAL RUNDALL, R.E., C.S.I.

Six years ago, H.R.H. the Prince of Wales, in his capacity of President of this Society, called the attention of the Council to the all-important necessity of securing a supply of pure water to the population of the United Kingdom, pointing out that while the great cities and populous towns were taking steps to permanently improve their supply, the smaller towns and villages were still dependent on sources wholly inadequate for health and comfort, and his Royal Highness added, that great public good would arise from an open discussion of the question in the Society's rooms. His Royal Highness rendered a great service to the country in thus removing the subject from the limits of merely local considerations, with which it had hitherto been treated, and placing it on the broad platform of a national question of the first importance. The records of the Society show how thoroughly the Prince's proposals were taken up, and the subject discussed from all points of view, and especially the administrative one; it is therefore all the more regrettable that no practical result has as yet followed the several Conferences held by the Society, and that the nation seems as far from deriving any benefit from the adoption of a comprehensive policy as it was previous to his Royal Highness's suggestion.

One cannot but be struck, after a perusal of the interesting and highly instructive papers and discussions recorded in the Society's *Journal*, how much the question of Water Supply is mixed up with the general hydrographic conditions of the country, so much so as to render it difficult, if not practically impossible, to devise a comprehensive scheme independently of them. While, however, there is almost a unanimous consensus of opinion as to the necessity for dealing with the subject on a national basis, there is some divergence as to the most desirable method of administration, and considerably greater difference as to the engineering arrangements, both leading to the inevitable conclusion that there must be some duly recognised authority capable of reconciling such differences, and controlling definitely the lines which a national scheme should follow. The constitution of such authority, however, is a point which will be reverted to afterwards, and it is merely alluded to now, as mainly suggestive of the title which the writer has given to this paper.

After the startling theories which have been of late so prominently propounded, as to the Land being the common property of the nation, the writer somewhat hesitates to pronounce on what may, at first sight, seem to be a parallel assertion, viz., that the Water of a country is really and truly National property. Falling from the heavens, it comes as a gift, not to individuals, but to the country at large; and in proportion as it may be controlled or otherwise, it proves to be either an element of unmixed good or an instrument of positive evil. It can, in no sense or instance, be deemed a "fixture," for in whatever circumstances it is found, it is ever liable to variation, increasing or diminishing by circumstances or phenomena which no human being can control. The rainfall is allowed by the proprietors of the uplands, in which it is in excess, to run off unchecked, regardless of the interests of proprietors lower down, to whom that superabundance carries absolute injury; while in other parts of the kingdom the population are at the same time in actual want of one of the absolute necessaries of existence, and by whom it is procurable only at great trouble and expense. If water is to be regarded as inalienable private property, the question arises, is the owner of such property responsible for only a definite proportion of the volume which falls within the limit of his estate, and to just as much as he finds it convenient to acknowledge an ownership, and is he at liberty to let the rest of it disperse itself wherever it can find a passage regardless of consequences? Again, who will undertake to define the principle on which a given proportion of the whole volume of a river rolling on towards the sea belongs to the respective riparian proprietors, or would those proprietors themselves care to admit any responsibility for mischief resulting from want of due control of their relative proportions, even supposing they could be defined?

In large rivers it is obviously impossible, but if principle is involved, then such principle cannot in equity be overridden by the fortuitous circumstance of the varying size of a river allowing itself to be controlled, and so admitting an exclusive appropriation of its waters. It is doubtful whether there has ever been hitherto such a recognition of its property by the national Legislature, or whether the principle has ever been admitted; the tendency has rather been to recognise the opposite principle, that its waters belong to any and everybody else but the nation itself. The remarks of such an authority as Mr. G. J. Symons, F.R.S., in his paper read at the Society's Congress, are much to the purpose when he observes, "Existing Private Bill legislation is creating rights of very doubtful expediency, granting absolute water rights over large tracts of land to the first company or companies that ask for them;" while one of the conclusions enumerated in the epitome of his views entirely goes to support those of the writer of this paper, viz., "That it would be much better if the entire administration of streams was under a single direction, seeing to all questions of drainage, sewerage, canalisation, motive power, and supply."

That Water is one of the main sources of our wealth seems hardly to have come home to us as a nation. Attention has been concentrated on our mineral, manufacturing, and agricultural resources, but not a single one of these can get on without the help of water. As an insular nation, water is the mainstay of our defences, carrying the symbols of the power on which we mainly rely for protection against foreign aggression; it is the one element of our commercial prosperity whose value no rival can diminish, or of whose possession no enemy can deprive us, so long, as a nation, we are careful to maintain the supremacy of the flag which, "for 1,000 years, has braved the battle and the breeze."

As a manufacturing nation, water is an element which enters essentially into almost every industry, either as a component part, an ingredient, an auxiliary, or a motive power. Whether it be the huge engines which move the millions of spindles of our peaceful industries, or the hundreds of machines which in our public dockyards or in private factories forge the instruments of war, all would be motionless and powerless but for the water from which the steam power is derived.

As an agricultural nation, water is indispensable, for if the heavens be as brass, the earth will be as iron; neither can seed be sown, or harvest reaped, while the cattle may wander in vain for pasture. True, it is seldom that such an extreme experience is encountered in England, and our lands, as a rule, suffer more from excess than lack of moisture; nevertheless, for agricultural operations, the due regulation of water is essential, for there are many tracts where water is only procurable on farms with much difficulty and expense. Surely, the evident deduction from the above considerations must be, that water ought to be looked upon in the light of National property, and if so, its conservancy, or rather its regulation, should be dealt with on a National basis.

Hitherto it has been customary to discuss each branch of water management separately, as though it were entirely distinct and unconnected with either of the others. It has either assumed the shape of a Conference on Water Supply, or a Commission on Drainage, a Bill for Protection from Floods, or a Select Committee on Canals. As long as these several branches of the water question are thus dealt with independently, so long will there be not only a succession of isolated and often unsatisfactory results, but there must necessarily be a prolongation of unremedied evils. The object of this paper is to draw attention to the value of its water to the nation at large, and to point out that the real and only effectual way of dealing with the several problems connected with it, is to take up the subject of its Regulation as a whole, and to deal with it on a comprehensive basis.

Not only is it impossible to separate the question of water supply from that of drainage, as was remarked by a member of the Congress, but both are intimately connected with that of protection from floods; and in the proper management of this last will be found the solution of one of the supposed difficulties to the extension of inland canal navigation, the necessity for which is every day becoming more and more evident, if England is to hold her own in the keen competition with foreign markets. The experience of a lifetime in dealing with the water question in its several phases, enables the writer to pronounce confidently on both its administrative and engineering features, and, it will be hoped, prove his excuse for any seeming dogmatism which may occur in his remarks.

The term Water Regulation embraces the four cardinal divisions specified in the title to this paper, and signifies the management of the water supply of any country on a recognised comprehensive principle, so that any one branch of it may not be pursued at the expense of the others, and that while individual and local considerations receive due attention, the interests of the country at large may not be lost sight of. The necessity for a comprehensive treatment of the water question in the United Kingdom, is made evident by a consideration of the distribution of its rainfall, the peculiarity and the great inequality of which is probably known only to the few who have made it a special study. The admirable chart attached to the Sixth Report of the River Pollution Commission of 1868 shows that, roughly speaking, a line drawn from Berwick down the centre of England to the Isle of Wight, separates the country into two nearly equal main divisions of small and large rainfall. In the Eastern half, it will be observed, the rainfall varies between 20 and 30 inches, the greater part being less than 25 inches; while the Western half fluctuates between 30 and 50 inches, including some tracts on the extreme west where the variation is from 50 to 70 inches, and certain isolated patches, such as the highlands of Wales, the lake district, and Dartmoor, in which the rain exceeds 75 inches. The same inequality is evident also in Scotland and Ireland, each of those portions of the United Kingdom being similarly nearly equally divided.

Turning to the hydrographical chart, however, it will be seen that the line of water partings does not coincide with that of the rainfall, and that for the most part the sources of the principal rivers in England and Scotland are situated within the limit of greater rainfall. Those running to the East Coast have for the most part a much longer course than those discharging on the west, with the exception of the Severn, and the areas served by them are fully twice as great. *There*, therefore, is an illustration on a large scale of Mr. Symons' remark, of a great rainfall with a sparse population on the one side of the kingdom, with those conditions reversed on the other. Curiously, however, the same arrangement does not obtain in Ireland, the main rivers there having the longest course to the west of the island. These conditions govern the flood discharges of the respective rivers. Those following to the Eastern Coast, though gathering from a much larger catchment basin, do not discharge a relatively greater flood volume, but maintain it for a longer period, while those running to the West Coast precipitate their floods with greater rapidity, and therefore in a shorter time.

Again, the Eastern rivers, occupying a larger area of catchment basin, have to serve a larger population with much less rainfall. It is stated by various authorities that not more than one-third of the rainfall on those districts is carried off by the rivers. If so, there is not more than 8 inches a year available, on an average, for all purposes; and if the navigable course of the rivers is to be maintained, it would be impolitic to draw off, during the low season, any portion of their volume for the domestic supply of towns and villages, let alone that required for manufacturing and other purposes. According to the statistics given in Mr. F. Toplis's essay, to which the Society awarded a silver medal in 1879, the population contained in the eastern district, measuring 34,000 square miles, amounts to over 16,500,000, leaving 8,750,000 for the 24,000 square miles comprised in the western district. The relative proportion of rainfall is thus in inverse ratio to the area and population. In arranging, therefore, for the distribution of the water, it would clearly be but equitable that those parts of the country which have the superabundant rainfall should, if need so require, supply those where it is scanty. But such equitable apportionment of the national property could only be effected by some systematic regulation of the water supply, for unless measures are taken to store the surplus in those districts where and when it falls, the greater portion will, as for instance in the lake district, owing to the character of its geological formation, pass off unutilised in the form of floods to the sea. That such regulation should be in the form of storage, is almost self-evident, for, as water is a valuable commodity, and every year becoming more so, it is better policy to construct a class of works which will eventually contribute towards the cost of regulation, by conserving the water for after distribution to the various purposes for which it can be utilised, than a series of works which serve only for protective purposes, and have no direct recuperative value.

It has been asserted on the highest authority that the average rainfall of the United Kingdom has been diminishing during the past half century. If such be the case, it would add a very cogent reason for storing a portion of the superabundant rainfall; but though this statement has been called in question, and reliance is not always to be placed on averages, yet, in dealing with water supply, it is an axiom that, in estimating the quantity of water available, the minimum and not the average rainfall should form the basis of calculation. An inspection of the registers for the east of England shows that four years out of every seventeen are years of scanty rain, in which not more than fifteen to eighteen inches fall.

Again, it was stated by Mr. (now Sir Robert) Rawlinson, in the discussion on the paper read by Mr. Bailey Denton before this Society, in the year 1867, that after a most careful series of observations carried on for many years, out of an average of 25 inches of rain falling in the Thames basin, four-fifths of the entire quantity could not be accounted for by measurement in any way, leading to the conclusion that 20 out of the 25 inches passed again into the atmosphere. Now, if such conclusion be correct, it is evident how seriously, in a year of minimum rainfall, the navigability of the Thames must be affected, and how jealously any abstraction of its volume should be guarded against.

Although the quantity required for the supply of towns and villages in the United Kingdom is but a small percentage of the average rainfall, yet a very large proportion of it is needed to maintain a uniform and effective depth in its navigable rivers. The state of the Thames itself affords an apt example. The navigable channel above Chiswick is notoriously becoming so deteriorated year by year, that the proposal has been seriously put forward of erecting a weir across it in the neighbourhood of Isleworth; and though the deterioration may possibly be due partly to the deepening of the reaches from Battersea downwards, causing a prolongation of the ebb tide, and so lowering the low water level in the upper tidal reaches, yet, were the surplus floods of the Thames stored in sufficient quantity when they occurred, such a regulated volume could be afterwards discharged during the summer months as would suffice to counterbalance this condition, and by restoring or further raising the low water level, preserve the full uniform depth necessary for maintaining the navigation in the highest possible efficiency. Probably, the interest of the outlay in storage might be partly met by the additional tolls leviable on vessels of greater draught and tonnage. But this is a point which the Thames Conservancy Board may have already considered. The volume of the extreme floods in the Thames near Teddington has been roughly estimated to be 20,000 feet per second; but the volume which the river can safely carry off in the lower part of its course has not been stated, nor the length of time for which such a discharge was maintained. Assuming, however, that it is capable of discharging three-fourths of that volume harmlessly, it would only be necessary to provide storage for restraining the remaining fourth for the specific number of hours during which the flood remains at its extreme height. One day's flow of 5,000 cubic feet per second would amount to 432,000,000 cubic feet, and could be stored in one or more reservoirs, aggregating seven-ninths of a square mile in area, with an average depth of twenty feet. For the number of hours over twenty-four that the Thames may run with a maximum discharge, that area of storage would have to be proportionately increased. Data recording the duration of a flood in the Thames at its maximum discharge are not available, but it is doubtful if it ever reaches three consecutive days, and if so, the expense of constructing storage for that quantity could not be excessive.

The aggregate amount of storage then required to retard a maximum flood depends on the number of hours during which such a flood remains above the volume that it can carry off harmlessly. As soon as it falls materially below that volume, assumed in the case of the Thames to be 15,000 cubic feet per second, then the retarding reservoirs may, if necessary, commence to discharge their contents. Such discharge could easily be regulated by standard gauges at various ruling stations on the main river and its tributaries, especially if those stations were connected by telegraph or better by telephones, and the reservoirs could be emptied and made ready against the approach of the next flood. With reference to the expense of such storage, it may be stated that Mr. Toplis, in his essay already alluded to, calculates that the population of the Thames catchment basin will require a supply of 150 million gallons, equal to 24 millions cubic feet daily. To furnish that quantity for twelve months would require an available storage, exclusive of loss by evaporation and absorption, of 8,760 million cubic feet, or more than six times the amount assumed above as necessary to retard the excess or injurious proportion of a seventy-two hours' maximum flood in the Thames. If these data and figures be respectively correct, they show that there exists a fair prospect of a moderate outlay on storage, as one of the remedial measures against floods, if properly regulated, being amply repaid by the subsequent distribution of the stored water for domestic purposes only. But if the question of maintaining an effective navigation throughout the dry period of the year be considered, it will be found that a still further portion of the floods may be profitably retained for subsequent discharge. The low water volume of the Thames is stated, in Mr. Denton's paper, to be 450,000,000 gallons daily, equal to 833 cubic feet per second, and that this amount is liable to be further diminished by abstraction by some of the metropolis water companies by one-third. Now let it be assumed that the summer flow, by being doubled, would make the river channel so efficient as to admit of a large class of vessels navigating it; 850 cubic feet per second would amount to 3,060,000 cubic feet, or 113,333 cubic yards per hour, or 2,720,000 per day, or say 272,000,000 for 100 days, the extreme period, probably, that there would be any necessity for augmenting the summer volume, being also six times the quantity required to be stored for the retardation of a three days' maximum flood. From hence it will be seen in what ways, and to what extent, the after distribution of flood water is capable of being profitably utilised, leading to a possible solution of the vexed question as to who is to pay for works for the prevention of floods, and rendering unnecessary the distinction made in the Floods Prevention Bill of lowlands, midlands, and uplands, and avoiding the contentions which are pretty certain to arise therefrom.

Without claiming actual accuracy for the figures, the following may be assumed as a rough approximation of the expense of storage, and a possible saleable value of the water. Supposing the population of the Thames catchment basin to require, as above stated, the storage of 8,760,000,000 cubic feet, or 324,000,000 cubic yards, the cost, according to various data for storing on a large scale, appearing to average 2,700 cubic feet, or 100 cubic yards per £1, would be £3,240,000. Taking 5 per cent. thereon to cover interest at 3½ per cent. and 1½ per cent. for sinking fund, and 2 per cent. for working expenses, or 7 per cent. in all, the yearly income must be £227,000. This would enable the stored water to be sold at the rate of 12,000 gallons for a shilling, or one penny per 1,000 gallons, to companies and corporations undertaking the detailed distribution. Or, to illustrate it more popularly, the quantity of water requisite for a household of ten people, consuming 200 gallons per day —73,000 gallons annually—may be provided for 6s. a year. To this has, of course, to be added interest on the capital cost of distribution, its working expenses, and management; but any householder is capable of calculating, from the rates which he now pays, whether the difference between an annual payment of 6s., or the rate of 1d. per 1,000 gallons, and his total water rate does not leave an extraordinarily large margin for covering the expenses of distribution and its management, &c. The charge usually made has been till lately at the rate of 1s. per 1,000 gallons when sold in small quantities by meter, and 6d. per 1,000 gallons for trade purposes—at least such are the prices given in evidence before the Rivers Pollution Committee by Mr. Gott, the borough engineer of Bradford, though in the instance of one very large consumer, who paid between £600 and £700 a year for his water, a charge of only 2¾d. per 1,000 gallons was levied.

The subject of Supply having been so elaborately treated by the Royal Commission of 1868, and subsequent Conferences, it is scarcely possible or necessary to add anything to the information that has already been collated. But a summary of the leading points, and of the general principles which should govern the water supply to cities, towns, and the country as a whole, may be here conveniently and briefly stated.

The two essential principles in the supply of so important a necessary of life are—

First, that the cost should be kept as low as possible, in order that the poorer classes may be supplied at the lowest possible rates, and the quantity should be practically unlimited. It is evident, if economy in construction be secured, then there will be less difficulty in obtaining an unlimited supply.

Secondly, if practicable, the supply should be taken from the sources available within the watershed of the district, whose towns and villages have to be supplied—for in a country like England, where the chief cities and towns are pretty evenly distributed, the presumption is, that the available supply will be wanted, and can be utilised, within its own area. But as is apparent from the unequal distribution of the rainfall, such an arrangement is not always practicable, and there may be cases, certainly, in which it may also not be desirable, as, for example, in the instance suggested by Mr. Symons, of "a large population in one district with very small rainfall, and a large rainfall in another district in which there is only a very small population, and so an arrangement by which one could be brought to the other may prove the most desirable." Otherwise it would seem, at first sight, to be more economical to draw the supply from the sources near at hand rather than from a distance, provided always that the water be of good quality. Whatever may be the difference of opinion as to the propriety of utilising stored water for supplying the population of towns, the preponderance of evidence is in favour of this method. When, however, the supply of towns and cities is treated as an entirely separate subject, and carried out by a small section of the community, with reference only to local requirements and irrespective of all other considerations, irreparable injury is likely to be inflicted by rendering impossible in the future improvements which would confer the greatest amount of benefit to a much larger section, who are not at the time aware of the sacrifice their interests may be sustaining.

It has been customary, hitherto, to look only to present requirements, and to leave the future to provide for itself; but it was justly pointed out at the Congress, by Mr. Symons, that in any national water supply scheme the arrangements should be sufficiently elastic for four times the existing population. The metropolis itself is a notable illustration of the wisdom of this remark, for, owing to its rapid growth, it is now suffering for want of such elasticity in the arrangements of many of its private water companies, and, in the contests now pending with the City authorities, a forcible instance is supplied of the need of systematic regulation of the national water resources, under some competent directing authority.

From the storage of water in connection with supply, to its utility as one means towards the prevention of floods, the transition is natural. For some years past, as the season for floods periodically recurs, the necessity of undertaking preventive measures forces itself on public attention. Not only has the subject been largely discussed, but much information has been collected by the various committees appointed from time to time, and remedial suggestions have been proposed at the meetings of several scientific and engineering societies. While opinions may have differed as to the best method of dealing with the problems which have presented themselves for solution in the cases of rivers of different types, there seems to be an almost universal agreement as to the absolute necessity for altering or improving the existing administrative management. A conspicuous instance where the evils of isolated and divided control have been made apparent, may be cited in the results which have attended the various schemes for the improvement of the drainage of the Fen districts. In a paper read before the Institute of Civil Engineers, in 1882, Mr. Wheeler stated that "upwards of £2,000,000 of money had been expended thereon, but all the engineering works were in an unsatisfactory condition, owing to the divided jurisdiction." No doubt, as long as the design and execution of remedial measures have to be discussed and decided by several local controlling authorities, so long will it be impossible to effect any comprehensive treatment of the evils to be remedied; much less will it be possible to attempt a combination of objects, such as would embrace works for the benefit not of local interest only but of those of the country generally.

Of course no absolute rule can be laid down as to the kind of works best adapted for the prevention of damage from floods. As has been shown above, the rivers of the east and west coasts differ in their condition materially, and so naturally require to be treated differently; but the writer is himself unable to agree in the view which he is aware is largely held by many engineers, that works for the regulation of floods should commence at the mouth of a river, and be proceeded with upwards along its whole length. He is of opinion that, realising the valuable property which a country possesses in its waters, the regulation of floods should be begun rather at their source than at their exit, so that a portion of the full value of that property may be reaped, instead of allowing it to be all wasted fruitlessly in the ocean. He does not mean thereby that the mouths also of rivers do not require improvements, but only that it is the wrong end to begin at; for this reason that the mouths of rivers are not to be improved by a regulation of their flood, but by that of their tidal volumes. Keeping in view the necessity in all river improvements of maintaining a provision for town supply, navigation, and water power, it would seem, *primâ facie*, that rather than endeavour to get rid of surplus water very rapidly, it would be more to the purpose to retain as much as could be profitably stored, and to discharge it after the flood seasons in such quantities, and at such times, as would supply the wants of the community dependent thereon. That, as regards the navigation in the Fen districts, such a course would have been beneficial, seems to be evident from the state in which those navigations now are. From the description given in Mr. Wheeler's paper already referred to, it appears they have been allowed to go to ruin, and shoals and weeds so choke the channels, that the rivers are less capable of discharging the drainage of the country than when left in their natural state, and constant floods consequently occur.

The canalisation of those rivers of course dates far back to a time when local wants received more attention than those of the general community; but as there can be no question as to the great advantage of maintaining water carriage in those districts, for the conveyance of not only such bulky articles of low value as are needed by an agricultural community, but also those which have to be carried to the manufacturing towns in the neighbourhood, it is evident that, in any comprehensive scheme for the prevention or regulation of floods that may in future be designed for the Fen districts, the restoration and maintenance of those old navigations should find a place. Their case furnishes an appropriate illustration of the need and value of some central authority, capable of dealing with the important duty of water regulation. As it does not come within the scope of this paper to go into engineering details, I will not attempt a discussion of any of the many suggested methods of dealing with floods, my object being rather to point to the connection which they have with the other branches of the water question, and of the necessity of considering, in any of the proposed remedies, the bearing which they may have as regards the supply, drainage, and especially the navigation of the rivers. It may, however, be useful to glance at some of the main causes of floods.

A good deal of stress has been laid on the improved plan of drainage now pursued in connection with a higher system of agriculture, contributing to a more rapid discharge of rain falling on the land. Much more importance has been ascribed to this than it merits, for subsoil drainage is oftener necessary in the low than in the higher lands of a river, and the quantity conveyed by such drainage is both small and carried off much more slowly than the surface drainage; so that probably, in most cases, much of the latter has passed off before the subsoil drainage can reach its outfall into the river.

The relative volume, height, and duration of floods depends principally on the configuration of the catchment basin and its extent. If it is somewhat circular in shape, with the sources of its tributaries nearly equidistant from the main river, and heavy storms are pretty evenly distributed over them all, both in point of time and quantity, then the various affluents will probably reach the main stream nearly simultaneously, and so precipitating their respective volumes at the same time, must necessarily choke the course of the main stream, and give it a greater duty than it can possibly perform. The floods, consequently, rising above the banks, must spread themselves over the country, to the injury generally of the growing crops, and sometimes to the stacks of harvested crops. If, on the other hand, the catchment basin be long and narrow, the rainfall will probably not occur simultaneously at the sources of all the feeders, and, therefore, the arrival of their respective volumes at the course of the main stream will be successive, and not simultaneous. Not only does the peculiarity of the configuration of the basin govern the engineering measures to be adopted, but they will depend also on the character of the river itself. For instance, the rivers in the Fen district having a small fall, with beds on a high level, and so partaking of a quasi-deltaic character, require different treatment from rivers like the Irwell and the Severn, which run in troughs with a steep slope. Nevertheless, whatever accessory works, such as marginal embankments, cut-offs, &c., may be needed in either case, still the general principle of retaining a portion of excessive floods for after distribution, rather than allowing all the water to run uselessly to the sea, will hold good in both engineering and financial aspects.

It may not be out of place here to notice a remark made in an article on "Floods," by a writer in the January number of the *Nineteenth Century*, to the effect that—

"Agriculturists are becoming more and more convinced that if English agriculture is to have any chance of commercial success, capital outlay must be conducted with extreme prudence and even parsimony; but that this truth is naturally more slow in reaching the minds of engineers and professional men, whose attention is directed to great works and professional fame rather than to economy and local rates. That if certain proposals made by eminent engineers had found their way into the Statute Book, there would have been opened for ratepayers an endless vista of taxation, and for the profession a prosperity second only to that enjoyed in Egypt in the best days of Ismael."

I think I may, in the name of all my brother engineers present or absent say, in reply, that the skill and fame of an engineer is measured by his ability to overcome the greatest obstacles by the simplest means and at the least expense, and that in most instances, and notably in so vast a subject as the water question, the best, surest, and most economical results are attained where operations are carried out on a large scale than on a small one; and that, therefore, the proposals which the writer states alarmed the House of Lords Committee were put forward for the purpose, not of advancing professional fame, but of securing the greatest good to the greatest number, and at the smallest cost to each individual concerned.

Proceeding now to the next branch of the subject, Drainage, it is scarcely necessary to point out how intimately it is connected with that of floods, at least that portion of it which comes under the title of Surface Drainage. The swamping of land may arise either from absence of slope not allowing the rainfall to run off sufficiently quickly, or from the overflow of surcharged rivers incapable of carrying off the accumulated waters of closely succeeding storms. Under the term drainage, however, is included also the removal of water from over saturated subsoil, and the waste water and sewerage of towns and villages. The two last do not, however, fall quite within the scope of the term drainage as intended in this paper, but yet they are in a measure connected with the general subject, inasmuch as it has become a serious question as to how the drainage of towns and villages is to be disposed of. The practice of allowing it to run into the rivers is becoming too serious a nuisance for the community to tolerate any longer. The opposition which the proposed Thames Valley sewerage scheme has created is an instance in point, for it is not without reason that grave apprehensions are entertained by the dwellers on its banks of the results, in a sanitary aspect; and that the inhabitants of the metropolis and suburbs view with alarm the prospect of a possibly irreparable pollution of the river which is their principal and favourite recreation resort. It would be impossible for such questionable schemes ever to be seriously entertained if they had to be submitted to a central authority charged with the duty of regulating the waters of the kingdom in the interests of the whole community. For the rectification of lands swamped by the overflow of rivers, it is evident that if such portions of excessive floods over and above what the natural channel of the river is capable of carrying off be retarded, a remedy will at once have been found; while for such low-lying lands as need the additional protection of marginal embankments, parallel drains carrying off the rainfall to a lower level will probably be found sufficiently efficacious. If such contributions to the river injuriously affect the flood volume, it will be owing to the sectional capacity of its bed having become deteriorated by neglect. The restoration of the entire river's regimen in such a case will evidently be necessary; but if left to be dealt with by the parties interested only in the particular tract of land to be drained, nothing but the local and immediate end to be gained would be attempted, without the slightest reference to the injury or inconvenience entailed on others. So, likewise, the conveyance of water from supersaturated soils would be locally dealt with, regardless of the effect that might be produced on neighbouring lands; or, possibly, as great an evil would ensue by the neglect of the proprietors to take measures for the removal of the surplus water, which, as in the Report on the Public Health Act of 1875 Amendment Bill, the committee justly observe, "impedes production, lowers the temperature, not only of the surface from which the surplus moisture is taken, but of the adjacent districts, and by the damp and chill lessens the vigor of human as well as vegetable life." Such instances, again, demonstrate how, for want of regulation, the water which falls from the heavens for man's benefit is, by his neglect, allowed to become a source of positive evil. A proper regulation of Floods thus reacts on the management of Drainage, and a due control of Drainage works will prevent unnecessary contamination of rivers which have to furnish the population with a Supply for domestic purposes. Treated singly, the few may be benefited at the expense of the many; but if these questions are dealt with as a whole, it is perfectly certain that those charged with securing the interests of the entire community will not lose sight of the needs of individuals. It, therefore, behoves the nation to take care that all legislation, in which it is proposed to deal with the waters of this country, is shaped not on the narrow limits of parochial or municipal needs, but on the broad, connected, and comprehensive basis of national requirements.

But when this has been accomplished, and the treatment of Supply, Floods, and Drainage, not singly but relatively, has been secured, there still remains a fourth, and by no means the least important, branch of the water question to be dealt with, and that is Transit by inland navigation. Unhappily for the interests of the kingdom, Water carriage, which has been truly called the National mode of transport, has been lost sight of ever since the discovery of railways as a means of locomotion, a neglect which could scarcely have occurred had there been any central authority to watch over the regulation of the water property of the country. Happily, the commercial community are beginning to awake from the fascination which the railways have till lately kept all classes spell-bound, and to see that, while the advantages they have conferred, and are still conferring, are unquestionably very great, yet the limit of economy in transport has not been reached, and that the United Kingdom has still not only to learn, but to adopt, a mode of carriage which will admit of its produce and manufactures being carried at such reduced rates as will enable it to hold its own successfully in competition with foreign countries, which are now rapidly supplanting British products in the markets of the world. It would be more correct to say that the nation has to *resume* rather than to learn the use of water carriage, for it needs only to study the history of inland navigation, and to look upon the works carried out by the eminent fathers of English engineering to perceive the important part that canals were wont to play, not only in the internal commerce of the country, but in the conveyance of its products to the coast for shipment to the rest of the world. A great authority, Mr. David Stevenson, commenced his treatise on inland navigation with the following words:—"That railways have entirely superseded, and will in future prevent the extension of canal or water carriage as a means of ordinary transport must at once be conceded." Judging from results as they exist at present, it must be confessed that Mr. Stevenson's opinion seems to have been justified. But the question arises, why should this supersession of canals have ever taken place? The answer usually given is that the railway is a much more perfect and superior machine; that canals cannot be depended upon, but are liable to interruption at one season from a deficiency of water, and at another from accumulation of ice, while the very limited speed at which boats can be propelled precludes them from meeting the needs of the present day, which insists on rapidity in transport. That a railway is a more complicated contrivance may be granted, but not that it is a more perfect one, for it may be asked what constitutes perfection in a carrying machine? To have one's goods conveyed with the greatest safety, at the least expense, and in a reasonable time, would seem to meet the idea of perfection; but it is averred that in the present day speed is an essential element, and one which is unattainable on canals. It may be conceded that *relatively* with railways a *high* speed is not economically attainable; but it is a fact, not generally known to those who are accustomed to see goods trains flashing past railway stations, that that speed is no criterion as to the actual time occupied by those very trains between terminus and terminus, and that the average rate at which goods are conveyed on lines not furnished with a separate "way" does not much exceed five miles per hour; so that speed in the delivery of goods being an essential requirement of transport in the present day has not been realised on even the majority of railways. There is no reason why all the existing canals should not also be adapted for steam traffic, at a sufficient speed for the class of goods for which water carriage is most suitable. Where, as in the case of the Aire and Calder Canal, intelligence, energy, and skill have been brought to bear on the subject, the cost of transport has been reduced to a figure which it is impossible for railways even to approach. The evidence given before the Select Committee on Canals last session contains a mass of valuable information on the capabilities of water carriage which will doubtless open the eyes of the public. Mr. Bartholomew, the engineer and manager of the Aire and Calder Canal, told the committee that for merchandise traffic, at speeds of from 4½ to 6 miles per hour, the cost of haulage, including depreciation and repairs, is only 1-34th of a penny per ton per mile! What has been accomplished on that canal may be done on any other. Though it does not necessarily follow that all the arrangements in the Aire and Calder would be applicable to the canal system throughout Great Britain, yet it is quite certain that, if similar pains were taken with each main line of navigation, the result in the reduction of cost of transport would be a great gain to the public as well as to the shareholders in such lines.

As regards the other objections, the want of water is one which would be very easily overcome, if the suggestion made above of storing some of the excess flood waters of rivers were carried out, while, as regards interruption to traffic during the winter months, it not unfrequently happens that when canals are blocked with ice, railways are choked with snowdrifts.

On the other hand, the advantages that canals have over railways are—

1. They admit of any class of goods being carried in the manner and at the speed which proves to be most economical and suitable for it, without the slightest interference with any other class.

2. The landing or shipment of cargo is not necessarily confined to certain fixed stations, as is obligatory on railways, but boats can stop at any point on their journey to load and unload, and discharge their cargoes direct over the ship's side.

3. The dead weight to be moved in proportion to the load is much less.

4. The capacity for traffic is practically unlimited, provided the locks are properly designed.

5. There is no obligation for maintaining enormous or expensive plant or establishments, as all that can and would be provided by separate agencies and distinct capital. Thus a large outlay in first cost and subsequent maintenance of rolling stock is avoided.

6. An almost total absence of risk, and the reduction of damage to cargo in transit, and consequently of insurance to a minimum.

Whatever advantage there may be in the capabilities of railways as regards speed, there can be no question that safety and cheapness are best secured by canals. It is no argument to point to the relative amount of traffic at present existing on the two methods of conveyance; for, in their existing conditions, no more common ground of comparison exists than between a perfectly modelled and furnished mail steamer of one of the great ocean companies and an antiquated model of a coal barge on the Thames. For, besides the defects in construction, the present system of canals labours under the following drawbacks—

1. A total absence of unity of management; for example (as stated before the committee by Mr. Lloyd, the manager of the Warwick canals), on one of the routes from London to Liverpool there are nine different canals and navigations. On another there are nine, and on a third ten different companies.

2. A want of uniformity of gauge in the locks, and in the canals themselves.

3. With few exceptions they are not capable of being worked by steam.

4. An unequal system of tolls.

5. Last, but not least, the fact of so many links in the communication being in the hands of the railways paralysing any unity of action, and rendering any scheme of amalgamation between the several lines impossible.

In thus prominently urging on the nation the expediency of re-establishing its ancient water lines on the most improved principles, that is n enlarging their sections and locks to a uniform gauge on the main lines, and adapting them to steam traffic, remodelling the boats, readjusting the tolls, and reforming the administration generally, the writer believes that the interests both of the public and of those to whom the canals may belong, will be equally materially advanced. As he explained in the memorandum which he had the honour to lay before the Select Committee—

"What is needed is not a ruinous competition amongst carrying companies in order to provide accommodation for the trade of the country, but an intelligent distribution of the traffic amongst the different modes of conveyance best suited to it. The re-establishment of water carriage on an effective basis in England need not, and would not, interfere (except beneficially) with the financial results of railways, for it would not only relieve them from the bulk of their least renumerative class of traffic, but set them free to provide larger and more convenient accommodation for passenger traffic, as well as for the extensive class of light and valuable manufactured goods. It would also greatly tend to diminish the number of accidents and liabilities to heavy compensation arising therefrom, would lessen the wear and tear of both "way" and rolling stock, would enable them to contract their overgrown establishments, and so, by reducing the per-centage of working expenses, tend to increase rather than diminish the dividends."

The canal system of Great Britain, as represented on the map, shows that all the main arterial lines are occupied; but, unhappily, even those lines are in the hands of different proprietors, and, more unhappily still, important links of those lines are, as before observed, in the hands of railway companies, as will be evident by an inspection of the map on which the railway owned or controlled canals are marked in red. A statement, handed to the Select Committee by Mr. Calcraft, Assistant Secretary to the Railway Department of the Board of Trade, shows that out of a total of 3,029 miles of canal in the United Kingdom, no less than 1,436 miles are either owned or controlled by railway companies. It is easy to understand, therefore, the difficulty with which water carriage has to contend, and something of the hopelessness with which canal companies view any endeavour to resuscitate the traffic which has been taken away from them. Though unquestionably much of the blame rests on themselves, for yielding so readily to the chains the railways have forged for them, yet the Legislature of that day cannot be acquitted for having omitted to insist on maintaining the independence of the canals, and to prohibit their purchase by railway companies. An attempt has certainly since been made to remedy that omission, by the establishment of the Railway and Canal Commission, but it has been found absolutely necessary in other countries to keep the two classes of communications perfectly distinct. According to M. Krantz, the member of the National Assembly appointed to inquire into railways and other means of communication, experience in France shows "that canals require the aid of a special director, who will both look after their interests and effectively protect them. Nothing but constant trouble results from a united direction of railways and canals." Equally so will it be to attempt to amalgamate their supervision in England or in any other country in the world.

Although it may be considered a digression foreign to the immediate title of this paper, it is impossible not to point to a lamentable instance of the impolicy of a nation neglecting to improve and maintain the waterways bountifully provided for it by nature, notably the Government of Egypt (not the present either *de facto* or *de jure* Government), but the rulers within the present century, who have failed to recognise the value of the grand highway which runs through the length of that kingdom. Had some of the outlay which has been expended on the railways running parallel to the Nile been devoted to removing or overcoming the obstacles on the river itself, and to the establishment of an effective steam flotilla, the Government could have dispatched an efficient force which would have nipped the insurrection of the Madhi in the bud, have avoided the necessity of Hicks army's march across the waterless desert, and have given that gallant commander a base from which his operations could have been conducted, without losing touch of army head-quarters at Cairo. It has been said that had the railway between Berber and Suakim been made when General Gordon recommended it, the late misfortunes would never have befallen the Egyptian Government, but it does not require much intuition to perceive that a horde of fanatical semi-savages, such as have lately swept across the country, would have made short work of a railway whose whole length of 250 miles it would have been impossible to defend, whereas such a river as the Nile would of itself defy any human attempts to interfere with its course, let alone the ease with which the principal points of its course could be defended by a comparatively small force, assisted by a flotilla of gun boats. The Nile would thus have done for Egypt what the

Yangtze Kiang did for China, in enabling General Gordon first to stem the tide of, and then to secure the final triumph over the great rebellion.

But to return to the Canals of the United Kingdom. Owing to the unaccountable general absence of reliable returns of canal traffic, it is not possible to arrive at an idea of the total weight of goods travelling over the entire water system at the present time; but it is quite certain that it is nothing like what would be conveyed, were the canals adapted to modern requirements, and the cost and charges reduced to the low figure at which it has been shown they can be worked. On the Leeds and Liverpool Canal the traffic in 1880 amounted to nearly 2,250,000 tons, and that Canal paid a dividend of 21 per cent. last year. There is no question that, in two particulars, land carriage cannot compete with water, and those are in cheapness and capacity. Perhaps it is owing to the distances in England being so small, compared with those encountered on the Continent and India, that the necessity for economical conveyance has, till recently, not been so much felt; but of late years, since the pressure of competition has been so great, manufacturers and traders have been led to look into the question, and have discovered that, in respect of cost of transport, they are working at a great disadvantage in comparison with foreign countries. Railway companies having practically ceased to be competitive, and having arrived at mutual understandings as regards passenger fares and goods rates, while the supervision of the Legislature has been insufficient to check such combinations, the public have had no remedy, and have been obliged to submit to whatever has been demanded; and hence have arisen those anomalies in rates which gave rise to the late Commission of Inquiry. The same thing practically would happen with canal or any other carrying companies, if they had the opportunity of coalescing either amongst themselves or with the railways, just as has happened on the Bridgewater Canal betweeen Manchester and Liverpool. What canals are capable of effecting in the way of cheapness is evidenced by the results attained on the Aire and Calder, where, as before observed, the cost of haulage has been reduced to 1-34th of a penny per ton per mile, at speeds of four and a half to six miles per hour. It is quite within the mark, then, to assume that a charge of 1-10th of a penny would suffice to cover all the other expenses, and yield a handsome rate of interest besides. At such a charge it is almost impossible to calculate the dimensions the traffic might not reach, for it would set in motion all kinds of articles of low value which now never move, because the cost of carriage is prohibitory. Hence it follows that much of the traffic that would seek the canals would not materially interfere with the present traffic on railways, for it would mainly consist of a class of goods which cannot afford to pay railway freight. The question, therefore, arises, Is it wise or politic for the nation to relinquish the enormous advantages it possesses in its existing system of canals, which originally so contributed to its wealth, and to refrain from undertaking their improvement up to the standard of modern requirements? No one can read the evidence placed before the Select Committee, and fail to see what the trading community and what the country itself is losing, by not following the example of all the continental nations, in putting their water ways into the highest possible state of efficiency, especially when the cost of doing so would amount to so small a sum in comparison with that which has been invested in the railway system.

The capital cost of the 4,000 miles of British canals has been variously estimated, at a mileage rate of £3,500 to £5,000, to stand at from £14,000,000 to £20,000,000 sterling, while the improvements of the main lines is variously calculated at from £5,000 to of £12,000 per mile more. If two of the principal lines were first taken in hand, one running north to Liverpool, and the other to Bristol from London, the metropolis and ports would then be connected with the districts yielding the three great products of coal, salt, and iron, and with the three great manufacturing industries, in cotton, pottery, and hardware. Along these two lines there would also be moved much of not only agricultural produce, but of farming requirements in general. It cannot be doubted that if the charge for carriage were reduced to one-tenth of a penny per mile, or from 2s. to 3s. a ton between London and Liverpool, and Bristol, the traffic would be enormous, and every class of the community, both producer and consumer, would greatly benefit thereby. This is not a question of theory, but deduction from actual facts, which are taking place at this time, and which are furnished by the experience of a properly designed and well administered canal like the Aire and Calder. Mr. J. Spencer Watson, of Blackwall, laid before the Select Committee a paper showing the relative cost of canal transport between London and Liverpool as it is, and as it might be with improved boats and steam tugs. The present cost of carriage in 50 ton boats is 10s. per ton, the future cost he estimates at from 2s. 6d. to 3s. per ton, both exclusive of tolls, and capable of further reduction if the carrier owned his own plant. The tolls between London and Preston Brook, 220 miles, are 5s. 2d., or at the rate of one-third of a penny per ton per mile, while on the remaining 20 miles of railway controlled canal to Liverpool the toll is 7s. 6d., thus obliging the canal carriers to charge 20s. to 22s. per ton, instead of from 8s. to 10s. Is it not, then, for the interests of the public generally that this matter should be taken in hand without delay, and endeavours made to repurchase the canals from the railways, and to remove the obstacles in divided interests and management which at present hinder these lines of communication from being placed under unity of control, whether as a private or a State enterprise. Surely if Water Regulation is a National duty, in no point could it be of greater importance than in the conservancy of its waterways, in protecting its internal lines of communication, and in the adoption of measures for the removal of the alleged obstacles, administrative and physical, before alluded to.

A universal revival of the Water Carrying trade throughout the country will give a great stimulus to many manufacturing industries. It would tend to enhance the value of all land bordering the canal banks; it would in its own direction, just as the railways have done in theirs, afford a vast increase of regular and well ordered employment to that portion of the population which is willing to work but cannot procure any, and would assist the exertions of those philanthropists whose sympathies have been lately stirred by the revelations contained in the "Bitter Cry of Outcast London," and similar pamphlets, by helping a large mass of the labouring classes to earn the means of paying for better accommodation, which, perhaps after all, is the first practical step towards securing the erection of a better class of dwellings. "God helps those who help themselves" is a trite saying not devoid of truth; so, if the aid of the Legislature is to be called in to devise a remedy for the evil of overcrowded habitations, could it be more usefully turned than in the direction of helping the poor to help themselves: and could this be better accomplished than by fostering a revival of an old industry, which used formerly to afford employment to a large mass of the working classes? That industry, if resumed on a scale commensurate with modern requirements, would not only again furnish a fair subsistence to greatly increased numbers, but, by the very nature of its business, necessitate the location of the work-people so employed in the neighbourhood of the suburban stations, where the mass of its particular traffic must needs be concentrated, and would thus probably contribute materially towards the desired object of relieving the present congestion in the heart of the Metropolis. But whether conducive to that end or not there can be no doubt that a restoration of the Canal System on a footing commensurate with modern requirements, will decidedly contribute towards ameliorating the state of the "Canal Population" itself, whose low social condition Mr. Smith, of Coalville, has not been content with only graphically and sympathetically describing, but has practically done his best to improve, by unceasing self-denying labour amongst them.

Having thus attempted to show the interdependence of the several branches of the Water question, and the consequent necessity for dealing with the Water property of the nation on a comprehensive basis as a whole, it remains to consider the administrative part of the subject, and the organisation by which it may be carried out.

The opinion expressed by some of the highest authorities, the recommendations of Parliamentary Committees, the resolutions passed at the Conferences of this Society, and the discussions held at other kindred institutions, are almost unanimous in the conclusion that the only way to secure the greatest good for the greatest number, will be by placing the Water Administration under a single direction, capable of judging of all questions on Supply, Flood, Drainage, and Transit. The recommendations contained in the Report of the Select Committee on the Public Health Act Amendment Bill, 1875, though referring more particularly to the water arrangements of the metropolis, are so thoroughly applicable to those of the whole kingdom, that they form a fitting conclusion to this paper:—

"It is," the committee observe, "essential to an economical as well as efficient sanitary improvement, that combined works should be carried out under one management. The less the extent of executive agency, the greater will be the concentration of responsibility and chances of early and successful execution. That the abandonment of water supply to private companies involves disregard of the public interest on important points, wherever the promise of trading profit does not arise, or when the continuance of such profit may be threatened, for example, first, in the item of cheap supply, and, secondly, in the case of possessors of rights on property who would, for public purposes, have conceded them at reasonable rates, but who consider themselves justified in acting on widely different principles, in dealing with the companies as the latter do with the public; that is, in exacting payment from them, not according to the service or value, but according to their necessities. Hence three or four times the market value of land or other property is obtained, one potent means of extortion being the expense of the procedure for obtaining private acts, and the threat of opposition if the terms are not complied with. By the execution of these works, however, as public works, the expense of which is defrayed by equal rates, and the necessity for immediate outlay obviated by a distribution of charges, all risks are saved to the capitalist and consumer; the middle or higher classes are relieved from undue burthens, and the charges may at once be lowered for all parties."

The Committee's general recommendations for the works of the metropolis are equally applicable for those of the whole kingdom, as advocated in this paper, viz., that:—

"Their execution will be best effected by unity of design and direction in the hands of a very few competent paid officers, giving their whole time and attention to the objects to be attained until they are accomplished. That the most effective and real responsibility will be secured to the great body of ratepayers as well as to every resident, not by attempting to fix responsibility on a multitude of fluctuating parochial (and it may be added), or municipal bodies, but by making it direct through the Government to Parliament."

The Committee conclude with observing—

"That the proper execution of the works will be best guaranteed, the responsibility of the persons charged with their execution best ensured, and the interests of the poorer classes of the population best guarded, by the control of Parliament."

There is one other point, only incidentally alluded to in the above remarks, that calls loudly for reform, and that is the expenses which all schemes for improvement seem obliged to incur before they can obtain Parliamentary sanction. It appears monstrous, for instance, that such an important scheme as the Manchester ship canal should have to incur an expenditure of £100,000 before it can obtain the necessary Act. Many deserving schemes are thus at the outset weighted with a large unremunerative outlay, and many, especially navigation improvements, it is said, cannot be brought forward, through the Companies being unable to encounter the Parliamentary and other expenses necessary to overcome needless opposition and obstruction.

The appointment of a permanent Water Commission, similar to the Railway Commission, whose time now is apparently fully and almost entirely occupied with railway matters, would probably prove the best central controlling authority. Its members should be appointed either permanently or for a definite number of years, and might consist of three, or, perhaps better, of five officers, seeing that the schemes to be brought before it embrace engineering, sanitary, legal, agricultural, and financial considerations. To it may be confided all the subsidiary arrangements as to local supervision, the composition and responsibilities of conservancy bodies, and the limits of their respective authorities, in fact the settlement of all administrative details; the Commission itself to be responsible to the nation through Parliament, to whom it should annually render an account of its stewardship.

There remains yet the financial portion of the subject to be considered. It appears to be the opinion of most of the eminent authorities who have expressed themselves on the point, that the method which would be attended with the most economy, would be for the Government to manage the financial arrangements. In the discussion on national water supply at the Congress held by the Society, Sir Henry Cole observed that "the general financial principles to govern the scheme should be the work of the Government. The capital required might be a hundred million pounds or more, but what was that, looking to the cost of railways, with so important a matter as pure water?" Without contemplating, however, such large expenditure, it would, doubtless, be practicable to raise a Government Water Loan at a low rate of interest, as has been done for the purchase of the telegraphs, or as was proposed to be lent to the Suez Canal Company, for the purpose of advances on reasonable security to such companies or corporations as may desire to carry out improvements to a scheme of supply or navigation approved by the Commissioners. Amongst other financial proposals, it has been suggested that the requisite capital might be raised on the guarantee of a penny income-tax. Though such a proposal would doubtless be met with strenuous opposition, yet it is tolerably certain that the taxpayers would be more than repaid by the great reduction in cost that would ensue in the single item of coal. The Continental system of executing public works by State agency is not one that commends itself to this country, the tendency of public opinion being to deprecate anything like State interference, but there is a difference between the State being the actual proprietor of the works, or the agency by which they are carried out, and its undertaking merely the financial operation of raising the requisite funds for their construction. At the same time, there is unquestionably also a difference between Water projects and schemes like railways involving merely the one element of carriage. In the former, sanitary, agricultural, and domestic, as well as public interests are involved, and, as experience has proved, such interests are better not left to the ministration of private associations. Therefore, doubtless, it is that so many influential advocates are to be found for Water schemes being undertaken by the Government for the nation.

From whatever point of view then the water question is regarded, whether as schemes for the Supply of a necessary of life for every household in the kingdom; or as a source of benefit or injury to property, according as Floods are regulated or unrestrained, or Drainage perfected or neglected; or as Navigation works for securing the cheapest possible conveyance of some of the most necessary articles of domestic consumption, and of the largest items of its internal trade, an end which the country is now anxiously seeking, there can be no hesitation in pronouncing it—in amplification of His Royal Highness's recommendation—an essentially National one; to be dealt with no longer by municipal or other local authorities, but to be treated as a vast imperial question of the greatest importance, demanding a combination of the highest talent and largest experience that are available for its solution.

APPENDIX.

SELECT COMMITTEE ON CANALS, 1883.—PAPER HANDED IN BY MR. J. S. WATSON, JUNE 14, 1883.

Statement of Cost of Canal Transport between London and Liverpool, if effected with three Boats (84 ft. by 12 ft. by 6 ft. 3 in. draft) carrying 120 tons each, and towed by similar-sized Steam Barge carrying 90 tons (450 in all), exclusive of Canal Tolls.

Time for Journey 5 days, with 2 days to load, 2 days to unload, and 1 spare day, say 10 days.

Total Cost of New 120-ton Barges.	Hire of Barges, the Owners doing Repairs.		£ s. d.
£620 each	£100 per annum	= 6s. 8d. per day for each barge for 300 days } 6s. 8d. per day + 10 days + 4 barges	13 6 8
	Wages	9s. per day for each barge — 9s. per day + 10 days + 4 barges	18 0 0
	Haulage, 18 horse-power; none fitted in steam barge.		
First cost of Machinery, New.	Hire of Machinery.		
£600	£120 per annum	= 8s. per day...... 8s. per day + 10 days £4 0 0	
	Wages of engine-drivers	10s. per day......10s. per day + 10 days 5 0 0	
	Coals, oil, &c.	5 days steaming 3 0 0	
			12 0 0
	Expenses incidental	Say 1s. per day + 10 days + 4 barges	2 0 0
	Nett cost* of transport, if the carrier paid hire rates for all his plant		45 6 8
	Profit, say 25 per cent		11 6 8
		Cost of transport of 450 tons would be	£56 13 4

This is equal to 2s. 6½d. per ton, and might fairly be reckoned at 3s. per ton exclusive of the canal tolls.

* The nett cost would be somewhat less if the carrier owned his own plant.

Cost of Canal Transport as now carried on between London and Preston Brook (for Liverpool) in two 25-ton Canal Boats, exclusive of Canal Tolls.

Time for Journey 8 days, with 1 day to load, and 1 day to unload, and 2 spare days, say 12 days.

Total Cost of New 25-ton Boats.	Hire of Boat, Owners doing Repairs.		£	s.	d.
£120	£30 per annum	= 2s. per day for 300 working days } 2s. per day + 12 days + 2 boats	2	8	0
	Wages	8s. per day per boat — 8s. per day + 12 days + 2 boats	9	12	0
	Haulage one horse to each boat.				
	Horse hire	2s. 6d. per day } 6s. per day + 12 days + 2 boats	7	4	0
	Horse keep and expenses	3s. 6d. per day...			
	Expenses, incidental	8d. per day per boat — 8d. per day + 12 days + 2 boats	0	16	0
	Nett cost, if the carrier paid hire rates		20	0	0
	Profit, say, 25 per cent		5	0	0
		Actual cost at present time for 50 ton	£25	0	0 = { 10s. per ton exclusive of tolls.

The present tolls charged on iron work from London to Preston Brook are, for 220 miles ...... 15s. 2d. per ton.
And at Preston Brook trans-shipment into larger craft is necessary, for which the Bridgewater Navigation Company charge for 20 miles ...... 7s. 6d. ,,

The actual rate is about 20s. to 22s. per ton ...... 22s. 8d. ,,

STATEMENT OF ABSTRACT LENGTHS OF CANALS, INDEPENDENT AND OWNED BY RAILWAY COMPANIES IN THE UNITED KINGDOM,

Presented by Mr. Calcraft, Assist.-Sec. Board of Trade, Railway Department, to the Canals Committee.

	England.	Scotland.	Ireland.	Great Britain and Ireland.
	Miles.	Miles.	Miles.	Miles.
Owned or controlled by Railway Companies ...	1,259½	85	92	1,436½
Owned by other than Railway Companies ...	1,428½	—	164	1,592½
Grand total				3,029

These lengths are exclusive of the Rivers Thames, Severn, Wye, Humber, Wear, and Tyne in England; Clyde, Forth, Tay, and the Caledonian Ship Canal in Scotland; and the Shannon and other Navigations in Ireland.

SUMMARY OF CANALS AND NAVIGATIONS IN ENGLAND AND WALES,

According to the statement presented to the Canals Committee by Mr. E. J. Lloyd, General Manager of the Warwick Canal.

	Miles.
Public Trusts	927¼
Independent Canals	1,445¼
Guaranteed and owned by Railways	1,333
Derelict	188½
Ownership not known	36¾
Converted into Railways	119¾
Total	4,050½

DISCUSSION.

Sir ROBERT RAWLINSON, C.B., being called upon to open the discussion, said he was sorry to say he could not endorse a good deal which had been put forward, and, at the same time, he was loth to throw out any disparaging remarks at the beginning of the discussion. With regard to the regulation of floods, however, there was a mistake, in one respect, in the figures adduced, as to the method of dealing with floods in the Thames. The writer stated, on some authority, that the flood was to the dry weather flow as about 24 to 1, viz., 20,000 cubic feet in flood to 833 feet in dry weather; but the fact was the Thames rose from 10 to 12 feet in flood, and the first few inches of that rise would give more than that difference. This would show what an enormous fallacy was involved in the figures given. In the drainage area of Lancashire and Yorkshire, where water supplies had been carried out, the dry weather flow was about half a cubic foot per second per 1,000 acres, whilst the flood flow was from 500 up to 600 times that amount. He had had the question of regulating floods in the Thames under consideration before, and had noticed that it had been treated of in magazine articles by writers who knew nothing whatever about it. Mr. Ruskin some time since recommended compensating reservoirs to regulate the floods in Italian rivers, but if he knew as much about floods as he said he knew about pictures, he would never have hazarded any such remarks. Reservoirs might be made for any purpose, and he did not disparage them for the purpose of canals or water supply, but as to making compensation reservoirs to regulate or diminish river floods, all the capital in the country would not do it. Such reservoirs must be either full or empty; if they were full they would be of no use, as they would hold no more water, and if they were empty, probably two days' very heavy rain would fill them. In a small area he had under his own control, where the dry weather flow was about 250,000 gallons per day for months continuously, the flood flow was in one day upwards of 90,000,000 gallons. What size then must be the compensating reservoirs for such a district? Where would you find the sites or the money necessary to make compensating reservoirs for the Thames? Last week he went down to inspect the water supply recently formed for the town of Leeds; not quite finished. The reservoir were about the finest he had ever seen; they were in the Valley of the Wharfe, three in number, one below the other; they cost from £150,000 to £200,000 each, and were capable of impounding 20,000,000 gallons per day. Out of that they were obliged to send 6,000,000 for compensation, leaving 14,000,000 for Leeds, and at one point they had pumping power by which they could raise 6,000,000 more if required. Those works, with the necessary distributing apparatus, had cost some £1,500,000, the population being about 320,000, or about £5 per head. The metropolitan water supply took each day about 150,000,000 gallons of water from the Thames, the Lea, and the chalk springs, equal to about one-third the dry weather flow of the Thames; but the quantity actually taken from that river was about 80,000,000 gallons. The various works were valued by Mr. Smith for the late Government at £33,000,000, but the present Government repudiated the bargain, and denounced it as a job. As an engineer, having some knowledge of the value of waterworks, he said it was not a job; he believed it was as honest a valuation as ever was made, by as able a man as ever undertook such a task, and that London would never again have so good a bargain offered it. He made this remark because the subject must come up again. He quite agreed with General Rundall, that the utilisation of water should, in many respects, be both national and municipal. Water should not be dealt with like sugar, butter, or beer; it should not be dealt out so as to produce the largest dividend, but should be so stored that it could be utilised by the community at the cheapest cost, and that all surplus might be used for public purposes at prime cost. Dwellers in London knew what a condition the streets and footways were in after two or three small falls of rain; but if the water-supply were in the hands of the municipality, every public footway might be washed with water, not costing more than ½d. per 1,000 gallons, instead of 6d. or 8d., as was charged by the companies now; and they would then be made as clean as they were after a heavy thunder storm, every week, and every day, if necessary. All the great municipal bodies were acquiring the water supply in the same way as London would have to do, if any municipal body were established which could have the control of it. They would have to pay a fair and honest price for it; not a confiscating price. That price would necessarily be large, but it would not be dear, if in future they had no more dividends to pay, but only the interest on the capital, which a community like London could borrow at 3¼ per cent. The companies were now paying 8, 10, and 12 per cent., hence the great value they put on their works; and as the works extended, that interest went on in the same ratio on a larger capital. If the municipality had the works, they would only have to pay the cost of management, and by consolidation, from £50,000 to £100,000 a year might be saved in management. It was just the same with regard to gas; Manchester, Birmingham, and Leeds had acquired the gas. Leeds gave a large price for the existing works, but they now supplied gas at 1s. 10d. per 1,000 ft., and made a surplus. In Birmingham there was not a man in the Corporation who dared to face the large expenditure involved in purchasing the water and gas works until Mr. Chamberlain became mayor, the idea being that it would saddle the town with an enormous debt, forgetting that when you bought a paying property you were not incurring a debt, but acquiring an estate. In 1852, he valued the Birmingham Waterworks, and they could then have been bought for some £350,000, but they were afraid of it. When Mr. Chamberlain became mayor he showed them that they had been losing about £7,000 a-year by not having bought them, and they then gave some £1,250,000. They had been considerably enlarged, the result being that the water was cheaper and better in quality, and was distributed over a wider area, and produced an income which more than paid the interest on the capital, and maintained the works in efficiency. With regard to the purport of the paper, he had no hesitation in saying that, if the question of utilising and storing water, and putting it to the most beneficial uses, were taken up as it was in France, enormous benefit might accrue; but he did not think the railways were going to be injured, or much of their traffic taken away. Still, there was a great deal of traffic which it was not all necessary should go at railway speed, and which might be carried by canals, and it was worth considering how far that could be done. He must repeat, however, that the idea of preventing floods by storage reservoirs was one that no engineer acquainted with the subject would dream of.

Mr. Martin Wood expressed his satisfaction that this large and pressing question of inland water transit had been brought forward. One of the foibles of Englishmen was to run too much in one groove at a time, and that had been the case with railways. The canals were too much cramped and subordinated to the railways, and if that state of things could be altered, it would have a very beneficial effect on our national industries. When we considered what was being done on the continent, we should see the importance of more attention being given to the question of water transit.

Mr. Liggins said there was no doubt that all large cities required a larger water supply, and more wholesome water for domestic purposes, as well as for cleansing the streets. But he did not like the idea of great impounding tanks being formed at the source of the River Thames; for instance, one of the most important adjuncts to navigation was a proper scour in the rivers to keep the channels clear, and he knew there were many men of the highest authority who were uneasy with regard to the shallow waters in some parts of the mouth of the Thames, which were more and more impeding navigation. To curtail the flood outlet would, to his mind, be a great mistake. The rural population higher up the river, as a rule, got their water from ponds and wells practically for nothing, and if these expensive works were carried out, it would necessitate the imposition of local rates, which would be strenuously resisted. When the Metropolitan Board, and the best engineering science of the day told them that a sufficient supply could be obtained from the chalk, he should hesitate to support an extension of the supply from the Thames. He had never heard a more unpractical scheme in his life than that for going back to canals for inland goods traffic. Thirty years ago he had to bring a large steam boiler from a Midland town to London for shipment to the West Indies, and it was frozen up in the canal between London and Birmingham for seven weeks, causing great delay and inconvenience to the ship which was to take it out. A railway company received goods in any town on one day, and, as a rule, delivered them next day at the dock; and the rates were nearly the same from all towns to any port in the neighbourhood of London. The canal companies did not appear to think so very much of the future before them, for there was a Bill lately in Parliament for converting the Regent's Canal into a railway. The metropolis wanted a good supply of pure water, and he did not think the public would long desire to continue the present system under which private companies had a monopoly. He hoped engineers would turn their attention to the question of obtaining a better supply of water from chalk.

The Chairman, in moving a vote of thanks to General Rundall, said he could not profess to follow him into the details of his paper, but he might say a word or two on a very important subject. The development of the water transit of the country was one of the main points treated of, and this was certainly a matter of great interest to the whole trading community. Although it was perfectly true that the railways were, and must remain, the dominant carrying power, still the question arose whether the best use was being made of the waterways which existed throughout the country. This was a question raised in the paper, and it was deserving of serious consideration. No doubt a great deal of the water communication had fallen practically into disuse, still, there were many instances in which canals were carrying a good deal of traffic, and earning very fair profits by so doing. The Bill for dealing with the Regent's Canal was not quite what it had been described by Mr. Liggins. It was a Bill to enable a company to purchase the Regent's Canal, and lay down a railway by the side of it, because the roadway of the canal afforded the cheapest and most easy means of laying down a railway in that direction; but the Bill contained a very stringent clause for keeping the water-way open, and of a certain specified depth, because that canal happened to be a most important outlet to the internal communication of the country. General Rundall also referred to the question of floods, which affected another most important national interest, that of agriculture. The question was one of enormous difficulty, and he should have been glad if Sir Robert Rawlinson had gone more fully into it. As a Member of Parliament, his attention had often been called to this subject, which was one of very great difficulty, both in an economic and legislative sense, and he was rather disposed to think, though he spoke with some hesitation, that it was one which must be dealt with in a broad and general way. It had more than once been referred to Parliamentary Committees, but it required such a large grasp of a difficult and scientific subject, that he feared such a body was hardly competent to deal with it. What was really wanted was a strong board of men thoroughly conversant with water matters, and having powers to deal either with the whole country, or with very large areas. One other question had been dealt with, perhaps most important of all, because it effected not only the commercial and agricultural interests, but almost every person in the country, and that was the water supply of large towns. He had been extremely pleased to hear what was said by the reader of the paper, and also by other speakers, with regard to the importance of giving to towns a supply of water in such a way that no interest was concerned in making a profit out of it; the great necessity being a plentiful supply of pure water at prime cost. He remembered the negociations which went on with regard to the purchase of the water companies of London, some years ago; he knew Mr. Smith, and was glad of the opportunity of bearing testimony to the great zeal and ability which he had displayed in the matter, and he feared that the labour he incurred in endeavours to carry out that most difficult negotiation, and his disappointment at its failure, contributed very much to his death shortly afterwards. He remembered his mentioning to him one point which it was very material to bear in mind in any negotiation of this kind, that if all the companies around London were united under one management, that fact alone would effect an enormous saving. Mr. Smith told him, when talking the matter over, that the moment he accomplished this union, although the price given might appear larger, there would be a saving in the cost of management of at least £50,000 a-year. He believed that was underestimating the figure, and Sir R. Rawlinson had put it much higher. But it was not merely the saving of money which was involved; the most important point was the power of drawing water from the most valuable and purest source, as well as the convenience of management. He greatly regretted that, owing to some misunderstanding in the mind of the public, and possibly also to a certain amount of party feeling, the negotiation broke down, and he should only be too glad if an opportunity occurred for its renewal, either on the terms then arranged, or, if possible, on more favourable ones, because he felt that it was of the utmost importance that the water supply should not be in the hands of private companies, but of a public body who would supply it at prime cost. But whilst saying that, he must guard himself against any suggestion that property should be taken without proper compensation. In dealing with private property it was of the greatest importance, not to the rich man only, but still more to the poor man, that rights of property should be most rigidly respected. If these companies had Parliamentary rights on which individuals and trustees had invested money, and the public were going to deal with the matter, those rights must be respected. The last point on which he would say a word was the suggestion that the canal or water system should be bought up and managed by the Government. He thought they were a long way from any scheme of that sort, and he had great doubts whether Government management was beneficial, except in certain exceptional cases. He thought Government interfered too much with private matters, and that, on the whole, most matters were much better left in the hands of private enterprise.

The vote of thanks having been carried,

Lieut.-General RUNDALL, in reply, said it was only right that a paper publicly brought forward should be freely criticised, and he was very glad that his paper had elicited so much discussion. Sir Robert Rawlinson, however, had slightly mistaken his figures. What he said was that the flood-water was 20,000 cubic feet, and that 5,000 cubic feet might be brought under regulation. Of course, every engineer had his own ideas about these matters, and, perhaps, as Sir Robert Rawlinson was so great an authority, it would not be proper to call his dictum in question; but he would not, perhaps, have made his concluding remark if he had been aware that he (Lieut-General Rundall) had been an engineer for thirty years, and had had under his control the reservoirs of the whole Empire of India, those reservoirs not being measured by acres but by square miles, so that he did know something about reservoir engineering. He had also had the charge of rivers of the greatest magnitude. With regard to other matters, such as the re-establishment of canal navigation, they could only be decided by a consideration of facts which actually existed, and as he had given those facts in the paper, he would not go over the ground again.

Miscellaneous.

PREPARATION OF TAPIOCA.

By JAMES COLLINS.

The tapioca plant (*Manihot utillissima*, Pohl), a euphorbiaceous plant, is too well known to need a description here. The late Dr. Seemann informed me that he had heard from Chinese that the peculiar lumpy form in which we receive tapioca was owing to the action of a peculiar kind of wood used in the preparation of the starch. In the case of India-rubber, in a certain part of South America, the addition of the juice of *Calonyction speciosum*, brings about the more speedy coalescence of the particles of rubber, and salt water or lime juice is used in the East for the preparation of India-rubber and gutta-percha. In India too, the capsules of *Puneeria coagulans* are used in the making of cheese instead of rennet, and thus the product does not interfere with the religious observances of certain castes. The common wood sorrel of the country, *Oxalis acetosella*, acts also as rennet, and in Jersey the leaves of the ash are used to prepare curdled milk and cheeses.

In the case of tapioca, however, I told Dr. Seemann that I believed the agglomeration and alteration was owing to the starch being partially changed into dextrine. This I have since proved to be the case. Whilst in the East I endeavoured to clear up the matter. In the case of gambier, I only saw part of its preparation in Malacca, where I was on sick leave. It was near a gambier plantation, and I saw two or three Chinese coolies just boiling down in the open air, the freshly gathered plant in a large copper, or "quallie," over an improvised fireplace. Their stirring apparatus consisted of two or three different kinds of wood, and a long-handled iron shovel, somewhat of the same shape as that used by bakers. The latter seemed to be most prized. Either from reticence or because the coolies understood but little Malay, I could not ascertain whether any particular wood was used or prized. In the case of the preparation of sago, although whilst in Singapore I purposely rode and drove several miles out into the country on various occasions, I never saw the whole of the process of preparing granulated sago, yet what I did see left me no grounds to believe that any particular wood was used, and I was assured by European planters and native operators that various woods were used, but none for any particular quality, and iron stirrers were much preferred.

As to tapioca, whilst in Malacca, I saw the whole process, from the fresh root stock to the finished product in the process of packing for market. I ascertained that there were two or three large tapioca plantations some miles up country, and a friend kindly offered to make arrangements for my visiting them. We visited two or three plantations, but as they were all conducted on the same principle, it will suffice to describe the largest and best. It belonged to a wealthy Chinese, and the factory was well and substantially built of stone and brick. The first thing we noticed was a large horizontal engine with a European engineer in charge. We were soon ushered into the presence of the owner, and received with that courtly ceremony for which the well educated Celestial is remarkable. Refreshments were quickly served, consisting of tea, tiger's milk, *i.e.*, cocoa-nut milk with a dash of brandy, various fruits, cigars, &c., and had to learn, if we did not know before, that an Eastern must not be hurried. At last we proceeded to the manufactory. Here above our heads, and in every direction, were driving bands, streams of water flowing in every direction, glowing fires, and a hive of Chinese—a loin cloth, and that of the scantiest dimensions, alone saving them from being quite naked.

Taking our station at the far end, we saw droves of Chinese arriving from the fields with baskets slung on poles filled with the fresh tapioca root stocks. These were at once taken by others to large tubs, fed with a constant stream of water, and the root stocks cleansed from adhering mud, and then passed on to the "paring" table. Here the dark outer coat was peeled off, just as one might peel a turnip, and all discoloured or bad parts removed. Next, the cleaned root stocks were passed on to a machine furnished with knives, and sliced, then passed on to a pulping machine. After being thus treated, the pulp was removed in cane baskets to the strainers. These strainers were large wooden frames, with calico bottoms, and were fed from the pulp baskets, Above these strainers were tanks giving off a powerful stream of water impinging on the pulp, and the strainers had a motion communicated to them by a shaft exactly like that given by hand in sifting. As the starch became washed out, it was received into inclined troughs, and allowed, whilst in suspension, to run into settling "vats." Here, after well stirring, the starch was allowed to settle, and the water drawn off, and fresh being pumped in till the starch became clean and white. In this part of the building, which was on a lower plane than the rest, the smell of hydrocyanic acid was by no means faint. When the starch had undergone this washing, and had been strained, whilst still moist, it was removed to the drying department.

The machinery we have mentioned occupied the central line of the building, and on either side, next the wall, was the drying apparatus. On the one side tapioca flour was prepared, and on the other the granular form of it. The flour was prepared by spreading the wet starch on a long iron table or slab, heated slightly by fires placed underneath, and constantly stirred and turned over with iron shovels to prevent agglutination, and ensure equal drying. The granulation was performed as follows:—There were a long range of quallies, or small iron shallow pans, slightly tilted forward on ledges of brickwork, and heated with a wood fire. Each operator had a qualie and fire to himself. Taking up a quantity of damp starch, he stirred it round and round with his iron shovel, and the heat being greater than in the former case, as it became stirred about, became agglutinated together in small masses, and became coated with dextrine. We could not but admire the dexterity with which it was done; how well the open fires were managed, so that no more heat than was necessary was communicated. The "bullet" tapioca we also saw made; it is done by pressing the starch through perforated plates and "cooking" in "quallies." No wood was used in stirring, and when I asked why, I was told that only those who could not afford iron used wood.

Notes on Books.

THE PATENTS, DESIGNS, AND TRADE MARKS ACT. With Notes, &c, by Roger W. Wallace. London: Maxwell, 1884.

To the text of the Act, Mr. Wallace has added a full commentary, in the form of notes to the various sections; he has also prefixed a general introduction, in which are given a summary of the principal changes effected by the new Act, a brief account of the origin of the Law of Patents, and some notes on the principles on which the law is based. There is also, before the text is reached, a table of the steps to be taken in order to obtain a grant of letters patent. The notes are for the most part explanatory or illustrative, but are in some cases critical, as when the author points out that the permission of opposition after the publication of the specification will encourage fraudulent opposition; or shows that the privileges granted to inventors as against the Crown are less valuable than they appear at first sight. In passing, it may be noted that Mr. Wallace has overlooked the fact that the examination as to sufficiency of description is to be confined to the provisional specification. From his remarks (p. 24, and again pp. 18 and 19), he does not seem to have appreciated this. On the whole, the author's comments are favourable to the Act, and he evidently expects that the results of its working will be beneficial to the inventor, especially if the Board of Trade hereafter exercise their powers of reducing the fees for the later stages. Several new points are taken. The fact that there are no references to the Channel Islands in the Act does not seem to have attracted any previous comment. Nobody appears to have noticed that the portions of clauses in which they were mentioned were, in deference to the susceptibilities of their governing bodies, quietly dropped out at one of the stages. It might be fair subject for inquiry. What is now the state of the Patent Law in those islands? Besides the Act itself, the rules issued under its authority by the Board of Trade and by the law officers are given, and, indeed, they occupy almost exactly the same space as the Act and the notes upon it—half the book, in fact, if the sixty pages of introduction be left out of reckoning. In conclusion, it may be noted that Mr. Wallace gives due credit to the Society of Arts for its efforts to promote a reform of the law.

General Notes.

Australian Saddlery.—In New South Wales the number of saddlery and harness manufacturers is 231, against 123 in 1875, the returns for 1874 being defective. The New South Wales imports of saddlery and harness during 1882 were:—Great Britain, 1,660 packages; Victoria, 1,765 packages; South Australia, 155 packages; Queensland, 57 packages; New Zealand, 5 packages; United States, 154 packages; New Caledonia, 1 package; and Germany, 11 packages. The total value of these imports was £81,631, of which the British manufactured goods amounted to £55,355.

Lace-making in Ireland.—Mr. Alan S. Cole delivered lately two lectures on lace-making and Irish lace, in the Lecture Theatre of the Royal Dublin Society. He said that the Science and Art Department had given him its directions to proceed to Ireland, in compliance with a request which had been made to it last year by members of Parliament representing Irish constituencies. As might be remembered, exhibitions of Irish embroidery, lace, crochet, and similar work were held last year in Cork and London. They demonstrated in a conspicuous manner that Ireland possessed an unusual talent for producing such works. But whilst that talent was strongly developed, the absence of correctly drawn patterns, and indeed of a supply of new patterns, was as strongly proclaimed. Without some effort to counteract that poverty in design, the workmanship, however good, must gradually cease to have any value of itself. An effort had therefore to be made. It was, however, only in its infancy, and required all the snpport and tending which could be given to it. The first symptom of the seriousness with which that effort was being put forward might, he thought, be seen in the applications for help which were sent by different schools and convents to the Science and Art Department. The influence of the Dublin School of Art and Needlework would, no doubt, extend in time to the numerous art needle-workers scattered throughout the country. The lecturer then passed on to the art of lace-making by hand, which, he said, had, for upwards of a quarter of a century, been struggling in Ireland. Having described in detail the characteristics and the process of making needle point, and pillow laces, he proceeded to deal with the subject of machine-made lace. Contrasting hand-made lace with lace manufactured by the aid of machinery, he remarked that thousands of yards of lace could be made in a day by a single machine, whereas but a foot or two of simple patterned narrow lace could be made in a day by a single lace worker. But, then, hand-made lace was attended by the advantage that the worker could introduce a plait or particular loop which the machine could not accomplish.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

March 19.—"The Elephant in Freedom and Captivity." By G. P. Sanderson, Superintendent of Government Elephant-catching Operations in Bengal. Sir Joseph Fayrer, K.C.S.I, M.D., F.R.S., will preside.

March 26.—"Vital Steps in Sanitary Progress." By B. W. Richardson, M.D., F.R.S. Sir Robert Rawlinson, C.B., will preside.

Foreign and Colonial Section.

Tuesday evenings:—

March 18.—"Borneo." By B. Francis Cobb, Vice-President of the Society. Admiral Ryder will preside.

APRIL 1.—"The Rivers Congo and Niger entrances to Mid-Africa." By ROBERT CAPPER.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings:—

MARCH 27.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R.S., will preside.

APRIL 24.—"Economic Applications of Sea-weed." By EDWARD C. STANFORD, F.C.S.

INDIAN SECTION.

Friday evenings:—

MARCH 28.—"Trade Routes in Afghanistan." By GRIFFIN W. VYSE. LORD ABERDARE, F.R.S., will preside.

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

CANTOR LECTURES.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint.

LECTURES I. and II. March 17, 24.—Gradual Development of the Processes of Coining. The Composition and "Standards of Fineness" of the Alloys used for Coinage in Ancient and Modern Times.

LECTURE III. March 31.—Methods by which Accuracy of Weight and "Fineness" of the Alloys is ensured.

LECTURE IV. April 7.—Questions connected with the liability to Reduction in Weight and various Coins by Wear during Circulation.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 17...SOCIETY OF ARTS, John-street, Aldelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts, "The Alloys Used for Coinage." (Lecture I.)

National Indian Association, Exeter-hall, Strand, W.C., 4 p.m. Annual meeting.

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. H. Woods, "Ensilage—its Influence upon British Agriculture."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper on "Evolution."

TUESDAY, MARCH 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. B. Francis Cobb, "Borneo."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Animal Heat, its Origin, Distribution, and Regulation." (Lecture III.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. James A. Longridge, "Wire-gun Construction."

Statistical, Royal School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. G. B. Longstaff, "The recent Decline in the English Death-rate, considered in connection with the Causes of Death."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

East India Association, the Council Room, Exeter-hall, Strand, W.C., 3 p.m. Mr. A. K. Connell, "Indian Pauperism, Free Trade, and Railways."

Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, MARCH 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. P. Sanderson, "The Elephant in Freedom and Captivity."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Brief Notes on the History of Thermometers." 2. Annual Exhibition of Thermometers and other new Meteorological Instruments.

Geological, Burlington-house, W., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. Thomas Morgan, "Review of the evidences and theories relative to Cæsar's Landing Place."

College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. H. Jackson, "Evolution and Dissolution of the Nervous System." (Lecture I.)

THURSDAY, MARCH 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Greenwood Pim, "Hairs occurring on the Stamens in Plants." 2. Mr. A. W. Waters, "Closure of Cyclostomatous Bryozoa." 3. Mr. C. B. Plowright, "Life History of *Æcidium bellidis.*" 4. Mr. F. Kitton, "Diatomaceæ, from Island of Socotra."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Gladstone, F.R.S., and Mr. Tribe, "Note on the Preparation of Marsh Gas." 2. Mr. R. Meldola, "The Action of Dibrom-a-napthol upon Amines."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "The Older Electricity, its Phenomena and Investigators." (Lecture IV.)

Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Special Meeting.) Mr. A. C. Kirk, "Compressed-Air and other Refrigerating Machinery."

FRIDAY, MARCH 21...United Service Inst., Whitehall-yard, 3 p.m. Colonel Sir Charles B. Nugent, "Imperial Defence—Part I. Home Defence."

Royal Institution, Abermarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. Matthew Arnold, "Emerson."

College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. H. Jackson, "Evolution and Dissolution of the Nervous System." (Lecture II.)

Philological, University College, W.C., 8 p.m. Mr. Thomas Powell, "The Keltic Derivations in Prof. Skeat's Dictionary of English Etymology."

Medical Officers of Health, 1, Adam-street, Adelphi, W.C., 7½ p.m.

SATURDAY, MARCH 22....Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thompson, D.Sc., and Mr. Colman C. Starling, "Hall's Phenomena." 2. Mr. H. Tomlinson, "Hall's Phenomena." 3. Prof. S. P. Thompson, "Some Propositions in Electromagnetics."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Captain Abney, "Photographic Action considered as the Work of Radiation." (Lecture IV.)

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FRIDAY, MARCH 21, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

APPLIED CHEMISTRY & PHYSICS SECTION.

The discussion on Dr. Percy F. Frankland's paper, "The Upper Thames as a Source of Water Supply," read on Thursday, March 13th, was adjourned until to-night, 21st inst., at 8 p.m. The paper, with the whole of the discussion, will be printed in the next number of the *Journal.*

CANTOR LECTURES.

The first lecture of the course "On the Alloys Used for Coinage," was delivered on Monday evening, the 17th, by Prof. W. Chandler Roberts, F.R.S., of the Royal Mint. He pointed out that although the gold coinage of this country is estimated to consist of no less than 700 tons of an alloy of gold and copper, information as to the nature and composition of the alloys used for coinage is far from being widely diffused. The views of many people on this important subject may still be expressed by the words of William Stafford, one of the earliest of English political economists, who writing in 1581, makes a knight "confesse that he could not perceave what hinderance it should be to the realm to have this metal more than that, for our coyne," provided it "be stricken with the Prince's scale." The operations of a modern Mint are chiefly remarkable for the extreme care and accuracy with which they are conducted, and, this being the case, it was considered advisable to devote the present lecture to tracing the steps by which the machinery and appliances now in use have been arrived at. It is, however, very difficult to describe the history of the mechanical side of coining chronologically, because the progress has been by no means continuous, as certain types of machines have survived persistently in some countries, and have been abandoned in others, often to be again introduced with or without modification. Illustrations of this fact were then given. The methods adopted by the Greeks in striking coins, and the casting of coins as conducted in late Roman times were indicated, while more recent plans were illustrated by cutting discs of metal, by means of an appliance formerly used in the Mint in the Tower of London, and by striking them by a press devised in the Paris Mint, early in the present century.

Professor Roberts said it had often been contended that art had suffered serious loss by the replacement of the old hand-struck money by coins struck by machinery. It was, therefore, not a little remarkable that the artists who were connected with mints appear to have been the very people to insist on the introduction of mechanical improvements. For instance—to take only the comparatively well-known names from those mentioned—Benvenuto Cellini described, in 1586, the screw press which, in a form modified to enable it to be worked by steam-power, has only just been abandoned in the Mint in this country. Leonardo da Vinci, as Dr. Richter has recently shown, devised in 1515, for use in the Mint at Rome, a method of cutting out discs of metal for coinage, which was a great advance on the crude methods employed in the 16th century. Briot, Engraver-General of the Paris Mint, invented a machine, used in this country in the reign of Charles I., which depends upon a principle definitely adopted in the new lever-coining presses now at work; and his pupil, Simon, the best engraver England ever had, employed an elaborate mechanical contrivance, which enabled him to produce one of the most beautiful coins known.

In order to meet the objection that the artistic side of minting was hardly within the province of the chemist, Professor Roberts quoted Biringuccio, one of the greatest of the early metallurgists, whose advice to the Mint master, written in 1540, might be briefly stated as follows :—"If the coins are very accurate as regards 'standards of fineness,' but small profits can be made ; while, if too much base metal is introduced, the execrations of the people will follow ; but especial care should be devoted to the preparations of the dies for striking artistic coins, so as to give the people pleasure in things they are obliged to use."

SOCIETY OF ARTS PRIZES.

The Council of the Society of Arts are prepared to award the following prizes in connection with the International Health Exhibition:—

Under the *John Stock Trust*, a Society's Gold Medal or £20, for the best example of sanitary architectural construction, Classes 20, 28, 29, 30, 32 of the Exhibition.

Under the *Shaw Trust*, a Society's Gold Medal or £20, for the most deserving exhibit in Classes 41, 42, 43, and 45 (relating to Industrial Hygiene).

Under the *North London Exhibition Trust*, a Society's Gold Medal or £20, for the best set of specimens illustrating the handicraft teaching in any school—Classes 49 and 50.

Under the *Fothergill Trust*, Two Gold Medals (or two sums of £20), one for the best exhibit in Class 27 (Fire Prevention Apparatus), and one for the best exhibit in Class 26 (Lighting Apparatus).

From the *Trevelyan Prize Fund*, Five Gold Medals (or five sums of £20), for the best exhibit in each of the following Classes:—2, 3, 6, 7, and 11 (all comprised within Group 1, "Food").

A full list of these Classes was given in last week's *Journal*.

Each prize will be a Gold Medal, or the sum of £20, at the option of the recipient.

The Council propose to ask the juries in each class to recommend for their consideration either two or three exhibits which they might consider deserving a prize.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1884, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce." The following is a list of those to whom the medal has already been awarded:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Professor Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to M. Ferdinand de Lesseps.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to M. Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to M. Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S.

In 1877, to M. Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to M. Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

The Council invite members of the Society to forward to the Secretary, on or before the 19th of April, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 18, 1884; ADMIRAL RYDER in the chair.

The paper read was—

BORNEO.

BY B. FRANCIS COBB,
Vice-President of the Society.

Away in the far East lies that grand cluster of islands known as the Indian or Eastern Archipelago, and chief among this group is the island of Borneo, the subject of the paper to-night. It is one of the largest islands in fact, except Australia, the largest in the world. Its coast line is upwards of 3,000 miles, its length is 850, and its greatest breadth is 600 miles. On the west are Sumatra and the Straits of Singapore, on the north the China seas, on the east the Straits of Macassar, the island and sea of Celebes, on the south is the Java Sea and the island of Java. The equator cuts through nearly the centre of the island, and the 115 degree of west longitude would do the same from north to south. It lies in the direct tract between Singapore and Hong-Kong, and breaks the long steaming distance of 1,300 miles. Recent surveys of the coast determine nearly 300,000 square miles as the area of the island.

The history of Borneo, like that of Australia, is modern; the earliest record dates from 1706, when the English occupied temporarily a small island on the north coast and again in 1763, they took possession of Balambangan, which was abandoned chiefly from the difficulty of withstanding piratical attacks. In 1812, and, again in 1813, expeditions were sent against "Sambas," but nothing appears to have come of them, and probably the only Englishman who in those days really appreciated the value of the Eastern archipelago was Sir Stamford Raffles. In 1776, the Dutch established a factory in Pontianak, and, in conjunction with the Sultan, made war with Sunadana, and were granted certain portions of the south coast. After being driven out by the English expedition of 1813, they returned in 1818, and have remained ever since in the south part of the island, Poutianak and Banjermassin being their principal stations, and the present residences of the Governors.

To the Dutch now belong the greater part of the island. From Cape Datse, on the second parallel of north latitude on the west coast, round to the fourth parallel on the east coast, the Dutch have a country through which flows no less than twenty-two rivers, besides numerous branches, many of which, such as those of the Barito or Banjermassin river, the Mahakkam or Samarinda river, the Kapolas or Poutianak rivers, are large rivers in themselves, besides having tributaries. Altogether the country is admirably watered.

Carl Bock, who was the commissioner of the Dutch Government, in speaking of the Kohi country, through which passes the Mahakkan river, says:—

"A short distance above Samarinda we came upon an unexpected symptom of future commercial activity, in the shape of a coal mine, which is occasionally resorted to by Dutch steamers, but is worked principally for the purpose of supplying the steam yacht belonging to the Sultan of Kortir."

This mine is not a hundred yards from the river. Another coal mine at Pelarving is worked by the Sultan, who sells the produce to the Dutch Government. Speaking again of a higher portion of this river, but where the flood tide still flowed, the same gentleman writes:—"Along the banks were frequent outcrops of coal strata," and he speculates upon the time when "smoky collieries would send their long track of black smoke across the clear blue sky." He also speaks of the large size of the many tributaries that he passed on his journey from Samarinda on the east-coast to Bangermassin on the south.

The influence of the Dutch is slowly making itself felt; but it is not too much to say that some of the native Dyak tribes of the interior, through which traverse the rivers Mahakkam and Barito, are still, as they have been since the island was known, and as Carl Bock found them recently, not only head-hunters but cannibals, and unless these peculiar habits be arrested by the authority of the white man, these tribes, if left to themselves, must become extinct. A chief of the Tring Dyaks informed this gentleman that his people did not eat human flesh every day, that was reserved for feasts, and on these occasions the brains, hands, and knees were considered the epicure's parts, and reserved for the chiefs.

English ideas of Borneo may really be said to date from 1839, when Sir James Brooke visited the island, and by his own personal energy and perseverance succeeded in founding Sarawak. With the aid of Admiral Keppel, he annihilated the dangerous piratical fleets that infested those seas, and only those who at that time passed through the Malay Straits in sailing vessels can thoroughly appreciate the great and good work that was then performed. The piratical proas were the terror of single merchantmen, and unless a becalmed ship could make an early successful shot or two from her usually insufficient guns, it fared hardly with the crews, for the pirates dashed in and boarded the ship. The fate of many a missing trader has been discovered by the chronometers, sextants, and such things from the ship being sold in Singapore some years after. Now, Rajah Brooke's peaceful settlement of over 30,000 square miles has, by the justice of its administration, succeeded in establishing perfect confidence of the natives towards their rulers, has turned a series of battle-fields into cultivated land, and Sarawak is a happy and prosperous settlement, with a population of over 240,000. A recent writer was so struck with what he saw there that he says:—

"The history of the English Rajahs of Sarawak is well worthy of study by politicians and statesmen; and it opens up the great question whether the future of the human race might not be benefited by the extension of the system here inaugurated, of the free government of small semi-barbarous states under trained and educated English gentlemen, untrammeled by the cramping influence of official subordination, and unburthened by the dead weight of a complex governmental organisation, and an elaborate system of loyal and official precedents."

The steady progress of Sarawak is shown by the increased population as well as by the exports of products and imports of European manufactures.

Passing along the coast from Sarawak in a north-easterly direction, we come upon the lands and territories of the independent Sultan of Brunei, of which Mr. William Crocker, a gentleman who has spent some fourteen years in Sarawak, writes:—

"It is much to be regretted that whilst Sarawak has much advanced, whilst the people under her rule are contented and happy, the subjects of the adjacent State of Brunei are still growing under misrule and oppression. Of this I could adduce overwhelming evidence, showing how the wretched inhabitants are ground down by the exactions of petty chiefs and princes."

Beyond this territory, both to the north and to the east of it, lies the new settlement, colony, or territory of British North Borneo, held under the charter of the British North Borneo Company, a territory comprising some 25,000 square miles, and, when taken possession of, inhabited by a population of about 100,000 souls. This to us must be the most interesting portion of the whole island, for here we find another instance of how great things may grow out of small ones; and the settlement of North Borneo under the government of a British company, working under a Royal Charter, having for its object the development of the natural resources of its soil, and the amelioration of the lot of its people, may be considered as one of the the most remarkable events of the present generation. The first idea of making a settlement under the management and control of white men appears to have occurred to Mr. Alexander Dalrymple, who was in the East India Company's service, and, as long ago as 1766, obtained a grant of North Borneo for the Company. Strange to say, the plan of the country he sent home was very like the present concession to the North Borneo Company. The East India Company paid but little attention to its new acquisition, and gradually it appears to have dropped out of sight.

In 1865, the American Consul at Brunei obtained from the Sultan concessions of territory of a similar nature to those now held by the North Borneo Company. The Consul endeavoured to form the American Trading Company of Borneo, and to this company, represented by Mr. Torrey as president, and some Chinese merchants in Hong-Kong, the lessee transferred his leases. The American company commenced operations on the coast, imported Chinese workmen and coolies from Hong-Kong, and formed a settlement on the Kimanis River on the north-west coast; but, from want of capital, the company did not flourish, and the settlement had to be broken up, the Chinese having to be returned to China. Shortly after, Mr. Torrey, as president of the moribund company, went with Baron Overbeck to Brunei, and assisted in obtaining from the Sultan fresh grants in favor of a new association, represented by Baron Overbeck on behalf of Mr. Alfred Dent, from which emanated the British North Borneo Company. The following year, viz., 1878, another grant was obtained from the Sultan of Sooloo.

Mr. Consul General Treacher, writing to Lord Derby from Labuan, thus reports on the transaction:—

"Concessions have been obtained by Messrs. Overbeck and Dent, from the Sultan, which includes the whole northern portion of Borneo from the River Sulaman on the west to the River Sibuco on the east. The new lessees thus become possessed of all the best harbours in Borneo, and which command, to some extent, the route to China. Not only does this portion of Borneo contain the best harbours, but it also possesses the best soil, and is richest in natural productions, such as birds' nests, camphor, gutta-percha, sago, &c., besides valuable minerals, the existence of coal being known."

There are in all five distinct leases or concessions—three from the Sultan of Brunei, another from his Prime Minister, or Pangeran, Tumongong, and one from the Sultan of Sooloo. These grants have been executed in the fullest and most formal manner. In order to convey to the inhabitants information of the grants, the Sultans deputed a high officer to accompany the representative of the company on a voyage round the coast. At each of the places touched at, these officers assembled the chiefs and people, and read to them a solemn proclamation announcing the grants, and exhorting them to obey the new authorities. Two years now elapsed before the charter was granted by the British Government. In the meantime, the agents and residents of the company had been acquiring the confidence of the natives, as well as a knowledge of the country, and establishing the elements of civilised government. Their success was most remarkable; their presence was everywhere welcomed, and their authority gladly admitted. Supported by no physical force, by personal influence they succeeded in evoking comparative order out of chaos, and in establishing a degree of security for life and property unknown before in North Borneo.

In 1880, Admiral Hall, then Commander-in-Chief on the China station, reported to the Admiralty that, in his recent visit to Usakan and Sandakan, he was very favourably impressed with the influence for good manifestly possessed by the agents of the company over the natives, and suggests that it would add to the prosperity of the people if the political aspect of the question would permit of H.M. Government recognising their status. Again, Vice-Admiral Coote, writing from the *Iron Duke* to the Admiralty, uses almost similar words. He says:—

"I was very favourably impressed with the influence for good manifestly possessed by them over the natives. These people apparently look up to the agents as their lawfully constituted governors, and seem most willing to be led by them into the paths of industry and commercial enterprise. Should the political aspect of the question permit of H.M. Government recognising, at an early date, their status in the country, I am of opinion that it would add materially to the prosperity and security of the people, to the development of the country, and open up new markets for our home and colonial produce."

Commander Johnstone, of H.M.S *Egeria*, reports later as follows:—

"The new settlement of Elopura, at Sandakan, appears to me to be very promising. The Chinese are laying out money, and the place has made advance since our last visit, two months ago. The administration appears to be very well carried on, and the Government to be popular with the natives."

Mr. Walters, the mineral explorer, in a long report, in which he frequently refers to the great satisfaction of the natives at the new Government, and to the disappointment evinced by others that the Government had not been extended to them also, concludes thus:—

"Permit me to conclude by saying that this noble enterprise has the best wishes of thousands in the far East, filling as it does this blank in one of the largest islands in the world, and opening up to civilisation and commerce a country hitherto the seat of piracy, slavery, and blood-shed."

A gentleman connected with the enterprise from the first, Mr. W. B. Pryer, and whose history during the last few years may be said to be an epitome of the history of North Borneo, has reported from time to time, and I will avail myself of that gentleman's reports and correspondence, for the purpose of showing what the results of the colonisation by the company has been. Mr. Pryer, writing to his Excellency the Governor of Labuan, from Elopura, in June, 1880, says:—

"When I arrived here in 1878, I found the only place in this bay to be a small village, hidden away in an obscure corner, in the far end of the bay. The entrance was frequently blockaded by pirates, and the reason for the small trade with surrounding islands was the danger to navigation caused by them. The important river of Kinabatangan was blocked by a jealous and suspicious chief. The coast line was in the hands of the rapacious Sulus, by whom the Bajows of the foreshore were ground down and oppressed in every way. The Indians of the forest, the Boolydoopies, were forced to yield to their exactions to such an extent that but very few years more would have witnessed the extermination of large sections of them; they had all but abandoned their fields and orchards. Of the Dyaks of the interior virtually nothing was known. As for trade, the little coasting steamer called at intervals of two or three months, but neither brought nor took away cargo, except birds' nests from one locality alone. Slavery was rampant, slave-boats containing cargoes of unfortunate starved wretches in such a state that it turned one's stomach to look at them, covered with sores, bruises, and ulcers, and many of whom certainly died, were frequently to be seen here or in the Kinabatangan; robbery was rife; there was no security for either life or property. Slaves were treated in the most atrocious manner, being frequently cut down or flogged, and mashed green chillies rubbed into the wounds. The rich soil of the country was entirely uncultivated, as the proceeds would certainly have been taken by the most powerful man when ripe—and, in fact, it is difficult to say in what way matters could have been in a more deplorable condition.

"Now, Elopura, placed on a commanding and carefully selected site at the entrance of the harbour, monthly gains in population and importance. Over a dozen Chinese traders do an increasing trade with all the rivers on the coast. The Kinabatangan opened for traffic, sends away 10,000 bundles of rattans, besides other produce monthly. I have communicated with the chiefs of the interior, who are anxious to receive the new Government, and send their goods and produce down for sale on a safe and free market. The Bajows of the foreshore, freed from their oppressors, offer to place themselves and their kreeses at my disposal for any emergency. The Boolydoopies, able to cultivate their crops in peace now, have wide, and every season increased, paddy fields. Slaves and slave boats are things of the past. The cost of food is less than half what it was. Crime is simply unknown. The Chinese do not even fence their kitchen gardens. The now hard working Sulus are clearing away the forest for farms, with the knowledge that they can sit down in their houses without fear of being kidnapped in the middle of the night and sold as slaves, or their crops taken by some one else. As for the pirates, the natives finding a strong helping hand behind them, and H.M.S. *Kestrel* in the harbour, put such pressure on them that they moved off bag and baggage to Palawan, and are seen no more."

A year later, in 1881, Mr. Pryer informs Mr. Dent that Panglima Mohardee, of Sibutu Island, wished to place himself, his people, and his island under the company's rule, and Mr. Pryer concludes his report by, "I beg to disclaim beforehand any connection in any way with this demand, or that it was in the remotest way instigated by me:" and the summing up a report on the east coast of North Borneo, which had been three years under Mr. Pryer's administration, is as follows:—

"The little money which has been spent from time to time in freeing slaves and the like, has not been thrown away. The various conflicting interests of Sulu and Dyak, Bajow and Booloodoopy, Chinaman and Malay, trader and artisan, fisherman, and coolie, have all been consulted and cared for, with the result that European planters can start planting to-morrow with as much security as though in an English country, instead of in a country which, three years ago, was impassable by small parties, owing to the fear of head hunters or tribal feuds, and on whose coasts it required a small fleet to move together to keep off the pirates."

In the Parliamentary Blue-book, C. 3,108, relating to the Charter of the North Borneo Company, and other matters connected therewith, will be found on pp. 117 and 119, the reports of acting Consul-General, W. H. Treacher, to Lord Derby, and following these Lord Salisbury's instructions, and the Consul's replies, showing how the Spanish gunboat compelled the Sultan of Sulu to sign a treaty, and demanded the same of the Sandakan Sulus of North Borneo, and how they refused, and it will be seen that, but for the energy of Mr. Alfred Dent, and his representative Baron Overbeck, the opportunity of founding this settlement would have been lost. Mr. Treacher subsequently became governor of the new colony under the company, and in his official report of December, 1882, a good deal of extraordinary information is given in such a matter of fact way, that it requires a knowledge of the fact that, but a few years ago, Elopura, Kudat, and the other stations were not even in existence, to appreciate as a fact what reads like a page from a romance. He gives the stations their respective populations and how composed, which being only to December, 1882, are now all largely increased, and then the sources of revenue to the company, viz.:—

1. Land sales.
2. Quit rents on town and suburban lots, and on agricultural lands.
3. Licenses, or rights to farm the sales of certain things such as spirits, opium, &c.
4. Royalties of 10 per cent. *ad valorem* on birds' nests, gutta-percha, beeswax, rattans, camphor, and other natural products collected and exported from the company's territory.
5. Import duties on spirits, wines, beers, tobaccos, &c.
6. The Government share of the birds' nests caves at Gomanton, near Sandakan.
7. Poll tax on certain villages in Papae transferred by the Rajahs of Brunei.
8. Inland tax of 2 dols. upon strangers entering the colony to export jungle produce.
9. Profit on sale of copper coinage.
10. Local house tax.

North Borneo, when taken possession of, was very sparsely inhabited; and a large revenue was, therefore, not to be expected, until a population had been attracted to turn to account the wealth locked up in the primeval jungle, and to till and cultivate the vast tracts of virgin soil, which the absence of any large native population leaves for the use of European and Chinese planters.

Not only may the above sources of revenue be reasonably expected to increase year by year with the growth of the population, but new ones will, from time to time, be added to the list. The following may be noted as additional sources of revenue in the future:—Spirit farms and pawn farms on the system in force in the Straits Settlements, tobacco farms, stamp duties, postage, circulation of notes, salt tax, rents of public markets at the principal stations, land rents from the native paddy lands, imposed as in Perak and the other protected states of the Malay Peninsula, lease of mineral rights, development of mother-of-pearl fishery in Marudu Bay and the adjacent islands, and of a trade in timber, firewood and charcoal. As the Chinese population increases, it will probably be found imperative to follow the example of the protected Malay States, and take steps to establish a control over gambling, to which the Chinese are passionately addicted.

The opening up of several birds' nests caves known to exist up the Kinabatangan river, is another assured source of revenue in the future, and Mr. Resident Pryer estimates that in three years he will be drawing a nett income of 20,000 dols. a year from birds' nests. The value of the guano of the Gomanton and other caves has not yet been ascertained; but, even should it not prove remunerative to export to Europe, there will be a large local demand when the plantations already commenced are thoroughly opened. The Gomanton Caves alone are estimated to contain at least 25,000 tons of guano, and the average price of samples sent to London for analysis was put at £7 per ton.

As one might naturally expect, the land sales formed the principal source of revenue during the first six months, and Governor Treacher reports as follows on the east coast or Sandakan district:—Sales, 95,000 acres, producing 59,733 dols.; 20,000 acres more had been sold to the Australian Sugar Company, represented by Mr. de Lissa, but these were not to be paid for until 1888. In the same district, from the 1st January to 31st March, 1883; the sales were 32,713 acres, producing 21,610 dols.

One of the steamers of the Eastern and Australian line, running between Hong Kong and the Australian ports, visited Elopura on her way north, having among the passengers on board Mr. de Lissa. This gentleman had had large experience of sugar growing in Mauritius, and in the northern territory of South Australia. He was struck with the suitability of the soil in Sandakan Bay for the cultivation of sugar, with the central position of Elopura, in steam communication with Australia, the Straits Settlements, and China, and with the facilities for obtaining cheap and good Chinese labour direct from the latter country. He therefore applied for 20,000 acres of land in the Bay, which, with the approval of the Court of Directors, were granted to him on more favourable terms than those laid down in the published Land Regulations, his case being treated under Clause 18 of those Regulations, which provide that "special arrangements may be made in the case of companies or persons wishing to take large tracts of land." This land is now being surveyed and cleared, and one square mile has been set aside for a settlement of Swatow sugar cultivators, with whom arrangements are being made for immigrating to this country under Government supervision.

The Melbourne *Australasian* of the 29th December last states that a company was formed in Melbourne for the purpose of taking up large tracts of land in North Borneo, recently granted under charter from the British Government to the North Borneo Company. They instructed Mr. William Reece, who has had considerable experience as a sugar planter in Fiji and elsewhere, to select their land, and he has just returned to Melbourne, after having fulfilled their commission. He left in March, and proceeded to Sandakan Bay, North Borneo, *viâ* Hong-Kong. He found that Sandakan was a pretty large town, with a population of about 5,000 Chinese, 100 European, and 3,000 Malays. He stayed a few days there, and then started southwards, in which direction he intended selecting the territory. Most of the journeying was by water, and as the rivers were numerous and large, he found no difficulty in speedily obtaining a comprehensive idea of the country. He travelled in a house boat, with a small party, and in his trip up the rivers and into the interior, by land when necessary, he found the natives very friendly. They are particularly cordial in their relations with Englishmen, and Mr. Reece was surprised to find how quickly they tell to what nation a foreigner belonged. The Dutch and Spaniards are not favourably regarded, because of the bad reputation they have gained in connection with their occupation of other parts of the island; but the natives feel that they have some assurance that they will be differently treated by England. The land taken up for the Australian Company is not more than 160 miles from Sandakan at the farthest, and comprises in all 100,000 acres. Mr. Reece speaks highly of the growing capabilities of the soil, both there and at other places which he visited. "I have never seen," he says, "products grow so fast anywhere. I saw coffee plants in full bearing in fourteen months, although in other places two years generally elapse before the berries can be used. Sugar-cane can be got ready for the mill within ten months. The climate is a grand one, the temperature being pretty even all the year round. The average annual rainfall is about 120 inches. The timber is some of the finest I have seen. I measured some of the trees, which were from eight feet to twelve feet diameter, and 120 feet in height before a branch appeared." The land seemed to be suitable for sugar, coffee, tobacco, and cocoa plantations, and to that use the company intend putting it. They will hold it under an agreement with the British North Borneo Company, which provides, among other things, that unless they occupy it within eighteen months of the completion of the contract the right will be forfeited. The rivers upon which Mr. Reece travelled were the Dawata, Tabarnak, Tagayan, Sagama, Kinabatangan, and Discovery, each of which has some relation to the enterprise he had in hand. The harbours generally he found to be very good. The company, in accordance with their agreement, will take early steps to occupy and cultivate their land.

It is interesting to read Governor Treacher's report on the imports and exports of the first six months of his reign, but these are limited to the Sandakan district; the reports from the west coast not being returned in time to be included. In forwarding these returns to the governor, Mr. Pryer, the "resident," remarks:—

"The most noticeable feature about it (export trade) is the increase in the export of birds' nests from 23,078 dols. in 1881, to 32,433 dols. in 1882, and this, notwithstanding that many of the Melapi collectors died of cholera, whereby the collection was delayed, and a lot of the nests spoilt. The fact is, that as the country is opened up, fresh caves are worked, and a permanent export of a valuable product from fresh districts is secured to the country. There is a noticeable increase in the export of all sea produce, the quantity of trepang being nearly three times as large as in the previous or any other year, while sharks' fin, mother-o'pearl shell, and sea-weed are brought to market here in increasing quantities from the islands of the adjacent seas. In gutta there is a falling off; the districts in which it is collected are undoubtedly growing more and more remote. Imports show a heavy increase, no less than 120,083 dols. value having entered the district this year in excess of last."

At present we have no inland officers, with the exception of Mr. Hewett in the Kinabatangan, so that the returns give but a slight idea of what the trade of the territory would be, were the inland districts, with their stores of gutta, rubber, rattans, camphor, beeswax, birds' nests, &c., thoroughly opened to the traders. In the course of a few years, we may confidently expect to see the tropical products of the plantations now being commenced figuring in our Returns of Exports, and perhaps also coal and other minerals.

Return of East Coast Imports for the Half-year ended 31st December, 1882.

	dols.
Arms	129·00
Cloth	24,863·82
Crockery	1,585·55
Hardware	8,588·58
Machinery	2,298·80
Oil	2,846·05
Opium	4,070·00
Provisions	8,433·16
Rice and flour	18,794·25
Salt	275·26
Spirits	1,627·07
Sugar	2,098·43
Sundries	21,893·63
Treasure	35,000·00
Tobacco	2,531.15
Total	135,034·75

Return of East Coast Exports for the Half-year ended 31st December, 1882.

	dols.
Birds' nests	10,292·00
Beeswax	42·00
Camphor	664·50
Copra (dried cocoa-nuts)	(not returned)
Gutta and rubber	25,768·62
Mother-o'-pearl shell	1,178·90
Rattans	13,092·48
Seed pearls	70·97
Seaweed (edible Agar-agar)	657·60
Sharks' fins	454·45
Sundries	576·52
Trepang (Bêche de Mér)	4,621·26
Total	57,419·30

It will be seen that the principal imports are cloth and rice. The natives, having the natural productions of their forests and seas ready to hand and easily collected, do not grow sufficient rice for their own use, but prefer to purchase it from the Chinese traders by barter. The exports at present are all natural productions of forest or sea. The principal are gutta-percha and rubber, birds' nests, and rattans. Agar-agar (edible seaweed) appears for the first time in the list of exports.

I must now give you section 11 of Governor Treacher's report, because it deals with the

"Armed forces." "The forces on the east coast consist of one European inspector, 16 native non-commissioned officers and corporals, and 78 privates. On the west coast four native officers and 32 privates." The Governor gives the particulars of the forces, and concludes thus:—"As this force is the standing army of the country, I do not consider it efficient either in number of the men, or quality of officers. An officer of higher rank should be command of the force." Section 12 of the same report is as follows:—"XII. Forts and Armaments"—"There are no forts in the territory. Six brass 12 lbs. howitzers are mounted at Kudat, three at Elopura, and three at Gaya, for saluting purposes."

In the discussion which occurred in the House of Commons at the time of the granting the charter, one of the speakers likened the enterprise to that of the French in Tunis. A more unfortunate comparison could scarcely have been made. The French in North Africa are there by the sole right of battle, fire, and the sword. The company, on the other hand, are established in North Borneo with the free assent, goodwill, and assistance of the inhabitants without a blow having been struck or threatened, and so far from there being any danger of collision with the natives, the difficulty will be to prevent the tribes outside the limitations of the company's territory rebelling against their own Rajahs, and throwing themselves upon the company. When Mr. Dent visited the settlement last year, a deputation of chiefs, from the Membakut and Bangawan rivers, waited upon him and Governor Treacher, and begged that their rivers might be taken over by the company. They had to be informed that their country belonged to the Sultan of Brunei, and that the company could not interfere beyond its boundaries. It was difficult to make these chiefs understand why the company's officers could not come to them also, and take control of the rivers, and relieve them from the tyrannical control of the native Rajahs. A greater contrast to the French rule in Algeria could not possibly be shown.

It must not be supposed, however, that because peaceful, the enterprise was free from anxiety, troubles, and cares; only the patient and indomitable courage, combined with great consideration for the natives, and firmness with the tribal chiefs, as shown by the officers of the Company, could have brought about such results. Mr. Dent, speaking at a farewell dinner given to him, at Sandakan, alluding to the many difficulties overcome, says:—

"While we were working at home, there were friends besides who undertook the still more difficult task of maintaining the position in North Borneo, pending the decision of Her Majesty's Government; and where should we now be if we had not left behind us men with such energy, pluck, perseverance, and patience as we know to be personified in the Resident of Sandakan, Mr. Pryer, who was landed at the Old Settlement, twelve miles down the Bay, in 1877, and has never left the country since. That real work has been done by the company's officers is manifest on all sides, and that a great strain in connection therewith has been put upon the residents, heads of departments, and indeed every officer of the district, I am well aware."

And Mr. Pryer, while modestly disclaiming too much praise, says:—

"I cannot in justice refrain from referring to the steady, faithful, and loyal way in which I have been seconded from the first by the natives, more particularly the Bajaus and Sulus; to their ready sympathy in times of trial, which has not been unfrequent in the old days, and to their quick appreciation and co-operation in all my projects at a time when I was almost alone in the land.

"With regard to the essential supply of labour, we look to China, whose thousands are already beginning to pour into our country, but our crops will be of no use if we cannot find a market for them. No doubt we can raise unlimited quantities of tobacco, of pepper, cocoa, sugar, rice, sago, coffee Liberica and Arabica, and other products, but of what good are they if we cannot find markets of easy and cheap access? These queries were answered in the hour the *Tannadice*, last August, steamed into our harbour, being but five hours off her course on the highway between Hongkong and Australia. As we can raise unlimited quantities of produce, so can China and Australia consume them, and we are here a port of call, between such large ports of consumption as Brisbane, Sydney, Melbourne, Adelaide, Singapore, and Hongkong."

Peace has her victories as well as war, and the bloodless victory of North Borneo, the victory of high civilisation and patient moral courage over what, but a few years ago, was one of the most debased of savage barbarisms, is one that will, when history records these events, shed a halo round the names of the brave gentleman who inaugurated and carried out the rescue and salvation of the tribes that were rapidly exterminating one another, and who planted peace, order, and a civilised rule, where death, treachery, murder, and slavery only were known.

Years hence, when the settlement shall have grown in population and importance, the names of Alfred Dent, Pryer, Treacher, Witti, Hutton, and others, shall live in the affectionate remembrance, and become household words among the natives and settlers of North Borneo.

DISCUSSION.

Sir Rutherford Alcock, K.C.B., thought that North Borneo would, one day, be a colony of great national importance. English people had great interest in these eastern seas, though they did not all know to what extent this interest really runs. Besides having a trade to the amount of forty millions sterling with China, from which a revenue of seven millions went to India, and was very essential to the finances of the Government of that country, and to the 240 millions of inhabitants, while four millions of revenue were derived in this country from the import of tea. The island of Borneo seemed to be the only place which had escaped the Spaniards and the Dutch, who had asserted possession over the whole Eastern Archipelago, and although there were sources of unknown wealth, with every possible inducement for colonisation, neither Spain nor Holland seemed to have the means of making great colonies of their setclements. The Dutch had made a garden of Java, and worked marvels there; and the Spaniards had done a great deal with Manilla, but the whole of Borneo had been left in a state of wilderness and jungle. When Mr. Dent, in the first instance, devoted his attention to it, it was really no man's land, that is to say, it was jungle, occupied by a very sparse number of natives, who did very little in the way of cultivation, though a good deal in the way of head-hunting. As this country projected right into the fair-way of our trade between India and China, an interval of 1,300 miles between Singapore and HongKong, it struck him some years ago as being a matter of national importance that they should have a port there, and he could see no reason why they should not occupy the place. It had been the destiny of Great Britain to colonise more extensively than any other State in the world, and the time was not far distant when the English tongue would be predominant over the whole face of the globe. As these possessions might hereafter afford homes to the overgrowing population of England, it was a matter of the greatest importance that they should be taken in hand. It was in vain for Englishmen to try to limit their responsibility, as it was their destiny to expand. Another reason for taking possession of this island was to be found in the fact that it was important for England, in the event of war, to have good harbours of refuge, and these harbours already existed at Borneo, and the natives were eager that England should take them. If they were taken by another State which happened to be neutral in any war that occurred, England would not be able to blockade them, and might suffer great loss. There was no annexation in a sense which politically could be objected to; the North Borneo Company merely required a charter which would secure them from molestation outside, they undertaking, in return, to find the capital with which to develop the resources of the country. No doubt, when they had spent a few millions in building up a great colony, England would be very glad to take it over. The colony was as yet in its infancy, but since the formation of the company, two years ago, the revenue of the place had increased to £13,000, and the population had also increased considerably. No doubt it would take some time before the company was a paying concern, but that it would pay was undoubted in his opinion Already a syndicate of Australian capitalists had taken up 96,000 acres of land, and sugar and coffee factories would soon be established. Although he might not live to see it, he had no doubt that Borneo would be a great colony, and one of immense national importance.

Mr. Hyde Clarke said that after the very able paper which had been read by Mr. Cobb, and the remarks of Sir Rutherford Alcock, it would be presumptuous on his part to detain the meeting with many observations. His connection with Borneo dated many years back, and he had always thought, in common with the ideas which had influenced Sir Rutherford, that it was a matter of great importance to England to take possession of as large a portion of Borneo as possible. Any one who had followed the history of those archipelagoes, and watched what the Dutch, Spaniards, and Portuguese had been doing, must feel that the relations of those islands should be put on a proper footing. They had been told what was the condition of South Borneo under the Hollanders; and as to the northen part, the condition had been very much the same, without any profession of government on the part of the Spaniards; so that it was evident, from what had been already done, that action had been introduced by the Company, healthy not only to England, but to all other nations. The policy heretofore had been one of monopoly, one of exclusion of all other nations from any participation in trade, and consequently the participation by any one in raising the condition of the natives; but that would now be entirely altered, and North Borneo would be thrown open, as India was, to the exertions of the whole of the world; and it would inevitably follow that those influences, which had been already applied to the benefit of the native tribes, would be carried to a still higher degree. He was sure that, in a short time, they would see such a development of civilisation, of wealth and of commerce in Borneo, as would make it a very valuable possession to our Empire, and a source of safety and security to the whole of our Indies, and by no means one of danger. Having watched the exertions of those eminent men who promoted the Borneo Company, he was able fully to appreciate the difficulties which they had to encounter, more particularly with the respective Governments of this country, on whose part there had been a natural timidity in acceeding to the application of the company, from fear of complications with foreign powers. Everyone knew the feeling which was excited in Spain when the charter was given to the company; and, therefore, to have reached this stage it must be evident that there had been very great exertion and perseverance in laying the foundation of what would, at no very distant date, be one of the greatest colonies of the Empire.

Mr. Liggins said that Rajah Brooke, and those who worked with him in founding this colony, had had a hard fight, not against the natives of this beautiful island, but against the Government of England; and it was most disheartening to find that whenever any attempt was made to increase the trade of England, the Government did their utmost to stifle it. The Government had thrown a wet blanket on the desire of the Australians to possess a neighbouring island, which might, at some future date, be a source of considerable danger to them, and it was very disheartening that an attempt to do good should be neutralised by our Government. He thought the paper which had been read might bring home to the minds of the leaders of the Government that there was a necessity for an altered state of things at home. It was the duty of Englishmen to assist their countrymen, no matter where they were located; and in Borneo the commerce could be increased by assisting the Borneo Company, in addition to which the passage to China would be rendered more safe and secure in the event of war breaking out.

Admiral Mayne observed that Colonel Gordon had pointed out the necessity for having a harbour and a naval station at Borneo, and there would be no difficulty in this being accomplished, as there were several excellent harbours round the coast, one being quite equal to that of Sydney. At Labuan, an ample supply of coal could be obtained for any number of ships. He believed that hereafter Borneo would be the depôt for trade between China and Australia. The Australians had already taken 100,000 acres of land, and a service of ships had been started from Singapore and Hong Kong, so that before very long, Borneo would be a most flourishing and prosperous colony.

The Chairman said that, having visited Borneo, he could fully confirm all that had been said about the colony by Sir Rutherford Alcock. He thought it would be most desirable to establish a coaling station at this point, as the supply at Labuan could not be depended on, and it was well known that many men of war could only carry coal sufficient for a run of 1000 miles. For war purposes they must have frequent coal depôts. The last link of the chain at present stopped at Hong Kong, so that if there was one at North Borneo it would be invaluable in the event of war as an ample supply could not be relied on at Labuan. He fully concurred in what had been said by previous speakers as to the importance of developing this colony. In conclusion, he begged to propose a hearty vote of thanks to Mr. Cobb for his valuable paper.

The vote of thanks having been unanimously passed,

Mr. B. F. Cobb said he much regretted that the time at his disposal was so limited that he had found it impossible to touch upon all the matters connected with so large a subject as Borneo. With regard to the influence which civilisation had had upon the natives, he might say that, whereas at one time head-hunting formed part of the religion of the Dyaks—none of their festivals or ceremonies being complete without a certain number of human heads, and no one being reckoned a warrior until he had obtained some heads—the adjacent tribes now got out of the difficulty by obtaining either the heads of monkeys or pigs; and there was, no doubt, that in time, as they became more civilised, the custom of having heads of any kind at the different ceremonies would be entirely abolished.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 19, 1884; Sir Joseph Fayrer, K.C.S.I., M.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Christie, John, Clevedon-lodge, St. Margaret's, Twickenham.
Howard, Walter, Oaklands, Cricklewood, N.W.
Ince, Francis, St. Fagan's, 17, Fitzjohn's-avenue, Hampstead, N.W.
Kent, Arthur, 11, Wigmore-street, W.
Langton, Henry Currer, Docklands, Ingatestone, Essex.
Trench, George, Standard-house, Faversham, Kent.

The following candidates were balloted for and duly elected members of the Society:—

Allen, Mrs., 18, Ashchurch-park-villas, Shepherd's-bush, W.
Bowick, Thomas, Stafford-lodge, Southend, Bedford.
Davey, Henry, Rupert-lodge, Headingley, Leeds.
Davies, William J., 59, Gunterstone-road, West Kensington, S.W.
Fielden, Edward Brocklehurst, Nutfield Priory, Redhill, Surrey.
Kinglake, Robert Alexander, Rushmere, Wimbledon.
Larnach, Donald, 21, Kensington-palace-gardens, W.
Moseley, Charles, Manchester.
Playster-Steeds, John, Grosvenor-gate, Twickenham.
Rose, Frederick, 28, Page-street, Westminster, S.W.

The paper read was—

THE ASIATIC ELEPHANT IN FREEDOM AND CAPTIVITY.

By G. P. Sanderson,
Superintendent of Government Elephant-catching Operations in Bengal.

Whilst the popular interest felt in the elephant is, perhaps, greater than that attaching to any other wild animal, I think it may be safely said that regarding none, tame or wild, do more fallacious impressions exist.

The peculiar opportunities which have been afforded me during fifteen out of nearly twenty years spent in India, of observing the elephant in its wild and domesticated states—opportunities which it has been at once my duty as a public servant, and my delight as a sportsman, to make the most of—have induced me to believe that what I may be able to tell you to-night, regarding some of the most interesting features of the Asiatic elephant, may be acceptable to you, as being facts, and perhaps be of some small service to the cause of natural history. I will first commence with a few remarks on the elephant's intelligence.

The elephant's size and staid appearance, its gentleness, and the ease with which it performs various services with its trunk, have given rise to the exalted idea of its intellect that prevails among those not intimately acquainted with it. And its being but little known in Europe, whilst what is known of it justly makes it a favourite, leads to tales of its intelligence being not only welcomed with pleasure, but accepted without investigation. Many elephant stories are intended for the amusement of little folk; but in a sober inquiry into the mental capacity of the animal, they must not be accepted as facts.

The opinion is generally held by those who have had the best opportunities of observing the elephant, that the popular estimate of its intelligence is a greatly exaggerated one; that, instead of being an exceptionally wise animal, its sagacity is of a very mediocre description. The truth of this opinion no one who has lived amongst elephants can doubt. It is a significant fact that the natives of India never speak of the elephant as a peculiarly intelligent animal, and it does not figure in their ancient literature for its wisdom, as do the fox, the crow, and the monkey.

One of the strongest features in the domesticated elephant's character is its obedience. It may also be readily taught, as it has a large share of the ordinary cultivable intelligence common, in a greater or less degree, to all animals. But its reasoning faculties are undoubtedly far below those of the dog, and possibly of other animals; and in matters beyond the range of its daily experience it evinces no special discernment. Whilst fairly quick at comprehending anything sought to be taught to it, the elephant is decidedly wanting in originality. To begin with, the elephant displays less intelligence in its natural state than most wild animals. Whole herds are driven into ill-concealed enclosures, which no other forest creatures could be got to enter; and though these enclosures are made immensely strong, and are generally capable of resisting the efforts of any single elephant, they would not for a moment withstand the combined attack of even two or three, much less of a whole herd. But elephants never thus combine to free themselves. I have frequently seen fifty or sixty crowded into a stockade only thirty yards in diameter, the palisades of which would have been of no more account than corn-stalks before the rush of three or four of them, but no such rush has been made. More significant still, I have, on several occasions, seen a single elephant in a herd, by a bold dash, burst through the palisade and effect its escape, but I never yet saw any other elephant follow, and the hunters have at once repaired the breach.

When a herd of wild elephants is secured within a stockade, or *kheddah*, the mahouts ride trained elephants amongst the wild ones without fear, though any one of the wild ones might, by a movement of its trunk, dislodge the men. This they never do. Single elephants are caught by being bound to trees by men under cover of a couple of tame elephants, the wild one being ignorant of what is going on until he finds himself secured. Escaped elephants are retaken without trouble; even experience does not bring them wisdom. Almost yearly, one or two tame elephants of the hunting establishment at Dacca are lost in the jungles by straying, or other accident, whilst engaged in the capture of their fellows. As an example, in December, 1878, an elephant which had been captured three years, and partially trained to hunting, took fright at the fires and guns used in driving a herd, and ran away. Her mahout fell off, and nothing more was seen of her until March last, when we re-captured her after four and a-half years absence, in a herd of twenty-one elephants, 100 miles from where she was lost. She had a calf at heel. When pricked with a spear, and ordered to kneel, she did so promptly, and in three days she, and another reclaimed runaway, were employed in the capture of their fellows. Whilst such facts testify to the docility of the elephant, they tell heavily against its intelligence.

Though possessed of a proboscis which is capable of guarding it against such dangers, the wild elephant readily falls into pits dug in its path; whilst its fellows flee in terror, making no effort to assist the fallen one, as they might easily do by kicking in the earth around the pit. It commonly happens that a young elephant falls into a pit, in which case the mother will remain until the hunters come, without doing anything to assist her offspring, not even feeding it by throwing in a few branches.

In its domesticated state one of the elephant's chief characteristics is, as before stated, its obedience; and it does many things, at the slightest hint from its mahout which much impress the on-looker unacquainted with the craft of elephant-guidance. The driver's knees are placed behind an elephant's ears as he sits on it, and it is by means of a push, pressure, and other motions, that his directions are communicated, as with the pressure of the leg with trained horses in a circus. It would be as reasonable, however, to credit performing dogs which spell out replies to questions with knowing what they are saying, as elephants with appreciating the objects to be gained by much which they do under the direction of their riders.

Then as to the stories regarding the elephant's reasoning powers, what an improbable one is that of the elephant and the tailor, wherein the animal, on being pricked with a needle instead of being fed with sweetmeats as usual, is represented as having deliberately gone to a pond, filled its trunk with dirty water, and returned and squirted it over the tailor and his work. This story accredits the elephant with appreciating the fact that throwing dirty water over his work would be the peculiar manner in which to annoy the tailor! How has he acquired the knowledge of the incongruity of the two things, dirty water and clean linen? He delights in water himself, and would, therefore, be unlikely to imagine it objectionable to another. If the elephant were possessed of the amount of discernment with which he is commonly credited, is it reasonable to suppose that he would continue to labour for man instead of turning into the nearest jungle? We commonly use elephants to carry provisions for the hunting parties through the same forests wherein they were disporting themselves as wild animals less than a year ago. That they thus submit must be regarded as more creditable to their good dispositions than to their good sense.

All who have had to deal with elephants will agree that their good qualities cannot be exaggerated; that their vices are few, and only occur in exceptional animals; that they are neither treacherous nor retentive of an injury; and that they are obedient, gentle, and patient beyond all other domestic animals. But it is no traducement of the elephant to say that it is, in many things, a decidedly stupid animal.

Another matter upon which much misapprehension exists is the height to which elephants grow. We hear and read of Indian elephants 12, 15, even 20 feet high! As a matter of fact, 10 feet in males, and 8 feet 6 inches in females (vertical height at the shoulders, measured as a horse), is very rarely attained, and is not exceeded by one animal in 500. As bearing on this subject, I may quote the following from the "English Cyclopœdia." The Mr. Corse referred to therein was a gentleman thoroughly conservant with the Indian elephant. A valuable paper of his on the subject was read before the Royal Society in 1799.

"During the war with Tippoo Sultan, of the 150 elephants under Captain Sandys, not one was 10 feet high, and only a few males $9\frac{1}{2}$ feet high. Mr. Corse was very particular in ascertaining the height of the elephants used at Madras, and with the army under Marquis Cornwallis, where there were both Bengal and Ceylon elephants, and he was assured that those of Ceylon were neither higher nor superior to those of Bengal."

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"The Madras elephants have been said to be from 17 to 20 feet high. Now let us see how dimensions shrink before the severity of measurement. Mr. Corse heard from several gentlemen who had been at Dacca that the Nabob there had an elephant 14 feet high. Mr. Corse was desirous to measure him, especially as he had seen the elephant frequently at a former time, and then supposed him to be 12 feet high. He accordingly went to Dacca. At first he sent for the mahout or driver, who, without hesitation, informed him that the elephant was from 12 to 14 cubits—that is from 15 to 18 feet high. Mr. Corse measured the elephant exactly, and was rather surprised to find that the animal did not exceed 10 feet in height."

In my own experience, I have had some amusing instances of the difficulty of getting at absolute fact in this matter. I have for some years made a point of ascertaining the height of all the largest elephants I have heard of in India. Five years ago, I inserted a request for information on this subject in all the chief newspapers of India. Accounts of 11 and 12 feet elephants poured in, but none stood the test of inquiry. To make it worth any one's while to establish such dimensions, I offered to give an order upon any gunmaker for the best double-barrelled rifle, and all accessories, to any gentleman who could produce evidence of an elephant even 11 feet high. This was never done, and I only found one elephant above 10 feet. This magnificent animal belongs to the Maharajah of Nahun-Sirmoor, in the Punjaub, and measures 10 feet $7\frac{1}{2}$ inches in vertical height at the withers. I made a journey of 100 miles in a palanquin to measure him with my own hands. He is the only elephant over 10 feet in height that I have ever seen, amongst many thousands, and he must be regarded as not less phenomenal than a human being of 8 feet.

In connection with this subject, I may mention that twice round an elephant's fore-foot is his height, within an inch or two; more frequently it is exactly so. Out of many hundreds of elephants of all ages which I have measured, I have only once found the variation to be as much as five inches.

There is, at present, in the Indian Museum in Calcutta, the skeleton of a male Indian elephant which Dr. Anderson, the Superintendent, informed me he thought must have stood about $11\frac{1}{2}$ feet when alive. But this estimate is based entirely on the height of the skeleton as at present set up, which may be, and in my humble opinion is, too great. I, unfortunately, have not got my note-book, which contains the height of the skeleton, with me in London. The elephant to which this skeleton belonged was shot whilst wild, and, therefore, could not have been measured, when on the ground, with any approach to accuracy. It was undoubtedly an exceptionally large animal, but was not over 10 feet, in my opinion, based upon the following consideration. There is now in the British Museum, in South Kensington, a skeleton which I lately brought to England of an elephant which died in June, 1883, at Dacca. I measured this elephant most accurately before his death; his height was 9 ft. 10 in. at the shoulder. Now, his femur bone measures over all 3 ft. $11\frac{3}{4}$ in., and is only an inch shorter than that of the skeleton in the Indian Museum in Calcutta. This seems to me to be a reliable ground of comparison between the two, and to be fatal to the claim advanced for the Calcutta Museum elephant of being 20 inches taller than one with a femur bone only 1 inch shorter.

In June, 1878, I measured the since famous African elephant, Jumbo. He was then 10ft. 5in. at the withers, and being about 17 years old, was still growing. I have been unable to ascertain his exact height, measured in the foregoing manner, when he left England for America in 1882. His height was then taken to the top of his back, with his fore and hind feet brought near together. This would tend to arch his back very considerably. He measured 11 ft. 6 in. in this way; but as his forefoot, planted firmly on the ground, measured 5 ft. 6in., his height at withers was probably about 11 ft. According to Sir Samuel Baker, who has seen large numbers of both Asiatic and African elephants in their native wilds, the Africans, male and female, average about one foot higher than the Asiatic. The case of Jumbo appears to confirm this to a great extent, as regards male elephants; but I have never seen African females even as large as Asiatic females. Of course in captivity we do not see one African to 1,000 Asiatics (taking India into account), so the comparison is unfavourable to the Africans.

Much misapprehension prevails regarding the uses and powers of the elephant's trunk. This organ is chiefly used by the animal to procure its food, and to convey it, and water, to its mouth; also to warn it of danger, by the senses of smell and touch. It is a delicate and sensitive organ, and is never used for rough work. In any dangerous situation, the elephant at once guards it by curling it up. The idea that he can use it for any purpose, from picking up a needle to dragging a piece of ordnance from a bog is, like many others connected with the elephant, founded entirely upon imagination. An elephant might manage the former feat, though I doubt it (I have never seen elephants raise coins and such small articles otherwise than by suction); the latter he would not attempt. Elephants engaged in such work as dragging timber invariably take the rope between their teeth; they never attempt to pull a heavy weight with the trunk. An elephant is powerful enough to extricate a cannon from a difficult situation, but he does it by pushing with his head or feet, or in harness, never by lifting or drawing with the trunk. Elephants do not push with the forehead, or region above the eyes, but with the base of the trunk or snout, about one foot below the eyes.

I may here mention that I have seen many instances of very severe injury to their trunks amongst wild elephants. These were evidently caused by the sharp edges of split bamboos whilst the animals were feeding. Some have had from a few inches to a foot of the member totally useless, merely hanging by a little muscle, both nostrils having been cut through.

The age to which the elephant lives is, as must ever be the case with denizens of the forest, uncertain. The general native opinion is that they attain 120 years in exceptional cases (they have been known to reach this age in captivity), but more usually to 80 years. Under the more favourable conditions of a natural life the elephant must attain a much greater age than in captivity. I think it by no means improbable, looking to their peculiar dentition and other circumstances, that elephants live to 150 or 200 years, but this view is, of course, to a great extent a supposition.

One of the most remarkable facts in connection with wild elephants is the extreme rarity of any remains of dead ones being found in the jungles. This circumstance is so marked as to have given rise to the belief amongst some wild tribes that wild elephants never die; whilst others believe that there is a place, unseen by human eye, to which they retire to end their days. The latter belief is untenable, as there are no parts of the forests of India that are not well known to, and occasionally visited by, the wild tribes who nhabit them.

In my own wanderings for many years through elephant jungles I have only seen the remains of one female elephant that had died in giving birth to a calf, and of one elephant drowned in a mountain torrent. Not only have I never seen the remains of an elephant that had died a natural death, but I never met anyone amongst the jungle tribes, or professional elephant hunters, who had.

Sir Emerson Tennant says in his work on Ceylon:—"The natives generally assert that the body of a dead elephant is seldom or never to be discovered in the woods. And certain it is that frequenters of the forest with whom I have conversed, whether Europeans or Singhalese, are consistent in their assurances that they have never found the remains of one elephant that had died a natural death. A European gentleman, who for 36 years without intermission had been living in the jungle, ascending to the summits of mountains in the prosecution of trigonometrical surveys, and penetrating the valleys in tracing roads and opening means of communication—one, too, who had made the habits of wild elephants a subject of constant observation and study—has often expressed to me his astonishment that, after seeing many thousands of living elephants in all possible situations, he had never yet found a single skeleton of a dead one, except those which had fallen by the rifle. The Singhalese have a superstition in relation to the close of life in the elephant; they believe that, on feeling the approach of dissolution. he repairs to a solitary valley, and there resigns himself to death."

This quotation from Sir Emerson Tennant shows the similarity of opinion between the natives of Ceylon and of India. But the belief of a universal sepulchre is untenable on many grounds. It may be believed that, in annually capturing large numbers of elephants, the hunters of the Dacca establishment penetrate the most retired parts of the jungles of Assam, Chittagong, and elsewhere; but though many men have grown grey in the service, I have not met one who has seen a dead elephant's remains, except at a time when an epidemic disease decimated the herds in Chittagong. Jungle fires seldom penetrate the large forests; thus their bones cannot be burned. Monsoon rains do not destroy them for some years, as is proved by the bones of elephants that have been shot, and which may be seen many years later. It may be thought that aged, weak elephants are sometimes unable to extricate themselves from morasses or the soft beds of rivers where they go to take their last drink, and that their remains are swallowed up therein. This possibly may occur occasionally, but there are many elephant jungles where no quicksands or bogs exist. In Mysore, for instance, a province where wild elephants abound, and which I know intimately, the jungle streams are small, and their beds are uniformly rocky. If elephants died in these, their bodies would be floated down through inhabited country where they could not escape observation. But this has never, to my knowledge, occurred. It is probable that the longevity of elephants may account to a great extent for their remains rarely being seen. If elephants live for 200 years, the annual deaths from natural causes would only amount to 5 per 1,000. This figure would, no doubt, be exceeded in reality, as elephants are liable to be killed by each other, and to die by various accidents. Though the number that die annually is thus, probably, much less than might be supposed, the mystery of what becomes of the remains of those that do die is still entirely unexplained.

Herds of elephants usually consist of from 30 to 50 individuals, but much larger numbers, even upwards of 100, are by no means uncommon. A herd is alway led by a female, never by a male. In localities where fodder is scarce, a large herd usually divides into parties of from 10 to 20. These remain at some little distance from each other, but all take part in any common movement, such as a march into another tract of forest. These separate parties are family groups, consisting of old elephants with their children and grand-children. It thus happens that, though the gregarious instincts of elephants prompt them to form large gatherings, if circumstances necessitate it a herd breaks up under several leaders. Cases frequently occur when they are being hunted; each party will then take measures for its individual safety. It cannot be said that a large herd has any supreme leader. Tuskers never interest themselves in the movement of their herds; they wander much alone, either to visit cultivation where the females, encumbered with young ones, hesitate to follow, or from a love of solitude. Single elephants found wandering in the forests are usually young males, animals debarred from much intimate association with the herds by stronger rivals; but they usually keep within a few miles of their companions. These wandering tuskers are only biding their time until they are able to meet all comers in a herd. The necessity for the females regulating the movements of a herd is evident, as they must accomodate the length and time of their marches, and the localities in which they rest and feed at different hours, to the requirements of their young ones.

Elephant calves usually stand exactly 36 in. at the shoulder when born, and weigh about 200 lbs. They live entirely upon milk for five or six months, when they begin to eat tender grass. Their chief support, however, is still milk for some months. I have known three cases of elephants having two calves at a birth. It cannot be said that the female elephant evinces any special attachment to her offspring, whilst the belief that all the females of a herd show affection for each other's calves is certainly erroneous; were such the case it would preclude the belief in any marked love for her own young. During the catching of elephants many cases occur in which young ones, after losing their mothers by death or separation, are refused assistance by the other females, and are buffeted about as outcasts. When a calf is born, the mother and the herd usually remain in that place for two days. The calf is then capable of marching. Even at this tender age calves are no encumbrance to the herd's movement; the youngest climb hills, and cross rivers, assisted by their dams. In swimming, very young calves are supported by their mother's trunks, and are held in front of them. When they are a few months old, they scramble on to their mother's shoulders, and hold on with their fore-legs, or they swim alone. Though a few calves are born at other seasons, the largest number make their appearance in September, October, and November.

The elephant is full grown, but is not fully mature, at about 25 years of age. At this period it may be compared to a human being of 18; and it does not attain its full strength and vigour before 35 years. Female elephants give birth to their first calf at from 13 to 16 years of age, when they are still palpably immature themselves. Only the male Indian elephant has tusks; the female is provided with short tushes, or downward prongs, in the upper jaw; they are seldom more than 4 in. in length. On the continent of India, *mucknas*, or male elephants without tusks, are decidedly rare. The absence of tusks appears to be a merely accidental circumstance. But in Ceylon male elephants with tusks are still more uncommon. Sir Samuel Baker says that not more than one in 300 is provided with them. It is difficult to imagine what can cause the vital difference of tusks and no tusks between the elephants of the continent and of Ceylon, as they are of the same species, and the climate, and their food, may be said to be identical. Elephants occasionally lose one, sometimes both tusks, in accidents in the jungle, and some have only one tusk from birth. The latter are known as *gunéshas*, and are reverenced by Hindoos if the tusk retained be the right hand one. Elephants never shed their tusks. Jerdon and others, following Mr. Corse, are undoubtedly in error in saying this occurs between the first and second years of the young elephant's existence or at any other time. The skulls of fœtal elephants exhibit milk tusks, but these never make their appearance; they are absorbed, and the tusk that cuts the gum is the permanent one. Nor are tusks lost by accident ever renewed.

The records of many hundreds of elephants, captured by the Dacca establishment, show that there are about 43 male elephants to 100 females; and one *muckna*, or tuskless male, in every 10 males.

Elephants are exceedingly inoffensive and retiring in their habits. They are very timid in their wild state, and withdraw at once from the intrusion of man. They usually drink after sunrise, and before sunset. They prefer the water of the small tributary streams to that of the larger rivers of the jungles they may be inhabiting; for what reason I have never been able to ascertain. Elephants seldom bathe after the sun is down, except in very warm weather. They swim remarkably well, as is proved by the fact that large numbers are annually sent across the tideway of the combined Ganges and Bramhapootra, between Dacca and Barrackpore, and they are sometimes six consecutive hours without touching bottom. I have seen an elephant swim a river 300 yards wide with his hind legs tied together. Elephants are sometimes drowned, apparently by being attacked with cramp, or by a fit.

The only pace of the elephant is the walk, capable of being increased to a fast shuffle of about fifteen miles an hour for a very short distance. The elephant can neither trot, canter, or gallop, nor can it make the smallest spring either in vertical height or in horizontal distance. A trench 8 ft. wide and 8 ft. deep is quite impassable to an elephant.

It has been satisfactorily settled that there is no such creature as a really white elephant, the so-called albinoes of the Kings of Burmah and Siam being merely elephants of a somewhat dirty cream colour, and in some cases even elephants with only an unusual amount of the flesh-coloured blotchings on the face, ears, and neck, common in some degree to all elephants. I need not advert here to Mr. Barnum's so-called white elephant further than to say that he is the commonest of common elephants, to be seen every day in India, and does not possess a single peculiarity of any description to justify the statements regarding his colour and special character, which preceded, and even followed, his arrival in England.

I will now pass to the modes of capturing and training the elephant. Elephants are not bred in captivity in India, as by the time the young ones would be of a useful age, 15 years, they would have cost more than would suffice to capture a number of mature wild ones. Elephants are, however, bred extensively in a semi-wild state in Burmah and in Siam, where fodder is very plentiful. With the exception of such elephants as come from Burmah, almost every elephant seen in India has been wild at one time.

The following are the methods of taking wild elephants. For single elephants, pit-falls; running down and noosing from trained elephants' backs; or tying the animal's legs together under cover of trained females, usually called decoys. When a whole herd is the object of pursuit, a salt-lick, or sometimes a pool in the jungles, is surrounded by a stockade. Men are constantly on the watch, and the gate is closed when a herd has entered. But the most certain plan is that followed by Government, namely, the surrounding a herd, wherever found in the forest, by a large circle of men, and the building a stockade, into which it is driven. This method will be described further on. With regard to the other plans mentioned, the pit-fall is an old native method, and is now prohibited in British territory on account of its cruelty. It may be imagined that an immense majority of the elephants that fell into pits from 15 to 18 feet deep sustained permanent injury, if they were not killed outright, as often happened. The native hunters seldom took the the trouble to put boughs into the pits to break the force of an elephant's fall. If an elephant was seen to be injured, it was left to die as it fell. I have known four elephants to fall into the same pit together, one only of which was got out alive.

The pits were arranged with great ingenuity by the hunters. Sometimes an uncovered one would be left in view, in avoiding which an elephant fell into a covered one alongside. Or several were dug in close proximity, in which others might be taken when fleeing in terror upon the fall of one of their number. Through the carelessness of the hunters, who only visited the pits occasionally, elephants were frequently starved to death before they were discovered.

The plan of enclosing elephants in salt-licks, or places to which elephants, in common with all wild animals, resort at certain seasons to eat the earth impregnated with soda, used formerly to be much in vogue in Assam. It also led to much cruelty. Natives could seldom procure a sufficient number of tame elephants to deal with a large herd, should one be enclosed; and in former days scores of elephants died in enclosures from want of food during the delay that occurred in sending for tame elephants. Several of these salt-licks are perfect Golgothas to this day. Such reckless waste of elephant life has now, however, been put a stop to.

Running elephants down, and noosing them from the backs of tame elephants, is very rough and dangerous, but highly exciting, sport. It is far from an economical method of taking them, as the wear and tear of the tame elephants is very great. It is conducted as follows:—Three or four fast tame elephants are equipped with a rope each, at one end of which there is a noose, the other being secured round their bodies. On some, the noose is on the near side, on others, the off. Each elephant has three riders—the mahout on its neck to guide it; the nooser, kneeling on a small pad on its back, holding the noose in his hands; and a spare man seated behind, whose duty it is to hammer it unmercifully with a spiked mallet. This urges an elephant to a much greater pace than any use of the driver's goad will, though that inducement is by no means omitted.

Thus equipped, the elephants approach a herd of wild ones. Sometimes a musket is fired to terrify them, and the chase commences through or over everything, the men saving themselves from being swept off as best they can. Where the ground is favourable, the tame elephants endeavour to range up on opposite sides of a fleeing wild one, of moderate size and strength, when the nooses are cast, and generally encircle its neck. If this is effected, the tame elephants are checked; but the choking of the wild one, or fatal accidents to the tame ones or their riders, by being pulled over, or dragged into ravines, or by being attacked by other elephants, are not unusual accompaniments to this rough work.

Hand-noosing is practised only in Ceylon, where several hunters on foot manage, with wonderful skill and activity, to noose the hind legs of an elephant when running away, and to secure the trailing ends of the ropes to trees as it passes.

The largest male elephants cannot be captured by the above plans; and from their habit of frequently absenting themselves from their companions, they are seldom caught with the herd by the stockade or kheddah plan. They are the most valuable beasts, and are usually caught in the following manner, or some modification of it. Four or five steady females, ridden by their mahouts, who partly conceal themselves with a dark-coloured blanket as they lie on their elephants' necks, are taken to the jungle where the solitary male is known to be, and are there allowed to graze like wild ones, and gradually to approach the male, if he does not take the initiative. Some wild males make off at once, probably scenting the riders, but many abandon themselves without reserve to the society of the females. These keep in constant attendance on the male, sometimes for two days and nights. When the male seems inclined to sleep soundly, usually soon after sunrise, the females stand close around him, and a couple of mahouts on foot tie his hind legs together, and bind him to a tree, if one be near; or they withdraw the tame elephants, and after the male has tired himself out, by dragging his legs after him in his flight, he is fastened to some tree as he passes it. In a day or two cables are got round his neck, and he is marched off.

I may here say that the term decoy, often used in reference to elephants engaged in the capture of others, is entirely misleading, as they use no arts to divert the wild one's attention, as has been constantly asserted, but act entirely at the command of their riders. The statement that one elephant will assist in binding another, except in as far as it will hand up the end of a rope, or pull one when ordered to do so, is entirely incorrect.

The Government kheddah plan is the most certain and economical method of taking wild elephants. As many as 118 have been secured in one drive by this means. A Government hunting party consists of 370 men, trained to the work. They are generally from Chittagong, the natives of that district being unrivalled in the craft. There is a large surplus labouring population in Chittagong, and there is no difficulty in raising one or two kheddah parties during December, January, and February, when there are no agricultural operations on hand. The men receive two and a-half months' pay at Rs. 7 (or about 15s.) per mensem, and they also have free rations.

A kheddah party of 370 men having been collected, it marches to the hunting grounds, sometimes 200 miles distant, where a base camp is ready, and where the establishment of tame elephants, generally from 100 to 150, has been collected, together with the stores, tools, and ropes required for the operations. Muskets and rations having been delivered to the men, and religious ceremonies for success having been performed, the hunters enter the jungle. The trackers of the party have probably already marked down a herd, whereupon the hunters approach to within a mile, and then divide under two experienced leaders, one half filing off to the right, and the other to the left, their object being to enclose the herd in a large circle by meeting beyond it. A man is left at every 30 yards or so along the lines, according to the nature of the ground. The skill with which this movement is effected is very remarkable, as the ground is usually quite unknown to the hunters, and the difficulty of crossing streams and hills, of forcing their way through dense jungle where no path exists, and of gaining the point they are making for without a compass, is considerable.

The circle, when completed, is often five or six miles in circumference. A large one, with men posted fifty yards apart or so, is more efficient in keeping in a herd than a smaller one with men much closer. Unless plenty of room be allowed to the elephants, they are liable to break through the cordon of guards; but it is a maxim in elephant catching that, the circle having once been formed, a herd can only escape through accident or great carelessness. It usually takes three or four hours to surround elephants. In a couple of hours the hunters run up a thin fence of split bamboos round the enclosure, and clear a path for communication between each others posts. Their chief duty then is to see that the elephants do not break out of the circle. The animals seldom give trouble during the day; at night large fires are kept up, and shouts and shots are used to drive them back should they approach. The bamboo fencing serves to show the chief hunters, who patrol the circle at intervals, where the elephants have broken out should they escape, so that the particular men who are to blame can be detected. This investment of the elephants may have to be maintained for a week, sometimes for a month, if the elephants cannot be secured in the first attempts.

The elephants usually give some little trouble for the first two nights, but their conservative nature then seems to lead them to believe that there are set bounds to their wanderings; and unless fodder or water becomes scarce, they seldom try to force the guards. A small herd always gives more trouble than a large one. The former may only be a wandering party from some large body of elephants not far away; it then shows a strong desire to break through to join its companions. A small herd, too, probably has no calves with it, which is a great disadvantage, as it is then restless and quick in its movements. And a herd of a dozen elephants or so may be well in command of one courageous leader; whereas, in a large gathering, timid animals preponderate so greatly that a panic is easily established, and elephants that might otherwise behave boldly become infected with the general fear.

One or two of the males of a herd frequently pass in and out of the circle; and I have known several cases in which a portion of a herd has been absent when their companions were surrounded, and has been admitted by the guards by withdrawing at the point where it wished to pass in. Sometimes, but not often, men are killed at their posts by the elephants.

On the day following the investment of the herd, the construction of the kheddah, or small enclosure into which the elephants are to be driven, is commenced. It is situated on one of their chief paths (within the circle) and is constructed with the trunks of young trees, about 6 in. in diameter, and 12 ft. high, arranged in a circle of from 20 to 50 yards across. Inside, round the foot of the palisades, a trench 6 ft. wide and 4 ft. deep is dug, the earth from this being thrown up into a bank on the inner side. The trench and bank of loose earth usually deter elephants from attacking the stockade, or should they do so, prevent their employing their full force against it. The palisades are lashed together with canes, and are strongly supported by cross beams and forked supports behind, the whole structure being designed to support outward pressure only. Were elephants to pull the palisades inwards, they would yield at once, but they never use their trunks for this purpose. An entrance of 4 yards in width is left for the ingress of the herd, and a gate, studded inside with sharp spikes, is either slung from the trees overhead, or is made in two leaves, and is pushed to upon the entrance of the herd, by men stationed behind it.

A stockade of 40 yards in diameter accommodates 100 elephants easily. To guide the elephants into it, two lines of strong palisades are run out from the gate along each side of the path by which the herd is to approach. These guiding wings diverge to perhaps 60 yards across at their commencement, which may be 100 yards or so from the gate. When the whole is completed, the new woodwork is hidden with leaves and branches. The stockade is usually completed in three or four days. The hunters consider Friday the most lucky day for driving, and they make extraordinary efforts to get the stockade ready by that day if possible. The work of the stockade is done by one-half the hunters being taken from the large circle from morning till evening daily, as a weak cordon of guards suffices to keep the elephants in during the day.

All being in readiness for driving, a number of men are taken from the original circle, and a smaller interior surround is formed by commencing at the guiding wings of the kheddah, and posting the men until the elephants are again closed. The original circle is, of course, still maintained, in case of the elephants breaking through the inner one. If the herd be in two or three detachments, as frequently happens, these are quietly driven together, and the whole are then moved forward towards the kheddah. Should they show an inclination to break to the right or left, the men deter them by striking their axes against the trees. When the elephants gain the funnel-shaped approach to the stockade, the men close in from behind, and from the sides, and urge them on with shots and shouts. If the herd suspects danger, and breaks back through the beaters, fatal accidents not uncommonly occur. Sometimes a herd declines altogether to go in the direction of the stockade, owing to their having the wind from that quarter. In such a case a new stockade may have to be constructed, and if that does not succeed, others also. In this way elephants are sometimes kept in a surround for a month.

Supposing the herd to have been got within the wings near the gate, a line of dry grass and bamboos arranged beforehand is fired, and their retreat is cut off. They then sometimes attack the guiding palisades, but men with spears and muskets receive them here. I have seen two cases in which the elephants forced the palisades, and killed men behind them. Tame elephants are used, if possible, to assist at this stage of driving, chiefly as a protection to the men on foot, who run behind them should any elephant turn and charge. There is much less danger of this occurring in dealing with large herds than with small ones, as should a single elephant charge out of a large herd, it is rarely supported, and it quickly rejoins its companions. But a determined leader of a handful of elephants is liable to be followed at once by the rest. When an elephant chases the men, they betake themselves to the shelter of tree trunks, bamboo clumps, or long grass, and it is astonishing how they frequently escape uninjured. I have known many cases of men standing against a tree, or hiding in tufts of long grass, within a couple of yards of elephants that were pausing in indecision, without being discovered, though the elephants were evidently aware of their close proximity, as they kicked up the ground in anger, and then made off. In such cases the slightest movement would have led to the hunters being instantly trampled to death. Men are frequently killed, of course, but they are almost always young hands who are learning. I saw one such make a narrow escape a few years ago; he ran from an elephant and climbed a tree; the elephant butted the trunk, and the man fell down, but his pursuer was so astonished at the sight that she fled at once.

Sometimes drives are conducted by torchlight, and these seldom fail, owing to the elephant's fear of fire. The scenes on these occasions are exciting beyond description. The elephants in rushing along tear down large branches of trees that are connected with the undergrowth by climbing-plants, and even sometimes upset dry trees bodily in their passage. The cries of the young, and the deep, thunder-like growls of the elders of the herd, the continued crashing of the jungle, and the shots and incessant cries of the men, form, with the unnatural light of the fires and of torches moving through the forest paths, a scene that cannot fade from the memory of anyone who has witnessed it.

When a herd has been driven into the stockade, the gate is closed and barricaded, and men with firebrands and spears repel any attacks upon it or the palisades. But the trench is usually sufficient to deter the elephants from crossing it. On the same, or following, day, ten or twelve tame elephants are admitted with a mahout and rope-tier upon each, and it is a very remarkable fact that the wild ones very rarely attempt to dislodge the riders, as they easily might. They naturally fail to comprehend anything so foreign to their experience as a man upon an elephant's back. I never knew a case, except one that happened to myself, of any rider being attacked by a wild elephant. The mahouts separate the wild elephants one by one from their companions, when their hind legs are tied by men who slip to the ground for the purpose. A rope is then secured round each captive's neck, and to its hind legs, and it is led out and picketed in the forest near.

If two well matched rival tuskers happen to be impounded in one stockade, they sometimes fight to the death, seemingly regardless of their novel position. If not well matched, the more powerful one bullies the weaker one incessantly. On one occasion, when a herd of forty-eight elephants had been impounded, a scene of this kind occurred, one elephant following and fighting with another almost continuously for two days and nights. The smaller elephant retaliated on others weaker than himself, and between them the pair killed four young elephants and a large *muckna*. They caused such commotion that the tame elephants could not be admitted. At last the larger tusker forced the smaller one across the trench, and against the palisades. The latter commenced to break his way out; and though muskets were fired into his face, and spears and digging tools, made red-hot for the occasion, were applied to his trunk and head, the inducement behind was so strong that the counter efforts of the men were unavailing, and he made his way through the palisade, and went off into the jungle. This was at 2 a.m., and was a sufficiently exciting scene. No other elephants attempted to follow, and the gap was quickly repaired.

Amongst these forty-eight elephants was one that had escaped about twelve years ago, judging from the ages of her three calves. We first observed the fact of her being an escaped elephant by seeing old rope marks on her legs. When the tame elephants entered the stockade, two ranged alongside this one, and on being pricked with a spear, and told to kneel, she obeyed at once. She was ridden alone a few days afterwards.

The number of wild elephants that can be taken care of is, at the most, 50 per cent. more than the tame ones. As each capture is concluded, the wild elephants are marched out of the jungle into open country, for if kept in the forest, they continue to be excited by jungle sights and sounds, and to struggle for liberty, whilst flies are much more troublesome to their wounds in the jungle than in the plains. Each batch of new elephants requires a number of tame ones to be detached in charge of it; thus the hunting operations are limited by the number of the latter.

When a sufficient number of elephants has been taken, the hunters are dismissed, and all elephants under 7 ft. in height are sold to merchants who follow the kheddah parties for the purpose of purchasing such. Those above 7 ft. are retained for Government service, except some males and old females, which are also disposed of. Not more than 30 per cent. of the elephants captured are young and strong females, thoroughly suitable for Government service. The selected wild elephants are now divided into gangs of twenties, with a proportion of tame ones in charge. These escort the wild ones, bring their fodder, and lead them to water daily. The march from the jungle commences about the end of February, and the elephants reach the depôt at Dacca in May. They are then put into training, and by November are quite steady, and are drafted for military service.

New elephants are trained as follows:—They are first tied between two trees, and are rubbed down by a number of men with long bamboos, to an accompaniment of the most extravagant eulogies of the animal, sung and shouted at it at the top of their voices. The animal, of course, lashes out furiously at first; but in a few days it ceases to act on the offensive, or, as native say, "*Shurum lugta hai*," "It becomes ashamed of itself," and it then stands with its trunk curled up, shrinking from the men. Ropes are now tied round its body, and it is mounted at its picket for several days. It is then taken out for exercise, secured between two tame elephants. The ropes still remain round its body to enable the mahout to hold on should the elephant try to shake him off. A man precedes it with a spear to teach it to halt when ordered to do so; whilst as the tame elephants wheel to the right or left the mahout presses its neck with his knees, and taps it on the head with a small stick, to train it to turn in the required direction. To teach an elephant to kneel, it is taken into water five feet deep when the sun is hot, and upon being pricked on the back with a pointed stick it soon lies down, partly to avoid the pain, partly from inclination for a bath. By taking it into shallow water daily, it is soon taught to kneel even on land.

Elephants are taught to pick up anything from the ground by a rope, with a piece of wood attached, being dangled over their foreheads, near to the ground. The wood strikes against their trunk and forefeet, and to avoid the discomfort the elephant soon takes it in his trunk, and carries it. It eventually learns to do this without a rope being attached to the object.

I have only time to add a few facts regarding the financial results of elephant catching by the Government establishment at Dacca. Referring only to the official year ended 31st March, 1883, the expenditure upon the hunting establishment for twelve months was* £12,948, and the receipts by surplus elephants sold, and the value of those retained, £19,492, showing a profit of £6,544. Of this amount, £4,000 was surplus from the preceding year.

During the past five years the annual average number of elephants captured during our short working season, from December to February, has been 154. The greatest number in any single year was 252 in seven weeks in 1882, and 199 in a similar period in 1883. A ready sale is effected amongst the native landowners, and others who are fond of keeping elephants, of all those not required by Government.

The belief that wild elephants have decreased in India is not an uncommon one, and may have arisen from the fact of laws having been passed in late years for their protection. Also, from their undoubted decrease some years ago in Ceylon. But the case of that island is not analogous to that of the continent. In Ceylon, elephants have always been made a peculiar object of pursuit by large numbers of sportsmen, and by paid native hunters, whilst their range is not without its limits. To show the numbers that have been destroyed there, I may quote the official statistics between 1845 and 1859, which show that during those fifteen years rewards were paid for 5,194 elephants killed in, I believe, only a part of the island. Similar destruction has gone on for years, until rewards were abolished some years ago. But elephants are again becoming numerous, and are again allowed to be shot.

But on the Continent of India the number shot by European sportsmen has always been small, and it was only for a few years that natives were induced to turn their attention to killing them by a reward given for their destruction in the Madras Presidency. This was soon withdrawn, and the representations of humane officials having further led to the curtailment of the wasteful methods of trapping them practised by native hunters, the wild elephant now enjoys perfect immunity throughout the Western Ghats, and those boundless forests extending for hundreds of miles along the foot of the Himalayas into Burmah and Siam. The number annually caught by the Government hunting establishment at Dacca (the only one at present in India), and by licensed native hunters, is, comparatively speaking, very small; and there is no doubt that all the forest ground that can be legitimately allowed to the wild elephant is as fully occupied at present as is desirable. The elephant-catching records of the past fifty years attest the fact that there is no diminution in the numbers now obtained in Bengal, whilst in Southern India elephants have become so numerous of late years that they are annually appearing in places where they had never been heard of before.

In the Billigarungun Hills, an isolated range of 300 square miles on the borders of Mysore, wild elephants first made their appearance about the beginning of this century, having strayed from the forests at the foot of the Neilgherry range, across an intervening strip of some thirty miles of civilised country. Prior to that time the Sholagas, a wild tribe that inhabit the Billigarungun hills, but which has now dwindled down to a handful of savages, were a numerous people; traces of their former extensive cultivation, even of orange groves, gardens, and iron-smelting furnaces, still exist, together with lakes on the summit of the hills, for the convenience of the cattle which used to be driven thither from the neighbouring low country for pasturage during the hot weather. The Sholagas were almost destroyed by three successive visitations of small-pox, a disease which is always exceedingly fatal amongst hill people in India; their lands relapsed into the densest forest; and wild elephants and bison now abound where probably not one was to be found a century ago. The case of these hills is an interesting instance of a large tract of country in India having relapsed into a wilderness in recent times.

To give an idea of the numbers of wild elephants in some forests, I may say that during the past five years, between 1878 and 1883, 1,066 wild elephants have been captured by the Dacca hunting establishment in a tract of country about fifty miles long by twenty miles broad, in the Garo-hills in Assam, whilst fully as many more were met with during the hunting operations. Of course these elephants do not confine themselves to that tract alone, but wander into other parts of the hills. There are immense tracts of forest in India similarly well-stocked with wild elephants.

I am sure it will be regarded as a matter for hearty congratulation by all, that so grand, interesting, useful, and harmless an animal as is the elephant is in no danger of becoming extinct in India. Though small portions of its haunts have been cleared for tea or coffee cultivation, the present forest area of the country will, probably, never be practically

* Taking the rupee at 2s., for convenience.

reduced, for reasons connected with the timber supply and climate; and as long as its haunts remain, the elephant must flourish under due regulations for its protection.

DISCUSSION.

Mr. A. D. BARTLETT said he had had many years' experience of elephants, but only amongst those in captivity. He had had to do with probably the largest one ever seen in Europe, viz., Jumbo. When he came to the Zoological Gardens he was about four feet high, and weighed 700 lbs.; at first he was troublesome, but after a very short time became perfectly manageable, and grew very rapidly. This was to be attributed to his good living, and his constant bath in warm weather; in seventeen years he had grown from four feet to eleven feet in height. During the last few years of his stay he began to display, during a certain period of the year, a very troublesome disposition, and terrified everyone who came near him, except his keeper, Scott, who had extraordinary control over him. Scott was a very curious man himself, and it was with the greatest difficulty he could be induced to allow another man to assist him in the management of the huge animal. But it was feared that on some occasion, if Scott fell ill, or were injured by the elephant, he would be entirely unmanageable, for no other man dared go near him in his house, though when out at exercise he was perfectly quiet. At night, however, he used to tear about, and almost shake the house down, and became such a source of trouble that the Council decided to part with him. He was glad to say that he had recently heard from Mr. Barnum that Jumbo had increased one ton in weight, and was the father of two little infants, and he believed it was Mr. Barnum's intention to send over here a female elephant which was expected to give birth to another descendant of Jumbo's in November next.

Admiral RYDER asked if Mr. Sanderson could give any information with regard to the worship of elephants in Siam.

Mr. WEDDERBURN MAXWELL was very glad to hear that the cruel system of taking elephants in pits was condemned, and hoped it would be put an end to throughout India. Having lived in a district adjoining the scene of Mr. Sanderson's operations, he could confirm all he had said, and thanked him for the very graphic and accurate description he had given of the mode of capture.

Dr. GARSON asked if some further information could be given as to the length and weight of the tusks.

Mr. MARTIN WOOD said Mr. Sanderson had assured them that the number of elephants in India was not likely to decrease; but they all knew that in Africa the animal was being mercilessly destroyed, and he should like to ask if any means could be suggested by which the pitiless warfare against this noble beast could be checked.

Mr. CHRISTY said this last point was of great importance. He frequently had inquiries from Africa whether it was possible to organise a body of retired officers, or others, who would go Africa and assist the planters and Europeans there in devising some means of capturing and taming elephants. They had even gone so far as to authorise the purchase of some Indian elephants for the purpose, if necessary, but up to the present he had not heard of any practical measures being taken, though the matter had been much discussed in the *Field* and other papers.

Mr. KLENCK was sorry to hear that there was so much sacrifice of human life in the capturing of elephants. He would also emphasise the remark of a speaker with regard to the cruelty of catching elephants in pitfalls.

Mr. ANDREW CASSELS thought most persons present were afraid to expose their ignorance on this subject, by making any remarks in the presence of two such authorities as the Chairman and Mr. Sanderson; but he must say that one of his illusions had been removed that evening, for up to then he had always looked upon the elephant as a very sagacious animal.

The CHAIRMAN said this was a subject on which he could talk for a long time, though he certainly could not claim to be an authority, and knew very little compared to Mr. Sanderson. As he had listened to the graphic description of the elephants rushing through the primeval forests in the sub-Himalayan districts, he could not help his thoughts reverting from those regions to the valley of the Thames in the time long past, when the very ground upon which they were then met was the *habitat* of elephants far larger than any of those whose dimensions Mr. Sanderson very rightly expressed such doubts about. Most people knew that the Thames valley was, at one time, the habitation of probably two species of elephants, whose remains were constantly dug up in the marshes. Only so recently as 1846, one of those enormous creatures, the *elephas primigenius*, which was by some supposed to be the ancestor of the modern elephant, was turned up in Siberia, by the action of the water, in a good state of preservation. He was 13 ft. in height and 15 ft. in length, with enormous tusks, and covered with a long coating of hair, with a thick matting of wool underneath, showing him to be adapted to a cold climate. The African and Indian elephants were the only remaining examples of a great race which had passed away, though the remains of eight or ten different forms were still occasionally found in certain parts of India, showing clearly marked resemblances to the present type. A question had been asked about the African elephant and its capabilities of domestication, and if anything could be done to stop its wholesale destruction. It would be very difficult to suggest anything in that direction; but he might say that, some years ago, the idea did occur to him and others that these animals might be caught and utilised, and he suggested then that Mr. Sanderson should be asked to go from India with a select number of men trained by himself in elephant catching, taking a certain number of elephants with them, and there set up an elephant catching establishment. Had that been done, he felt convinced that long ere this there would have been a number of useful working elephants in Africa. The African elephant was just as capable of being tamed and trained as the Indian, though there were certain differences between them which might be of some practical importance. For instance, he did not know how a mahout could sit on the neck of an African elephant, on account of the immense size of its ears, but there might be other means of driving it. It was quite ascertained, however, that the African elephant was as docile, intelligent, and as capable of doing good work as the Indian, and there was no reason why he should not be utilised in the same way. There was very little doubt that the elephants mentioned in the classic authors, as being employed in the Punic and other wars of Hannibal, and those slaughtered in the amphitheatres at Rome, were of the African species, as was shown by medals and drawings, though these were not always perhaps perfectly reliable in details, such as in the size of the ears and shape of the cranium. He hoped the suggestion made, some years ago, by Mr. Sclater and others, as well as by himself, would eventually bear fruit. Certainly such a scheme could be placed in no better hands than those of Mr. Sanderson, for there was no one living who knew more about elephants; and, if a mission of this kind were entrusted to him, within a few years he felt sure he would produce as good a stud of elephants in Africa as could be got in India. He did not know that he should agree with him in all he said, but where he did not, he should defer to his opinion. He confessed he put the animal's intelligence somewhat higher than Mr. Sanderson did, but perhaps this was because Mr. Sanderson had seen them more in the wild state, and might not have seen so much of their after training; but he had certainly seen from time to time instances of intelligence which went beyond what Mr. Sanderson had described. If the elephant fell short of the intelligence of the dog, it certainly came very near to it, and he could not call the elephant a stupid animal. He should have liked to know something more about the growth of the animal, and when it attained full maturity. He did not think this was yet known and appreciated in India, and he believed that if the *mukhna*, now in the Zoological Gardens, or his female companion, were presented to an ordinary mahout, he would put their ages considerably beyond 15 or 16, which was the undoubted age, because their birthdays were known. He had known them for many years, having come over in the same ship with them in 1876, when they were quite small; but they were now both over 8 ft., and in India such a sized elephant would generally be put down as 20 or 25. He had a certain amount of experience of these animals, from having kept them, known them well, and been known by them. The last elephant he had was a very good one, staunch, faithful, unintimidated in the presence of tigers or any other wild animal, and was about 30 years old, or possibly a little more, when he lost her, with other property, at the time of the mutiny. Several years afterwards, when he returned to India, he happened to go up into Oude, and in making a journey, part of it had to be accomplished on elephants. When he got out of his carriage to mount the elephant she recognised him immediately, before he recognised her, and he thought that certainly showed a greater amount of intelligence than could be expected from a stupid animal. Another important question was, how to tell the age of an elephant. By looking in his mouth you could tell approximately, but probably not within three or four years. Mr. Sanderson had mentioned an important fact, which was not yet generally acknowledged, that the tusks of an elephant, which did not represent canine teeth, but incisors, were not deciduous, but came once for all, and remained. Comparative anatomists said that these teeth had a deciduous form at first, that they grew for a year or a year and a-half, and were then shed and replaced by the permanent tusks. Mr. Sanderson said this was not so, and though this had yet to be verified, he (the Chairman) thought he might be right. That there was a deciduous tooth which was followed by the permanent one he had no doubt, but apparently it was not shed, but absorbed, which would explain the matter. If they looked into a large elephant's mouth they would see two enormous teeth, double teeth, but not generally more than two, and if they looked into the mouth of one of the elephants in the Gardens now, they would probably see in front of one the fragments of another double tooth. The fact was that the elephant had six molar teeth on each side in the lower jaw, three of which represented the deciduous, and three the permanent teeth; one grew behind the other, and pushed it forward. The first three were lost in the first nine years. At about the 20th to 25th year the fourth tooth was lost, and for the rest of its life the animal depended on the two last. Knowing this, you might, up to a certain period, estimate approximately the age. Again the mahouts said they could tell the age of an elephant partly by the general appearance, but what they depended most upon was a fold in the upper part of the ear; however he doubted if they were not frequently out some years. Then there were questions as to the kind and amount of food the animal required, and the best means of keeping it in health. It was laid down in the commissariat of India that, for an elephant at sea, there was required daily, 150 lbs. of hay, 20 lbs. to 30 lbs. of flour, a certain amount of rice, 4 oz. to 6 oz. of salt, and 30 or 40 pails of water. The amount consumed by Jumbo was a truss and a-half of hay, two of straw, 2 lbs. of rice, 1 bushel of bran, 1 peck of oats, 7 lbs. of biscuit, grass or green food as much as he could get, and 10 pails of water; so that an elephant was a costly animal to keep. Yet he remembered the time when you could keep one in India, including the mahout and grass cutter, for thirty or forty rupees a month. It would cost more than twice as much now. As to the value of elephants, their price was perfectly arbitrary and conventional. You might pay almost any sum for a good tusker or even a good *mukhna*, which was a male with very small tusks like those of a female. If they wanted to see fine specimens of well formed elephants, they could not do better than examine those in the Zoological Gardens, both of which had been carefully selected by men of extremely good judgment and knowledge of the animal. The larger, though the younger one, was a perfectly beautiful elephant, and was selected especially by the late Jung Bahadoor, who was a great lover of elephants; on the table was a picture of a very fine tusker which belonged to him, and was considered the finest in India. With regard to ivory and the size of tusks, he had copied some figures on the subject, stating that some African tusks weighed 100lbs. each, and one pair weighed 325lbs. It was also stated that the best ivory came from Siam, though why that should be better than the Indian he did not know, as it was the same species. The ivory of the mammoth was even yet exported in tons from Siberia, but whether after being exposed for so many centuries to the weather and water it was of as good quality as the modern ivory, he could not say. He concluded by proposing a vote of thanks to Mr. Sanderson, which was carried unanimously.

Mr. Sanderson, in reply, said he could not give any information about the alleged elephant worship in Siam, for he knew nothing about it. As to the use of pitfalls, he had intended to make it clear that the Government had prohibited them all over India, and though they were still in use in some of the native territories, yet even from these they had had inquiries as to the more advantageous method of catching elephants, and some of these native States had expressed their desire to abolish this barbarous system. With regard to the length of tusks, he had himself seen a pair from the Garrow hills, in Assam, obtained in 1879, which measured 8 ft. 9 in. in length, and he had no doubt they were still in the possession of Lord Lytton, who was then Governor-General. They weighed 168 lbs. Sir Victor Brooke, in the Mysore, shot an elephant, one of whose tusks was eight feet in length, and weighed 90 lbs. As to discouraging the slaughter of African elephants, he feared that nothing short of giving up the use of ivory would bring it about; for as long as the native traders could sell the ivory they would destroy the elephants. With regard to the sacrifice of human life in elephant hunting, everything was done to prevent it; but it must be remembered that risk of life was unavoidable in fishing, and indeed in almost all industrial pursuits. Unless the elephant was left alone altogether, there must be some danger, but every possible precaution was taken to prevent loss of life. With regard to elephant catching in Africa, Sir Joseph Fayrer communicated with him on the subject some four or five years ago, and submitted a plan to him. He then suggested that it would be well to send a few Indian elephants over first, to see if they would stand the tsetze fly, because some Indian buffaloes which Dr. Livingstone took there were killed within about ten days' march from the coast. Subsequently four elephants were shipped from Bombay, and landed at Zanzibar; they were under the care of Mr. Carter and another gentleman; but unfortunately, after a few days, they quarrelled with the Indian attendants, who left, and he did not know how they got on. There were accounts sent that they were not at all affected by the fly, and did very well for some weeks or months; then one or two of them died, and subsequently the expedition was cut up. Mr. Carter and the other gentlemen were killed, and what became of the elephants he did not know. As regards riding African elephants, he had three about 7 ft. high in the Dacca establishment for two years, with the object of testing them by the side of the Indian elephants, and they were found to be docile, but more stubborn. He had heard the same character of them from the keepers of menageries in England. The men sat upon their shoulders, and put their feet behind the ears; if necessary, a pad could be arranged to be kept behind the elephant's ears, to take off the pressure on the rider's legs. It would be a very good thing if the African elephant could be subjugated, because one would carry as much load as thirty or forty porters, and half the difficulty of African exploration arose from having to take so many, the greater part of whom were carrying goods to be given to themselves and their fellows as wages. Three elephants would be sufficient for any expedition, and this would, no doubt, be the best means of opening up Central Africa. Unless, however, it was decided to settle in the country for some years, he did not see how elephant catching was to be established; the negroes were perfect savages, who regarded an elephant simply as so much meat; and so long as the African slave hunters had more profitable employment in their own line, they would not take to elephant catching. It would, therefore, require a permanent establishment. He had made many experiments on the quantity of food an elephant would consume, having kept as many as ten for a month on a stone platform, where everything they had was carefully weighed. They would eat from 650 to 800 lbs. of green fodder in eighteen hours, and the rest of the time they had been out in the jungle getting it, during which time they got a picking also. With regard to their age, the sign of the ear was much relied on by the natives, but it was not always satisfactory, and required to be taken in conjunction with other things. As to the deciduous teeth, no doubt Sir Joseph Fayrer was perfectly accurate, and he was satisfied that they did not shed their tusks. He believed Mr. Corse originated the idea; whether any elephant ever did so he was not prepared to say, but to test the fact, he had, in a large number of instances, had a file mark put upon the tusk the moment it came through, but although he watched them carefully, and had never known a tusk drop, nor was the idea entertained by anyone in India who was connected with elephants. Mr. Tegetmeier, however, and other naturalists, judging from the skull, asserted that he was wrong, and that elephants had milk teeth. This was no doubt correct, but they were absorbed in the gum.

Miscellaneous.

THE FRENCH VINTAGE OF 1883.

The total production of wine in France, which in 1879 only amounted to 25,000,000 hectolitres (or about 550,000,000 gallons), rose in 1880 to 29,000,000, and in 1881 to 34,000,000, while it fell in 1882 to 30,000,000. Last year, however, it amounted to 36,000,000, an excess of 5,142,830 hectolitres over the previous year, and only 9,023,879 hectolitres less than the average of the last ten years. The *Journal de la Société de Statisque de Paris*, for March, says that the year 1883 was the most prosperous as regards results obtained, that has been experienced in France since the phylloxera commenced its work of destruction. Although the results of the wine harvest cannot be regarded as anything but most satisfactory, yet the favourable and healthy appearance of the vines at the commencement of the season gave a prospect of even a much more abundant yield than was actually obtained. In certain of the eastern districts, notably in the departments of the Doubs, Haute Savoire, and Jura, though the heavy rains and frost, to a great extent, injured the crops, yet the extreme mildness of the early spring was eminently favourable to the development of the vine. In other departments, such as the Dordognes, Landes, Isère, &c., sharp attacks of hail seriously injured the vines and prevented the grapes from ripening. In the departments of Aveyron, Gers, and the Haute-Loire, the extreme heat and absence of rain which was experienced during the months of August and September, burnt up the grapes, and materially affected the quantity if not the quality of the production. The departments which have suffered most from the ravages of the phylloxera are the Aude, the Bouches-du-Rhône, Cher, Pyrenees-Orientales, Rhône, Deux-Sevres, and Herault. It has again made its appearance in the Indre et Loire and the Loiret, and in addition another disease to which the vine is subject has made its appearance in the Gard, the Basses-Pyrénées, Vaucluse, and the arrondissement of Aix; this is the mildew. On the other hand, many vine-growers in several of the districts of the Midi have been most successful in their efforts to reconstitute their vines, the departments where this is particularly noticeable being the Ardèche part of Ariège, the Bouches-du-Rhône, the Herault, the Lozere, the Loire, Drôme, Vienne, Var, and the Gironde. In all these departments the young American plants are to be found flourishing. Taking the whole of the departments, it will be found that in spite of the many adverse atmospheric and other influences to which the vines have been subjected, fifty-nine show an increased yield last year as compared with 1882, and in twenty-nine, the production in 1883 has considerably exceeded the average of the last ten years.

As in previous years, it has been found necessary to have recourse largely to importations to meet the demands of consumers, and the country from which the supplies have been chiefly drawn is Spain, whose exports of wine to France during the first eleven months of last year exceeded 5,501,000 hectolitres, or 121,022,000 gallons. There is another source from which supplies are now largely drawn in France, and to which considerable attention has of late been directed; this is the vine of Algeria. Though a very recent introduction into this colony, and only within the last few years, the vine has proved eminently successful, and has shown increased production each year. Great things are expected from this vine culture in Algeria, and it is confidently anticipated that it will be very largely developed, and become a source of considerable revenue to the mother country. In 1876 there were only 16,700 hectares under vines in Algeria, with an estimated production of 221,000 hectolitres; in 1882 the extent of land under vine cultivation had increased to 37,000 hectares, and the production to 947,153 hectolitres. Many of the vineyard proprietors reside in France, where the Algerian wine is sent to be sold.

THE VICTOR EMANUEL LIBRARY OF ROME.

Her Majesty's Secretary of Legation, at Rome, says the Victor Emanuel Library is one of the richest in Italy, and has been taken over by the Government from the Jesuits, together with a large building known as the Collegio Romano, which contains a celebrated museum of archæological and other treasures, as well as one of the best observatories in the kingdom. The Collegio Romano is four stories high, and cover an area of 13,400 square metres, including 3,772 occupied by the church of St. Ignatius, and a garden of 2,000 square metres. On the ground-floor are the Lyceum Government School, the new Philological Institute, the Scholastic Museum, a portion of the library, and a space for the National Geographical Society. The first and second floors contain the bulk of the ancient library, which has been entirely re-arranged and largely added to under the new administration. The Jesuits formerly divided the collection into the "secret or major library," used only by the priests, and the "minor library," for the use of teachers. The former division contained over 65,000 volumes, and many precious manuscripts, including those of Cardinal Pallavicino, Largomarsini, and others, some of which appear to be now missing. A new hall has been built, capable of containing 2,400 volumes, and suitable arrangements have been made connecting the various departments of the library. The reading-room recently added is capable of holding 200 persons. To the Collegio Romano is now united the celebrated Casanatense, the richest ancient public library in Rome. With this addition the Victor Emanuel Institution has space for a million works. The books collected from forty-eight monasteries, together with those already in the Collegio Romano, amounted to 360,000 volumes. There were 120,000 in the Casanatense. In 1876, the date of its inauguration, about 200,000 scientific works had already been arranged on the shelves of the library, and about the same number of theological books remained to be set in order. In appealing to the Italian Government for the requisite funds to support and develop the institution, it was mentioned that the British Government expends on the British Museum alone an annual sum of £50,000—more than double the amount laid out by Italy on all her libraries, museums, art acquisitions, ancient monuments and excavations put together; while in one year alone, 1872, England spent £34,800 for the purchase of books—more than six times the sum devoted by Italy to the same purpose. The organisation of the new institution is of undoubted value in the preservation of literary works from the gradual destruction which menaced them. Three new collections have been added to the old Kircherian Museum; these are the Prehistoric, Ante-Roman, and the Lapidary Museums. To complete the circle of intellectual bodies comprised under the roof of the Collegio Romano, each institution has its own school and meeting-room. On the 25th November, 1882, a report was issued, showing the progress made since the opening of the library, from which it appears that the assiduous labour of several years will yet be necessary before the desired arrangement can be fully completed. Meanwhile a reading-room has been given to the public, with a supply of 369 magazines and periodicals. During the first ten months of the year this room and the remainder of the library was frequented by 14,770 readers, and it is recorded that not a single book or paper had been found missing throughout the whole year, nor has the least damage been caused to the property of the institution. The main resources of the establishment have been devoted to supplying the want of modern standard works, of which there was found to be the greatest deficiency. Among those purchased may be mentioned the collection of Didot, Hachette, Brockhaus, and the works of Goethe, Voltaire, Darwin, Shakspeare, Milton, Humboldt, Kepler, Laplace, and many other of the most eminent writers of England, France, and Germany. For nearly a whole century the monks appear to have added little or nothing to their collection, and this is quoted as a reason to justify the Government in taking possession of their neglected property. The whole number of periodicals now possessed by the library amounts to 1,127. From November, 1881, to November, 1882, there were purchased 4,594 scientific works (in about 15,000 volumes), while the Government officials sent in 16,186 pamphlets, or other documents; 910 books were deposited for purposes of copyright, and 2,229 works of different kinds were presented as gifts to the institution. Great labour has been expended on the compilation of a new catalogue, which is bound in boards of an ingenious model, invented for the purpose, locked and opened by a special key, and so formed as to afford immediate detection of the removal of any portion of its contents. At present, this catalogue is only arranged alphabetically, but it will, in time, be supplemented with another, arranged according to the classification of the works. Telephonic communication has been laid between the library and the central telephone office, for the convenience of the Ministries and the Houses of Parliament, and several excellent internal arrangements have been made for the accommodation of the public. The library is opened on every working day, from 9 a.m. until 3 p.m., and also, from the 5th November to the 31st May, from 7 to 10 o'clock in the evening. Persons under 18 years of age are not admitted to the reading-rooms.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock :—

March 26.—"Vital Steps in Sanitary Progress." By B. W. Richardson, M.D., F.R.S. Sir Robert Rawlinson, C.B., will preside.

April 2.—"The Dwellings of the Poor of Great Cities." By Elijah Hoole.

After Easter.

May 14.—"Telpherage." By Professor Fleeming Jenkin, F.R.S.

Foreign and Colonial Section.

Tuesday evenings :—

April 1.—"The Rivers Congo and Niger

entrances to Mid-Africa." By ROBERT CAPPER, Major-General Sir FREDERICK JOHN GOLDSMID, K.C.S.I., C.B., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

APRIL 24.—"Economic Applications of Sea-weed." By EDWARD C. STANFORD, F.C.S.

MAY 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R S., will preside.

⁂ The date of this meeting has been changed from March 27.

INDIAN SECTION.

Friday evenings :—

MARCH 28.—"Trade Routes in Afghanistan." By GRIFFIN W. VYSE. LORD ABERDARE, F.R.S., will preside.

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

CANTOR LECTURES.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint.

LECTURE II. March 24.—Gradual Development of the Processes of Coining. The Composition and "Standards of Fineness" of the Alloys used for Coinage in Ancient and Modern Times.

LECTURE III. March 31.—Methods by which Accuracy of Weight and "Fineness" of the Alloys is ensured.

LECTURE IV. April 7.—Questions connected with the liability to Reduction in Weight and various Coins by Wear during Circulation.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 24...SOCIETY OF ARTS, John-street, Aldelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts, "The Alloys Used for Coinage." (Lecture II.)
Surveyors, 12, Great George street, S.W., 8 p.m. Mr. W. Fowler, "The Ancient Terms applicable to the Measurement of Land."
Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut.-Colonel Sir Charles W. Wilson, "Notes on the Physical and Historical Geography of Asia Minor, made during Journeys from 1879 to 1882."
British Architects, 9, Conduit-street, W., 8 p.m.
Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. W. Topley, "The Physical Structure of England, and its Influence on Agricultural Practice."
Medical, 11, Chandos-street, W., 8½ p.m.

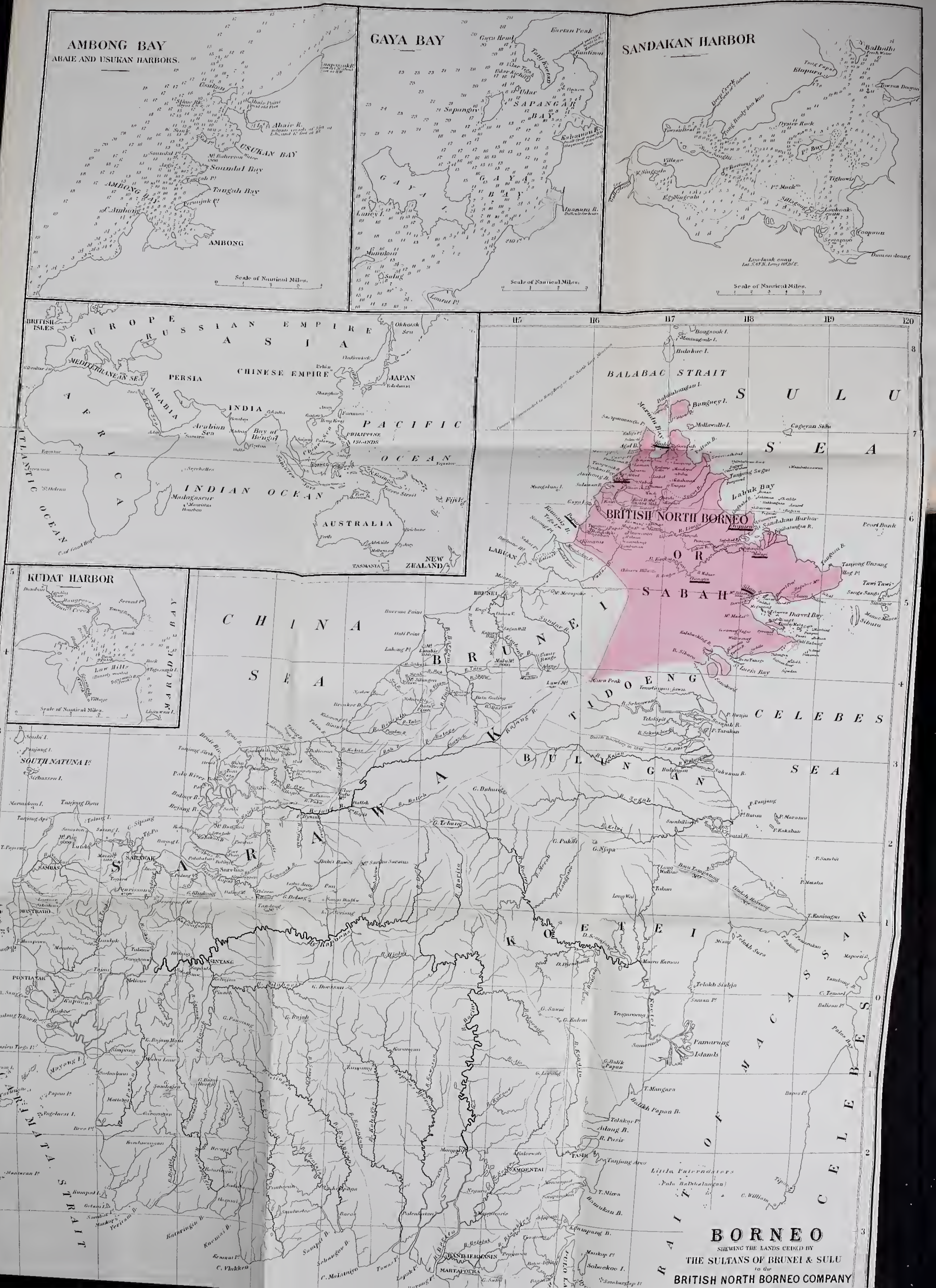
TUESDAY, MARCH 25...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Animal Heat, its Origin, Distribution, and Regulation." (Lecture IV.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. James A. Longridge's Paper, "Wire-gun Construction."
Anthropological, 4, St. Martin's-place, W.C., 8 p.m. 1. The Earl of Wharncliffe, "Exhibition of a Flint Implement from the North Riding of Yorkshire." 2. Mr. F. G. Hilton Price, "Note on some Ancient Egyptian Bronze Implements." 3. Mr. J. G. Garson, "The Frankfurt Craniometrical Code."

WEDNESDAY, MARCH 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. B. W. Richardson, "Vital Steps in Sanitary Progress."
Hospitals Association, 11, Chandos-street, Cavendish-square, W., 8 p.m. Mr. William J. Nixon, "Difficulties associated with the administration of the Out-Patient Department, and how best to deal with them."
Royal Botanic, Gardens, Regent's-park, N.W. Exhibition of Spring Flowers.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.
College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. H. Jackson, "Evolution and Dissolution of the Nervous System." (Lecture III.)
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. Thomas Cole, "Steam Tramways."

THURSDAY, MARCH 27...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. Forbes Robertson, "Some Remarks on International Exhibitions, with Special Reference to the Recent Exhibition at Munich."
Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 8 p.m. Mr. W. Watson Cheyne, "Practical Demonstration of Bacteria, particularly of the Organisms Occurring in Disease."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "The Older Electricity, its Phenomena and Investigators." (Lecture V.)
Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Professor George Forbes, "The Proportion which ought to subsist between the Size of Conductors and the Strength of Currents." 2. Mr. Thomas H. Blakesley, "The Relation which should subsist between a Current of Electricity and the Conductors employed to convey it."

FRIDAY, MARCH 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. Griffin W. Vyse, "Trade Routes in Afghanistan."
United Service Inst., Whitehall-yard, 3 p.m.
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Osborne Reynolds, "The Two Manners of Motion of Water."
College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. James Andrew, "Ætiology of Phthisis." (Lecture I.)
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
Browning, University College, W.C., 8 p.m. Paper by the Rev. Mark Pattison.

SATURDAY, MARCH 29...Geologists' Association, 2½ p.m. Visit to the British Museum under the Direction of Professor Rupert Jones.
Royal Institution, Albemarle-street, W., 3 p.m. Captain Abney, "Photographic Action considered as the Work of Radiation." (Lecture V.)


AMBONG BAY
ABAIE AND USUKAN HARBORS.
Scale of Nautical Miles.
GAYA BAY
Scale of Nautical Miles.
SANDAKAN HARBOR
Scale of Nautical Miles.
EUROPE
RUSSIAN EMPIRE
ASIA
CHINESE EMPIRE
JAPAN
PERSIA
ARABIA
INDIA
AFRICA
PACIFIC OCEAN
INDIAN OCEAN
ATLANTIC OCEAN
AUSTRALIA
TASMANIA
NEW ZEALAND
KUDAT HARBOR
MARUDU BAY
Scale of Nautical Miles.
BALABAC STRAIT
SULU SEA
BRITISH NORTH BORNEO
OR
SABAH
LABUAN
BRUNEI
CHINA SEA
SARAWAK
TIDOENG
BULUNGAN
CELEBES SEA
KOETEI
STRAIT OF MACASSAR
CELEBES
CARIMATA STRAIT
SOUTH NATUNA Is
BORNEO
SHEWING THE LANDS CEDED BY
THE SULTANS OF BRUNEI & SULU
to the
BRITISH NORTH BORNEO COMPANY

Journal of the Society of Arts.

No. 1,636. Vol. XXXII.

FRIDAY, MARCH 28, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONFERENCE ON WATER SUPPLY.

In accordance with an invitation from the Executive Council of the International Health Exhibition, the Council of the Society of Arts have undertaken to organise a Conference on Water Supply, to be held at the Exhibition on some date to be hereafter announced. H.R.H. the Prince of Wales, President of the Society, has graciously intimated his intention to preside on this occasion.

INTERNATIONAL HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow Members of the Society of Arts the privilege of purchasing Season Tickets for the Exhibition at half-price. Each Member will only be allowed the privilege of purchasing a single ticket on these terms, which will be a personal admission, not transferable. Season tickets admit to the opening ceremony on the 8th May. As soon as the tickets are ready, due notice will be given in the *Journal*.

SIEMENS PRIZE.

Lady Siemens has placed at the disposal of the Council a sum of £20, to provide a prize, to be called the Siemens Prize, to be offered for the best application of gas to heating and cooking in dwellings (Class 24 in the International Health Exhibition). The prize will consist of a Gold Medal or £20, and will be awarded under the same conditions as the prizes announced in the *Journal* of the 14th inst.

CANTOR LECTURES.

The second of the course of lectures on the "Alloys used for Coinage," was delivered on Monday evening, the 24th inst., by Professor Chandler Roberts, F.R.S.

It was shown that the word "alloy" is inaccurately used in Mint language, as it is applied to the base metal added to a more precious one, and not, as it should be, to the mass of the mixed metals. Biringuccio, speaking of the gold alloys, had used the word with perfect accuracy in 1540. "I have told you," he said, "that an alloy only signifies an intimate association of one metal with another," and that is what a chemist understands by an alloy at the present day. The history of the more important alloys actually used for coinage in different countries, was then traced and illustrated by references to the results of assays made on ancient coins, several of the results being published for the first time.

It was pointed out that, within certain limits, the selection of a "standard fineness" for the alloy to be used for coinage was not a matter of much importance, as there were many alloys of precious and base metals of which very convenient coins might be struck, while, at the same time, they possessed excellent physical properties, probably the most important being the power of resisting loss of metal by wear.

INTERNATIONAL HEALTH EXHIBITION HAND-BOOKS.

The Executive Council of the International Health Exhibition propose to issue a series of hand-books, dealing with the various subjects included in the Exhibition programme. They propose, at the conclusion of the Exhibition, to present the copyright of these books to the Society of Arts, and the Council of the Society have readily undertaken to continue their publication after the Exhibition has closed.

The following is the list of hand-books for which arrangements have already been made. Others are in contemplation:—

Food. Mr. A. W. Blyth, M.R.C.S.
Principles of Cookery. Mr. Septimus Berdmore.

Food and Cookery for Infants and Invalids. Miss Wood, with preface by R. B. Cheadle.
Drinks, Alcoholic. John L. W. Thudichum, F.R.C.P., M.D.
Drinks, Non-Alcoholic, Aerated. John Attfield, Ph.D.
Fruits of all Countries. Illustrated. Mr. W. T. Thiselton Dyer, M.A., C.M.G.
Condiments, including Salt. Rev. J. J. Manley, M.A.
Dress in Relation to Health and Climate. Illustrated. Mr. E. W. Godwin, F.S.A.
Athletics. Part I. Illustrated. Rev. E. Warre, M.A.
Athletics. Part II. Illustrated. Hon. E. Lyttleton, M.A., and Mr. Gerard F. Cobb, M.A.
Manual of Heating, Lighting, and Ventilation. Illustrated. Captain Douglas Galton, C.B., F.R.S.
Healthy Town Houses and Country Houses. Parts I. and II. Illustrated. Mr. W. Eassie, C.E., and Mr. Rogers Field, C.E.
Healthy Villages. Illustrated. H. W. Acland, C.B., M.D., F.R.S.
Healthy Bedrooms and Nurseries, including the Lying-in-Room. Mrs. Gladstone.
Healthy Furniture and Decoration. Illustrated. Mr. R. W. Edis, F.S.A.
Healthy Schools. Illustrated. Mr. Charles Paget, M.R.C.S.
Health in Workshops. Mr. J. B. Lakeman.
The Ambulance. Illustrated. Surgeon-Major Evatt, M.D., A.M.D.
Legal Obligations in Respect to Dwellings of the Poor. Mr. Harry Duff, M.A., Barrister-at-Law; with preface by Mr. Arthur Cohen, Q.C., M.P.
Moral Obligations of the Householder, including the Sanitary Care of his House. G. V. Poore, M.D.
Laboratory Guide to Public Health Investigations. Illustrated. W. W Cheyne, M.B., and W. H. Corfield, M.D., F.R.C.P., M.A.
Scavengering and other such Work in Large Cities. Mr. Booth Scott.
Fires and Fire Brigades. Illustrated. Captain Eyre M. Shaw, C.B.

MAP OF BORNEO.

A map of Borneo, to illustrate Mr. Cobb's paper (see *ante* p. 400), in which the British possessions are marked red, is issued as a supplement with the present number of the *Journal*. The Society is indebted to the North Borneo Company for the map.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Kentish-town Science Classes, Wilkin-street, N.W.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, March 13, 1884, the Right Hon. Sir LYON PLAYFAIR, K.C.B., M.P., F.R S., in the chair.

The paper read was—

THE UPPER THAMES AS A SOURCE OF WATER SUPPLY.

By PERCY F. FRANKLAND, Ph.D., B.Sc., F.I.C., Assoc. R.S.M.

During the past year, the average quantity of water supplied in London amounted to 145,000,000 of gallons per day; of this enormous volume as much as 72,000,000 of gallons, or nearly one-half, were taken from the Thames, whilst of the remainder nearly the whole was derived from the River Lea, and but a comparatively small fraction from deep wells sunk into the chalk.

The Thames water is supplied by five independent companies to the western portion of the metropolis, both north and south of the river. These several companies all abstract their respective supplies from the river between Hampton and Sunbury. Thus the intakes of these water companies, situated as they are a few miles above Teddington Lock, lie almost at the bottom of the Upper Thames basin, by which is understood the area drained by the Thames and its tributaries down to Teddington Lock. By means of this lock the waters of the Upper Thames are shut off from—and rendered independent of—the tidal waters of the Lower Thames, which extend from Teddington to the sea.

Reference to the map on the wall shows that the basin of the Upper Thames is an area of vast extent, covering 3,676 square miles. The waters draining from such a large area might be expected to be of very different chemical composition; owing, however, to the geological formations of which this basin is composed being almost all more or less calcareous, the chemical composition of the waters of the Thames and its tributaries varies within comparatively small limits. Thus the total solid matter in these waters is generally about 30 parts in 100,000, of which about 20 to 25 parts consist of carbonate of lime, or other hardening or soap-destroying ingredients.

The River Wey, which is one of the last tributaries to join the Thames above the intakes, forms a noticeable exception to this rule. Its waters are chiefly derived from the greensand, and exhibit considerably less hardness than the other waters of the Upper Thames basin. (See analytical table, p. 436.)

In addition to these mineral ingredients, there is present also a small quantity of organic matter, partly dissolved and partly suspended, the amount of which varies considerably with the season, being greatest when the river is in flood, and least in dry weather. The presence of this organic matter in the waters of the Thames and its tributaries imparts to the river that particular colour intermediate between green and brown, which, although difficult to describe, is so familiar to all. Although this organic matter is, as regards its mass, one of the least significant, a mere mustard seed indeed among the ingredients of the water, yet, from a sanitary point of view, it is of far greater importance than all the other ingredients put together. It is with this organic ingredient of Thames water that I propose alone to deal this evening.

The questions which naturally suggest themselves in inquiring into the subject of this organic matter are:—

(1). Its origin and nature.

(2.) Possibility of excluding it from the river and its tributaries.

(3.) Its removal before the water is employed for domestic purposes.

On considering the extent and character of the Upper Thames basin, it is at once apparent that the rain falling on this area must, in its passage to the river, come in contact with abundance of organic matter, both vegetable and animal. In so doing, it exerts on this organic matter its solvent action on the one hand, and on the other its mechanical power of carrying matter in suspension. And, consequently, it reaches the river bearing a certain amount of organic matter in solution, and a certain amount of organic matter in suspension. The presence of vegetable organic matter in water, although undoubtedly objectionable if excessive, is yet comparatively of such small importance by the side of animal organic matter that, in our present investigation, it may be altogether disregarded. The animal organic matters gaining access to the waters of the Thames are principally the excrements of man and the lower animals; these animal matters are either discharged directly into the river in the form of town drainage, or they find their way there by soakage from manured land.

Ever since it has been established beyond doubt that the excrements of man may be the means of communicating and distributing enteric disease, the presence in the waters of the Upper Thames of such animal matters has been the cause of uneasiness and inquiry. In the year 1866, this uneasiness in the public mind led to the appointment of a Royal Commission, to inquire into the subject of the Water Supply of the Metropolis. It was before this Commission that those vast schemes of supplying the inhabitants of London with water from Wales, and even from Cumberland, were ventilated and discussed in detail. Among the chemical witnesses, whose evidence was, as usual, highly conflicting, there were not wanting those who unhesitatingly pronounced the Thames water, into which the drainage of every town in the Upper Thames basin possessing a sewerage system was freely discharged, a perfectly wholesome and suitable source of supply; whilst others gave it as their opinion that water which had once been fouled by sewage could not be considered a safe or satisfactory source. These latter gentlemen, moreover, were of opinion that no process of purification with which they were acquainted could render sewage fit for mixing safely with water intended for domestic use. In plain words, it was the moderate and common sense opinion of these gentlemen, that no process of purification known to them could render sewage a fit and safe beverage for man. The Royal Commissioners, after balancing this conflicting evidence, express the following opinion, which I extract from their Report, p. 126:—

> "That, when efficient measures are adopted for excluding the sewage and other pollutions from the Thames and Lee, and their tributaries, and for ensuring perfect filtration, water taken from the present sources will be perfectly wholesome, and of suitable quality for the supply of the metropolis."

Fourteen years have now elapsed since that report was published, and yet no measures for excluding the sewage, not to mention the "other pollutions," have been taken. Indeed, the efficient execution of such measures would involve the expenditure of a sum of money which renders any scheme of the kind practically impossible. Improvements, and these important ones, however, have taken place upon the banks of the Thames, and to a less extent upon those of its tributaries. All these improvements have, however, been in the direction of sewage-purification, and not of sewage exclusion. In order to illustrate how extensive these improvements have been, I may mention that in the year 1874, according to the Sixth Report of the Rivers Pollution Commissioners, there was, in the basins of the Thames and the Lee, only one town, viz., Banbury, where the mitigation of the sewage nuisance was effectively carried out. In order to ascertain the progress which has been made in this respect during the last ten years, I have recently addressed inquiries to all the towns of 5,000 inhabitants and upwards, situated in the basin of the Upper Thames and its tributaries, with regard to the system of drainage carried out, and I must take this opportunity of expressing my thanks to their respective Local Boards of Health, for the courtesy and frankness with which my questions have in most cases been answered. From the accompanying diagram you will see in what a large proportion of these towns, representing a total population of 269,221, it is attempted to purify the sewage before it finds

DISPOSAL OF SEWAGE IN UPPER THAMES BASIN.

Name of Town.	Population, 1881.	Drainage.	Treatment of Sewage.	Watercourse receiving effluent.	Remarks.
SURREY.					
Farnham	11,058	Partial.	None.	Wey.	
Guildford and Stoke	14,143	Partial.	None.	Wey.	
Chertsey	9,215	Partial.	None.	Thames.	"Tub" system.
Woking	8,554	Partial.	None.		
BERKS.					
Reading	43,494	"Separate" system.	Irrigation.	Kennet.	
Newbury	7,017	Partial.	None.	Kennet.	
Wokingham	5,043	Drained.	Irrigation.	Loddon.	
New Windsor	7,831	Drained.	Chemical treatment and irrigation.	Thames.	
Slough	5,000	"Separate" system.	Irrigation.	Thames.	Farm of 25 acres.
Abingdon	7,019	Drained.	Irrigation and intermittent filtration.	Thames.	Farm of 50 acres.
Maidenhead	8,220	Imperfect.			
HANTS.					
Aldershot	20,155	"Separate" system.	Hanson's process.	Blackwater.	200,000 gallons daily.
OXON.					
Oxford	35,168	Drained.	Irrigation.	Percolation only.	Surface drainage into Isis & Cherwell.
Banbury	12,127	Drained.	Irrigation.	Cherwell.	
GLOUCESTER.					
Cirencester	7,737	Drained.	Irrigation.	Tributary of Thames.	
BUCKS.					
Aylesbury	7,795	Drained.	Native guano process.	Haydon Mill stream.	(Thame)
Chesham	6,502	In construction.	Chemical treatment & intermittent filtration.	Chess.	8 acres.
Chipping Wycombe	8,320	In construction.	Irrigation.	Tributary of Thames.	
HERTS.					
St. Albans	14,895	Drained.	Irrigation.	Ver.	
Watford	15,507	Drained.	Intermittent filtration.	Colne.	
Hemel Hempstead	9,064	Partial.	None.	Gade.	
Tring	5,357	Partial.	None.		

Treated	196,593
Untreated	72,628
Total	269,221

its way into the Thames or its tributaries. The improvements have in most cases been carried out at great expense to the towns in question; thus the sewage works at Slough, where the drainage of about 5,000 persons is disposed of, were carried out at a cost of about £25,000. Indeed, it appears that in some cases the estimated expense of such works greatly exceeds the whole rateable value of the district, thus rendering the execution of such improvements exceedingly difficult. In several cases it has been admitted to me by local authorities that untreated sewage does enter the Thames and its tributaries, a fact which is sufficiently well-known to all frequenters of the river. Moreover, in the smaller towns and villages comprising the greater portion of the population of the Upper Thames basin, the sewage is generally allowed to collect in cesspits, the overflow from which usually communicates with the nearest stream or watercourse, whilst in other cases the street-drains are utilised for conveying the sewage matters into the nearest running water.

The Thames Conservators, in their report of last year, state that the river is now "practically free from sewage;" but even had they used the expression, "untreated sewage," the statement would have been sufficiently premature, for how frequently do we not read of the Conservancy prosecuting some offending town which has still failed to discontinue the discharge of unpurified sewage into the river? Thus, the following passages were extracted from the daily papers within a week or so of each other, October, 1883—

"Mr. Harrison, C.E., held a Local Government inquiry at Newbury yesterday, upon the application of the Newbury Urban Sanitary Authority, for powers to obtain a loan of £25,000 to carry out a scheme for the drainage of the borough. Dr. Shea, Medical Officer of Health for Reading, appeared for the Reading Corporation, who had lodged a complaint against Newbury for polluting the River Kennet with sewage. The evidence of the engineer, Mr. Anstie, and others having been given, the inquiry terminated."

Again, October 30, 1883—

"The Staines Local Board were summoned before the Spelthorne magistrates yesterday, by the Thames Conservators, for allowing to flow from their drains in Church-street into the River Thames foul and injurious matter. Mr. Payne, who appeared for the Conservators, stated that the Board had been fined three times before for polluting the River Thames, and yet had taken no steps to prevent a recurrence of the nuisance. This case was one of the worst that had ever been taken, and as the inlets of the water companies were within a few miles of the outfall of this sewer, the consequences might be of a very serious nature. Mr. Engall, the clerk of the Staines Local Board, said that the Board were doing all they could to carry out a system of drainage for the town, and were only waiting to receive Mr. Hawksley's report. The Board were in this position—the Conservators threatened them with penalties if the Church-street drain were not closed, and the inhabitants of Church-street threatened to sue them if the drain was cut off. The Bench imposed a fine of twenty guineas. Mr. Payne then applied for a summons against the Board for allowing foul matter to flow into the Thames from their drain in the London-road, and this was granted."

A few days afterwards, it appears Mr. Hawksley's report arrived; it contained, however, but little consolation for the ratepayers of Staines. Thus on November 20, 1883, we read—

"The Staines Local Board were yesterday summoned before the Spelthorne magistrates, for the fifth time, for having failed to comply with the notice served upon them by the Conservators of the River Thames on the 27th of September, 1871, and causing or suffering offensive or injurious matters to flow or pass from their drain near Station passage, Staines, into a water-course communicating with the River Thames. Mr. Engall said the Board had endeavoured to secure a system of drainage, and had consulted several competent engineers. Mr. Hawksley had just reported that Staines was the most peculiar, the most exceptional, the most difficult, and would prove the most expensive place of any he knew to provide with an efficient system, and that to drain the place, with a population of five thousand, would cost £32,000, or thereabouts. The Bench decided that the Local Board were at last taking steps to provide the town with drainage, and imposed a penalty of one guinea only, and five guineas costs."

Judging from the result of a more recent prosecution by the Thames Conservancy, it appears that their laudable crusade against Thames pollution is fraught with insuperable difficulties, even when a clear case of sewage discharge is proved, and even admitted by the defendants. Thus:—

"At the Uxbridge Petty Sessions yesterday, the Uxbridge Local Board of Health were summoned by the Thames Conservancy Board, for having, on the 22nd of November and the 3rd of January last, caused, or suffered to pass into the Colne from their sewage works at Uxbridge-moor, injurious or offensive matter which was likely to enter the Thames and prejudicially affect the river. Mr. F. O. Crump was counsel for the complainants, and Mr. H. S. Greene for the defendants. Great interest was taken in the case from the fact that in February, 1881, the Thames Conservancy were beaten by the defendants under precisely similar circumstances. Mr. Wigner, the analyst to the Conservators, deposed that a sample of water was taken from the mouth of the outfall belonging to the defendants and found offensive and injurious matter, unfit to pass into any tributary of the Thames within a distance of ten miles of that river. Similar evidence was given by Dr. Stephenson, another analyst; but the defence was that even supposing sewage matter of the worst description entered the Colne at Uxbridge-moor, there was not the probability of its injuriously affecting the Thames in any way, it having to run seven and a quarter miles before it reached that river. Evidence on this point was given by Dr. Tidy, who deposed to having found that the polluting matter was entirely destroyed after proceeding half-a-mile. Professor Wanklyn, public analyst for Middlesex, also gave strong evidence for the defence, and, after an inquiry extending over six hours, Colonel Cox, the chairman, announced that the magistrates were unanimously of opinion that the case had not been proved. Mr. Green applied for costs, and the Bench decided to grant the Local Board forty guineas."

I believe it used to be stated by Dr. Letheby, and subsequently by his disciple, Dr. Tidy, that it required ten miles' flow for a river to purify itself; but I suppose that the high-pressure system, which is so characteristic of the present day, has even affected our rivers, which now succeed in performing this wonderful feat in half a mile instead of in ten!

Really, as long as there are magistrates to be found who are so ignorant as to credit such romances as the destruction of sewage matters in half a mile's flow of a river, even the most zealous Board of Conservators can expect but little success.

In connection with the prosecution of the Staines Local Board, the following extracts from a letter to the *Times*, by the Vicar of Staines, is interesting and instructive:—

"Sir,—The parish of Staines has been lately brought unfavourably under public notice, in reference to the pollution caused in it to the water with which some of the water companies are supplied, the Thames Conservancy having frequently summoned our Local Board for the offence.

"It is quite true that impure stuff does run from some of the drains and water-courses of this parish into that part of the Thames which is above the intake of some of the London water companies, and most desirable it is that this should be prevented. But it is not easy to decide which, if any, of the many modern systems of town drainage would be the best for the town of Staines. It is so very flat, and so subject to floods in winter, that it will be difficult so to construct main drains and their house connexions that in time of floods the water shall not force its way into the pipes, and thus carry their contents not only into the river, but into the flooded streets and houses, thus imperiling the health and lives of the inhabitants.

"Staines is one of those places which continue to use the once universal system of cesspools, notwithstanding which, its death-rate will compare favourably with that of most English towns; and until last year its entire water supply has been drawn from wells, for no one here would think of drinking the water of the Thames. If our new water company, which draws its supply from the chalk, can give the town a sufficient supply of water, it may well be doubted whether a continuance of the cesspool system, accompanied by a well-organised plan of periodical cleansing, officially carried out, will not be the best for both the river and the town, as wel as the most economical.

"Our Local Board, of which I am not a member, has been at considerable pains to arrive at a sound conclusion in the matter, and have sought the advice of competent authorities. That there should be considerable hesitation on their part in arriving at a decision will not be wondered at when I state that the system last recommended to them will, from first to last, cost about £40,000, the rateable value of the parish being only £27,000.

"Meantime the Thames Conservancy are frequently summoning our Local Board, and thus parading before the public as the zealous and watchful guardians of the purity of the water for which they charge the water companies of London several thousands a year —a mode of appropriating to special purposes what is public property which I commend to the notice of Mr. Lefevre, in connexion with his recently-announced crusade against encroachment on the public rights of the Thames.

* * * * *

"Any one acquainted with the upper reaches of the Thames knows that thousands of persons bathe in it, and that hundreds of dogs are washed in it almost daily in the season, and that many of the eyots form the camping ground of boating parties. Moreover, every year sees a vast increase in the number of house-boats on the river in this neighbourhood and other places above the intake. These boats are inhabited day and night, sometimes for three or four months at a stretch, by parties, all of whose necessary pollutions go direct into the Thames. The contamination of the water supply of London by these causes can be more easily imagined than described. Do the Conservators of the Thames take any steps to mitigate these pollutions?

"Again, it is well known that accumulations of sewage are used, with other dressings, as manures for the fields which border the river. Every heavy fall of rain drains some of the impurities into the Thames. For this, of course, the Conservancy is not responsible; but when the floods rise and spread over the riparian lands, they in their fall sweep into the water supply of London tons of the offensive matter. . . . . I remember an instance not long since where the floods covered a large grass field which had just been dressed with manure largely composed of night soil, and when, after a few days, the water subsided, there was not a trace of it to be found in the field; it had all gone down to London.

"J. H. Armstrong, Vicar of Staines.

"November 29, 1883."

Even where sewage purification is, under ordinary circumstances, efficiently carried out, it is only in those towns which are provided with what is known as a "separate system," that the cleansing of the sewage can be carried out in times of flood. The separate system consists in having two independent drainages, the one for carrying away the rain water from the streets and housetops, the other for conveying the true household sewage. The street drainage is in such cases discharged directly into the nearest available watercourse, whilst the sewage proper alone is subjected to purification. The advantage of this system is that the sewage purification can take place even in times of flood, as the quantity to be treated is practically independent of the rainfall, and dependent only upon the abundance of the water supply. The disadvantage which the separate system obviously entails is the discharge of street drainage, without any purification, into the river. Now, street drainage, although unquestionably less objectionable than sewage proper, is yet, I take it, an undesirable ingredient of drinking-water.

In those towns where no such separate system exists, the purification of the sewage in times of flood is quite impossible, as the appliances for such purification are proportioned to deal with the average volume of the drainage and not with the excessive quantity occasioned by flood-waters. In all such towns, therefore, untreated sewage must, in times of flood, be freely discharged into the river.

Here it may be well to pause for a moment, and consider what the various processes of sewage treatment in vogue at the present time are; in what they differ from each other, and to which the preference should be given.

The methods of sewage purification may be divided into two classes—

1. Those depending upon filtration through soil.

2. Those depending upon precipitation by means of chemical reagents of one kind or another.

The first of these two classes includes the well-known processes of "broad irrigation" and "intermittent downward filtration." As these terms have become, I may say, household words in sanitary engineering, it is almost unnecessary for me to explain them here. I may, however, briefly state that in broad irrigation the sewage is distributed over the surface of cultivated land, drained either naturally or artificially. In percolating through the soil, the coarser solid particles of the sewage are arrested, an active process of oxidation goes on, resolving more or less of the organic matters of the sewage into inoffensive mineral ones, whilst this process of purification is assisted by the vegetable life with which the land is clothed.

Intermittent downward filtration, on the other hand, may be described as a concentrated form of irrigation; a far larger amount of sewage is applied to a given surface of land, and in order to meet this greater tax put upon the soil, the latter must be drained at a considerably greater depth. As in irrigation the land must not receive the sewage continuously, but must be divided into separate plots, which are worked in succession. During the period of repose which each plot of land enjoys in turn, the soil becomes recharged with oxygen, and when thus revivified is fit for the reception of a fresh quantity of sewage. The accompanying Table

PURIFICATION OF SEWAGE.

Name of Process.	Average per-centage of dissolved organic pollution removed.		Average per-centage of suspended organic pollution removed.
	Organic Carbon.	Organic Nitrogen.	
Chemical Processes.			
Best result	50·1	65·8	100
Worst result	3·4	0	59·6
Average result	28·4	36·6	89·8
Downward Intermittent Filtration.			
Best result	88·5	97·5	100
Worst result	32·8	43·7	100
Average result	72·8	87·6	100
Irrigation.			
Best result	91·8	97·4	100
Worst result	42·7	44·1	84·9
Average result	68·6	81·7	97·7

shows that the degree of purification attained by means of irrigation, and by intermittent downward filtration, is much the same. Both processes, in fact, when carried out with care, yield equally satisfactory results. The choice between the two processes will obviously depend upon circumstances; where land is cheap and a suitable site obtainable, irrigation may be carried out with most success, the expense being more or less defrayed by the crops yielded; where, on the other hand, land is costly, the more compact form of intermittent downward filtration will find most favour with the sanitary engineer.

The various processes, and their name is legion, of sewage purification by means of precipitation, all depend upon the well known property which lime, iron, and alumina possess of entering into mechanical combination with organic matter.

A great number of patents have been taken out for treating sewage by precipitation, but in most cases they have attracted merely passing notice, and have then disappeared into that obscurity from which they ought never to have emerged.

The simplest as well as the most ancient process of precipitation is by means of lime. This process has been tried in more places than any other, and although it fails to purify the sewage, it acts as an efficient clarifier, and doubtless renders the sewage more fit for treatment on land.

As far as I am aware, the only precipitation processes of sewage purification which are at present in operation in the Upper Thames basin, are the so-called "A. B. C. or Native Guano Process," and "Hanson's Process." The former is employed at Aylesbury, and the latter at Aldershot.

The A. B. C. process has attracted an altogether undue measure of popular attention; probably on account of its very plausible and seductive name, which we can imagine may not be without influence upon the ignorant persons who are frequently entrusted with the management of local sanitation.

This process was very thoroughly investigated by the last Rivers Pollution Commission, and the result of their exhaustive examination is embodied in the following words:—

"1. The A. B. C. process removes a large proportion of the suspended impurities from sewage; but on no occasion, when we have seen it in operation, has this removal been so complete as to render the effluent sewage admissible into running water.

"2. The A. B. C. process removes a very small proportion of the soluble polluting matters from sewage. After treatment by this process, the effluent sewage is very little better than that which is obtained by allowing raw sewage to settle in subsidence-tanks."

The most reliable analytical figures, upon which the above opinion is founded, are contained in the following Table:—

Results of Analysis in Parts per 100,000.

Description.	Dissolved Matters.						Suspended Matters.		
	Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Total Combined Nitrogen.	Chlorine.	Mineral.	Organic.	Total.
	A. B. C. or Native Guano Process.								
London Sewage	67·3	3·614	1·886	5·418	6·348	10·23	10·30	18·00	28·30
Ditto after treatment	80·5	2·257	1·878	6·086	6·890	10·20	Traces.	Traces.	Traces.
	Hanson's Process.								
Raw Sewage	132·72	7·441	2·234	·90	2·975	5·7	4·96	44·70	49·66
Ditto after treatment	120·16	4·777	1·802	·80	2·461	7·1	2·36	—	—

This then is the only barrier interposed between the raw sewage of Aylesbury and a tributary of the Thames.

"Hanson's process" consists in treating the sewage with lime and alkali waste. The efficiency of this process has, during the past year, been investigated in my laboratory. It is not difficult to form an opinion concerning its value, on reference to the above analytical figures. The sewage of Aldershot thus undergoes but very imperfect purification, before passing into a tributary of the Thames.

If we reflect that these processes of precipitation thus signally fail in removing such organic matter from sewage as is recognisable by chemical analysis, the thought cannot be entertained that they either arrest or destroy those subtle forms of organic life which are capable of communicating zymotic disease.

Indeed, even in the case of sewage purified by the far more efficient processes of irrigation and downward intermittent filtration, there is absolutely no evidence to show that morbific matter, if present, would be removed. But on the contrary, there is very strong reason to believe that these processes of purification offer no sort of guarantee that noxious organised matters present in the sewage may not pass through into the effluent. For the removal of organic matter, by means of either irrigation or intermittent filtration, depends upon the oxidising action which a porous soil exerts upon such matter, and is quite analogous to the purification of water percolating through a few feet of soil into shallow wells. Now, the instances on record of the percolation of sewage into shallow wells becoming the means of infection are so numerous and well authenticated, that it is unnecessary for me to refer to them here. If, therefore, the filtration through in many cases considerable depths of porous strata, does not suffice to exclude such organised matter from shallow wells, what reason is there to believe that the far less favourable filtration which takes place in the purification of sewage should be more successful in attaining this result? As I shall presently demonstrate to you, the effluent from such sewage works is always charged with minute suspended particles which have escaped removal in the process of purification.

At Stuttgart in Germany, and Winterthur in Switzerland, some years ago, epidemics of typhoid fever were proved most conclusively to have been caused by the contamination of the water supply with the effluent from irrigated meadows.

It thus appears that the waters of the Upper Thames are contaminated with:—

(1.) Raw town drainage.

(2.) The effluent from sewage works.

(3.) The drainage from cultivated land, frequently manured with human excrements.

Of these sources of pollution, the first, or that due to raw town drainage, is, thanks to the exertions of the Thames Conservancy, becoming annually diminished. The second, or that due to sewage works, is, for the same reason, increasing; whilst the third cause, viz., drainage from manured land, remains practically stationary. Further, by means of all three polluting causes, noxious organic matters may gain access to the river, although the second and third sources of contamination are in this, as in other respects, less objectionable than the first.

As we have now seen that there is no guarantee whatever that noxious organic matters do not find their way into the Upper Thames, let us consider what kind of assurance there is that such noxious matters, when present in Thames water, are removed before the latter is supplied to the London consumer.

Before proceeding to this investigation, I must allude to the composition of the waters of the Thames in various parts of its course, so that we may understand what the character of the water is with which the London water companies have to deal.

I have recently made a systematic chemical examination of the Thames water between Oxford and London, and the results of my analyses are recorded in the accompanying tables and diagrams.

In order to obtain a knowledge of the general quality of the Thames water in various parts of the river's course, I had samples for analysis collected on the same day at Oxford, Reading, Windsor, Hampton, and other places. A somewhat similar investigation was made by the Royal Commission on Water Supply, in 1868, but in their case, the value of the experiments is greatly reduced by the samples not having been all collected on the same day, nor, indeed, within the same week. I may, however, mention that it was upon the evidence of these some ten or twelve samples of Thames water, collected, as it appears, in the most haphazard and unsystematic manner, that the Royal Commission on Water Supply lent their support to that fallacious doctrine of the self-purification of river water which has probably done more to check and paralyse the prevention of river pollution than anything else. My analyses show that on the day in question—and on this day the river was in a perfectly normal condition—the water above Oxford contained but a very moderate proportion of organic matter, considerably less than is often present in drinking water; the sample taken below Oxford contained somewhat more, the river having received the polluted water of the Cherwell. The sample taken just above Reading exhibited a further increase; that from Windsor more still; whilst the sample collected at Hampton contained a larger proportion than any of those taken higher up the river. A sample taken at Staines, which lies

RESULTS OF ANALYSIS EXPRESSED IN PARTS PER 100,000.

Description.	Total Solid Matters.	Average Organic Matter in Thames in 1868 = 1000.	Organic Carbon.	Organic Nitrogen.	Ratio of Nitrogen to Carbon.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total Combined Nitrogen.	Chlorine.	Hardness.		
										Temporary.	Permanent	Total.
Nov. 4, 1883.												
River Thames, above Oxford	30·28	724	·136	·039	1 : 3·5	0	·178	·217	1·06	17·09	4·71	21·80
,, ,, April 29, 1868	28·4	939	·199	·028	1 : 7·0	·001	·218	·247	...	10·5	7·7	18·2
River Cherwell, 500 yds. above Thames	36·92	1,588	·305	·079	1 : 3·9	·016	·164	·256	1·44	20·86	6·29	27·15
,, ,, ,, April 29, 1868	32·95	1,199	·265	·025	1 : 10·6	...	...	...	...	...	...	22·7
River Thames, below junction with Cherwell	33·04	802	·158	·036	1 : 4·4	·010	·197	·241	1·17	19·43	5·57	25·00
,, below Iffley lock	32·76	794	·165	·027	1 : 6·1	·002	·173	·202	1·20	19·16	5·14	24·30
,, below Oxford	31·04	794	·161	·031	1 : 5·2	·004	·190	·224	1·18	19·59	4·71	24·30
,, ,, April 29, 1868	31·6	1,009	·216	·028	1 : 7·7	0	·277	·305	...	10·9	8·2	19·1
,, above Reading	33·32	860	·183	·025	1 : 7·3	·007	·255	·286	1·23	20·72	6·43	27·15
,, ,, April 24, 1868	32·7	1,336	·291	·0 2	1 : 9·1	·001	·286	·319	...	12·8	8·2	21·0
River Kennet, at junction with Thames	27·80	678	·128	·036	1 : 3·6	·008	·215	·257	1·26	19·44	4·86	24·30
,, at Reading	29·24	641	·125	·030	1 : 4·1	·014	·220	·262	1·26	21·13	4·57	25·70
,, ,, near drain-pipe	30·84	1,365	·256	·074	1 : 3·5	·023	·232	·325	1·60	19·73	4·57	24·30
River Thames, just above Windsor	31·80	1,084	·224	·038	1 : 5·9	·001	·219	·258	1·32	20·31	6·14	26·45
,, ,, May 2, 1868	31·0	1,187	·259	·028	1 : 9·6	·002	·205	·235	...	14·8	7·4	22·2
,, at Hampton	30·52	1,245	·254	·047	1 : 5·4	·001	·204	·252	1·43	16·99	5·86	22·85
,, ,, May 4, 1868	27·87	1,175	·260	·024	1 : 10·8	0	·196	·220	...	15·7	4·3	20·0
Nov. 17, 1883.												
River Colne, branch in Staines	36·84	1,572	·318	·062	1 : 5·1	·019	·266	·344	1·45	23·7	3·4	27·1
,, main stream at junction with Thames	31·52	1,166	·236	·046	1 : 5·1	0	·254	·300	1·45	22·8	3·6	26·4
River Thames, above Staines gasworks	32·92	1,146	·242	·035	1 : 6·9	·003	·202	·239	1·33	20·1	5·6	25·7
,, just above Staines	32·40	1,100	·230	·036	1 : 6·4	·004	·194	·233	1·40	19·9	5·1	25·0
,, ,, May 2, 1868	31·2	1,352	·304	·027	1 : 11·2	0	·215	·242	...	10·3	10·5	20·8
,, just below Staines	31·12	1,154	·245	·034	1 : 7·2	·001	·209	·244	1·36	20·8	4·9	25·7
January 2, 1884.												
River Wey, at Weybridge	20·44	1,468	·270	·085	1 : 3·2	·030	·223	·333	2·00	9·3	4·7	14·0
River Thames, at Chertsey	34·16	968	·187	·047	1 : 4·0	·014	·287	·346	1·45	20·3	4·2	24·5
,, at Hampton	31·92	914	·186	·035	1 : 5·3	·008	·281	·322	1·48	17·5	4·0	21·5
January 9, 1884.												
River Thames, above Windsor	36·68	1,000	·197	·045	1 : 4·4	·003	·193	·240	1·47	20·3	4·2	24·5
,, at Hampton	34·88	1,299	·227	·087	1 : 2·6	·008	·229	·323	1·52	19·1	3·9	23·0
January 13, 1884.												
River Thames, above Windsor	36·40	1,464	·291	·063	1 : 4·6	·010	·227	·298	1·50	18·8	5·7	24·5
,, at Hampton	33·56	1,505	·309	·055	1 : 5·6	·020	·226	·297	1·52	17·3	6·0	23·3
January 28, 1884.												
River Thames, above Windsor	28·72	2,382	·478	·098	1 : 4·9	·014	·223	·332	1·7	13·6	6·4	20·0
,, at Hampton	29·76	2,204	·451	·082	1 : 5·5	·024	·222	·324	1·7	13·6	5·3	18·9
River Thames, above Windsor (average)	33·55	1,377	·275	·058	1 : 4·7	·008	·230	·295	1·49	18·66	5·33	23·99
,, at Hampton ,,	32·13	1,431	·285	·061	1 : 4·7	·012	·232	·304	1·53	16·90	5·01	21·91
AVERAGE COMPOSITION OF WATER SUPPLIED TO LONDON IN 1883.												
Thames	28·11	850	·174	·031	1 : 5·6	0	·207	·238	1·5	...	...	19·9
Lea	29·30	620	·127	·023	1 : 5·5	0	·252	·275	1·6	...	...	20·6
Deep Wells	32·10	321	·060	·018	1 : 3·3	·017	·322	·353	2·3	...	...	19·2

NOTE.—Those dated 1868 were analysed for the Royal Commission on Water Supply in 1868. All the river waters were filtered through Swedish paper before analysis.

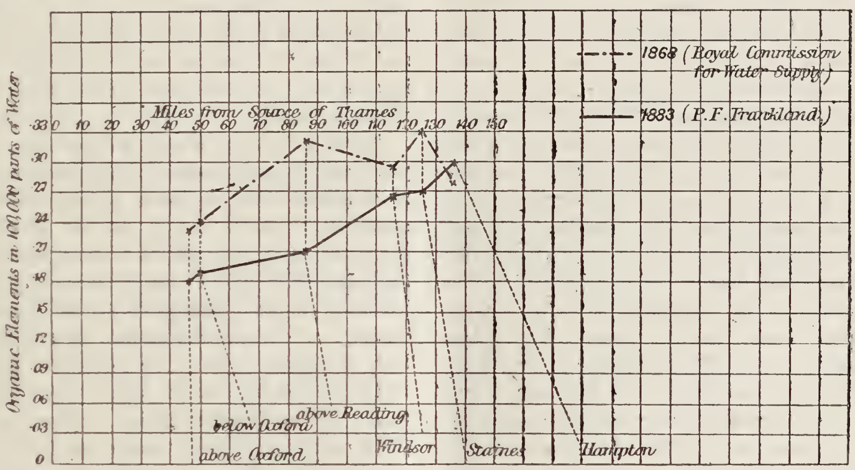
between Windsor and Hampton, although collected about a fortnight after, presented a quantity of organic matter intermediate between that in the Windsor and Hampton samples.

On comparing these analyses with those made for the Commission on Water Supply, in 1868, it will be seen, that with the exception of the Hampton sample, the river was at all the above points in a worse condition in April and May, 1868, than in November of last year. From the superiority of the Hampton sample to those taken higher up the river in 1868, it has been generally supposed since, that the river at Hampton contains less organic matter than at any point above. As this state of things appeared from my analyses to have become reversed, I deemed it worthy of further investigation. I consequently collected weekly samples during January last, at Hampton on the one hand, and at Windsor or Chertsey on the other. The average of these samples show in 100,000 parts of water.

	At Windsor or Chertsey.	Hampton.
Organic carbon	·275	.285
Organic nitrogen	·058	.061
Organic elements....	·333	·346

The difference between the two is not great, but, such as it is, is in favour of the Windsor samples, as indeed *à priori* considerations would lead one to expect. For between Windsor and Hampton, there enter the Thames two tributaries of moderate size, the Colne on the north and the Wey on the south; now both these streams, and especially the Wey, are more highly impregnated with organic matter than the Thames itself at the points of

PROPORTION OF ORGANIC ELEMENTS IN THAMES WATER AT DIFFERENT PLACES IN 1868 AND 1883



junction, as is apparent from the foregoing analytical table. Indeed, all the tributaries of the Thames that I have examined, viz., the Cherwell, the Kennet, the Colne, and the Wey, are, with the exception of the Kennet, richer in organic matter than the Thames at the points where it is joined by these streams. In fact, the Wey is a particularly objectionable tributary of the Thames, and exhibits pollution with very highly nitrogenous organic matter; it receives as we have already noticed, the untreated sewage of both Farnham and Guildford, towns of no inconsiderable magnitude. The sewage of Farnham has only recently been the subject of litigation, on account of the nuisance which it causes to the riparian landowners below, and on this occasion the sewage discharged into the Wey was analysed in my laboratory. From the analytical figures below, it will be seen what an excessively foul liquid was there permitted to enter a tributary of the Thames.

RESULTS OF ANALYSES EXPRESSED IN PARTS PER 100,000.

Description.	Total Solids.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Total Combined Nitrogen.	Chlorine.
Farnham Sewage from outfall March 6, 1883.	188·70	7·284	9·616	27·00	31·851	45·76

SUSPENDED MATTER.

Mineral.	Organic.	Total.
71·80	139·40	211·2

The treatment which this Thames water undergoes at the hands of the companies who abstract it at Hampton, is twofold. In the first place, the water is stored in large reservoirs, where it remains at rest for many hours or even days. In these storage reservoirs the water deposits a great deal of the coarser matter which it holds in suspension, and thus becomes prepared for the second process of clarification, viz., filtration through a few feet of sand. Now, beyond this, the water receives no further treatment at the hands of the companies, and, during the greater part of the year, this treatment is sufficient to render the water of the Thames clear and transparent to the eye. The manner in which these two operations—storage and filtration—are carried out by the several water companies, has undergone very marked improvement during the past few years. Thus, whereas in 1868, out of 84 samples of river-water examined there were only 48 clear and transparent, in the past year there were out of the same number of samples no less than 73 clear and transparent. Moreover, the 11 turbid samples last year were all only slightly turbid, whilst in 1868, out of 36 turbid samples, 20 were slightly turbid, 9 turbid, and 7 very turbid. It is not without great exertions on the part of the water companies that this amelioration has been accomplished, for most of the companies have expended large sums of money in the extension of their storage reservoirs, and in perfecting their filtering plant. These improvements, although deserving every recognition as highly beneficial to the public, still furnish no guarantee whatever that the waters of the Thames are thereby rendered suitable for human consumption. Neither the process of storage, nor yet that of filtration through a few feet of sand, is able to remove from the water those lower forms of life which may at any time be present, and which are so dangerous to health. Some exceedingly interesting experiments on this point have been recently made by Professor Pumpelly, of Newport, for the National Board of Health of the United States. Professor Pumpelly allowed water to filter through a stratum of fine sand, 100 feet in depth, the bottom of the column being connected with a flask containing a sterilised infusion of beef, and he found that the first water which passed through the sand was sufficient to cause the putrefaction of the infusion. As these experiments were performed with the very greatest care and judgment, they most conclusively prove that filtration through even great depths of sand offers no barrier whatever to the passage of bacteria.

That Thames water, after filtration by the water companies, still contains suspended particles, may be very strikingly shown by passing a beam of light through a flask containing such water. A beam of light, it is well known, is only visible to an observer not placed in its path, when minute particles of matter are present to reflect the light which impinges on them. If a beam of light be passed through a flask with distilled water, its path is practically invisible, owing to the absence of suspended particles; and in this manner the presence of some suspended matter, although exceedingly small in amount, may be demonstrated in the purest water obtained from deep wells in the chalk.

It is thus evident, firstly, that the exclusion of sewage matter from a river like the Thames is practically an impossibility; and, secondly, that such sewage matters may at any time be accompanied by the germs of zymotic disease; and, thirdly, that no process to which the water is subjected can remove these germs should they be present.

These are facts which are becoming every year more clearly understood and more widely recognised, and in those places where the question of water supply is not fettered by the investment of a capital amounting to many millions of pounds in existing works, the River Thames is not employed as the source of supply. The accompanying diagram shows how unpopular are the Thames and its tributaries as sources of water supply in other towns of the Thames basin. Indeed, there is good reason to believe that even some of the metropolitan water companies themselves are new deeply impressed with the necessity of ultimately abandoning the Thames. In many cases a first step in this direction is already being made, by utilising certain subterranean waters that are available on their premises, and by sinking deep wells into the subjacent chalk.

The accompanying diagrams clearly indicate the immense superiority of this water from deep wells in the chalk to the river water. Unlike the latter, it is not liable to those fluctuations in quality, which so frequently render it impossible to furnish even moderately pure water, however perfect the appliances of the water companies may be. Indeed, this deep-well water, which is so abundant in the Thames basin, is, as regards freedom from organic matter, unsurpassed by any water in the kingdom.

Water Supply of Towns in Upper Thames Basin.

Name of Town.	Source of Supply.	Gallons raised per annum.	Price per 1,000 gallons.	Service.
Aldershot	Chalk.	40,000,000	1s.	Constant.
Barnet	Well in chalk.	110,000,000	1s. 3d. to 1s. 6d.	Intermittent.
Farnham	Springs.	...	...	Constant and Intermittent.
Godalming	Well.	1,540,000	...	Constant.
Guildford	Well.	80,500,000	1s. to 1s. 6d.	Constant.
Henley-on-Thames	Well in chalk.	...	...	...
High Wycombe	Well.	...	...	...
Maidenhead	Well in chalk.	169,000,000	9d. to 10d.	Constant.
Oxford	Spring in gravel.	410,580,000	1s.	Constant.
Redhill	Wells in chalk and greensand.	85,000,000	1s. 6d. to 2s. 6d.	Constant.
Swindon and district	Springs in chalk.	55,000,000	1s. to 1s. 6d.	Constant.
Richmond	Artesian well.	145,000,000	7d.	Partly constant.
Reading	River Kennet.	511,000,000	6d. to 1s. 3d.	Constant.
Banbury	River Cherwell.			
Basingstoke	Well in chalk.			
Epsom	Wells in chalk.			
Harrow	Wells in chalk.			
St. Albans	Well in chalk.			
Tottenham	Well in chalk.			
Uxbridge	Wells in chalk.			
Windsor	Well.			
Slough	Well in chalk.			

Proportion of Organic Matter Present in Water Supplied to London.

The Average Proportion of Organic Matter in the Thames water, delivered in 1868, *being taken as* 1,000.

Year.	Thames.	Lea.	Deep Wells.
1868	1,000	484	254
1869	1,016	618	312
1870	795	550	246
1871	928	604	150
1872	1,243	819	221
1873	917	693	250
1874	933	583	287
1875	1,030	751	250
1876	903	562	246
1877	907	596	243
1878	1,056	747	323
1879	1,165	947	387
1880	1,254	1,013	393
1881	993	765	405
1882	1,033	711	409
1883	850	620	321

Maximum Amount of Organic Pollution in the River Waters Supplied to London.

Thames.			Lea.		
Year.	Elements of organic matter in parts per 100,000.	Months in which maximum pollution occurred	Year.	Elements of organic matter in parts per 100,000.	Months in which maximum pollution occurred
1868	·45	January.	1868	·27	February.
1869	·60	February.	1869	·33	February.
1870	·42	January.	1870	·30	Janubry.
1871	·52	October.	1871	·22	February.
1872	·48	Jan. & Dec.	1872	·39	December.
1873	·46	January.	1873	·33	January.
1874	·37	March.	1874	·21	March.
1875	·49	November.	1875	·28	November.
1876	·44	December.	1876	·24	March.
1877	·40	January.	1877	·30	January.
1878	·36	December.	1878	·26	June.
1879	·38	February.	1879	·33	July.
1880	·42	October.	1880	·33	February.
1881	·34	February.	1881	·34	February.
1882	·37	November.	1882	·26	December.
1883	·32	January.	1883	·24	December.

There is, perhaps, no test of the purity of water so crucial or searching as its use in the operation of brewing. For successful brewing it is indispensable to have a water almost wholly free from organic matter, as the latter in any but the most minute quantity induces a premature and unhealthy fermentation of the brewer's wort. The brewer, in fact, requires a water free from bacterial life, so that in the process of mashing, the diastatic action of the malt may take place unmolested by the chemical changes which are incidental to the life of bacteria. Now these deep well waters find especial favour with brewers, whilst the river waters supplied in London are only under the most exceptional circumstances employed. The natural filtration which this deep well water has undergone, in passing through the porous strata, is of the most complete and thorough nature, and places almost beyond doubt the impossibility of its containing even any trace of noxious organic matter.

Unfortunately, this source of pure water, which the chalk at present furnishes, is so far wholly unprotected by law, as was shown only a few weeks ago in an action—Ballard *v* Tomlinson—heard in the Court of Chancery, before Mr. Justice Pearson. The plaintiff in this case is the proprietor of a brewery at Brentford, who for the purposes of his trade, has for many years used the water from a deep well sunk through the London clay into the chalk beneath his premises. A similar well sunk into the same stratum exists at 100 yards distance on the premises of the defendant, who has converted this well into the receptacle of the sewage from his printing factory. The sewage matters thus put down the defendant's well find their way into the plaintiff's well, and render the water thereof wholly unfit for brewing purposes. That the wells are intimately connected, was conclusively proved by putting chloride of lithium down the defendant's well, and discovering it, after twenty-four hours' pumping, in the water of the plaintiff's well. The pollution was, indeed, not denied by the defendant, who simply contended that inasmuch as he was admittedly entitled to abstract every drop of water from the chalk, he surely must have an equal right to alter the quality of the water by any act that he might be pleased to perform on his own premises. This ingenious line of reasoning found favour with Mr. Justice Pearson, who dismissed the action with costs. (See p. 455). Thus, according to Mr. Justice Pearson, it is at present lawful for a person to introduce into the water-bearing stratum on his own premises any poisonous matter which he is perfectly well aware will find its way into his neighbour's water supply. If this really is the present state of the law—and there appears to be no reason to doubt that it is—no time should be lost in remedying such a palpable defect, which imperils the safety of the annually increasing numbers who are becoming dependent upon the chalk and similar strata for their water supply.

The feasibility of supplying London with this deep-well water is clearly shown by the Kent Company, who have, since 1866—and even before—continuously supplied this water to a portion of the metropolis, and the magnitude of their supply is now equal to that of the Chelsea Company drawing from the Thames.

I have thus shown :—

1. That the present water supply of London from the Thames is, to say the least of it, an unsatisfactory one; and, moreover, that it is unsatisfactory in spite of important and very expensive improvements that have been made on the banks of the river, and in the appliances of the water companies.

2. That it is impossible to protect a large body of water like the Thames, flowing as it does through a populous district in a high state of cultivation, from contamination with sewage and other objectionable matters.

3. That such matters are at present largely discharged into the river, in spite of the active measures which are taken to prevent such pollution.

4. That water which is polluted with sewage, and even with sewage effluents, may at any time carry with it infection, and that the water of the Thames is not subjected to any process by the water companies which can ensure the removal of such morbific matter, if present.

5. That in nearly all other towns in the Thames basin, the Thames and its tributaries are rejected as sources of water supply, and that these towns are generally supplied with spring or deep-well water, which is especially abundant in the valley of the Thames.

6. That the great obstacle in the way of a similar supply being obtained for the metropolis is the great magnitude of the capital invested in existing works, the interests of which capital are at present allowed to override all other considerations.

DISCUSSION.

The CHAIRMAN said it had been a great pleasure to him to preside on this occasion, Dr. Frankland's eminent father having been a pupil of his in former times, so that he might consider Dr. Percy Frankland as his scientific grandson. When he heard pointed out the pollutions which were sent into the Thames by so many towns on its banks, he was in hopes that Dr. Frankland would have gone on to point out how those evils were to be removed, and he could not help thinking of the words of Macbeth—

> "Come, Sir, despatch; if thou coulds't, doctor, cast
> The water of our land; find its disease,
> And purge it to a sound and pristine health,
> I would applaud thee to the very echo
> That should applaud again."

But, unhappily, Dr. Frankland had not been able to give them the comfort of thinking that the Thames, under any system of purification, could ever be thoroughly purified from that organic matter, which a large experience all over the world showed to be the great source of disease. On the other hand, the water from the chalk promised a source of supply, which was, perhaps, equal to the occasion. He should be glad to believe this, but he had some doubts of it, because the operations of breweries in London showed that the pumping of water for those breweries acted to a large distance from London. The Rev. Mr. Clutterbuck, a good many years ago, when living at Watford, measured the depths of the wells every day, and found there was more water in them on Monday than any other day in the week, the reason being that there was no pumping on Sunday, so that, even at that distance from London, the effect of pumping for the large breweries was something considerable. He hoped it was true that there was abundance of water in the chalk to supply the metropolis. Much had been added to the chalk water supply, and much more might be added, but whether it would supply their whole requirements he should like to hear from those of more experience. As there was a probability of a discussion coming on in the House of Commons that evening, in which he had undertaken to speak, he must ask Sir Frederick Abel to take his place.

Sir Frederick Abel having taken the chair,

Mr. Norman Bazalgette said he must admit it was rather presumptuous in him, as a layman, rising to criticise this paper, but with the indulgence of the audience he wished to offer some remarks upon some points which seemed to call for criticism. In the first place, the author having quoted from the report of the Royal Commissioners of 1869, said fourteen years had elapsed since that was published, "Yet no methods for excluding the sewage, not to mention other pollutions, had been taken." Was the energetic action of the Thames conservators during the last fourteen years to be altogether ignored. But this statement was contradicted by the author himself, for further on in the paper it was stated, "that these sources of pollution, the first, or that due to raw town drainage is, thanks to the exertions of the Thames conservators, becoming annually diminished." What, then, did he mean by saying that no measures had been taken for excluding the sewage during the last fourteen years? Again in another place, he said—"If we reflect that these processes of precipitation thus signally fail in removing such organic matter from sewage as is recognisable by chemical analysis, the thought cannot be entertained that they arrest or destroy those subtle forms of organic life which are capable of communicating zymotic disease." That no doubt referred to the celebrated germ theory advocated by the author's distinguished father; not being an expert, he had not been able to pursue investigations into these matters himself, but it had been over and over again proved that chemical analysis had, at the intakes of the water companies, failed to discover these germs. If, then, they were passed into the rivers, and could not be discovered at the intake, what became of them if they were not destroyed by the agency of oxidation? In another place the author referred to magistrates being ready to believe such romances as the destruction of sewage matters in half a-mile's flow of a river, which evidently meant to intimate that the notion of self-purification in polluted rivers was a fiction of the brain, and that, if it existed at all, it was so slight as to be practically inoperative. If that were so, he might quote two or three authorities who believed in such a romance. He did not know that there was much romance in Dr. Letheby or Dr. Angus Smith. He could not attempt to pose as an authority on this self-purifying power of rivers, but he threw in his lot with those who believed in oxidation. The bulk of the evidence, taken *pro* and *con*, must certainly prove that this self-purifying power was a most important feature. He should not attempt to defend the "A. B. C." process, as there were other gentlemen better qualified to do so; but when he found the statement made that this process removed a very small proportion of soluble polluting matters from sewage, and that after treatment it was very little better than that obtained by letting the raw sewage settle in subsidence tanks, he could not keep silence altogether. The author there was quoting from very ancient history, the report of the Rivers Pollution Committee in 1874. That report being the work of his father, of course was entitled to all respect, but that statement, judging by the light of present experience, required considerable modification. When he first read that report he was much prejudiced against the process, but since then he had been to Aylesbury and looked into the matter himself, and was so far a convert that he believed it was the best of all the precipitating processes. With regard to the germ theory, he would simply refer to an answer given by Dr. Angus Smith before the Royal Commission in 1879, the purport of which was that a sufficient quantity of pure air acted as a barrier to the communication of zymotic diseases through the atmosphere, and a sufficient quantity of pure water would act in the same way. That struck him as an answer which appealed eminently to common sense. A considerable portion of the paper was devoted to analyses made by the author of Thames water, and the discovery of what was called noxious organic matter; but he should be glad to hear from him what was his authority for describing it as noxious. Of course they all knew there was organic matter in the water, but could he show, by reference to health statistics, that it had been productive of any injury to the health of the population which consumed it? Before coming to that meeting, he referred to the report of Messrs. Crookes, Odling, and Tidy, on the London water supply for 1882, which was entitled to some consideration, inasmuch as the opinions there expressed were based on the examination of more than 1,200 samples of water from the mains of the seven London companies drawing their supplies from the Thames and Lea. From that it appeared that the filtered Thames water, as supplied to London, contained a variable, but always minute, proportion of organic matter, ranging from less than $\frac{3}{8}$th of a grain to $\frac{3}{4}$th of a grain per gallon, and that would be of importance only if it could be shown to be an unwholesome constituent of the water; but taking a series of years, and relying solely on the water analyses as supplied to the Registrar-General, it showed with singular perversity that the years in which the rate of mortality was excessively high were those years in which the proportion of organic matter in the water was relatively low, whilst the years in which the mortality was low were those in which the proportion of organic impurity was high, not of course because the organic constituent was any more wholesome than it was prejudicial, but most probably because the climatic conditions of the years which affected the rate of mortality in one way, affected the proportion of organic matters in the opposite way; thus in the successive years, 1869, 1870, and 1871, with a high mortality of over 24 per 1,000, the mean proportion of organic impurity was 912, whilst in the years 1872, 1880, and 1881, in each of which the mortality was exceptionally low, being less than 22 per 1,000, the amount of organic matter reached 1,171. Having regard to these statistics, what became of the argument that, because there was organic matter in the river it was necessarily noxious. A most interesting paper had been compiled by Mr. Baldwin Latham, who compared, as regards the zymotic death-rate, those districts which derived their water supply from the river with those deriving it from the chalk. Taking the death-rate due to diarrhœa, which all would agree was a disease peculiarly attributable to bad water, though, of course, other considerations also affected it, he would select two places as fairly comparable as possible, Lambeth on the one hand, supplied by the Lambeth and Southwark and Vauxhall Companies, with an estimated population of 229,190, in which the deaths from diarrhœa were 1·00, and on the other hand, Greenwich, supplied by the Kent Water Company, with an estimated population of 110,920, and a diarrhœa death-rate of 1·05, so that the advantage was very slightly in favour of the district supplied by river water. There were other statistics in those tables which pointed in the same direction. What was the use of going into chemical analysis, and saying that it showed the organic matter discovered must be prejudicial to health, when by reference to statistics you can gauge its precise effect on the health of the consumer, which was worth ten times as much as theoretical considerations of the possible effect. He would also refer to a diagram prepared by Sir Francis Bolton, upon which were traced lines showing the death-rate in London from 1868 to 1882, the ratio of organic impurity in Thames water during the same years, the same with regard to the Lea water, and the same with regard to the water from the chalk. It was somewhat remarkable that that showed there was absolutely no connection between the death rate and the organic impurity in the Thames and Lea water, but there did appear to be some connection between it and the ratio of impurity in the chalk water. Lastly, with regard to the conclusions drawn by the author, he maintained that the first was not borne out; the second he agreed with, though at the same time sewage was being gradually excluded, and would be totally excluded in a few years, whilst the impurities that did enter were got rid of by oxidation; the third might be admitted. With regard to the fourth, there ought to be some statistics brought forward to show that the morbific matter referred to was present; the fifth simply meant that those towns which had their own supply of well water preferred that to the Thames water, and so would anybody, but it said nothing against the use of Thames water; and with regard to that he might observe that the title of the paper was somewhat misleading, as while it professed to be a paper on the "Upper Thames as a Source of Water Supply," it was really an attack upon the Lower Thames. With regard to the sixth, he submitted that the present supply was eminently satisfactory, and that the investment of capital for the purpose of introducing another substituted or supplemental supply would be a wasteful expenditure of the money of the ratepayers.

Sir FREDERICK NICOLSON said so many allusions had been made to the Conservators of the Thames, that he hoped he might be excused for saying a word or two. He would not go into chemical details, but would bring to the notice of the meeting a few facts showing what had been done for the purification of the River Thames. He, like the previous speaker, had been much struck with the statement made by Dr. Frankland, that for fourteen years nothing whatever had been done. Beginning with the smaller affairs, Aldershot and Farnham, and a great many other places on the diagrams, were beyond the limits of the Conservators' jurisdiction, that embraces, first, the river proper, and originally three miles up the tributaries, which had been subsequently extended to five miles, and was now ten miles in a direct line from the river. Dr. Frankland had skilfully alluded to two or three cases where proceedings had been taken against places on the tributaries where the Conservators had been unsuccessful, thanks to certain eminent chemists, in stopping the pollution of those tributaries. At Uxbridge, the effluent was about seven miles from the Thames, and there was an immense difference of opinion on the part of chemists as to whether seven miles would purify an effluent or not; some said it was purified in half a-mile, whilst others said it was never purified at all. Dr. Frankland seemed to belong to the latter class. Then there was Staines, a very unhappy town with regard to its situation, being at so low a level that, although it had had consulted four engineers to try and doctor the sewage, they hardly knew how to devise a plan to do so. It would cost about £40,000 to keep it out of the river, and the inhabitants were only 4,000. It was only a part of the sewage of which there was any serious complaint, so that, although it was above the intakes of the water companies; this was not a very serious case, but to show that the conservators were not lax in their endeavours to carry out the Acts, he might say, that they had obtained five convictions against that town, which was now in the hands of the Local Government Board, and he hoped that ultimately a satisfactory result would be produced, and that it would become one of the towns whose sewage was entirely diverted. In framing the Act under which the conservators endeavour to purify the tributaries, certain words were introduced with regard to them rendering it necessary to prove that the effluent was "likely to flow into the Thames." Those words were probably put in to help the Conservators, but, on the contrary, the words had proved a stumbling block, and if the Act had been worded as the Rivers Pollution Act is, there would have been no difficulty whatever. They would not then require any expert chemists, because the offence would consist in passing something offensive or injurious into the tributary, and they would not be obliged to prove, as they now had to do, that whatever went in was likely to reach the Thames. Still, it would be some satisfaction to the meeting, after what had been stated, to know that something at any rate had been done. At Oxford, sewage works were completed in 1880, at a cost of £185,810; those at Abingdon were completed in 1877, and although there was little hitch in 1880, they were now satisfactory, at a cost of £23,000. At Wallingford, £19,000 had been spent; at Reading, £205,000; and at Henley, £22,000; there again they were now extending the works to meet a slight impurity. At Marlow, Cookham, and Windsor, the sewage was diverted, £45,000 having been spent at the latter place, and the Castle works, which were separate from the town, had cost £14,000. At Eton and Eton College the sewage was diverted. The total expenditure on all these works has been £513,800—a fair proof that the statement, quoted from the Conservators' annual report by Dr. Frankland, was correct, viz., that the Thames proper is practically free from sewage, all these towns having diverted their sewage from the river. He was aware that some chemists would say that no matter what they did to the sewage the water was not thoroughly pure. Into that question he did not enter, but after all this expenditure by these towns, it was rather too much to say that nothing had been done. As to the details of what the conservators were doing, they maintained a thorough supervision of the river, getting monthly reports from every part above the intakes, and with the exception of occasionally small cases up the tributaries, where eminent chemists said the effluent was so distant from the river that it had no practical effect on the water supply of London, he maintained that the river was practically free from sewage. He should also add they had not always been obliged to institute legal proceedings, but by serving notices, &c., they had obliged all the manufactories, as to which there was formerly great complaint, to keep their effluents and refuse out of the river.

Sir Robert Rawlinson said he knew something of the Thames and its water, and had necessarily paid attention to the question of water supply, but although he had a great admiration for Dr. Frankland, for his able son, and for the able Chairman, he could not adopt the views that chemists took of what water should be, or the effects it had or might have on the human constitution. Three times within the last 30 years he had lived out of London under conditions which he assumed those gentlemen would tell him he ought to live under—that is, in pure water districts, where the water came from the granite, and in each case it had very seriously affected his own health, and that of his family, and he had been uncommonly glad when he got back to London again, and got the hard water. For thirty-five years he had been supplied by the Chelsea Water Company; his cisterns were never any trouble in cleaning, his toilet service was pure and white, and he had not had occasion to find fault more than once or twice with any turbid appearance of the water. If it was absolutely necessary to health that water should be absolutely free from all impurities, he was in despair, because he had not the slightest idea where such water was to be got, or how it was to be preserved. The pure water that fell on the granite mountains of Scotland came into contact with everything growing on the surface, and he apprehended that every particle of growing matter was imbued with ammonia, which would combine with the water, and there was also the chance of other forms of impurity from decaying organic matter. Whether that going into solution in the soft water was the cause of the injurious effects it had on strangers, he did not know; but he knew that, in 1745, when the British army went into the Highlands, Dr. Pringle, the most celebrated army doctor of the period, recorded that the entire British army became disorganised by drinking the water. It seemed to be a question of acclimatisation, and he believed that the changing from one class of water to another might be very injurious. But taking water as it was found on the surface of the earth, he would say that, out of the whole population of the globe, 95 per cent. must be drinking water which, according to chemical tests, ought most seriously to injure their health; and more than 50 per cent. of the water would horrify any person who had the chemical contents explained to him. All through India and China, water was more or less polluted; and on the Continent, wherever wells could be sunk, they were almost invariably sunk in close proximity to the farm middens. Yet those people went on year by year drinking that impure water, no doubt with some injury, but not with all the injury imputed to it. He knew some extraordinary cases with regard to the non-effect, apparently, of water on population. In 1833, 1849, and 1854, cholera prevailed in Staffordshire, and the towns above Birmingham, such as Bilston, were decimated. The whole of the cholera virus was washed down into the streams and tributaries of the Thame, from which Birmingham was supplied. The water was neither strained nor filtered, but was pumped direct from the reservoirs fed by the Thame, but there was not a single case of cholera generated in Birmingham. At North Shields, when cholera prevailed at Newcastle-on-Tyne, there being nearly 2,000 cases with no quarantine, the water of Tynemouth was so bad, that it was sold in canfuls at the street corners, with a flannel bag tied round the nozzle to keep the filth out; there was not a single case of cholera generated in that town. When he was in the Crimea, he saw the Sardinian army come in 16,000 strong, and a finer body of men he never saw. They took up virgin ground, supplied with a magnificent volume of water from the oolitic rocks in a large Russian fountain. One thousand of those men died of cholera the first month. When he came back he heard Dr. Snow explaining the theory that cholera-polluted water was necessary to the production of cholera, and he then said to him that it must be a mistake, because he had seen, on the largest possible scale, that it was not a fact; and whatever might produce cholera, he was satisfied that it could not be imputed, in all cases, solely to impure water. He did not say London should not have the best supply of water which could be given to it; but in his opinion, to sacrifice the present source, and to lay out fresh capital to bring in some imaginary pure supply, would be gross waste of money, and would not accomplish the object intended.

Mr. BRYAN, as a comparative stranger to London, but having read a good many alarmist paragraphs in the London papers, had been somewhat puzzled to understand how it was that London, with the water supply which it had, should be so much healthier than the large towns of the North, with most of which he was well acquainted, as well as their sources of water supply, especially Liverpool, Manchester, Burnley, Preston, Bolton, Halifax, Bradford, Leeds, and Lancaster. He also knew the gathering-grounds for Glasgow. He was responsible for the water supply in one of the largest towns in Lancashire; its gathering-ground was 6,800 acres, and at the intakes of the waterworks there was absolutely not a single source of pollution. Other towns he knew had similar gathering-grounds. Most of those waters were delivered unfiltered, very soft, but not as bright as the London waters, being sometimes tinged with peat. Nearly the whole of these towns were exceedingly well drained, having spent during the last few years large sums in dealing with the sewage, and yet these towns were much more unhealthy than London. Most of them had a death-rate from 6 up to 20, and even 40 per cent. higher than London. He lately read the report by Dr. Tripe, of Hackney, giving the statistics of that borough, from which it appeared that the population being about a quarter of a million, the death-rate for six months was 17, which he thought was the finest testimonial to the two water companies supplying that district he had ever seen. Another peculiar thing occurred in the North of England. Many of the towns were formerly supplied by companies, and at that time there were always complaints, but as soon as the corporation obtained the supply, no complaints were heard, and he had no doubt that when the waterworks of London were acquired by some central authority, they would hear very little of the impurity of the water. With regard to the quantity of water to be obtained from the chalk, he had lately tried some experiments in the valley of the Lea, and he was informed that of all the wells already existing, the level had steadily decreased during the last forty years approximately one foot per annum, depending on the amount pumped. One well which he knew very intimately affected another well three-quarters of a mile away to a very great extent, so that he did not think it certain that chalk was a reliable source to supply a large population requiring about 145,000,000 gallons a day. No doubt the steady increase in the number of houses on the constant supply would do good to the quality of the water, and no doubt also the companies would be very happy to give a constant supply, if the inhabitants would like to take it. He knew a case where the supply was 32 gallons per head per day, and on the constant supply it rose to 100 gallons. Manchester got about 17 gallons per head, Liverpool 17, Nottingham 17, Norwich 17, but in London, on the average, it was over 30.

Mr. HOMERSHAM asked what were the precise wells referred to by the speaker?

Mr. BRYAN said he referred to the wells north of the Thames, in the valley of the Lea. He could not give the names, but his informant was a gentleman who had sunk more wells than anybody else, Mr. Docwra.

The discussion was then adjourned.

ADJOURNED DISCUSSION.

Friday, March 21st, Sir FREDERICK ABEL, C.B., F.R.S., Chairman of the Council, in the chair.

Dr. FRANKLAND said he could not compliment the author of the paper upon having arrived at any original conclusion, as he had followed a long succession of authorities who had substantially expressed the same opinions. First of all, they had Professor Brand's Royal Commission, which sat in 1828, and which emphatically condemned the Thames as a suitable water supply for London; and then they had the General Board of Health sitting in 1850, which arrived at the same conclusion. Another Commission, composed of Professor Graham, Dr. Hofmann, and Professor Miller, of King's College, investigated this subject very carefully in the year 1851, and also arrived at the conclusion that other sources of water would be better for London than the Thames. Next they had the first Rivers Pollution Commission, presided over by Sir R. Rawlinson, which condemned the Thames water as being unfit for the supply of the metropolis; and then came the Duke of Richmond's Commission, which reported in 1869, and which gave a modified derogatory opinion of the Thames as a source of water supply, saying that if the sewage were diverted from the Thames, and if the water were efficiently filtered, it would then be wholesome, and fit for the supply of the metropolis. Next came the second Rivers Pollution Commission, of which he had the honour of being a member, which reported in 1874 much to the same effect, and a similar opinion was also uttered by Sir Lyon Playfair, as chemical adviser to the Board of Health. Why, he would ask, was the Thames water not considered suitable for the supply of the metropolis? This was a very serious question indeed. An enormous amount of capital had been spent in the construction of water works, and he must say that he was one of those who did not think that property of this description ought to be lightly meddled with. He thought the private companies who had had the courage to attack a problem of this kind, and to run great risk in embarking their capital in such a project, ought not be thrown overboard lightly when their project had succeeded in producing a good revenue. That was his candid opinion about the position of the water companies. They had the Vestries and the municipal authorities in the metropolis, and it was owing to the parsimony and cowardice of these bodies that they had not themselves taken up the water supply; they waited until some private company had furnished a supply, and then they wished to take it over when there was no longer any risk; but in such cases the companies ought to be liberally treated, if it was contemplated to purchase them under such circumstances. Now what was it that made Thames water unfit for domestic supply? As everyone knew. it was the influx of sewage into the river. Why should sewage make the Thames water unwholesome and unfit for domestic supply? A very large proportion, indeed, of the inhabitants of this country had been in the constant habit of drinking their own sewage or other people's, and they had very often not been injuriously affected by it; it was not, therefore, merely the discharge of sewage into a river which made it unwholesome, whatever might be said upon the sentimental view of the question, which he would not deal with. From a strictly physiological point of view, the admission of sewage into the water supply of a town did not necessarlly affect the health of the inhabitants drinking the polluted water; but if you have fever epidemics occurring upon the banks of such a river, if you have abnormal or infected sewage discharged into it, then you run a very great risk; you run a risk probably proportionate to the number of infected persons contributing to the sewage. At any rate there could be no doubt that infected sewage was most deadly when it gained admission to a water supply. Moreover it must also be borne in mind that infected sewage could not, by any process with which they were acquainted, be disinfected before it was discharged into a stream. It was true that many processes of sewage purification rendered the liquid clear and palatable, so much so that he knew a physician who put effluent sewage upon his dinner table, so that his guests might drink it, and he then asked their opinion upon it, the effluent being clear, transparent, and palatable. All the experiments which had been made had proved in the strictest way that none of these processes could destroy those living germs which propagate epidemic or zymotic diseases. All the processes were more or less efficient in purifying sewage, but they afforded no guarantee that the water so purified would not communicate the disease with which the contributories of unhealthy sewage had infected it. It had been proved over and over again that the bacterial life, of which zymotic organisms were examples, was exceedingly persistent. The germs of bacteria might be boiled for three or four hours and yet not be destroyed. He had himself seen that they continued to exist in an atmosphere of cyanogen; they got on very well in sulphurous acid, in fact there were very few poisons which would affect them. Now, it must be borne in mind that such polluted river water was the raw material with which the companies supplying London from the Upper Thames at the present moment had to deal. As Sir Frederick Nicolson considered that the Thames Conservators had not been sufficiently recognised in the paper, he would willingly say a word in their behalf, for he thought their efforts had been most successful in excluding from the Thames those obvious pollutions which rendered it offensive to the eye, and offensive generally to the senses, though he did not think that their powers were sufficient to enable them to divert sewage from the Thames, or that there was a possibility of so dealing with the sewage of these places that it should not enter into the water supply. The work had been sewage purification, and not sewage diversion, or sewage exclusion. Statistics were utilised by Mr. Bazalgette on the last occasion, and though he was always suspicious of statistics, as an offset to those of Mr. Bazalgette, he would quote two or three with regard to the prevalence of fever in London, and under that head he would class typhoid and typhus, and remittent or relapsing fevers. Of those three separate kinds of fever, typhoid was by far the most prevalent. Beginning in the year 1851, when all the water supplied to London was derived from highly polluted sources, namely, from the Thames between the bridges, and from the Ravensbourne, which was, perhaps, the more polluted, the deaths in that year from fevers reached 20 per week per million of population, which amounted to about

133 attacks per week per million of population. In the year 1861, when all the water companies had abandoned the Thames between the bridges, and had gone above Teddington-lock, and the Kent Company had abandoned the Ravensbourne, and begun to use their deep well water, the deaths from fever fell to twelve per week per million, and the attacks from 133 to 80. Between 1861 and 1871, the metropolis main drainage scheme had come into nearly complete operation; but, notwithstanding this enormous work, the deaths in the year 1871 from fever were not very greatly reduced; instead of twelve deaths per million per week, they were only ten, and the number of attacks fell to 67. Between 1871 and 1881, the water companies had effected great improvements in purifying the water; they had done all that could be expected of them; they were told by Parliament where to go and obtain their supply, and they had, as a rule, done their duty in purifying the water to the greatest possible extent, so that the only complaint that could be made respecting them, was that they had been rather too slow in going to other sources. Many of them were now actively engaged in substituting other sources for the Thames. In 1881, the death-rate from fever was reduced to six per million per week, and the attacks to 40. In conclusion, he would say that the amount of water available in the Thames basin for supplying London was ample for years to come. It was useless to go into statistics as to the rainfall, and the quantity which evaporated, because they had a most trustworthy source of information, in the quantity which flowed over Teddington-lock, which was 400,000,000 gallons per day in dry weather; that quantity represented the yield of spring water from the chalk oolite and greensand above Teddington, and all they had to do was to intercept a portion of this water, to prevent it from going into the Thames at all, and to convey it in a pure and wholesome condition to London.

Dr. Meymott Tidy said it certainly was not his desire to have taken any part in the discussion, and in doing so he yielded most reluctantly to the wishes of those whose opinions he valued. He did not hear the paper delivered, and having read it only within the last forty-eight hours, he had had but little time to arrange his remarks, and therefore must crave indulgence should any want of order or continuity be apparent in his observations. Further, he must beg Dr. Percy Frankland to bear with him, and to forgive him, for the criticisms he should have to offer; they would be offered in all friendliness, but the occasion was one which demanded that he should speak in no unknown tongue. He was bound to say that he had never read a paper so deluged with extravagant partisanship as that which Dr. Percy Frankland had read before the Society; a paper which would entirely undo the very object it was designed to effect. As he apprehended, the view put forward by the author was this. If a river be once polluted by sewage matter, the water of that river was for ever unfit for dietetic purposes, and that no practical distance of flow would render that river safe. The Sixth Report of the Rivers Pollution Commissioners stated this definitely. And here he should like to mention that in future he should call this report Dr. Frankland's Report. Although it was signed by another gentleman, who was well known, Mr. Chalmers Morton, an excellent editor and agriculturist, still he knew nothing about chemistry, as he had often himself admitted. The report was, for practical purposes, Dr. Frankland's, and Dr. Frankland's only. Dr. Frankland said, "We are led to the inevitable conclusion that the oxidation of the sewage proceeds with extreme slowness, and that it is impossible to say how far such water must flow before the sewage matter is thoroughly oxidised." His own view was directly the opposite, and he would state definitely the conclusions at which he had arrived, viz., that when sewage was discharged into running water, after the run of a few miles—the precise distance depending upon several conditions—the whole of the impurities would be removed; and that whatever might be the cause of certain diseases, the *materies morbi* which found its way into the river was destroyed together with the organic impurities. There were three methods by which this purification was effected, the first being what was called subsidence, the forcible carrying down of impurities; the second was the influence of fish life and of the lower forms of life. The remarkable report of Dr. Sorby had shown beyond all question that a large part of the more objectionable constituents of sewage were removed by the unobjectionable action of minute animals. That view, which was so stated by Dr. Sorby, was adopted by the Royal Commission on the London sewage in their report, in which they stated:—"Besides the purification of the river by oxidation, there is evidence of its purification by means of animal and vegetable life; animals of a low type, notably the *entomostraca*, such as water fleas, feed upon the solid elements of sewage. These animals excrete solid matter, but in a diminished amount; the balance is decidedly in favour of purification." Subsidence was admitted as a purifying process by Dr. Frankland. The influence of the lower forms of life, which had been proved by Dr. Sorby, and accepted by the report of the committee, he might take as fairly well demonstrated. As to the third point he would deal with that only, viz., the influence of dissolved oxygen, and of the oxygen set free by the action of plant life on water purification. He had discussed that over and over again with Dr. Frankland, and he had looked in the paper for a single new fact to support the view which his father had advocated, but had failed to find one. Nothing to his mind was more delicious than the manner in which Dr. Frankland absolutely ignored all arguments used, and all the facts proved upon the other side. He would now proceed to argue the truth of his own propositions, and the inaccuracies of Dr. Frankland's, discussing the subject from three points of view. First, as an ordinary observer; secondly, as a chemist; and thirdly, as a medical man; and he would ask whether, regarding it from any of those points of view, Dr. Frankland's theory did not go to the wall. As an ordinary observer, he did not desire any exaggerated importance to be attached to naked eye changes. He was quite ready to admit that bad water was not necessarily bad looking; but when he saw a river at one spot with a black and a slimy bed, containing water turbid, offensively brown or black in colour, without vegetation, except sewage fungus possibly the higher forms of fish life entirely wanting, and then gradually, within a mile or so, changing its character, the bed becoming clean, the water clear, inoffensive, colourless, and full of fish, with abundant vegetation, surely he was justified in saying that that water had undergone some change. Common sense might suggest that the water had improved. Whereas, at one spot, he would not have tasted it, at another place he could drink it without a shudder. That was no romantic sketch. Look at the Soar, at Leicester black, and at Loughborough clear; look at the Irwell, black at Manchester, at Warrington clear; the Colne, at Uxbridge black, becoming within a mile and a-half clear; the stream at Witney, black, and at a mile distant perfectly clear. What could be said of this. He maintained that the common-sense view of this question was not to be despised, even when regarded by the instruments given to them by nature. Judge Dr. Frankland's theories by common sense, and where were they? He would now deal with the matter as a chemist; and here he would limit himself to oxidation. Did analysis confirm the appearances seen by the naked eye, or the reverse? He had given numberless illustrations to prove that analysis did confirm them. For instance, on the Severn, the Wear, the Shannon, and various other rivers. But all these were passed over by Dr. Frankland. Were they discredited? No. He would give another case, and this time he would quote Dr. Percy Frankland:—"I have examined all the tributaries of the Thames," and he mentions the Colne, which he says is richer in organic matter than the Thames at the point where it is joined by these streams. He (Dr. Tidy) knew the Colne better than most people, for very few persons had had the opportunities of examining it which he had had, and he knew where the Uxbridge sewage went in exceedingly well. Where the sewage went in, the organic matter rose enormously. But he knew also the composition of the river before the Uxbridge sewage went in; it had a given quantity of organic carbon, required a given quantity of oxygen to oxidise the organic matters, and contained a given quantity of free oxygen. The sewage went in, and immediately up went the organic matter; up went the oxygen required to oxidise the organic matter, and down went the free oxygen. Three-quarters of a-mile further on, the whole thing again became normal, and the organic carbon, the oxygen required to oxidise the organic matters, and the free oxygen, were absolutely identical to what they were before the sewage went into the river. Dr. Frankland said that the Colne at its junction was not so pure as the Thames, but that statement he entirely disputed, for taking the average of the Colne at its junction with the Thames, it gave ·160 of organic carbon, ·020 of organic nitrogen; while the Thames above the junction gave ·182 of organic carbon, and ·030 of organic nitrogen; so that, as a matter of fact, the Thames was improved by the junction of the Colne, and the magistrates, in dealing with the case before them, were of that opinion. It should not be forgotten that Dr. Percy Frankland and Dr. Frankland had never given any estimations of free oxygen in water. And no doubt there were reasons for that, which he would discuss directly. He would go a little further, in order to see what facts Dr. Frankland had to support his contentions. According to his report, he had made five experiments on three rivers, the Irwell, the Mersey, and the Darwen. Knowing those rivers exceedingly well, he could say that three rivers more pre-eminently unfitted for determining oxidation in running water it would be impossible to imagine. As Dr. Frankland was rather strong upon this point, he would read what he said about it:—"The rivers upon which the foregoing observations were made are notoriously much polluted by sewage and other refuse organic matters; so intense, indeed, is their pollution, that ordinary life is entirely banished from their waters." To this he would add something else, viz., that they are rivers which along their whole course were perpetually receiving constant supplies of impurities, everything being against their regaining purity. What, however, were the results obtained by Dr. Frankland? In two of his experiments he showed that, after a run of a few miles, a decrease of organic elements occurred, to the extent of, in one case 41 per cent., and in another case of 31 per cent. In the other three cases there was an increase. Dr. Frankland did not like these results, because he said—"We deemed it desirable, in order to complete this part of our investigation, to ascertain the effect of a flow of some miles of the water of a river less polluted, and in which animal and vegetable life still flourished; for this purpose we selected the Thames." The analyses of the Lechlade and Hampton samples, which were collected by Dr. Pole and analysed by Dr. Odling and himself, are given. Did they help him? No. Dr. Frankland was in a kind of despair, and so he very properly wrote, "The Thames is not well adapted for the study of oxidisation by flow in any part of its course, but it lends itself most readily to the support of *ad captandum* arguments about oxidisation." Then Dr. Percy Frankland comes to the rescue, and he selected samples on the same day at Oxford, Reading, Windsor, and Hampton. He says, "My analyses show that on the day in question—and on this day the river was in a perfectly normal condition—the water above Oxford contained but a very moderate proportion of organic matter, considerably less than is often present in drinking water; the sample taken below Oxford contained somewhat more, the river having received the polluted water of the Cherwell. The sample taken just above Reading, exhibited a further increase; that from Windsor, more still; whilst the sample collected at Hampton contained a larger proportion than any of those taken higher up the river." This was a single set of samples, but he (Dr. Tidy), had taken similar samples, off and on, for the last three years, and the conclusion at which he had arrived, based upon a series of experiments extending over a long period, was diametrically opposed to that arrived at by Dr. Frankland from this one sample. The case was this. A large river, free and open, moving with rapidity, occasionally, perhaps, lashed into a foam by mechanical obstacles, constant fresh surfaces being exposed to the air, in parts luxuriant with vegetation, and full of fish. In such a case they had rapid oxidation. "No," said Dr. Frankland in substance, "nothing of the kind. Because, if you put a little sewage mixed with a little water into a little bottle, and shake it up, you get no proof of oxidation." To compare a long river with a little water in a bottle brought into contact with a few bubbles of air was not, he urged, a fair comparison. He should not attempt to criticise these experiments further, because a far more able critic than himself had done so, and he would leave Dr. Frankland to fight this question with Dr. Odling. He would not discuss in detail the experiments which he himself had made on running water in a series of troughs. It might be remembered by some that those experiments were made with an enormous amount of care. The water was allowed to run backwards and forwards in these troughs, and the results obtained incontestibly proved oxidation. He was bound to say that in the matter of these experiments he had received but scant justice from Dr. Frankland. To his mind this scant justice and pooh-poohing stamped the value of the experiments. He knew the labour they had cost, and the care with which they had been made, and Dr. Frankland's treatment of them proved that he knew something also of their value. Although he should be the last person to suggest unfairness, still he could not forget that Dr. Frankland had suggested before the Royal Commission that the apparatus used was not constructed in the manner it was, and further, he had read an extract from his (Dr. Tidy's) paper, in which he scarcely showed his accustomed fairness, by leaving off in the middle of a sentence, as if it was a full stop. Dr. Percy Frankland talked of the romance of oxidation. Dr. Frankland had an opportunity lately of stating his views before a Royal Commission, and he stated them at great length, other chemists having done the same; viz., Dr. Odling, Dr. Dupré, Dr. Voelcker, the Chairman, and himself. Were all these romancing? The Royal Commission heard the evidence, upon that Commission there being one of the most distinguished chemists of the present day, Professor Williamson, and the conclusion at which they arrived was this:—"On the whole, the chemical analyses show that there is a progressively increasing impurity in the river from Teddington down to the outfall; the oxygen dissolved in the water exhibits a corresponding decrease where the impurity enters, and *vice versâ*. This shows, not only the impurity of the water at and near the outfalls, but also that the oxygen does active work in oxidising and thus purifying the sewage impurities of the river. Besides the purification of the river by oxidation, there is evidence of its purification by means of animal and vegetable life. The nett result of these complex processes is pollution by sewage, oxidation of the sewage by minute animals, and re-oxidation of the water of the river by animal and vegetable life, and by renewed absorption of oxygen from the air;" and so on. Was this Commission romancing? Dr. Frankland's theories, judged from a chemical standpoint, had been shattered to atoms. Lastly, dealing with the question as a medical man, he knew that he was on the unpopular side, and that Dr. Percy Frankland was upon the popular side. He was upon the unpopular side, because he was not a sensationalist. He did not believe in the bewildering consciousness of ever-present peril, and that all things around and within them were working together for evil. Although neither Dr. Frankland or his son were medical men, they had ventured within the medical arena, and they must take the consequences. Dr. Percy Frankland said, "That water which is polluted, and even with sewage effluents, may at any time carry with it infection, and the water of the Thames is not subjected to any process by the water companies which can ensure the removal of such morbific matter, if present." Again he said:—"It is thus evident, firstly, that the exclusion of sewage matter from a river like the Thames is practically an impossibility; and, secondly, that such sewage matters may at any time be accompanied by the germs of zymotic disease; and, thirdly, that no process to which the water is subjected can remove these germs should they be present." Now let them listen to what his father had said. The following quotation stood alone, and was not in the least degree altered by anything which came before or after it, and he would be very careful not to read the passage with any unfairness. "The supply of such water" (that is the Kent Company's water), "either softened or unsoftened, to the metropolis generally would be a priceless boon, and would at once confer upon it absolute immunity from epidemics of cholera." That was romancing with a vengeance! Now descend to the hard arena of facts. There was nothing more fallacious, said Dr. Frankland, than statistics. Dr. Frankland did not like statistics when they did not prove his case, though he did not mind them when they did. He would give Dr. Frankland's statistics, quoting from the Registrar-General. He says, "In London the high mortality of the week was due to diarrhœa, which always becomes fatal when the temperature of Thames water rises above 65°. In the last week of June it rose to 65°, then to 67°; the deaths from cholera rose from 78 to 156, and 349 in the corresponding weeks; thus the deaths in the last four weeks were 786 in the district supplied by Thames and Lea waters, whereas the deaths in the district supplied with water drawn by the Kent Company from the chalk were 19—the deaths were in ratio of 3 to 1. Again, in the following week ending July 27th, 1878, the deaths referred to diarrhœa and simple cholera, which in the five preceding weeks also rapidly increased from 23 to 249, again rose to 457, of which 336 were of infants under one year of age, and 99 of children one to five years. During the same period (that is to say, the five weeks) "the annual death-rate from diarrhœa within the area supplied by the Kent Company was 1·7 per 1,000, while in the other parts supplied from the Thames and Lea the diarrhœa death-rate averaged 3·7 per 1,000." So that, as a matter of fact, when statistics answered Dr. Frankland's purpose, he took the statistics of three or four weeks. Such statistics he (Dr. Tidy) admitted were misleading. He would not ask them to take the statistics for a few weeks, but for years. The lowest death-rate recorded since 1868 was in the year 1872, and in 1872 the quantity of organic matter in the Thames was, according to Dr. Frankland, higher than it had ever been; the highest death-rate known was in the year 1870, whilst the year 1870 exhibited the smallest quantity of organic matter that had ever been in the Thames. That was rather awkward, especially when looked at from Dr. Frankland's point of view. But to go to larger statistics, he had taken eighteen towns so supplied by wells, having a gross population of 889,000, and eighteen towns supplied by rivers, having a population of 911,000, and had estimated the average death-rate for 14 years. The well towns gave an average death-rate of 22·81, and the river towns 22·68. So that the death-rate was in favour of towns supplied by rivers over towns supplied from wells. With regard to the view taken by Dr. Frankland, as to the absolute immunity from cholera to result from obtaining water from the chalk, all he could say was, he could not understand why the *materies morbi*—inconceiveably minute cellular structures, Dr. Frankland would tell them—should not get through chalk fissures as readily as through the pores of filters. Now as to the question of the London water supply. London, in spite of Dr. Frankland's chemistry and of Mr. Hogg's microscopy, was the healthiest large city in the world. He challenged Dr. Frankland's results about the turbidity of the filtered water. In 1881, his colleague and himself had examined 2,181 samples; clear 1,993. In 1882, 2,110 samples; absolutely clear 2,059. In 1883, 2,224 samples; perfectly clear 2,187. In the three years, 6,515 samples drawn from the mains of the London water companies had been examined, and 6,239 were found absolutely free from all matters in suspension. In some of them there was a slight turbidity, infinitely too minute to estimate. He knew that Dr. Frankland did not like the conclusions drawn by the Royal Commission presided over by the Duke of Richmond. That committee heard everything Dr. Frankland had to say; and here he might be permitted to remark that their report was the most recent, having a judicial character, because he did not admit that the Report of the 1860 Commission was judicial. This Royal Commission having heard all the evidence, the conclusion they arrived at was that they saw no evidence to lead them to believe that the water supplied by the companies was not generally good and wholesome. He knew that Dr. Percy Frankland did not think much of that, but that was the result of a Commission which was judicial in its character. He unhesitatingly asserted that Dr. Frankland had not proved his point, and that no better supply of water could ever be found for London than the supply which at present was drawn from the Thames and Lea. He was now going to say something he could have wished there was no necessity to say. He would tell Dr. Frankland—and some day he would remind him of what he now said—that a time would come when Government would not want his monthly reports. That time would be when they had acquired the property of the shareholders of the London water companies. Depend upon it, the authorities then would be perfectly satisfied with the present supply, nay, would be enthusiastic in its praise. They would no longer ask for words of warning and condemnation from South Kensington. It was said that history repeats itself, and perhaps they would listen to a story he was going to tell. In the year 1876, a certain water company, which Dr. Frankland knew very well, taking its supply from a certain river, came to Parliament for powers to do certain works, and to take a larger quantity of water from this said river. The local authority fought the the company vehemently, and chiefly upon the quality of the water. Foremost amongst their advocates was Dr. Frankland, who stated in his evidence, "I have no hesitation in saying that water contaminated as this is is entirely unfit for domestic supply." The Committee accepted that view, and the company were compelled to sell their undertaking to the corporation. But what had been the action of the corporation since 1876? No doubt every one would suppose, with Dr. Frankland's warning notes of "contaminated supply," "unsafe water," and "dangerous" (for that was the word he used) ringing in their ears, that they would have altered the state of things when the concern got into their hands. Not a bit of it, for at the present time they continued identically the same supply which the company had in 1876, and so perfectly satisfied were they with it, that they had come to Parliament for power to take an unlimited supply from the same river. A curious question which occurred to him was, "Would they retain, or had they retained, Dr. Frankland in their present case?" He did most earnestly implore Dr. Frankland to prevent his deservedly magnificent position, his great name, his high reputation in the annals of scientific research, from being used as levers to bolster up Parliamentary measures, or for the purpose of making political capital.

Mr. CRESSWELL said that, after the startling speech they had just heard, he felt that anything he had to say would sound stale, flat, and unprofitable. The question before the meeting was one of the most momentous ever raised in that room. If the author were correct, it seemed that no time—not a day—should be lost in urging the Legislature to pass an Act absolutely prohibiting the supply of water from the Thames or the Lea. If, on the other hand, he were incorrect, and his conclusions were open to dispute, he was blameable for having raised an alarm unnecessarily, and probably, if they had a hot summer, for creating a panic. He understood from the paper that there were three causes of pollution so important as to render it imperative that no more water should be taken from the Thames to supply the metropolis. The first was that which all recognised, the flow of sewage water in its crude condition into the river above the intake of the water works; second, the flow of sewage effluents from those works which had been erected for the purpose of modifying or removing that mischief; and thirdly, the continued flow, in times of flood, of more or less organic matter from highly cultivated fields in the Thames valley. As to the first, if the decisions of the Uxbridge magistrates were upheld, he feared that instead of diminishing it would be likely to increase, for he could not conceive a greater dilemma than that in which the unfortunate rural Justices were placed in being called upon by the Conservators of the Thames to decide between two learned doctors like Dr. Frankland and Dr. Tidy in such a question. They must, in construing a penal statute, construe it strictly, and he thought they did their duty in refusing to convict. Unless, therefore, the Conservators were able to obtain a modification in the Act, and remove that great defect to which Sir F. Nicolson referred the other evening, by erasing those ridiculous words, "likely to flow into the Thames," for he did not see how it was possible that any solution going into the river could do otherwise—even at Uxbridge water would not flow backwards—these cases would be likely to increase. The second cause of pollution he would leave for a moment, and turn to the third. He did not see how it was possible to avoid that; so long as water flowed by gravitation, and fields in the neighbourhood of the Thames were highly cultivated, that source of pollution would be inevitable. If there was nothing in oxidation or any other principle which would remedy or modify that portion of the mischief, they must be content to bear it, or at once determine not to take the water supply from the river at all. Now, coming to the most important source of pollution, sewage effluent, the paper of Dr. Percy Frankland almost took his breath away. There were three different systems of sewage disposal and utilisation—irrigation, intermittent filtration, and precipitation. With regard to irrigation, they had been taught to believe that that was an infallible remedy for dealing with the causes of disease and destroying the sources of pollution in sewage. He would leave the champions of irrigation to deal with the author on that point. He said it was the best method of dealing with sewage; but he went on to say that there was no guarantee whatever that it would destroy the sources of disease; that these pestilent morbific germs could not be destroyed by any process of utilisation or disposal. Now if that were so, he could not see the use of any sanitary precaution whatever, or of the Rivers Pollution Act, and even of the Public Health Act, so far as adapted to sewage, if no sanitary expedient were sufficient to destroy the sources of disease. He did not pretend to discuss the chemical question, but he was a lawyer, and was accustomed to sift evidence, and he must say he had never yet seen or heard of any such evidence as would convince a reasonable being of the existence of those marvellous germs which were supposed to be present in every effluent. They were probably the minute undefined cause of disease; but as to their habits and habitat, so far as he could learn from scientific men, they knew nothing, and he apprehended, therefore, for all practical purposes, they might be considered a bugbear. Intermittent filtration was also dealt with by the author in the same curt manner, and he said that it would not produce the desired result, and destroy the germs of morbific disease in sewage, which was essential in order that they might carry out the one simple object of preventing the spread of infection by means of excreta of the human body. If it could not be done by this intermittent filtration, how was it to be done? Now he came to the last point, and here he had to say something which he would fain not have said. When the author came to deal with the question of precipitation, he relinquished that calm, placid, philosophic tone which he had before observed. In speaking of the native guano process, to which of course he was obliged to call attention to (for it was one of only two or three which had survived a long list of 36, and, therefore, even on the Darwinian theory was entitled to some respect), in speaking of it he said, "The A. B. C. process has attracted an altogether undue measure of popular attention; probably on account of its very plausible and seductive name, which we can imagine may not be without influence upon the ignorant persons who are frequently entrusted with the management of local sanitation." Of course ignorant persons were always open to delusion, but when Dr. Frankland came to that room, he was well aware that he was not addressing ignorant persons, and he thought to ridicule a company, because some one had given it a nick-name, was not a fair argument to use in such an assembly. Having given that foretaste of the manner in which he was about to discuss the question, he quoted two extracts from a document to be found in the archaic lore of the Local Government Board, which had probably been pigeon-holed for the last twelve years. But the idea of quoting, in 1884, two passages of such a document as the Rivers Pollution Report of 1870, in order to illustrate what the Native Guano Company could do at the present day, was not worthy of the subject or the man. But not satisfied with that, he gave, as usual on such occasions, a diagram showing the results of analyses. On looking at it, he (Mr. Cresswell) thought the result shown to be obtained by the native guano process was very low, but there was something about it which attracted his eye and seemed familiar to him, and on going home he found to his astonishment that of those analyses put before a London audience in 1884, the one relating to the A. B. C. process was taken by Dr. Frankland in 1870 on London sewage. Was it just to the company, or fair and ingenuous to an audience, to treat them with stale, unprofitable analyses of fourteen years ago, in order to demonstrate the inefficiency of a company at the present moment to deal with a great difficulty, and which had spent thousands of pounds in the endeavour? Was it fair to those who were seeking for the truth to be told that estimations of London sewage treated in 1870 were to be a guide to men groping in the dark still in 1884? Was it fair to take such an analysis at all? It was taken on London sewage; and it must be remembered that London sewage was peculiar—nobody knew why; but the Legislature had said it was not to come within the Rivers Pollution Act, he supposed, because it did not pollute the river. Even if Dr. Percy Frankland himself had not been willing to go a little further in his excursion up the Thames, as far as Aylesbury, to see what was actually being done by this company at the present day, he could have found, even in the archives of the Local Government Board, some better test of the merits of the native guano process than that archæological specimen. In the records of that Board, there was an analysis which bore on the question of the evening, which was—Could you precipitate by chemical means organic matter in solution so as to make the sewage effluent fit to be poured into a river which was a source of water supply to a town? It was said that the organic nitrogen and carbon was the test, and he would assume it to be so. Dr. Angus Smith, in a report published in 1879, at the request of the Local Government Board, on various effluents from various processes of irrigation, filtration, and precipitation, made a report on the native guano process. Instead of a diminution of about 33 per cent., namely, from 3·6 to to 2·2 in organic carbon, he found, taking samples over a period of a month, and at times when he was not expected at the works, and when he had every opportunity of obtaining a fair test, that it was reduced from 6·7 to 0·6, or by 90 per cent. With such analyses of organic carbon lying in the archives of the Local Government Board, certified by Dr. Angus Smith, one of the chief inspectors, why should Dr. Percy Frankland, in order to throw dirt at the much-abused, but very meritorious company, parade this ancient analysis? The same analysis showed that the free ammonia was reduced by 75 per cent., in startling contrast to the result shown on the diagram. The albuminoids were also reduced from ·66 to ·07, or very nearly 90 per cent.; and many were of opinion that albuminoids and ammonia were the best test of the polluted or non-polluted condition of an effluent. In conclusion, he might mention a list of men who were part of the large body of ignorant persons who, as the author intimated, were deluded by the jingling name of the A. B. C. process. He had a list of gentlemen who gave evidence before the Privy Council the other day, to the effect that the A. B. C. process was the best yet invented, and in the absence of other means, was the best available process for sanitary engineers. Amongst these names were Mr. Crookes, Dr. Tidy, Professor Wallace, of Glasgow, Professor Way, Mr. Collingridge, sanitary officer of the Port of London, the late Mr. Keates, Major Flower, Mr. Baldwin Latham, Mr. Hawkesley, and the Mayor of Leeds. Those were the ignorant persons among whom he begged to include himself. On one occasion, when Mr. Norman Bazalgette read a most interesting paper at the Institute of Civil Engineers, an illustrious chemist then present said in effect, "I do not approve of this constant habit of flinging and slinging against these precipitation companies. They have at least done good, and even negative results are of substantial value in the cause and progress of science. They serve to indicate the way we should go. It is ungenerous of us to decry and disparage their efforts. They at least have been content to make sacrifices, and have had the courage of their opinions, and I far one, although I am so well known as an advocate of irrigation, declare that we owe a debt of gratitude to these companies, that, like Curtius at Rome, 'plunged into the gulf to save the State.'" The man who made use of that language came before the Kingston inquiry in 1880, and in cross-examination by him (Mr. Cresswell), said he still adhered to every word of the sentence, both in the spirit and in the letter. That man was Dr. Frankland, and he would recommend the sentiment to his son, as showing the proper spirit in which to approach the discussion of this momentous question. Knowing where it came from, he hoped that he would pay respect both to the authority and to the dictum.

Dr. Jabez Hogg said he was much inclined to come to the conclusion that they had not been discussing the question of the paper, but rather indulging in an attack upon the author. The subject of discussion was Dr. Percy Frankland's paper on the Thames as a source of water supply to London; but instead of discussing this, they had got into various inconsistencies of opinion between chemists, scientific men, and trading companies, who were doing their best to prove that effluent water which passed into the Thames is perfectly pure and wholesome. No one would deny that Dr. Tidy was deeply earnest in this question. It was evident that there were two sides to the water question, and he had been much surprised to hear what had fallen from some of the speakers. Dr. Tidy would excuse him for pointing out that he had been discussing one side of the question whilst the author of the paper had been thinking of another. Dr. Tidy, speaking of his process of oxidation, would lead the meeting to believe that that process would do everything in the way of improving a bad water, forgetting to mention that the oxidation he referred to was the oxidation of dead matter, whereas medical men are thinking of quite another thing; they want a mode of killing living matter, the specific organic germs of disease. Dr. Tidy had also fallen into error in supposing these could not be seen by the miscroscope. The new process of staining in microscopy enabled the observer to see, with a comparatively low power, that which was invisible a few years ago, living organisms in millions in every drop of water. These organisms could now be plainly seen, and they were divisible into various species, if evolutionists would permit him to use the word, distinct species, which were palpable, and which were so far believed to be associated with certain specific forms of disease. For instance, the bacillus of tuberculosis was a distinct organism altogether in shape, character, and life history, from the ordinary bacterium known to microscopists. They had here, at all events, a new organism associated with a disease, which was palpable to the eye of every practical man acquainted with the subject. Another remarkable form was the bacillus of splenic disease; and again, the spirillum of fever which affects large tracts of country in India; this was a thing altogether different in character from the bacillus of tuberculosis. It is a spiral form of vegetable cell, and which, when stained violet, could be seen with a very low power of some 250 diameters. It is these living organisms which medical men desire to kill, and which Dr. Tidy, with all his acuteness, has never seen killed by any process of oxidation in a running river. A considerable run would not kill these organisms; he need only refer to the remarkable instance which occurred at Caterham Waterworks, where by the merest accident of one workman suffering from typhoid fever, who went down into the well and worked there a few hours, and defiled the well, thus contaminating hundreds of millions of gallons of water which were pumped out, and distributed to the townspeople round about. Four hundred cases of typhoid followed the next week, and seventy or eighty deaths occurred in consequence. Such cases proved that neither dilution nor oxidation would make bad water good. He readily admitted that oxidation did something for water, but what was stated in the paper was that, if water was infected with typhoid fever germs, it might run any number of miles, and be diluted to any extent, and yet you would have the fever appear in a person predisposed to fever who drank the water. He did not say that every person would take it, but where there was a predisposition, any person drinking infected water would take it. Again, take the improvement of water by *entomostraca*; granted these crustaceans did purify the water to some extent, though not to an equal extent as living vegetable matter. But taking that, they were most active scavengers, what followed? They were found in enormous numbers, and that certainly was a measure of the gross impurity of the water, as without abundant supply of food they would not have multiplied. In Boston, America, on one occasion, these *entomostraca* were so rapidly productive, that a particular form of disease, choleraic diarrhœa, became prevalent throughout the town, and numbers of persons died through drinking these noxious creatures with their water. In fact, many other animals, as frogs, and fish, denizens of the water, were also affected, and died in large numbers. A similar instance occurred in Sweden. There were ample illustrations of the danger to health from drinking contaminated water. With regard to the statistics of visitations of disease, he would confine his remarks to London. Dr. Tidy had referred to a table on the wall which showed that there was a great diminution of disease in a given year; but he had kept out of sight a fact that in London there had not only been watchful care with regard to water, but great attention had been given to every circumstance of a hygienic nature, and the diminution of disease depended more on general sanitation. Typhoid fever, or, as Mr. Simon had called it, dirt fever, was brought into the house through bad drains, neglected drains, or want of proper drainage. It might be propagated by the air as well as by the water; perhaps the greater number of fever cases were due to foul air. Outbreaks of cholera have, however, been most clearly traced to the water supply. Take, for instance, the principal outbreaks in the years 1832, 1849, 1854, and 1866. The mortality in 1832 was very great, the number of deaths reported being 5,275. The population then amounted to only 1,681,641, so that the deaths were at the rate of 31·4 per 10,000. In 1849, the deaths from cholera were 14,137, out of a population of 2,286,800, or 61·8 per 10,000. In 1854, the number of deaths was 10,738, and the population 2,504,198, or 42·9 per 10,000. This was just at the period when the water companies were changing their intake going higher up the river, to improve the quality of the water. In year 1866, when the estimated population was 3,037,991, the cholera slew 5,596 persons or 18·4 per 10,000. The water companies at this time had removed their intake to the Upper Thames, and the water was much less contaminated. The remarkable circumstance connected with the outbreak of 1866 was, that it was much confined to the East-end of London, where it originated, and was indisputably traced to the East London Waterwork Company, then drawing a supply from a very contaminated point in the River Lea. These striking statistics show that in every epidemic visitation of cholera, mortality varied in intensity according to the excremental pollution of the water which Londoners were compelled to drink. The more detailed facts published in the Rivers Pollution Commission must convince the most sceptical of the close connection existing between cholera mortality and the excremental pollution of the water drawn from the Thames. With regard to typhoid fever, too, there were numbers of instances showing that oxidation did not greatly effect the purification of contaminated water, as Dr. Tidy supposed. At Lausanne, a village much resorted to for the purpose of health, having a population of about 800 or 900, there was a remarkable outbreak of typhoid fever. The water supply was obtained from the opposite side of the mountain, and came to the village from two streams. The head of one portion of the stream flowed past six farmyards where typhoid fever prevailed, and joining the other portion of the stream before entering the mountain, and filtering through a rock, principally of oolitic formation, on its way to Lausanne. In doing so, it travelled several miles, so that oxidation had the fullest possible opportunity of improving the water, nevertheless, it came about that 130 people who drank freely of this water contaminated by typhoid fever excrement were attacked, and many died, whilst six other houses in the village provided with shallow wells, and which consequently did not use this water, were not attacked. That showed how difficult it was to deprive polluted water of its power for mischief. Of course in the case of typhoid fever, fewer persons died in proportion to the number attacked than in cholera. The difficulty, however, lay in ascertaining when water was sufficiently oxidised to render it pure enough to drink. They knew very well, with regard to the Thames and the Lea, that in spite of all the efforts of the Conservators they could not keep out sewage polluted water. With regard to the Thames, it had been sufficiently well shown that it was not a safe water supply. He did not say Thames water was always dangerous to drink, but if an outbreak of fever were to take place in the Upper Thames, above the intake of the water companies, it would most certainly infect the whole of the river. The purport of Dr. Frankland's paper was to show that river water was always, more or less, attended with danger to the public health, and that as London paid the best price, it ought to have the best water it could possibly get for its money. He apprehended the real object of the meeting was to enable them to form some clear common-sense notion as to the best mode of improving the London water supply.

The discussion was then further adjourned, to a day to be fixed by the Council after Easter.

The following is an extract from the Judgment of Mr. Justice Pearson, in the case of Ballard *v.* Tomlinson, February 13, 1884, referred to in the paper at p. 440:—

"It is plain as far as regards quantity, one person cannot have, as against his neighbour, the same right to water which a riparian owner has; the right of the lower riparian owner as against the upper riparian owner being that the lower riparian owner is entitled to have the stream sent down to him in the same quantity and of the same quality as the upper proprietor has it at his premises.

"If, then, quantity is taken away, does quality remain? The argument before me has been that it is impossible for the defendant, although he might abstract all the water, to alter the quality of the water in any respect. I must say that I have the most absolute difficulty in following such an argument. If the defendant is at liberty to take away all the water and to deprive the plaintiff of it, I am at a loss to conceive how you can separate the quality from the quantity, and to say that whilst he may deprive him of all the quantity he, nevertheless, must leave the quality as he found it originally; and I come therefore to the conclusion that the plaintiff has no right in the quality of the water any more than he has in the quantity of the water. If I had to determine the exact point as to whether or not an upper proprietor of land, under which at the depth of 300 feet or more there is found to be subterranean water, had a right to deal with that water as he pleased as regards the quality of it, and to have no action brought against him by the lower proprietor with regard to that subterranean water, and change its quality, I think I should without much hesitation decide that in the affirmative, and say that when the Courts have decided that the upper proprietor has the complete control over the water in his premises, that it is impossible to split that control between quantity and quality, and say that he has the control as regards quantity, and he has no control as regards quality."

SIXTEENTH ORDINARY MEETING.

Wednesday, March 26, 1884; Sir ROBERT RAWLINSON, C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Cosedge, Hiram, 16, Clifford's-inn, E.C.
Crickmay, Thomas, 17, Parliament-street, S.W.
Esson, William B., European Telegraph Works, Dalston, E.
Glyn, Hon. and Rev. Edward Carr, M.A., the Vicarage, Kensington, W.
Hughes, Richard Deeton, 12, Bedford-row, W.C.
James, Edward, 22, Westbourne-terrace-road, W.

Kirkpatrick, Robert, 1, Queen-square, Strathbungo, Glasgow.
Lovett, Phillips Cosby, J.P., Liscombe-park, Leighton Buzzard.
Murphy, Shirley F., 158, Camden-road, N.W.

The following candidates were balloted for and duly elected members of the Society :—

Bratby, William, Sandford-street, Manchester.
Byrne, Charles Pitt, B.A., 52, Bedford-gardens, Campden-hill, W.
Fletcher, Thomas, United Telephone Company, Oxford-court, Cannon-street, E.C.
Francis, E. G., 59, Fulham Palace-road, S.W.
Griffith, R. W. S., Eyeworth-lodge, Lyndhurst, Hants.
Johnson, George Stillingfleet, 11, Savile-row, W.
Johnson, Samuel H., West Ham-hall, Forest-gate, E.
Lethbridge, Roper, C.I.E., 19, Clanricarde-gardens, W.
Nightingale, E. W., 139, Denmark-road, Camberwell, S.E.
Rawes, Francis Bristow, Bowbridge Works, Newark-on-Trent, and 13, Brunswick-ter., Newark-on-Trent.
Smith, Surgeon-Major Samuel, Wyndham-house, Kingsdown Parade, Bristol.

The paper read was—

VITAL STEPS IN SANITARY PROGRESS.

By Benjamin Ward Richardson, M.D., F.R.S.

The work suggested to me for this paper, and which I have undertaken at the request of some of the most trusted and respected members of the Society, is to indicate what, in the future, are the lines which the Society should follow for promoting the progress of sanitation.

I propose, therefore, to speak to-night on four vital steps or advancements for the improvement of the national health, including under the term those steps which relate to the life of the people—indirectly of course to their comfort and happiness—but directly to their life—the reduction of their mortality.

These steps are—

1. The physical purification of the people.

2. The radical suppression of those diseases which kill by communication of the affected with the unaffected.

3. The promotion of a better knowledge, and of thrift, and provision of food and drink for the masses.

4. The encouragement of organisation and unity in sanitary administration.

I might introduce many more topics. I consider these sufficient. If we could for, say, four years, concentrate on these four subjects, physical purification, suppression of the devastating diseases, provision of proper food, and organisation of the sanitary work that has been, by accidental progress, carried out, we should be true sanitarians, trenching neither on the medical nor the social scholars.

Fortunately, our Society is able, on all these subjects, to influence public opinion most favourably. Neutral in politics, it has on its Council men of all callings; politicians, lawyers, engineers, architects, statisticians, meteorologists, historians, men of letters, men of business. It has, in a word, every requirement for the study of sanitary discovery, application, administration; and, asking the attention of the Society to-night to the subjects named, and inviting the discussion on them, I shall state plainly my own views, not merely because they are my own honest convictions, but in order that, by plainness of speech, I may draw forth the views of others, either for or against what is said, without reserve.

Physical Purification.

In speaking, a few months ago, on one of the departments of physical purification, I seem to have startled the proprieties of many of the people by the assertion that absolute cleanliness—cleanliness of the body and mind, and all that belongs to them—is the beginning and the end of the sanitary design, and that such perfect cleanliness would wipe off all the diseases which cause at this time the leading mortalities. I do not withdraw from that statement a syllable, and I again place this subject of national purification first on the paper.

Into all the varied studies connected with this argument it were impossible to enter. It will be fittest to take two of the Augean stables which have to be cleansed.

Underground Purification.

The complete removal from our communities, day by day, of all their organic excreta, is still an unsolved difficulty which, remaining unsolved, is a block to every step of perfect purification.

We are are yet distracted with the debate ever going on between the advocates of the combined and the separate system of drainage. Shall all our organic excreta go with the storm-water into the river and sea, or shall the water go to the river and sea, the sewage to the land? Unlike our neighbours on the other side of the Channel, we have agreed to give up the cesspool, and to divide on two questions which they have not, seemingly, admitted, and one of which, that of disposal in running streams, they have long legally prohibited. But, in giving up the cesspools, have we greatly advanced, so long as we pollute the running stream and lose the natural fertiliser of the land? Looking back on all the controversy for the last thirty years, and reading back still further, I feel we have not advanced. I do not think it would be wise to return to the most scientific system of cesspoolage, but I cannot conceive any next worst plan than the plan of passing the sewage with storm-water, even on the most scientific system, into running streams, and of robbing the land of its greatest requirement for its fruitfulness.

I submit, therefore, as a point to be argued out, that this Society can never be soundly assisting sanitation until it assists none other mode for removal of excreta than the separate system.

In saying so much for the separate system I do not, however, wish to contend for the introduction of that system in the hard and unchanging line which some would fight for. I know quite well, from the inspections I have had to make, officially, of different towns and districts, that there are centres of population in which the separate plan, in its rigid application, is not suitable. A town may have no river into which its storm-water can run. A town may have a river, but no land near to it which can be cultivated. These conditions may affect details, while they need not affect the principle. For storm water for which there is no natural outlet, there is always the good resource at hand of storing it for domestic use. For sewage that cannot be utilised on land near to the community which yields it, there is always land not far away which is waiting for it. In these days there need never be necessity for any difficulty in the removal of sewage day by day from the largest centres of population, presuming always that it is not mixed and increased in volume by storm-water. Closed sewage tanks moveable by night train, closed sewage tanks moveable by steam-power on sewage canals and rivers, closed tanks moveable by steam-power on the sea, could convey away all this product for fertilisation, and deposit it where it could administer its full benefits to the earth. Barren portions of our sea-coasts could, by these modifications of the separate system, be made the most fertile and beautiful of all our tracts of vegetation.

To the engineer, when once a system were decided on and declared, these modes of transit, and many improvements on them, would occur. With the engineers it is not our special province to interfere. They exist to carry out what has been determined on, and when they know what the people want, they will do what is wanted, as surely as they will lay down, after the country has said they must, a new railway or a telegraph. We have but to declare the principle, and get it fixed, that every town in England must be cleansed of its organic excreta out and out, day by day, as certainly as it is supplied with the food that is brought into it, and the thing will be done.

Toward such perfection any powerful society, steadily and resolutely devoting itself, would soon be backed up by the common sense of people who require but a competent instructing authority in order to understand the subject accurately. The utter failure of the combined system as a permanent solution of the drainage difficulty, and as a mere transition from the cesspool to the method of removal day by day, combined with immediate and fruitful utilisation, is of itself becoming apparent with such swift conviction, that it will come whether assisted or not by our will and deed. But it were wise to hasten it, and it is one of those pressing practical things which we could hasten effectively, if, irrespective of all interests but true ones, we laid ourselves out for the duty.

At the instance of Mr. Edwin Chadwick—whose name as a sanitarian is a name of the century—we did, some time ago, commence an inquiry here bearing upon the vital point now under consideration. We opened—or, more correctly speaking, we re-opened—the sewage question, and we discerned all at once, although our inquiries were entirely confined to limited areas of London, so much evil, that we rather abruptly closed the evil up again, as if we were frightened at it. It is all in vain, for sewage, like murder, will out, and we must once more proceed. What we did discover was in truth so serious, that the wonder we labour under is how London can be so healthy as it is. We found that London is still honeycombed with what are in fact, if not in name, cesspools, a fact we all practically recognise by the second-hand measures we take to meet the primary blunder.

From the window at which these remarks are written, I see that one of my neighbours, the owner of a large house in our square, has carried out of his house, from the basement, a three-inch tube to above the level of the parapet, in order to deliver into the air any gases that may accumulate in main drain of the residence.

It is not good for the air which I and many others have to live upon, that it should receive the foul air which rises from the decomposition of my neighbour's organic excreta; and if everybody's neighbours did it, it would be detected in some weathers, so that the process must be stopped, as it was in a former day on a recommendation of the Royal College of Physicians. I do not, however, blame my neighbour for what he has done, because I have done it myself. It is a natural species of self-protection amongst those who know best how to protect themselves. My contention is, that the necessity for any such a method is proof demonstrative of the rottenness of the primary system which causes the necessity, and which keeping us foul beneath our houses, makes the air, at its best, foul also above them. My contention is that the decomposition which gives origin to the gases that are let out by thousands upon thousands of channels, by tubes from houses, by soil-pipes within houses, by accidental openings and pores in all directions, by gullies in streets, by great outlets of sewers from accumulations of sewage, ought never to have been generated at all, but that the sewage, removed clean away, hour by hour, many miles from the community, without having decomposed either above or below the living place, should never infect the place nor have any destination except the land which is calling for it, and which dies if its demands be not naturally supplied.

The moment we can, by the skill of our engineers, get our in and out going drainage system as good as our railway system, as true in its working, as continuous and automatic, the most important of all the basic sanitary reforms will have been introduced. Without any stretch of the imagination, volumes might be written on the affirmative side of this proposition. I must be content to put the negative side. I must declare on all heads of experience and observation, that until the basic reform is carried, there can be no sound sanitation at all. I have asked many times, sought many times, for so much as one instance in which the combined system—apart altogether from its loss and extravagance, which might be tolerated if its results were good—has proved a sanitary success. I cannot find one instance of the kind.

The towns which depend on storm-water to flush and inundate their sewers, are like the old mariners who depended on favourable weather for a favourable voyage. The day has passed for that, as it has for a system of sewerage which at all costs must be swept away.

Overhead Purification.

The plan for completest removal of the fluid and solid organic excreta, basic as it is, would not be perfect unless it were attended with the purification of the air above as well as of the earth beneath. Just now the public mind is full of this topic, and Mr. Westgarth's munificent donation to this Society of prizes for plans of reconstruction, will rival handsomely the Health Exhibition itself in the interest it will excite. A clear sky in a place like London; clearer and cleaner streets; the emancipation in close places of one person from the empoisoned breath and emanation of another; room to breathe; these are the blessings which the people are looking to their sanitary deliverers to give them.

We shall have in this Society sufficient work for some months to come in adjudging on the schemes proposed for these intents; we shall be overwhelmed with details; we shall have before us every plan and every model which human ingenuity can devise, to compromise interests, and make necessity the mother of invention. I will not presume to anticipate the judicial labours of the Society for the awards that will have to be made, nor suggest for it any new labours at present in this direction in addition to these, which will, probably, be sufficiently onerous.

I may, however, tell the Society, that if I were going to be one of the competitors for the purification of London through the reconstruction of it, I should propose such a reconstruction as would be, in an architectural sense, perfect revolutionary. I should propose to go up stairs to the top of the houses to do it, and should indicate the construction of another London over head—London-super-Aër.

To convey what I mean, let us move to the best constructed, as well as the most beautiful street of this metropolis, if not of the world—Regent-street—in the part called the Quadrant. That is laid out for such a design as if it had been prepared for the experiment. All the houses are of the same height, and the height throughout is just right for a city like ours. It is sufficient to be handsome and commodious without being overwhelming and without excluding the light from the streets. The roofs of Regent-street, at this part, are flat in comparison with other roofs. They are utilised here and there by photographers' studios, which, although temporary structures, stand firmly and well, in ready communication with the houses on which they are placed. The studio, where it exists, seems naturally to form and become a part of the house. When we glance along the line of roofs, as on a level terrace, the idea of reconstruction of all roofs, and of the re-adaptation of them, becomes most distinct and suggestive. The width of most London houses averages, as near as I can estimate, about 25 ft. from front to rear. Here, then, is good space for a terrace for foot-passage. Imagine along two lines of long streets a terrace of this kind, with handsome railing on each side, and perfectly level floor surface of wood; and, at intervals, light bridges spanning from one terrace to another, and you have an upper-dayLondon which might almost relieve all the pressure from foot traffic in the streets below. Each house would have its own exit, or door, at the upper as well as at the lower parts; and, at convenient spaces, each terrace would be accessible from the street as the Holborn-viaduct is at the present time.

It suggests, at first, a revolution of ideas to conceive such a change. It suggests much out of which a humorist can for a moment make capital. I know all this very well. But there is, in point of fact, nothing more in it than in the first idea of making a tunnel under the streets or under a river. When the suggestion is looked at bit by bit, without prejudice, it offers more of sanitary advantage for the purification of the atmosphere, the protection of property, the comfort of the people in transit, the lodging of the people, the exercise of the young, and the beautifying of the whole city, than could be entertained on a mere general statement of the proposition.

In the first place, for every house in connection with an upper terrace, there would be the most perfect through and through ventilation of air. The staircase would no longer be a closed cupola for holding and storing all the emanations from the basement upwards.

In the second place, the fact of having terraces on the upper surface of London would lead to immediate arrangements for the purification of the air from smoke. So soon as the roofage was accessible as a terrace, from the plan which Mr. (now Sir) Spencer Wells projected for the removal of smoke from every house, by laying down horizontal conducting tubes with central exits and smoke consuming furnaces, would be easily practicable, presuming always that some smokeless fire be not invented, or that coal gas does not become the fuel of the people. These terraces would then be the healthiest parts of London; charged with flowers and trailing evergreens, they would be the empyrean gardens of the great city.

The terraces, with their light intercommunicating cross-bridges in the long thoroughfares, would be more than pleasant foot-ways and shady lanes for the foot travellers, or travellers in light noiseless vehicles, like tricycles; they would be most useful for other purposes. Along them the electric lines would pass and enter the houses direct; and from them the letter carriers would most easily deliver their letters.

These terraces, while relieving the traffic in the streets below, would remove all necessity for the fire-engine, and would make London practically safe from fire. From them water would be supplied readily, a trained police for this upper London being ready at every moment to go down and extinguish fire in every domicile, carrying his hose with him, or plying it from above.

I think that no one who reflects will fail to see that all these changes would be advancements of great value for the health of a city like ours. They are, however, not the chiefest advantages. If anyone will take the trouble to go observingly through the busy parts of London, where there are long miles of roadway—along Whitechapel and Mile-end, for example—he will see the most jagged, hideous lines of roofage. Here a row of houses two stories high; there a row of three or four stories; then a single house five or six stories; and so on, over and over again, like a set of bad teeth. If the plan here suggested were carried out, all this would be rectified. A street like Regent-street expanded into a straight line, would extend from the Marble-arch to the City, and from the City to the extreme East-end. The line of terrace pitched at five stories would necessitate the building up to the same level all the houses in that line, by which at least one-fourth more housage would be supplied, with arrangements for giving comfortable and healthy homes, beyond what now exists, to a fourth of the present population. The suspension cross-bridges would not be without their compound service. They would be bearers of electric lines along their side-ways, and would probably soon be utilised as centres from which electric beacons would be suspended to light the streets beneath.

Imagine the metropolis turned into a fairy land by this adventure of science into the domain of art, and art reciprocating the idea with all her rich resources, and we see in our mind's eye what our children, when we are all of us gone, may really see, and, perhaps, thank us for proposing for their benefit.

Objections will be made about mechanical and architectural difficulties. I heard them all made when the Holborn-viaduct was projected; I saw them all melt away as Colonel Haywood's practical mind came into work, and his unthanked skill and industry and responsibility and genius carried all before him.

It will be objected that flat-roofed houses are not weather-tight. In the year 1825, the then Parisian Asphalte Company roofed two houses with asphalte in Hinde - street, Manchester-square. I lived in one of those houses for twenty-eight years, and a better roof I never knew; but for the London smoke, it would have been made into a garden. Men working upon it, walking over it, communicated no sound whatever into the rooms immediately below.

It will be objected that houses will not bear the weight of super-imposed suspended terraces for foot-walks. If they will not, they ought. In no direction would the sanitary improvement for the purification of a great city be more useful, as a side improvement, than in so reconstructing defective houses as to make them capable of bearing an equalised weight which, carried by many, would, as we know from the bearing of ice, be comparatively light and practicable.

Of the many plans which have been suggested for giving space to crowded cities such as terraces in the streets opposite to first floor windows, and tunnels subterranean—none seem to me to be half so practical, half so likely, to secure the purification of atmosphere as this, which I have now for the first time, after some years' hesitation, ventured to sketch out, not as expecting ever to see such a project realized in my own time, but foreseeing as even a necessity and practicability in the times to come.

Isolation of the Infectious Sick.

The vital step in sanitation to which I have referred as the isolation of the infectious sick, is one which demands all our care, all our encouragement. No earnest sanitarian can be satisfied with the slowness of the progress of arresting these formidable plagues which, so late as 1880, killed in England and Wales in the one year 106,205 out of the 528,624 who died from all the causes of death. By comparing the mortality of the year 1847 with that of 1880, for a table of my book, "The Field of Disease," I find a small difference in favour of the later period, but it is ridiculously small—3·17 per cent.—considering the long labour that has been expended in the study of prevention.

Great noise has been made about the causes of these plagues; much aside speculation of natural history has been bestowed upon them, and some additions to natural history has been gathered, which, no doubt, will be curious as well as interesting in a future day. But of work of practical prevention, work that is of specific, reliable, and rapid application, little has been effected. Yet without any reference to hypotheses of causation, these diseases are most manageable under a proper system of isolation. Dr. Blackburne, writing in 1803, says:—

> "Mature reflection upon the nature and origin of one contagious disease, and the laws and modes by which it is communicated, naturally drew my attention towards the sources of all acute infections. It appeared from this investigation that so strong an analogy pervaded the whole class, respecting their generation and the methods by which they were multiplied or diminished, that a plan for extinguishing the whole race seemed as obvious and practicable as their partial destruction."

The plan proposed by Blackburne was that of isolation of the sick before they became sources of infection. His plan was not original. Twenty-four years previously, viz., in 1779, the renowned Dr. Haygarth had related how, in the school of the Rev. Mr. Vanburgh, at Chester, scarlet fever, contracted by one of the scholars, had been prevented from spreading in a house holding thirty-seven persons, the majority susceptible to the disease, by one act, that of instant isolation of the one imported case.

These facts have been from then till now well known. They have been lessons which medical men, generally, have adopted. In my career in medicine, extending now from 1845, I have profited by such lessons so advantageously, that I can say I have never known a contagious disease spread in any house into which it has been imported, when the means were at my command to completely isolate the first case. Three times in my own house, since I have been in housekeeping, the accident of importation of contagion has unfortunately occurred; it has never spread. There is not one of the common diseases of the contagious class which has not many times come under my observation in single examples, and been checked at once by perfect isolation, when none but the person affected had been exposed to the contagion.

Yet, with such facts before us, we hesitate to follow Blackburne's advice, to stop the whole race of the contagious plagues as we would one of them; to apply whole measures as we do part. The means of suppression are in our hands, and I earnestly urge on this Society to encourage every effort for the complete organisation and support of these simple means. The secret of the success lies in isolating the sick from the healthy at once, by having stations, under the direction of the Medical Officers of Health, for the reception of every case that cannot be safely treated at home.

In putting forward this view, I should propose :—

1. That there should be no aggregation of infectious cases in large central institutions.

2. That every parish should bear its own burthens, and accept its own responsibilities for the retention and management of the infectious cases occurring within its own boundaries.

3. That the sanitary committee or authority in every parish should have all the special centres of infection in each of its districts thoroughly mapped out, and that it should know, on a calculation of cases occurring in quinquennial periods, what is the permanent accommodation required for its infectious sick.

4. That the required accommodation being known, the local authorities should keep ready, at all times, within the parish, such necessary accommodation, by means of small hospitals situated in different parts of the parish or locality.

5. That each hospital should not be larger than is sufficient to receive twenty-four persons at one time, on the separate system; should be constructed of iron, that it may at any time be absolutely purified by fire throughout all its structure; should be placed on the upper story of a building, forming, in fact, the top storey of one or more houses, that it may be lighted and ventilated directly from its roof, all the air that passes out of the hospital when it is occupied by infectious persons, passing through fire; and that each patient should be carried into the hospital by a valved lift, which should pass through a shaft, so as to draw up air during its ascent, and when required, be effective for flushing the hospital with pure air.

6. That the general supervision should be in the hands of the Medical Officer of Health, and that the nursing, also under the supervision of the Medical Officer of Health, should be carried out by trained nurses, who might be educated to their work in the Union Infirmaries.

7. Lastly, that the medical attendance should be conducted by a special staff of duly qualified medical men, acting under the Medical Officer of Health, and responsible to the local authority, by whom they should be approved and remunerated.

Were these vital steps for the management of the contagious diseases carried out for a few years, irrespective of all hypotheses as to origin, the diseases, in another 33 years, instead of dropping 3·17 per cent., might be remembrances of a past and less happy age; remembrances like the sweating sickness and black death, of interest to the scholar and the historian, unknown to the work-a-day world.

In the neighbourhood of great schools for poor children—Board schools — these fever stations are peculiarly wanted. When in Brighton, two years ago, a lamentable rise in mortality scared the public so seriously, the cause of the scare was largely this want. One infectious case, for which there was no ready receiving station, lighted up an outbreak which, in one school alone, gave eighteen deaths within a few days of each other. Three forms of epidemic, scarlet fever, measles, whooping cough, then followed each other, spreading, always from an imported case, through these child communities until there was almost a panic.

Instant isolation would have prevented this catastrophe; would prevent other such; for which reason I place isolation as a vital step in sanitation, in the absence of which there can be no certain check to the devastations of the great zymotic family of disease.

Supplies of Food and Water.

I need not stay to urge this Society to encourage every reform in supplies of food and water. But there are some reforms which are more pressing than others, and these should have our more careful attention.

I urge once again, with all the power I can, the scientific application of the Jewish system of inspection of all our animal food. The broad fact that in the markets of Deptford and Whitechapel alone, the Jewish inspectors, as Mr. Daniel Tallerman has shown, in the year 1880, rejected as unfit for human food—6,143 oxen out of 13,116; 634 calves out of 1,964; 5,535 sheep out of 19,743; and that the rejected carcases were eaten by our people who are not Jewish, is sufficient to indicate that this subject can hardly be over-expressed, or the practice of inspection it suggests over-emphasised.

The inspection of food ought not to be confined to animal food only. It should extend to the vegetable market also. An immense amount of disease, affecting children especially, is produced by unclean and unwholesome fruit. The summer cholera, as it is called, from fruits, is constantly due to this cause, and, as we know, it largely increases the mortality.

There is another subject relating to food for the people which the Society should watch with the object of giving encouragement on every proper opportunity when true advancements are made. I mean vegetable feeding as a cheap, wholesome, and simple system. I am not a vegetarian, and, therefore, I speak without any bias in favour of the system. But as a fair observer I am bound to say that, within these last three or four years, I have witnessed results which, *a priori*, I should not have expected. That a man, by keeping close to vegetarianism, can live well on sixpence a day, and, with sound health of body and mind, go through regular hard work both of body and mind, I have seen demonstrated by an experiment of the kind which has been brought directly under my observation in the most convincing manner.

Such truths, bearing directly on sanitary progress, we, of this Society, cannot ignore. It is our duty to encourage an art which so obviously ministers to the health of the community, and what our course should be towards the movement is plain. We should encourage the scientific development of it. At present the common error of the vegetarian is that he often mistakes quantity for quality, and takes water in what seems to him solid vegetable substance, instead of the parts of food which should build up his tissues, and keep him warm. We should, consequently, encourage instruction in the process of such preparation of vegetable foods as will supply, through them, all the required principles of food. We ought, further, to encourage that chemical art which must one day be reached, and which aims to transmute, in the laboratory, vegetable products into something like the condensed form of food presented by animal structures. Why should thousands of cows be kept, at immense cost and trouble, often in unwholesome sheds, to produce milk, for human consumption, out of the primary elements, supplied ready made by the vegetable world, in grass and clover? Why should not the chemist, from the same or similar primary supplies always existing in the vegetable kingdom, make the same fluid, or the exact equivalent of it, in the laboratory, by a process of faultless purity? It is a simple absurdity, in these days, to use cows as laboratories for the production of a food like milk, every constituent of which we are perfectly familiar with, in regard to its sources, its properties, and its uses, and the parts of which, if the requisite labour were given to the research, could be put together from the vegetable world just as effectively as if they had been through the body of a lower animal, and could be brewed daily in our great cities at less trouble than the beer from the breweries.

I do not want to omit altogether, while I need not dwell on, the subject of water, pure and unlimited, as a vital necessity for sanitation. This is a subject which, of all others, seems to be a natural study in our Society. There is not the slightest occasion, as the recent paper by Dr. Percy Frankland and the discussion on it have shown, to urge attention to it, except in the direction to which I refer in the last and immediate section of my paper.

Sanitary Administration.

To direct the public in matters relating to sanitary administration is a function of this Society of the most explicit character, and one on which its powers can scarcely be too rapidly or too earnestly expended. At this moment every part of sanitary administration, local and central, is chaotic. For nearly a quarter of a century the medical officers of health have been furnishing their reports. These reports are State papers in the true historical sense. The reports of Dr. Armstrong, of Newcastle; Dr. Dudfield, of Kensington; Mr. Wynter Blyth, of Marylebone, and many others which I could name, are local histories from which the writers of another age will collect the choicest and most reliable information respecting the present time. So valuable are these reports, that I would venture to beg every officer to send two copies of each of his reports regularly to Dr. Bond, the chief librarian of the British Museum, so that in the National Library they may be all classified according to time and locality, and be kept there as important parts of the literary treasures of this century.

When, however, we read these reports, we read the chaos which exists in administration in all its fullness. It looks as if all the labour were lost in the helpless confusion that prevails. No man seems to be speaking the other man's sanitary language in regard to administrative recommendations, or to know what the other man thinks, or what the central authorities think, on any matter that is administrative. Some things appear to be wanted which cannot be carried out; other things appear possible which are not wanted at all. One thing most wanted always seems wanting, power for instant action when there is most emergency.

In the next few years, when English statesmen can find time and temper to look at England, these faults must be remedied, and an Act passed which shall comprehensively unite existing local administrations into one great, and consistent, and workable system.

In helping forward this progress, we here shall have to consider, chiefly, the mode of combining effectively the local and central sanitary authorities, and of getting unification in the functions of both. Let me touch for a few moments on one or two subjects bearing first on the local and then on the central reformations, and so conclude.

Constitution of Local Authorities.

I think it good practice, in the selection of representatives of local boards to select from all classes of the community who are eligible for election. I began life with the notion that none but the best informed and most fortunate should rule in sanitary affairs. I have lived to see that if we do not take all classes into our councils, we can do nothing well; and that if we take in all representatives of respectable men, we can do anything that can be done, as they learn their duties and feel their responsibilities, both of which are acquired with remarkable facility. I would go so far as to let women become eligible for seats on local sanitary Boards; for women are by nature sanitarians; they see the lights of health and the shadows of disease much more acutely and keenly than men do. They are quick at suggesting sound and wholesome reforms, and they know infinitely more about the domestic life and the home than men know. When they are well informed and interested in sanitation, they are allies of the first order; while, when they are not informed, and are not interested in reforms, they are opponents which no man and no Board can withstand.

Some general system requires to be introduced for regulating the numbers that shall constitute a local sanitary council in each locality. At present the system, if that may be called a system which has nothing systematic in it, is altogether irrregular. In some places there are too many, in other places there are too few, local health legislators. In the largest places there ought to be one local representative of health to three thousand of the population, as a minimum of representation.

Again, in respect to the selection of sanitary Boards, more care than now exists should be taken to select members to serve in answer to local demands within the district itself. I mean by this that each person elected should have under his particular knowledge and interest his or her particular district, the requirements of which should be at all times before the mind. The district would in this manner be under the most perfect observation, and the Medical Officer of Health would at all times have the most valuable help at his command.

The Medical Officer of Health.

In every local district the Medical Officer of Health should have the true place that belongs to him in all that relates to official action bearing upon health. He should hold to the sanitary department just the same position as the Recorder does to the legal. He ought not merely to be the adviser of his Board, he ought, by virtue of his office, to be the chief and chairman of the sanitary department. He ought to be elected for a definite period; he ought to be upheld in every useful health reform he brings forward; he ought to be encouraged to inaugurate reforms; he ought to be placed in such an independent position that he can inaugurate any reform and correct any evil without being subjected to the risk and personal anxiety of dismissal for good service. He ought, in a word, to be able to put down disease of which he is the medical judge as freely, as unsparingly, as fearlessly, as the legal judge or magistrate puts down crime. Until this is the rule, medical officers of health will remain as mere clerks and chroniclers of disease; suggesters of placebos in sanitation; scapegoats of sanitary blunderers; gentlemen of education engaged by money for incomplete service.

Nor would it, I think—in parenthesis—be quite out of place to go a step further in recognition of national sanitary labours, and to crown those who all their lives have laboured for sanitation, with the same honours as are rendered to the representatives of the ruder and more savage arts. Scientific labours are their own reward, some say. To greatest minds they are. But as Burke so well expressed in his great speech on economical reform, "ordinary service must be secured by the motives to ordinary integrity. I do not hesitate to say that that State which lays its foundation on rare and heroic virtues, will be sure to have its superstructure in the basest profligacy and corruption."

Central Guiding Authority.

A larger share of sanitary work, committed to a larger community, should be accompanied by more certain rules of practice emanating from the central governmental and guiding authority. Such a central authority it is the business of a Society like ours to help to promote and consolidate; and if a committee of the Council were inaugurated to take the initiative in devising the best plan of reconstruction as a suggestion for the nation, it would be doing one of the most useful of national undertakings.

That which is required is a Board or Ministry of Health, distinctive in character and comprehensively simple in constitution. To such a Board should be referred all matters that relate to the health of the people. To it should be entrusted everything that relates to the registration of disease, mortality, vitality, marriage, birth. To this centre should pass for analysis and report all the meteorological records; to it should go for classification and report all the coroners' returns; under its direction the whole subject of adulteration of foods and drinks should be supervised. The inspection of factories should be brought under its control. To it should be transferred whatever is now done by the Veterinary Department of the Privy Council; to it also should be committed the inspection of prisons and of police establishments, in so far as health and regimen are concerned. To it, lastly, should be entrusted the supervision of public works in relation to their sanitary requirements.

You will say that to a central Board as here projected, there would be relegated some portion of the duties of many departments of the State, of the Privy Council, the Home Department, and the Local Government Board, not to go further. That is so, and so much the better. It is because there is so great a dispersion of supervising powers, that so little is done for the community.

A Ministry of Health would bring all work relating to health into a focus. It would ensure capable heads for each department, and it would give to the Government, from time to time, the appointment of a supreme head, or Minister of Health, to whom, not England alone, but our colonies and all the civilised world, would look up with respect; whose judgments would become precedents, and whose annual reports —if they were, as they should be, divested of all political vagaries—would represent the very heart and soul, the potential energy of the nation.

DISCUSSION.

The Chairman said he had paid great attention to the paper, and agreed with much that had been put forward, but on one or two points he might offer a word of correction. There was a central body for the administration of health, and every portion of the kingdom was under a sanitary Board, either urban or rural, which had power to appoint medical officers, and in many circumstances they were appointed. Local authorities also had power to erect infectious hospitals, and many of them were doing so. The separate system was the one acknowledged by the central Board, of which he was the chief of the engineering department, and it was taken up by sanitary engineers all over the civilised world. Miss Nightingale had initiated the idea that the hospitals should always be in excess of requirement to the extent of at least one-fourth, so that each one should lie fallow for at least three months out of twelve, and be thoroughly purified; in fact, no hospital should be continuously occupied by patients as they now were. The question of unwholesome food was of the utmost importance, and the statistics mentioned with regard to the Jews were worthy of attention. We had more knowledge of that race than of any other; it had shown wonderful vitality, and produced, perhaps, more governing and leading spirits than any we were acquainted with; and very possibly this was in great measure due to the care exercised in the choice of wholesome food. As an inspector under the Public Health Act, he had made inspections all over the country, and he could assure the meeting that the amount of unwholesome food consumed was something appalling. The wonder was that so little disease was occasioned by it. No country was farther advanced than England in the matter of water supply, but unfortunately, whatever chemists might say with regard to absolute purity, they were compelled to put up with what nature furnished, for it was impossible to obtain water absolutely pure unless by distillation.

Captain Douglas Galton said the only chance of real progress being made in sanitation was for every one in the community to feel the necessity for it; and he observed that these beautiful theories for the reconstruction of London which were now suggested could only be carried out provided the whole population were thoroughly impressed with the necessity of such efforts being made. Those now proposed were, perhaps, more feasible than the City of Hygeia, which Dr. Richardson described some years ago, but that had been put forward as the ideal that we should aim at. He quite agreed that the separate system of sewage should be adopted whereever it could, but in such large towns as London, there would be immense difficulties in the way; difficulties which had grown with the growth of the city itself. Although, as an engineer, he should be prepared to carry out any task set before him it seemed impossible to imagine that the whole refuse water of the community could be carried away in trucks by railways as suggested. He concurred in the importance of having a central sanitary authority, but we have the Local Government Board; this body might easily be made much more useful and efficient if outlying departments, such as the veterinary department and Ordnance Survey were transferred to it with advantage, but he should be sorry to see any more centralising authority given to it with regard to local action in different towns.

Mr. E. C. Robins, as an architect, could not approve of roadways on the tops of houses, an idea which did not commend itself to him either as a convenient mode of transit or access, or as beautiful in itself. It would also tend to perpetuate a great height in buildings, instead of having the buildings spread wider abroad, and there would be an excuse for not widening the streets and opening out the spaces. It seemed to him that one of the evils of the present day was, that when individual buildings were made thoroughly healthy, such as model lodging-houses, there was a temptation to make them over top every building in the locality, forgetting that the time might come when their sanitary arrangements might not be so perfect as they were now, and the death-rate might prove not so satisfactory. London had one great advantage in its squares and parks, and these should be increased. A great point about Dr. Richardson's suggestions was that hardly any of them could be carried out alone; each involved a whole series of improvements, even the high roadways could not be carried out without getting rid of the smoke, and for the sake of doing that, he should be willing to put up with them. Each thing accomplished would be an incitement to something better.

Mr. Westgarth said he had been much interested in the paper, especially in the first part, which contained much akin to his own ideas for the sanitation and reconstruction of central London, as expressed in the paper he recently read, in which he had adopted the idea of utilising the roofs. Notwithstanding the difficulties mentioned by the last speaker, it seemed to him that, with the vast resources of London, all these things could be easily accomplished if people only had the courage to set about them. Besides the roof-terraces, he thought there should be a terrace arrangement on an upper floor in the business centres of the city, by which pedestrians might pass along without being exposed to the dangers of the streets, in which were now killed about 270 persons per annum, besides a great number who were injured. Then, again, subterranean accommodation was urgently required for gas and water pipes, sewerage, and electric conductors for conveying the newest form of energy, for the development either of light or power, so as to avoid the constant breaking up of streets which now went on. He was not quite so despondent as Dr. Richardson as to these things being done in his own time. The Lord Mayor had taken an interest in his own scheme, and had kindly called a meeting for next Monday to consider it, when he hoped that Dr. Richardson would be present. His great object, at first, was to get the trust or company established which he had sketched out; and as soon as that was done, and a board of management constituted, they would at once proceed, with due reverence, to reconstruct and beautify the old city.

Mr. W. Lascelles-Scott congratulated the Society on the paper which had been read. Some years ago, Dr. Richardson published a series of what might be termed poetical aspirations with regard to sanitation, rather than practical suggestions for the bettering of our lives and homes, and he feared that at that time they created some little prejudice against the author; but to his later utterances, and especially to the eloquent words spoken that night, no such objection could be taken. Having studied for many years the question, not only of how the poor lived, but how they died, he thought the main proposals now put forward were neither so impracticable nor Utopian in character as some gentleman seemed to think. Low rooms, for instance, were not so easy to ventilate as lofty ones, and on the same principle, within due limits, better arrangements could be made of streets if the houses were of a fair height than if they were too low. With regard to the hanging gardens of this modern Babylon, it seemed to him that the mere presence of health-bearing plants on the roofs would be of much benefit, even if every particle of smoke or carbon were not removed. With regard to centralisation, he thought more could be done by well instructed private effort than by imperial centralisation, which would be extremely unpopular. He had paid some attention to the subject of food, and though he had no doubt that large quantities of unwholesome fruit and vegetables were consumed, yet it occurred to him that there was a natural craving for this kind of food at certain seasons of the year, and if the poor could not get the best, they would naturally obtain what they could, and if it were all destroyed, he doubted whether the remedy would not be worse than the disease. The whole tenor of the paper seemed to be that the question of the reconstructed cities of Great Britain was one, not of engineering, chemical, or sanitary science alone, but of nature herself, and if it were approached in that spirit, not in a spirit of narrow dogmatic theorising, no doubt by degrees immense good might be accomplished.

Mr. H. DOULTON had been much pleased with the paper, for it was always well to have an ideal before one. The principle of the rainfall to the river and the sewage to the land had always struck him as the right one, though no doubt there were many practical difficulties. He did not much like the idea of these flat roofs, for a beautiful or picturesque sky-line seemed to him far preferable. Nor did he like the idea of abolishing cows. There was, besides, it seemed to him, one important omission in the paper, and that was all allusion to the importance of preserving open spaces in and around London. Twenty-five years ago, Kennington-common might have been enlarged by many acres for a very small sum of money, but the apathy which then prevailed on this subject was astounding. When he first went to live at Tooting-common, the manorial rights over sixty-three acres were sold for £1,400; the right of the purchaser to enclose that land was contested, and about £13,000 or £14,000 were spent in litigation over it, which might have been all saved if those manorial rights had been purchased on behalf of the public. During the fight, however, he was glad to think that something was done which prevented the enclosure of commons in the neighbourhood of London for the future. At that time, he remembered that the then member for East Surrey, Mr. Alcock, who was the owner of Banstead Downs, said, that if there were any public body which had power to deal with open spaces and manage them, he would willingly give fourteen acres to the public for ever. But there was nobody to take the matter up, and now that beautiful spot was crowned by a hideous lunatic asylum. He would urge, therefore, the importance of preserving the open spaces which remained, and also of converting disused grave-yards into gardens and playgrounds, as had been done in Lambeth, with very great advantage.

Mr. WOLSTENCROFT drew attention to the question of infectious diseases being spread by means of laundries, which he suggested should be inspected and licensed. He also mentioned an invention by Mr. Buck for collecting rain water from house tops in a comparatively pure state, the first washings from the roofs being sent down the drains, and the remainder stored for use.

Mr. LIGGINS said he would venture to make a few remarks from the point of view of a vestryman of Kensington. There was a great variety of houses in that parish, and it was always the desire of the Vestry to do their best for their poorer neighbours, but in many cases they wanted more powers. With regard to the elevated terraces, he thought on such weather as the present, with a cold east wind, he should much prefer the shelter of the streets. Perhaps the greatest objection to them, however, would be the smoke, and he was glad to hear of another suggestion for getting rid of it. Dr. Dudfield's monthly reports were most valuable, and as far as the law allowed, the isolation of the sick was enforced in Kensington, but people had a great objection to their sick relatives being removed to hospitals, and he was not aware of any power to enforce such isolation. He also drew attention to some papers on the housing of the poor, which appeared in the *Nineteenth Century* recently, but took exception to the statement by Mr. Forster that no more law was required. There was power to turn people out of unhealthy dwellings, but it was out of the question to do so in many cases until other accommodation in the neighbourhood was provided for them, and that was a very large and difficult subject.

Mr. HENRY MAUDSLAY said there was one point not touched upon which seemed to him of some importance, viz., the distribution of population. If this could be better arranged there would be less disease, the hospitals would be less crowded, and Miss Nightingale's suggestion could be carried out; but so long as there was a superabundant population congregated together in particular districts, he did not see how the condition of things could be much improved. He had travelled all round the world, and in nearly every part of it, and found that there was plenty of room for our surplus population in places where there was abundance of animal and vegetable food to be consumed. If our population could be distributed in those lands, with its existing knowledge, Christianity, and energy, and with the power of communication by steam and electricity, immense benefits would result. If the Government would only put on board the vessels now lying idle some of the surplus population, and if the various parishes would contribute so much per head for those willing to emigrate, and to assist those willing to be assisted in colonising our own possessions, the sanitary condition of this country, and especially of the metropolis, would be so far improved, that the system so beautifully expounded by Dr. Richardson would soon become a possibility instead of an ideality only.

Dr. RICHARDSON, in reply, said he was very glad to hear the Chairman express his approval of the separate system of drainage so decidedly. The Chairman had always supported it, and no doubt the time would come when he would have his reward in the general recognition of the principle. He did not wish to say a word against the Local Government Board, the duties of which he thoroughly believed were well carried out; but there was so much which now lay outside its sphere, which ought to be combined with it, that at present everything was in a state of chaos. A Medical Officer of Health often did not know what to state or where to apply for information, and very frequently he was thwarted in his administrative duties. For instance, there were factory surgeons, who had certain functions under an Act passed early in the century—probably the first sanitary Act ever passed; they had to inspect children and determine the conditions under which they were to work in factories, and with regard to those duties they had the very best means of information; but, he believed, that if an epidemic broke out their function in respect to that was gone, and the Medical Officer of Health could step in. The centralisation which he advocated was not to force upon people any measures for which they were unwilling, nor to interfere with local legislation; but a centralisation to supply information, and thus bring about unity and harmony. He did not know that a Minister of Health should have power to enforce anything; the local authority should have the power, and the central authority should be the guide. Mr. Robins objected to upper London on account of the height of the houses, but that was not a part of the project at all. This suggestion applied to houses of the same height as those in Regent-street, which was about the proper height, and as to the idea of spreading the houses farther apart, they knew that with regard to the poorer population that was one of the greatest difficulties; the farther the poor were taken from their work the more time they had to spend in going backwards and forwards. So long as great cities existed, and it seemed a natural instinct for men to congregate in cities, it should be their aim to make them as healthy and beautiful and accessible as possible. He did not agree with too much extension, or they would have London extending all over the country, which was not at all desirable. He only wished he could set Mr. Robins to work to make the first roadway along the roofs, for he was sure it would be a beautiful work of art, which would immortalise him. Mr. Westgarth was more hopeful than he was, but in many points they were at one. Mr. Scott seemed to find a little fault with his earlier speculations, and to think that with increasing years he was getting wiser. He hoped it was so, but he could not admit that his ideal city of Hygeia had been useless. The intention with which he put it forward had been thoroughly carried out. In writing that project, of course he had no idea of its being instantly realised, but some people who read it thought it was real, some wrote to ask where the city was, and one gentleman declared he had seen it. The truth was, that he had remarked for years that the subject of sanitation did not seem to bite, so to speak; people were apathetic about it; they treated it as a disagreeable subject, connected only with drains and pipes; and so he thought he would strive to give it a start in a new way by drawing a picture of what might be. That picture had been exhibited, not only all over the country, but all over the world, and from the most distant colonies he had had letters thanking him for it. In Lancashire it had been printed with the "Pilgrims' Progress" and sold for 1d. It gave the public a taste for sanitation, and the result was that Hygeia was rising up everywhere, you saw a little bit of it in one house and a little bit in another. Jules Verne, in his own inimitable way, had constructed another city, which he said he had copied from it, and so the thing spread, and in time it would be all realised. Mr. Doulton objected to unbroken sky-line, and no doubt it was well to have a sky-line broken by towers or minarets, or domes like the dome of St Paul's; but when you walked along Whitechapel, and saw the sky-line there formed of irregular, dirty, and ugly houses, he should much prefer such a line as Regent-street, with a beautiful terrace and gardens on the top. He agreed with Mr. Doulton entirely as to open spaces and disused graveyards, and for years he had been endeavouring to get two of the latter in Marylebone converted into playgrounds. The question of laundries was very important, and though they might not be licensed, they would be all the better for voluntary inspection. With regard to the inconvenience of east winds on the terraces, he did not propose that any one should be compelled to walk there who preferred the streets; but he should prefer the top, especially when the weather was clear and the atmosphere free from smoke. He was glad to hear that isolation of sickness was carried out so thoroughly in Kensington, which was known to be one of the best sanitary districts. He quite agreed that, so far as population could be distributed throughout the planet, so far sanitation would prevail, presuming always that that distribution was on sound sanitary principles. But in proportion as that distribution did take place, so there would be again an increase of the human family, and therefore it was important that we, who considered ourselves the *crême sur crême* in sanitary knowledge, should set such examples as the coming nations might usefully copy and improve.

The CHAIRMAN then proposed a vote of thanks to Dr. Richardson, which was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock:—

APRIL 2.—"The Dwellings of the Poor of Great Cities." By ELIJAH HOOLE. His Eminence Cardinal MANNING will preside.

The arrangements for meetings after Easter will be announced in the next number of the *Journal.*

Foreign and Colonial Section.

Tuesday evenings:—

April 1.—"The Rivers Congo and Niger entrances to Mid-Africa." By Robert Capper, Major-General Sir Frederick John Goldsmid, K.C.S.I., C.B., will preside.

Indian Section.

Friday evenings:—

March 28.—"Trade Routes in Afghanistan." By Griffin W. Vyse.

Cantor Lectures.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. Chandler Roberts, F.R.S., Chemist of the Royal Mint.

Lecture III. March 31.—Methods by which Accuracy of Weight and "Fineness" of the Alloys is ensured.

Lecture IV. April 7.—Questions connected with the liability to Reduction in Weight and various Coins by Wear during Circulation.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts, "The Alloys Used for Coinage." (Lecture III.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. E. Packard, jun., "Experimental Farms."

Chemical, Burlington-house, W., 8 p.m. Anniversary Meeting. Election of Officers and Council.

Actuaries, the Quadrangle, King's College, W.C., 7 p.m. Mr. T. B. Sprague (President), "Some Remarks on the Application of the Principle of Non-Forfeiture to Ordinary Policies."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Prof. G. T. Bettany, "The Germination of Seeds."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, April 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Robert Capper, "The River Congo and Niger Entrances to Mid-Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "Animal Heat, its Origin, Distribution, and Regulation." (Lecture V.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. William Foster, "Experiments on the Composition and Destructive Distillation of Coal."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Dr. Chotzner, "Notes on the Life and Social Position of the Hebrew Women in Biblical Times." 2. Rev. A. Löwy, "Technological Terms (Hebraic and non-Hebraic) marking the Progress of Ancient Culture."

Wednesday, April 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Elijah Hoole, "The Dwellings of the Poor of Great Cities."

Institution of Naval Architects (at the House of the Society of Arts), 12 noon. Annual Meeting. Address by the President, to be followed by the Reading of Papers and Discussion.

Geological, Burlington-house, W., 8 p.m. 1. Rev. E. Hill, "The Rocks of Guernsey." With an Appendix on the Microscopic Structures of some of the Rocks, by Prof. T. G. Bonney. 2. Prof L. C. Miall, "A New Specimen of *Megalichthys*. from the Yorkshire Coalfield." 3. Dr Bunjiro Kotô, "Studies on some Japanese Rocks."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Prof. Redwood, "Aqueous Extraction of Cinchona Bark." 2. Dr. Thresh, "Proximate Analysis of the Seeds of the *Amomum Melegneta*."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Rev. S. M. Mayhew, "Tenby, and the Cathedral of St. David's."

Obstetrical, 53, Berners-street, W., 8 p.m.

College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lecture.) Dr. James Andrew, "Ætiology of Phthisis." (Lecture II.)

Thursday, April 3...Institute of Naval Architects (at the House of the Society of Arts), 12 noon. Morning Meeting. Reading of Papers and Discussion. 7 p.m. Evening Meeting. Reading of Papers and Discussion continued.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. P. M. Duncan, "A Revision of the Families and genera of the *Sclerodermic Zooantheria*, the *Rugosa* excepted." 2. Mr. Charles F. White, "Pollen from the Egyptian Mummies." 3. Mr. T. J. Briant, "The Anatomy and Functions of the Tongue of the Honey Bee."

South London Photographic (at the House of the Society of Arts), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "The Older Electricity, its Phenomena and Investigators." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Special Meeting.) Captain Andrew Noble, "Heat-action of Explosives."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Cayley, "Double Algebra." 2. J. W. Russell, "A Direct Investigation of the Equation $F(x, y, z, p, q) = O$, with a Way of Remembering the Auxiliary System." 3. J. J. Walker, "The Floatation of a Triangular Prism."

Friday, April 4...Institution of Naval Architects (at the House of the Society of Arts), 12 noon. Morning Meeting. Reading of Papers and Discussion. 7 p.m. Evening Meeting. Reading of Papers and Discussion continued.

United Service Inst., Whitehall-yard, 3 p.m. Colonel Sir Charles B Nugent, "Imperial Defence. Part II.—Colonial Defence."

Royal Institution, Albemarle-street, W., 8 p.m. Prof T. G. Bonney, "The Building of the Alps."

College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. James Andrew, "Ætiology of Phthisis." (Lecture III.)

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Mr. A. J. Ellis, "The Dialect of the Lowlands of Scotland Part II.—Insular.."

Saturday, April 5 ..Botanic, Inner Circle, Regent's-park, N.W., 3¾ p m.

Royal Institution, Albemarle-street, W., 3 p.m. Captain Abney, "Photographic Action considered as the Work of Radiation." (Lecture VI.)

Journal of the Society of Arts.

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FRIDAY, APRIL 4, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

DEATH OF H.R.H. PRINCE LEOPOLD, DUKE OF ALBANY.

At a meeting specially summoned for the purpose on Wednesday last, 2nd inst., the Council of the Society passed the following resolutions :—

"The Council of the Society of Arts desire humbly to offer to her Most Gracious Majesty the Queen the assurance of their profound sympathy on the occasion of the sudden and untimely death of His Royal Highness Prince Leopold George Duncan Albert, Duke of Albany, and their sorrow at this unexpected termination of a career so full of promise.

"The Council had confidently anticipated that, as one of the Society's Vice-Presidents, his Royal Highness, following the example of his distinguished father, would have rendered valuable aid in the advancement of those liberal arts and sciences for the promotion of which the Society was founded, and to whose study his Royal Highness devoted so much of his powers.

"The Society of Arts have, therefore, special reason to deplore the loss which they, in common with all her Majesty's subjects, have sustained."

"The Council of the Society of Arts desire to convey to his Royal Highness the Prince of Wales, the President of the Society, the expression of their deep regret at the heavy loss his Royal Highness has sustained by the death of his beloved brother, his Royal Highness Prince Leopold George Duncan Albert, Duke of Albany.

"While thus assuring his Royal Highness of their profound sympathy, the Council wish also to express their sorrow that they find themselves deprived of the prospect of that efficient aid which the distinguished abilities of his Royal Highness the Duke rendered him specially capable of affording the Society in his capacity as Vice-President."

"The Council of the Society of Arts desire sincerely to condole with her Royal Highness the Duchess of Albany in the sad bereavement she has sustained by the sudden and unexpected death of her beloved husband, and respectfully to assure her of their profound sympathy on this melancholy occasion."

INTERNATIONAL HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow Members of the Society of Arts the privilege of purchasing Season Tickets for the Exhibition at half-price (10s. 6d.). Each Member will only be allowed the privilege of purchasing a single ticket on these terms, which will be a personal admission, not transferable. Season tickets admit to the opening ceremony. As soon as the tickets are ready, due notice will be given in the *Journal*.

CANTOR LECTURES.

The third lecture of the course "On the Alloys used for Coinage," was delivered on Monday evening, 31st ult., by Professor W. Chandler Roberts, F.R.S. The history of the various methods of assaying gold and silver, from those officially adopted at the time of Pliny to the present day, was traced in detail, special attention being devoted to the gradual steps by which the minute accuracy that marks the present methods had been attained. For instance Geber, who wrote in the 8th century, gives, if mediæval translations of his works are to be trusted, a sufficiently accurate account of the method of the assay of silver by cupellation to enable the process to be conducted at the present day with no other aid than his, but his description more nearly corresponds to the cupellation of silver, as conducted on a large scale with a view to extract silver from lead, than to a mere method of assay. In the 12th century the assayer was instructed, in conducting official trials of the coin, to take an entire pound weight, and it was not until the reign of King Henry VI. that a record is found of small quantities being taken for the trial; at this later period, however, about twelve grains, or nearly the amount used at the present day, was used. The work of Sir Isaac Newton was alluded to, and the furnace with which he is supposed to have cupelled silver, in the Tower of London, was exhibited. After the history of the method of assaying gold had been dealt with, Professor Roberts showed how small a portion of the "remedy" or variation from the exact standards of weight and fineness, allowed by law, is actually used at the present day in Mints. He concluded by saying that these questions might appear to be somewhat abstract and unimportant, but that all questions connected with alloys, used for coinage, must have had a very vivid interest for those who lived at the period embraced between the reigns of King Henry VIII. and Queen Elizabeth, when the coinage was extremely debased, and at the present day the question was of hardly less importance, because vast commercial transactions were based on the integrity of the British gold coin.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1884, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce." The following is a list of those to whom the medal has already been awarded:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Professor Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to M. Ferdinand de Lesseps.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to M. Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to M. Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S.

In 1877, to M. Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to M. Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

A full list of the services for which the medals were awarded was given in the *Journal* of March 14th.

The Council invite members of the Society to forward to the Secretary, on or before the 19th instant, the names of such men of high distinction as they may think worthy of this honour.

Proceedings of the Society.

INDIAN SECTION.

Friday, March 28, 1884; ANDREW CASSELS, Vice-President of the Society, in the chair.

The paper read was—

ROUTES THROUGH AFGHANISTAN.

By GRIFFIN W. VYSE.

I shall endeavour, in my paper this evening, to refute some of the statements recently made regarding the trade of, and routes through, Afghanistan. It seems hardly credible that one of our leading journals should have stated, only a few weeks ago, that there are only two passes from Afghanistan into India, that there is no trade in that country, which is a land of rocks and stones, and its people unfriendly to our rule. It is true that, until the late Afghan war, we knew of only three or four passes leading from India into Afghanistan, viz., the Khyber, Gûmul, Sanghar, and Bolan, but we now know of the existence of 289.* North of the Khyber two good roads exist, and between that pass and the Bolan lie all those celebrated routes dis-

* Q.M.G. Department: Intelligence Branch (confidential).

tinguished as being about the oldest highways in the world, traversed for thousands of years by the countless generations of the early traders (for the wealth and riches of India were transmitted to the great emporium of the west when Babylon was at the height of its glory), and traversed, too, by the hordes of conquerors who have poured into India from the steppes of Central Asia, the plains of Persia, or far-off Macedonia.

These old routes subsequently became for centuries the haunt of the most blood-thirsty determined robber tribes ever known, so that in modern times the Kafilas and trade convoys were compelled to abandon most of them for the more circuitous, but safer, lines of travel. Cleared of marauders, however, and under British control, they would doubtless become, as formerly, the chief roads for trading caravans from India to the heart of Central Asia.

Fertile and populous, India, with its enormous mineral wealth and varied products, has from pre-historic times, had a fascinating charm for the hardy adventurers of the North. Hindustan was the goal of their keenest ambition, and countless armies, and millions of the human race have been sacrificed in winning, or trying to win, that land of gold, the richest and brightest gem of Asia. Some of the fiercest battles on record have taken place along many of these Afghan routes. The very extensive graveyards, on almost every peak, pass, and gorge, prove that the country must have been at one time densely populated. One large grave-yard I saw in the deserted Luni Valley measured more than three square miles; it had been the battlefield of Biluch and Afghan tribes for over a hundred years.

Nearly all the great conquerors of India came from Central Asia and Persia. The roads chosen by Alexander, Baber, Nadir, and many other invaders, are still open, and all the routes, whether from Persia or the Oxus, converge upon Kandahar.

The chief trade routes are from Bokhara and Samarkhand, *viâ* Merv and Herat to Kandahar; from Persia, *viâ* Meshad to Herat; from Bokhara, *viâ* Karshi, Balk and Khulm to Kabul; from India, *viâ* the Khyber to Kabul; from the Punjab, through the Kûrûm Pass; from India, by the Gûmul to Ghuzni, to Kelat-i-Ghilzai, to Kandahar and Quetta; from Sind, *viâ* the Bolan to Quetta and Kandahar; and from East Turkestan by Chitral to Jellalabad, or to Peshawur, *viâ* Dir; and this latter route from East Turkestan is now a very good one.

Many of the old abandoned trade routes, supposed to be blocked or impassable, I have been through when field engineer with one of the columns, during the late war, and found them open, and capable of being used by all arms of the service, mountain artillery included. Extensive "deserts," so-called, on the map, we found rich fertile soil, watered by perennial streams, and capable of being turned into vast gardens; other parts of the country, marked "unexplored, supposed waterless tract," proved to be magnificent high plateaux 3,500 feet above the sea, where water was in abundance, the climate most agreeable, and where the land was ready for the plough.

Afghanistan is bounded on the north by the ancient Oxus, south by Biluchistan, east by British India, and west by Persia. Its length is about 900 miles, and its breadth about 600, which, in round numbers, gives a superficial area of 540,000 square miles; but although the late Amir Shere Ali was nominally sovereign over the whole of this territory, yet the present Amir's power does not extend over one-fifth of it. The semi-independent Khanates south of the Oxus, and the really independent tribes who dwell between our border and Afghanistan proper, such as the Waziris, Luni-Pathans, and the people of Kafiristan, defy the present Amir's authority, and the revenues through these provinces can only be occasionally and partially collected by force of arms, as also in the Kûrûm, Khost, Kakar, and the Hazara country.

There are, officially or theoretically, eight provinces in Afghanistan—Kabul, Jellalabad, Yusufzai, Seistan, Ghuzni, Kandahar, Herat, and Balk; but owing to clan feuds, it is deemed expedient, for the safe protection of the trade routes, to work by tribal divisions rather than by Government provinces.

Kabul is extremely mountainous, and the vast rugged mountain ranges north of Kabul, some of which are among the highest in the world, are an off-shoot of the "Bam-i-dunya," or "Roof of the World," and may, from their impregnability, be regarded, with the Hindu-Khush, as the natural boundary of India and Afghanistan. The Suliman mountains, running south towards the Indian Ocean, are of great geographical importance, and are full of interesting historical associations, from their having contained the old world's routes to the rich empire of Hindustan. From these, countless spurs of minor importance are formed, principally in parallel ranges, with lofty peaks, and deep gorges, through which the rivers flow towards the Indus, and these river-beds formed the old trade routes. The country between consists of many transverse ridges, parallel valleys, and remarkably fertile plateaux, where there is a grand field for the antiquarian, rich in archæological vestiges of lost cities and lost nations. The same is true of the country lying between that network of old routes in the Sulimans, and the road from Kabul to Kandahar, made ever famous by Roberts' brilliant march and complete victory over that renowned Asiatic soldier, Ayoob, in 1880.

The plants on the east of the Sulimans yield the sacred *soma* juice and wood mentioned in the Rig-Veda hymns, and give silent but unerring identification of the roads by which, says Markham, the earliest Aryan settlers found their way into the Valley of the Indus. It was by the perilous route on the northern face of the Safid-Koh, that the early Chinese pilgrims reached the revered sites of Gautama's ministrations, and by the same way the Greeks marched to the conquest of the Punjab.

About the year 999, Mahmûd of Ghuzni, with 15,000 horsemen, marched through the Kabul route, and returned by Sakki-Sawar. Mahomed Ghori traversed the Zhob route in 1191, and his general, Ilbuz, kept open the various routes from the Indus to Ghuzni, *viâ* the Kûrûm Pass. Down the same pass, says Markham, the heroic Prince Jalâlû-d-Din was hunted by Chingiz Khan, and driven into the Indus. The conquering Timour used the Kûrûm for the invasion of India. Baber, the founder of the dynasty of the Great Moguls, used the Khyber, Gûmul, Sakki-Sawar, and Sanghar Passes; he was the first geographer among the conquerors of India, and his descriptions are faithful and masterly. Baber's descendants afterwards reversed the current of invasion, and scaled the Sulimans with an Indian army; thus the Emperor Jehanghir marched through the Zhob and Tal-Chotiali routes to Kandahar, but the tide soon turned again, and in the last century, Nadir Shah and Ahmed Durani led conquering hordes down the Khyber, Pishin, and Bolan Passes; while in our own day British troops have renewed Jehanghir's experience in advancing from India by these very routes.

The chief rivers are the Oxus (or Amu Daria), a noble river capable of being made navigable; the classic Helmund (the river of ancient Persian tales, as related in the pages of Ferdosi) is navigable from Girishk to Nâdalî, and could be made so throughout its lower reach; and lastly, the Indus, which in Afghanistan is merely a torrent such as can be forded, except during floods or melting of the snows, when it swells into a river of considerable magnitude.

The climate is very variable, depending more on the elevation than on the latitude of the country. The Hazara country is terribly cold in winter, snow remaining for months on the ground, and the thermometer recording as much as 15° below zero. By the side of low plains, upon which the sun's rays scorch up all life, are high plateaux, where the climate is dry, bracing, and enjoyable, and mighty mountains, where there is perpetual winter, and the snow has never melted. In Herat, the temperature is moderate and the climate pleasant, resembling that of Naples. The heat of Kandahar is not greater than that experienced at Alexandria, and the winter is delightfully mild. Kabul closely resembles Vienna in temperature. In the high *shums* or plains of Southern Afghanistan, the climate is delightful for nine months in the year, and for the remaining three not so hot as in the mildest part of the Punjab plains; whereas, on the higher Suliman ranges, the Jindhran and other mountains, the climate is very much the same as in England, only drier, more bracing, and far healthier. At Sibi, at the mouth of the Bolan, the heat is appalling; the Kâchi desert indeed is the hottest place I was ever in, in the five quarters of the globe. The natives say of it—"Khûdá né is jhagar chordîr"—literally, God has let go His hold of this place, or, as we say, "A God-forsaken country." In point of fact, you can have any temperature you please in Afghanistan, and at any time of the year—from the most intense heat to almost Arctic cold.

The population is divided into two great and distinct classes—the Afghans, or Pushtoo-speaking, and the Parsivans, or Persian-speaking races; both are subdivided into many tribes, each speaking its own local dialect. In addition to these are a number of Hindus, Buddists, Armenians, Jews, and other settlers, whose political influence is of little note. The latest estimate of population is as follows:—Afghans, 2,800,000; Parsivans, 2,600,000; other races, 1,100,000; total, about 6,500,000. The Afghans, or Pushtoo-speaking tribes, are the dominant race; they are divided into two separate classes, viz., the fixed and nomad, the former of which dwell in

Kabul. They are all Mussalmans, chiefly of the Sunni sect, and as many of their ceremonies are closely allied to the Jewish rites, it is widely believed that they are of Semitic origin.

The prevailing language, Pushtoo, is a mixture of ancient Persian, Arabic, and Hindustani, but the invading armies who passed through Afghanistan all left colonies behind them, which have never quite amalgamated, and each has a provincial language which remains distinct.

The Afghans have really no literature of their own, and the imperfect notions of geography, astronomy, medicine, and history which they may have derived from Persian authors, have not much assisted in developing their faculties.

The chief clans are the Duranis, who dwell in Kabul, Kandahar, and Herat; the Kakars, who live in the south-east part of Afghanistan; the Ghilzies, who live on the western slopes of the Sulimans, and about Kabul and Kandahar; the Yusufzies about Peshawur; the Shinwaris, who reside east of Jellalabad, towards Kafirstan. The various semi-independent tribes, such as the Tajiks, Mongols, Jadrans, Gurbuz, and Parsivan Eimaks have little influence; and some of the larger independent tribes, the Waziris, Orakzis Afridis, and Swatis, though Afghans, acknowledge no allegiance to the present Amir, and form, as it were, a buffer between his country and ours.

The Duranis are a very powerful tribe in numbers and in political importance, and the reigning Afghan family has sprung from it. Nadir Shah, who conquered the Duranis, restored their country on condition that for every plough in their fields they should find a horseman for his army. This condition was fulfilled until recently, and the Durani Horse of the Afghan Army has played a great political part in the various conquests of the country. They are naturally, however, peaceful enough, and like the Scotch of old, who gloried in plundering and cattle-lifting, are quite ready to give that up and settle quietly down to honest avocations, on proof that these may be safely and profitably exercised. They are fine, robust, manly fellows, religious without bigotry, kind to their women, hospitable and courteous, preferring to do a good action rather than a bad one. I have employed them in thousands on public works, and they work more like Englishmen, without that constant supervision necessary with East Indians. They make good, trustworthy soldiers, and have done excellent service in our forces. Until quite recently, only the Hindus kept shops, but now the Duranis no longer consider it undignified to become traders. This radical movement was entirely due to British influence, enterprise, and example, during our occupation of Kandahar. They have great reverence for that city, where most of their holy men and chiefs are buried. The great bulk of the army was composed of Duranis, and in the old days of the Amir entirely depended on their loyalty. They display the highest military qualities, and their bravery is unequalled; they number about 800,000, and can muster 40,000 fighting men.

The Ghilzies are the second important Afghan tribe; they number about 600,000, and are sub-divided into many clans. Some are settlers, but the majority are travelling traders. This brave and gallant tribe was supreme in Afghanistan at the beginning of the last century, and once possessed the throne of Ispahan. They are of Turkish origin, and at one time were connected with a famous family of Delhi kings. The Powindahs are chiefly from this class, and accompanied by their wives and families, thread their way in large caravans through the various routes by way of the Sulimans, to vend their merchandise in every bazaar in India. They bring dried fruits from Bokhara, poshteens and sheepskin coats for our Punjab troops, also camel's-hair chogas, mats, carpets, rugs, &c., from Central Asia. These Ghilzi Powindahs, are as much soldiers as merchants, and when conveying their goods through the unused passes, have often to run the gauntlet of the robber tribes. They move in large bodies under an elected leader. In British territory they go unarmed, and consider a very few of their men sufficient to escort their caravans through India. They display a cunning quite commercial, says Sir William Andrew, never take the law into their own hands, but appeal to the justice of our magistrates. In the Waziri hills, however, they are hardy soldiers, and generally succeed in beating off any robber force that may oppose them. It is interesting to watch a Powindah caravan, with its long trains of gaudily equipped camels, their head-stalls ornamented with coloured beads and strings of shells, wending its way through one of the routes. On the best camels are slung the covered *khajawars*, containing the wives of the richer merchants—these form the main body of the procession, which is made up of other camels laden with bales of merchandise, of droves of sheep, goats, and of troops of children screaming and laughing. A few men guard the main portion, and a few hundred yards ahead may be seen a compact body of the fighting men of the clan, mounted and dismounted, all armed to the teeth, who form the vanguard. On either flank, crowning the heights, advance, with the greatest military exactitude, a similar body of footmen; whilst in rear follows a strong guard—all on the watch for their hereditary enemies, the Waziris. The Powindahs have long been on friendly terms with the British, and show themselves keenly alive to the advantages of civilisation; only twice since 1849 have they proved troublesome. They have, on the other hand, often aided us materially on the frontier, and many of our roads, canals, buildings, and outposts are their handiwork; while the men were thus employed, their women, for the time, have sometimes taken charge of the caravans.

The articles brought by the Powindahs into India are, from Bokhara and Samarkhand—silk, horses, drugs, wool, manna, gold coins, furs, gold and silver wire, some dried fruits, rugs, poshteens, thread, &c.; from Herat and Merv—Persian carpets, mats, jewels, wool, fine goats' hair, various dyes, antimony, dried fruits, seeds, Herat silks, &c.; from Kabul—fruits, seeds, spices, asafœtida, shawls, skins, dyes, silks, &c.; from Ghuzni and Kandahar*—madder, wool, rice, fruits, spices, chogas, camels' hair cloaks, Russia leather, native cloth and silk stuffs, nuts, seeds, &c.

The horse trade is with the Syads of Pishin, Kakars, and Ghuzni breeders. The Syads once dealt largely in slaves, the Hazaras being the principal victims. The goods which the Powindahs export from India, through the Suliman routes, are English cotton piece-goods, silks, European coloured cloth, merinos, velvets, copper, tin, tea, Indian muslins, indigo, salt, steel, firearms, gunpowder, cotton, English tinned goods, gaudily coloured German pictures, and patent medicines.

There can be no doubt that now steps have been taken by Sir Robert Sandeman and other distinguished frontier political officers to secure the safety of the routes, the traffic and commerce will increase enormously. The past Governments, both Liberal and Conservative, unfortunately, have by no means taken that keen interest in the development of trade with Central Asia which was desirable; and what has been done is due, in chief measure, to the independent action of British frontier officers, who have worked unprompted by, and perhaps unknown to, the supreme Government. The trade was, a few years ago, gradually being drawn north, and diverted from India, when proposals were made by the Derajat commissioner to undertake, in conjunction with the Amir, the defence of the Gûmul route* and the other principal highways of commerce, but the Government of India declined a policy of interference; fortunately, our frontier officers had the courage to act on their own responsibility, and carry out a necessary system of organisation.†

The Niazis are one of the principal Powindah clans; a great portion of them have settled at Isa-Kheyl, on the Indus, and become quiet, loyal agriculturists, though from this law-abiding tribe we have drawn many of our bravest and most faithful soldiers, ever ready to volunteer their services in times of need.

The Kakar tribe are also a powerful body of the Shiah sect, and were once very fanatical. They occupy the south-east country about Toba and the borders of Biluchistan, and are very friendly with the Ghilzis. During the late war, they had, on one occasion, a brush with us, and when beaten, their chiefs came in and said they would never fight us again. After this we trusted them, and had no cause to regret our confidence; we found them most useful to escort treasure, convoys, and caravans, as they proved thoroughly trustworthy, sometimes defending their charge even at the cost of their lives. Many of the old trade routes leading through their country, from Tal-Chotiali towards Kelat-i-Ghilzai, and in the Pai, Borai, Luni, and Zhob valleys, have recently been re-opened, and caravans now pass unmolested. The Kakars and Maris were old enemies, but owing to Sir Robert Sandeman's influence, are now good friends, and have lately taken to agriculture.

The Hazaras reside in the wild, rugged, extensive country, along the Hindu Khush Mountains, and on the way from Kabul towards Herat. They speak Persian, and are of the Mongol type;‡ they are *Shiahs*, or heretics, and never pay tribute to the Amir unless compelled. Some of the clan who have taken service in our forces, have proved excellent soldiers. The trade with this tribe has lately been somewhat revived, but the various routes through their impregnable

* Kandahar is the focus of all the Central Asian routes.

* Sir William P. Andrew, K.C.S.I.

† Commissioner, Derajat.

‡ Those caught by the Syads in battle, prior to 1842, were sold as slaves.

country, are rough, and require much engineering, particularly along the Argandab and Helmund rivers, and the Hindu Khush passes.

The Kazil-Bashis, also *Shiahs*, are Persianised Turks, they speak Persian and possess considerable influence with the Duranis. They are a superior class and better educated, furnishing many merchants, *hakims*, writers, &c. They are the descendants of the Persians whom Nadir Shah left in the country, and are fine, handsome men, composing indeed the flower of the Amir's cavalry. They can muster 30,000 fighting men; they greatly encourage British trade, and to their industry and intelligence the Parsivans of the country owe all their wealth, power, and influence.

Eimak is a term for a sept, or section of a tribe; it is generally applied to certain nomad tribes west of the Hazaras, and north of Herat. They were originally known as "the Four Eimaks," and are Sunis.

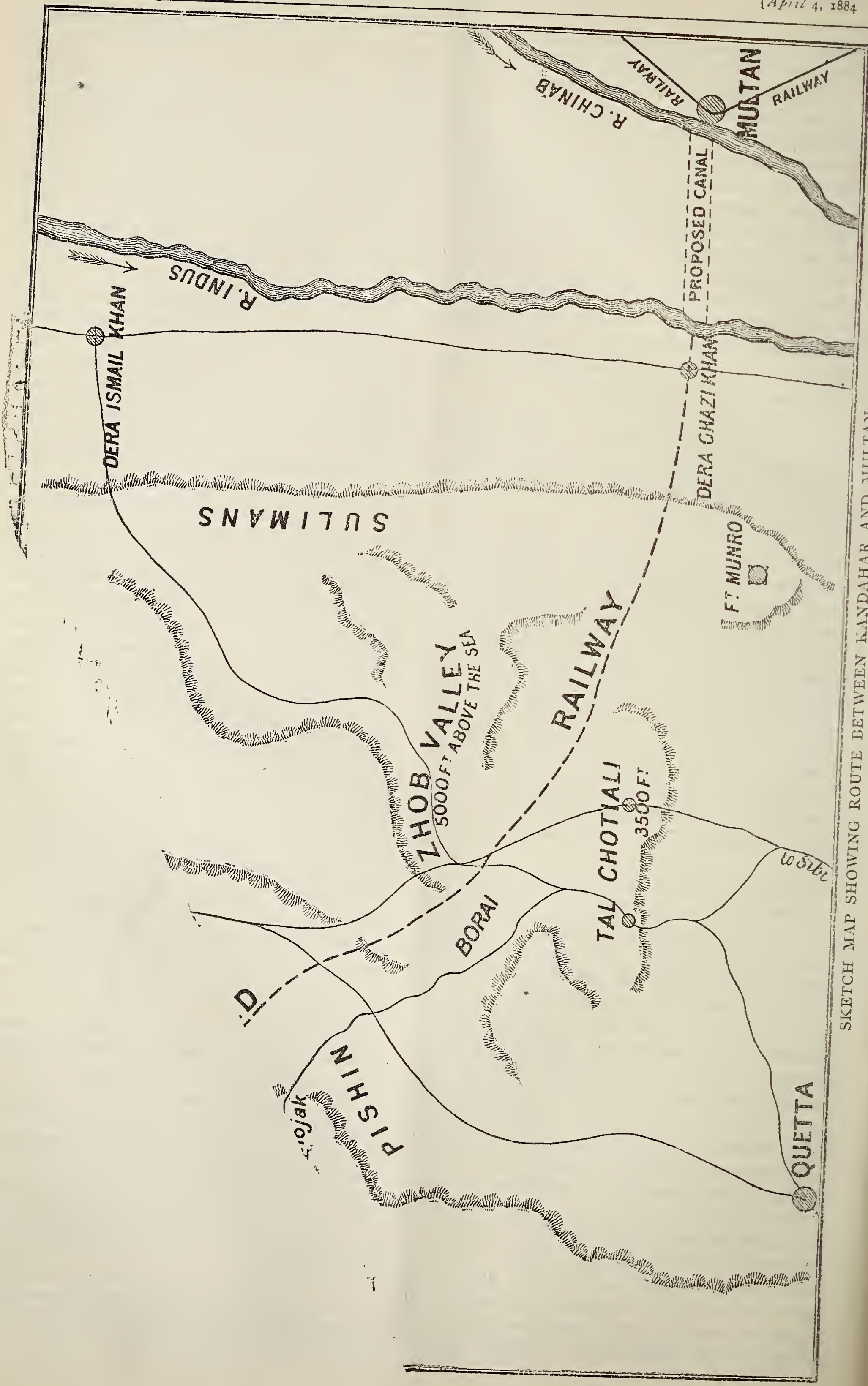
I have to describe only one more of the Afghan clans. The Tajiks, who number about 950,000, are scattered over a very large area, and are so much given to pastoral and agricultural pursuits, that their fighting men are comparatively few. They are descendants of the original Parsivan Suni settlers. The trade routes through their country are generally safe, for they refuse to give shelter to any robbers. Those who are driven by poverty to become soldiers in our service, have displayed the greatest courage; and, in times of danger, possess those rare qualities of faithfulness and loyalty which belong to a brave and noble race.

The Afghans have been called semi-savages, but with such grand material to work upon, education and civilisation will, under a sound and just Government, one day develop them into one of the finest races in the world. The typical Afghan is tall, active, strongly built, of an olive or fair complexion—some, indeed, are as fair as Englishmen, with light hair and well marked features. The Kakars, some of the Ghilzis and Duranis, imitate the Biluchis, and wear their hair in long curls round their head. The Afghans fully appreciate fun, and are generally very merry; they are brave to rashness, of great energy, enterprise, and endurance, and seem born for war. They require to be governed by a race like the English, for they make most excellent subjects, but, like most Asiatics, wretched masters, and as a people seem utterly incapable of organisation or management. Sober, generous and frank, courage with them is the supreme virtue. Their motto, "You give or I take," is being superseded by a higher principle, "Do unto others as you would be done by." Force, which was at one time their only argument, is regarded by those who know the English as no longer justifiable; and this race which has been condemned as the worst on earth, can, under the mild and just rule of England, produce honourable and good men, industrious law-abiding agriculturists, staunch and loyal soldiers, faithful and true to our cause, even unto death.

Kandahar* may be regarded as the great central point where, from the earliest of times, the chief trade routes met, either from Central Asia or Persia. The commerce of Khiva, Bokhara, Samarkand, Merv, and Herat was brought here, and was met by the great trading caravans from Persia, by way of the holy city of Meshad, and Herat. That renowned highway from Kabul, passing through Ghuzni and Kelat-i-Ghilzi, terminated at Kandahar. The chief Kafila road from Khelat Quetta, and Pishin also led to the same great mart, and it was here that the goods from Sind through the Bolan, the produce and merchandise of the Punjab, through the Tal-Chotiali, Sanghar, and Sakki-Sawar routes, were marketable. The inexhaustible supplies and riches of India were chiefly conveyed through the Gûmul Pass, North of the Takht-i-Suliman (*i.e.*, the throne or seat of Solomon). This renowned pass, one of the most interesting in the whole range, was the great trade route between Hindustan and Persia and Central Asia, for over 1,000 years; the various traffic routes by way of Zawa and Zhob valleys, in the direction of Toba peak, and again by some other passes south of the famous Takht-i-Suliman, were all feeders to this great trading highway, which from the mouth of the Gumul to Kandahar is 299 miles, to Ghuzni 233, to Kabul 318, and to Herat 380.

The Zhob valley route has been abandoned for over 100 years, owing to the robber tribes who infested it, but it is now likely to be reopened. I found there traces of a system of irrigation of a high order. The old *karez*, or subterranean aqueducts, conveying the waters of united springs to the surface, and the various bunds, made to catch the drainage and irrigate the lands at different elevations, give some idea of the great engineering talent of this lost people.

* Was once the capital of Central Asia. It is 3,000 years old, and after Alexander's visit was called after him, Iskandahar, Alickjalandar, Kandahar.



SKETCH MAP SHOWING ROUTE BETWEEN KANDAHAR AND MULTAN.

It is said that the Zhob, Borai, and Tal-Chotiali districts, covering an area of 14,000 square miles, once formed one of the most productive provinces in Afghanistan. In a climate which nearly reached perfection, the fruits of temperate and tropical countries grew at various elevations in profusion, and the soil teemed with vegetation and abundance.

Ages of bloodshed have, however, rendered unavailing the bounties of nature, but the land still remains full of hidden riches, and of mineral wealth untold. The natural elements of its ancient beauty and life still exist in the marvellous fertility of the soil, and in the manliness of character of the clans who reside outside these districts. The day cannot be far distant when this province will again become one of the finest and most prosperous in the East.

"We found," said Sir M. Biddulph, "three great valleys having theirorigin in the highlands east of Pishin, so disposed as to offer a choice of routes towards the Punjab. We never could have anticipated that this hitherto unexplored country would prove to be laid out so favourably for the routes we were in search of. We were first made completely acquainted with the whole arrangement of the internal part of the Pishin basin on gaining the top of the Surai Mugzai Pass, and in making the excursion in the Barshore Valley. This great open space is inhabited by a few Syuds, Turins, Kakars, and Achukzis, generally employed in agriculture and engaged in mercantile pursuits; they are decidedly peaceable in their habits, and would gladly be defended from the incursions of their more warlike neighbours. The country is abundantly well watered, and requires repose and the fostering care of a strong and good government. Before the next twenty years," adds Sir Michael Biddulph, "the railway will have passed on towards Persia, through tracts of country over which it is even now possible to drive a phaeton. Roads and railways will have been constructed down the easy and fertile valleys of the Kakur country to India. The area of cultivation will have increased, and groves will have sprung up around valleys and along the water courses. The people already traders will have benefited by the new communications, and in carrying their produce down to India, and returning with European goods, they will have learnt by their intercourse the value of commerce, and of a peaceable, just, and firm rule."

Speaking of this country, Sir Henry Rawlinson has said, "It was, in ancient times, a district of great wealth and consideration, it included Pishin, and took in all the western skirts of the hills. It was called Bálish or Válish, from a tribe of Turks who, in the 9th century, passed from the vicinity of Ghuzni; they left their name in the district of Malisan, near Ghuzni of to-day; they built large towns, and for 300 years maintained their celebrity, but their name has since vanished, and the towns are in ruins."

The late lamented Sir William Merewether said, in speaking of the routes between India and Kandahar, which we reconnoitered in 1879:—"The Tal-Chotiali Field Force has explored a region of the greatest importance. It was formerly well known as the easiest and best of routes between Central Asia and India. In earlier times, the capital of the Empire of Hindustan was Delhi, and naturally the products of Central Asia followed the shortest and best possible route to reach that city, *viâ* Dera Ghazi Khan to Delhi."

A little study of the map will show the great strategical and commercial importance of cantoning troops here, as a support to Quetta. We have troops at various stations along the low hot valley west of the Indus; these might be reduced in number, and brought here. Such concentration and placement would cover and protect the Punjab and Sind frontiers most effectually. The road leading from Tal and Khaja, at the head of the Zhob valley, commands the recently discovered easy road on Kandahar, which city is only eighty-nine miles off.* In a northerly direction it flanks all the passes leading from Afghanistan into the Punjab, and in the south it flanks the Bolan, which can be entered from it in many directions. I do not speak from mere guess-work, but from actual personal experience of the country, and many years residence on the frontier. Some years ago, I submitted a scheme to Government for colonising 15,000 square miles of the rich and fertile, but deserted plateaux, by granting lands to the loyal and industrious Sikhs, from the over-populated districts in the Punjab. It may be accepted as an axiom that, when once a people settle down as peaceable agriculturists, as the Sikhs have done, they become a tower of strength to the ruling Government, and will never throw in their lot with insurrectionists and invaders. The British Government have an opportunity of developing a great and

* An excellent road now crosses the Khojak; the proposed railway follows a still easier route at Gwaja; all the Pishin routes are open here.

powerful province at the head of the Khojak, by giving the Sikhs, Punjabis, and Gurkhas, plots of land, now lying waste and profitless. The whole country could be utilised and brought under cultivation, and these valleys and high plateaux lie on the chief direct route between Khorassan and India. A colony of such a people would be a strong outwork and barrier against invasion, and in times of emergency we might, as, indeed, to some extent we do now, draw our best and most loyal soldiers from these races.

The tranquility of this portion of Afghanistan would bring back the diverted commerce, and this great highway would become, as in ancient times, the chief route for trading caravans between India, and that great commercial and strategical centre, Kandahar.

My views, in short, may be condensed thus:—Constitute Multan a garrison of the first order, and make it the direct military base for all operations in Southern Afghanistan and Biluchistan; link the Chinab with the Indus at Dera Ghazi Khan by a navigable canal, and so place Multan in direct communication with the old Indus frontier at all seasons of the year. A line of railway from Dera Ghazi Khan, *viâ* the Chachar or Sakki-Sawar, which could be constructed very cheaply (there are no engineering obstacles along either alignment of country), would take you to a perfect climate at Tal and Zhob—which are neutral ground, commanding all the routes and passes on either flank, and where the land is capable of immense development, affording the grandest field for European enterprise.

Government experimental gardens were tried along most of the frequented routes in Afghanistan, with marked success. Model farms and depôts should be established along the best routes, and mules, hill ponies, and cattle bred for transport and commissariat purposes.

On the higher range of the Safed Koh, and in the Kûrûm heights, and on the higher Sulimans, grow magnificent trees, noble deodara pines, larch, yew, walnut, oak, and peach trees. At a lower elevation, varieties of rose, wild olive, honeysuckle, rhododendron, and dwarf palms are most common. In the high plateaux, acacias, palms, lilies, a variety of orchids and luxuriant shrubs bearing sweet scented flowers are to be found. In the cultivated parts the magnificent orchards yield abundantly all the fruits known in India, England, and the Continent. It should be remembered that the apple was originally indigenous in Afghanistan as the potato was in America.

There are, as in India, two harvests in the year. Kandahar supplied all the forces of Primrose, Roberts, and Ayoob Khan, in spite of two bad seasons, without difficulty, and at one-third of the Quetta prices. The granary supply of the district is practicable inexhaustible. Along the Kandahar routes tobacco grows to perfection, also wheat, barley, rice, jowar, sugar-cane, indigo, madder, castor oil, opium, dates, melons, &c. These and the celebrated grapes and other fruits of Pishin and Kandahar are renowned throughout Asia.

The horses of Northern and Southern Afghanistan, the Waziri country and Biluchistan, are justly famous all over the East; they are hardy, of extraordinary powers of endurance, up to great weight, capable of standing all weathers, and they are largely exported to India.

The cows are similar to the Guernsey breed, and, like them, give much milk. The flesh of the ox is excellent. The fat-tail species of sheep forms a great source of wealth to the nomad population. Owing to the richness of the grasses, the mutton is the best in Asia, and the wool trade with India has increased to 5,000,000 lbs. annually. The various goats of Southern Afghanistan are renowned for their hair, with which the natives make excellent winter clothes. The silk trade of Kandahar has lately been revived, and promises, ere long, to be very large. All goods in Afghanistan are carried on camels, stronger, more robust, and better built than the Indian kind. The Afghan camel is indeed very clever, can go over all sorts of rough mountainous roads, can climb hills of sharp gradients, cross roaring torrents, and is equally good in the barren sandy deserts.

Afghanistan is a magnificent country for the sportsman, large and small game, such as panthers, wolves, tiger cats, wild asses, pig, various sorts of antelope, elk, red, mouse, hog, and spotted deer, sambur, barra-singhar, wild sheep, and goats abound. Tigers and reptiles are, it is true, uncommon; of birds, there are eagles, vultures, herons, bustards, kulan, three kinds of partridges, four kinds of pheasants, sand grouse, syris, three kinds of quail, four kinds of snipe, jungle fowl, pigeon, and innumerable kinds of duck. Fish are very plentiful in all the streams and rivers.

The principal trade of Central Asia is managed by Hindus. The Merv, Meshad, Herat, Kandahar, and Pishin trade is, however, in the hands of Persians, who bring silk, horses, arms, rugs, and carpets, which latter are of excellent quality, soft, durable, and brilliant in colour, and are generally sold in England as "Persian." There is also a great trade in felts, goods woven from the hair of the camel, sheep, and goat. The Kandahar Persian merchants buy up the Powindah goods from India, such as piece goods, fabrics, skins, patent medicines, &c.

The mineral wealth of Afghanistan is prodigious. Gold is found in nearly all the rivers, and streams, and famous silver mines were worked at the head of the Panjshi Valley, near the Toba Peak, also in the Pishin, Tal and Zhob Valleys. Iron of excellent quality is found in Bajour, Kûrûm, Gûmul, and south of the Takht-i-Suliman. Iron ore is in abundance near the Bamian route and Hindu Khush; copper ore, lead, antimony, zinc, sulphur, nitre, coal and petroleum, are to be found all along the various routes traversed by our columns.

Will it be believed that, with all these *data* open before it, so renowned a journal as the *Saturday Review* should have committed itself to the absurdity of asserting that there were only two roads from Central Asia into India, viz., the Bolan and the Khyber, that Afghanistan itself was a barren country, and its people a despicable, fanatical race.

The same assertion might have been made with hardly more extravagance regarding Switzerland; that also is a country of rock and mountain, and where also large areas—which is not the case in Afghanistan—are covered by water, and, therefore, unproductive; yet, even the *Saturday Review* is aware that Switzerland, in many departments of commerce, is a formidable rival to England itself.

The Government returns of the Punjab, for 1883, show that the value of the foreign trade fell off by nearly 25 lacs during the past year. The decrease in exports (31½ lacs) is chiefly with Kabul and Bajaur, and the Lieutenant-Governor states it is due to the Russian trade policy in Central Asia. The chief decrease in exports to Cabul was 13 lacs in piece goods, 10 lacs in tea, and 2 lacs in indigo. The total Kabul trade fell from 48¼ to 42¾ per cent. of the whole Punjab foreign trade. The Kabul import trade shows a satisfactory increase in silk and madder. The import of silk from Central Asia, which was diverted to the Western Orenberg route and Bombay, has resumed its old course to India by the Punjab.

The most valuable Punjab import trade is that from Kashmir; the most valuable export trade that with Afghanistan. The Ladakh and Yarkhand trade shows a general improvement, owing to a more settled state under Chinese rule, and to the growing popularity of the Lahoul-Kulu route, due to the excellent state and safety of the road through British territory. Imports, 5½ lacs, exports, 3½ lacs. Opium is now largely imported from Kabul, Kandahar, and Herat.

There are registering posts at the head of all our frontier routes, and five new roads to Gandab were re-opened last year. The bulk of Kabul traffic passes by the Khyber. It is protected by our Government to Lundi Kotal, and by the Khan of Lalpura to Dakka.

The great falling off of the Punjab trade with Central Asia is due to the interdicts and prohibitive tariffs imposed by Russia, against which our Government has protested; but Russia maintains her right to protect her own industries, and is rather pleased than otherwise at our discomfiture. The railway to Kandahar would win back the trade that was once in our hands, would tranquilise the whole country, and be the pioneer of civilisation. The circulation of coin and bullion with Afghanistan and Central Asia cannot be accurately checked. The metal in both forms is conveyed secretly in considerable quantities. The excess of exports over imports is met partly by this importation of foreign gold coin and wire, and partly by Bombay exchange bills.

From the Kohat district the most used routes are *viâ* Thull and Manduri. The Admela Tarwari route is the safest. The only duty levied is at Kabul. The Government report that all is quiet in the Kûrûm, and that caravans can take the old routes as before. There is a large increase in imports over exports from Kabul at Kohat. The horse trade being the most important, next comes Kabuli coin, then leather, tobacco, and dried fruits.

The imports on the Gûmul route, show 53,356 Rs. more than for 1882. The Powindah camels which passed this way into India, were 52,000 against 46,000 in the previous year. There is a decrease of 12½ lacs on exports, due to the traders using the railway, together with the increased duties imposed by Russia.

The Tirah trade shows a considerable increase in imports—that of raw fibres was double that of 1882, and of food grains there is also a large increase, attributable to the good harvests, and perfect tranquility of that province. The Sewistan trade is very encouraging. Imports, for 1883, are 3¾ lacs, showing 99 per cent. increase since the late war; exports 7½ lacs, or 87 per cent. increase since that time.

The Bannu reports show an increase of imports, but a slight decrease of exports. The roads there are open, and no robberies of caravans are known to have occurred, though beyond British territory there was one Kafila looted. In the Dera Ishmail-Khan district, the Shiranis have have their routes re-oponed and trade has revived. The imports and exports of Tank Zam show a large increase, owing to the reduction of duties from one-sixth to one-twelfth.

The Vehowa route, which had been infested by Biluch robbers, was re-opened last year, and the robbers punished. Although there are 92 passes in the Dera Ghazi Khan district, only four are registered for trading purposes. The Sanghar route show an increase in imports; the trade had suffered from continued squabbles between the Kasranis, Bozdars, and others, but all disputes have now been amicably settled. The Fort Munro route shows an increase in exports of 121,000 Rs., and in imports of 31,000 Rs. This route is well guarded, and is even safer than the Sarri, which also leads into the Khetran Valley. Fort Munro is 7,000 feet above the sea, and is the hill station for the officials and officers from the garrisons in that district. The climate is very cool and bracing, with practically no rain. Government have there a model farm and English garden, where all kinds of fruits and vegetables grow to perfection. The most admirable arrangements have been made with the various chiefs of the frontier tribes to protect life and property, and the duties levied by them in their different districts are lower than formerly, but will bear further reduction. The Khyber imports are 18½ lacs, and exports 37 lacs; the Gûmul imports are 10½ lacs, and exports 18 lacs; the Bolan imports are 9 lacs, and exports 24 lacs.* These far exceed all others in importance. The total gross traffic registered with Afghanistan was, in 1862, imports 32 lacs, exports 30 lacs; 1880, imports 32½ lacs, exports 98 lacs; 1882, imports 35¾ lacs, exports 100 lacs; and by last returns, imports 41 lacs, exports 70 lacs. The total gross imports into the Punjab from Biluchistan, Afghanistan, and Central Asia were 104 lacs, and the exports 166 lacs, which gives 87 per cent. increase on the total gross imports and 98 per cent. on the total gross exports since 1870. These figures are taken from the Blue-books just presented to Parliament. The excess in the value of exports is due to the fact that imports of bullion escape registration, and also that Powindahs and others come down in winter and take back their earnings in kind; and it was noted in last year's report that *hundis* on Bombay were granted in exchange by the Bokhara Jews. Another reason for the great excess of exports over imports is found in the fact that the war disorganised the import trade, while the large amount of coin circulated there during our occupation increased the purchasing power of the country.

The construction of a railway to Kandahar is most essential, and the opening out of the roads into the heart of the rich prolific country of which that city is the central point, would cause the people, with their strong commercial instincts, to turn their tulwars into ploughshares, and become traders with our Indian Empire on a very large scale. The miraculous change in the Punjab since it has come under our rule will give us a fair picture of what the Zhob and Pishin provinces might speedily become.

I think I have shown, and I hope convincingly, that there is in Afghanistan a grand field for commerce, and that, far from being a barren land where there is no trade, its people are very keen traders, and the country only needs money and enterprise (which England has so largely at her command) to develop it into one of the richest countries in the East.

Since the old frontier of 1849 was annexed, we have constructed over 5,000 miles of district roads and feeders, and bridged most of the streams and canals. There are 375 serais and rest-houses erected for the natives, a thorough system of police has been organised, so that life and property are as safe there as in England. The trade returns show a rapid increase; the revenues, too, have developed in a marvellous manner, and the Tables annexed will show how crime has decreased under our rule. The Government have constructed or remodelled over 3,000 miles of canals for irrigating the lands, and nearly 5,500 square miles of country are under cultivation. The once barren frontier between the Sulimans and the Indus is now one rich garden, peopled by a happy, prosperous, law-abiding, agricultural race.

One word in conclusion. Our highest and most competent Indian authorities have, after careful consideration, deemed it expedient not to annex but to occupy Kandahar by friendly arrangement, as we now occupy Quetta.

* These figures show an increase of 250 per cent. since 1870.

Our history of India affords us no cause for pride, but our dealings on our north-west frontier can be read with the greatest satisfaction.

The work of pacification has required tact, energy, and gallantry, attributes common enough amongst the Englishmen who have been the pioneers of civilisation on the Afghan frontier. The Punjab School has produced such heroes as Nicholson, Taylor, Jacob, Lawrence, and scores of others whose glorious deeds are indelibly engraved on the blazing scroll of the best deeds ever performed by Englishmen. Others, alas! have gone to their graves after nobly doing their duty, unhonored, undecorated, and unknown; but there are still a host of others ready to follow in their footsteps, who would sport with the difficulties which would have to be overcome. Until now Southern Afghanistan has lain under the curse of Islam; robbery, tyranny, slavery, barbarism, and bloodshed were rampant, but it only needs the guiding spirits of men like Chamberlain, Probyn, Brownlow, Merewether, the Greens (one of whom is with us this evening), worthy followers of Jacob, and a host of others, to show this manly energetic people how their fertile soil can be cultivated, and their mineral wealth utilised, with the aid of British pluck and British gold.

If ever this country, as the mother of nations, had a duty to perform, it is to carry her civilising mission into these parts, and to teach the people "Peace on earth, and goodwill towards men." It is not in the name of this or of that Government, in this or of that policy, but in the name of civilisation and humanity, we desire the good work that has been begun under Sandeman and his lieutenants carried out.

The man who would thwart or in any way frustrate this noble work is not worthy of the name of Englishman.

APPENDIX.

District.	Per-centage of increased cultivation since annexation to 1884.	Per-centage showing the increase of population since annexation to 1884.	Canals and rajbahas open. In miles.	Decrease of crime since annexation to 1884.	Number of passes and routes leading into Afghanistan in each district.	Chiefly peopled by races now called
Peshawur	127·	18	195	86	38	Indo-Puthans, &c.
Kohat	141·5	15	124	79	47	Waziri-Puthans, &c.
Bannu	158·6	27	131	90	51	Panjabi-Puthans.
Dera Ismail Khan	245·	45	986	121	61	Waziri-Puthans, suc. by Biluch-Puthans.
Dera Ghazi Khan	289·	87	1,570	161	92	Indo-Biluchis.
Jacobabad	376·	71	897	89	75*	Scind-Biluchis.

* These lead into Biluchistan.

Miles of New Roads and Routes opened for Traffic along the direct thoroughfare between Pishin and India.

District.	Miles.	Remarks.
Sewistan	47	Surveyed and reported on by Major Howe Showers, Capt. Wells, R.E., and G. W. Vyse, in 1879, and subsequently, in 1883, by Dr. Duke, Capt. Jennings, R.E., and other Officers under Col. Sir Robert Sandeman, K.C.S.I., Agent to Gov. Gen. for Biluchistan, &c.
Harnai	24	
Zhob	46	
Zawa	28	
Tal-Chotiali	36	

Strength of Armies.

	Infantry	Cavalry	Artillery.[1]
Amir's regular army	37,000	24,000	2,000 badly manned
Do. in war time	150,000	87,000	10,000
Khan's forces, peace time	12,000	1,000	135 of no real strength
" " war "	80,000	12 ,000	...
Irregular forces of frontier tribes. About 50 per cent. badly armed with matchlocks.	150,000	69,500	none

MILITARY STRENGTH OF TROOPS ALONG OLD FRONTIER AND IN BILUCHISTAN.

British troops	8,300
Native ,,	24,500
,, militia	16,100
Police and Burkandazis	7,850
Total....	56,750

SUBSIDIES PER YEAR.

To the Amir of Afghanistan	£120,000 and presents.
To the Khan of Khelat about	30,000 with presents.
To the various chiefs along frontier	12,500 and silent money.
Total....	£162,500

PRINCIPAL EXPEDITIONS ALONG THE AFGHAN FRONTIER.

Year.	Names of Offending Tribes.	Commander.	Casualties on our side		Enemy's casualties.		Remarks.
			Killed.	Wounded	Killed.	Wounded and prisoners.	
1849...	Landhkor Swatis ...	Col. Bradshaw, C.B....	9	45	1,100	85	Tribe surrendered.
1850...	Afrdis, Kohat Pass	Sir C. Napier	19	74	3,800	251	For murdering British subjects
1851...	,, ,,	Capt. Cake	11	25	464	19	Across the border and raiding.
,, ...	Waziris, Miranzi ...	Brig. Chamberlain	1	18	27	319	,, ,,
,, ...	Mohmands	Sir C. Campbell	3	9	117	1,000	,, ,,
1852...	Swatis, Black Mnt.	Col. Mackeson	3	17	415	4	,, ,,
,, ...	Utman Khrl	Sir C. Campbell	14	48	196	36	,, ,,
,, ...	Waziris, Kafir Kot	Major Nicolson	23	5	353	29	,, ,,
1853...	Bori Afridis	Col. Boileau	8	53	506	6	For rebellion.
,, ...	Shioranis	Brig. Hodgson	5	42	714	4	Raiding and murdering British
,, ...	Kaeranis	,, ,,	11	31	100	198	subjects.
1854...	Mohmands	Sir S. Cotton	2	16	86	217	,, ,,
,, ...	Afridis	Col. Craiger	9	39	29	1,654	For stealing our subjects.
1855...	Urakzis	Brig. Chamberlain	10	23	36	2,176	
1857...	Bozdar, Biluchis ...	,, ,,	12	49	300	1,000	Murdering.
,, ...	Niranzi	Maj. Vaughan and Sir S. Cotton	6	36	417	200	Marauding.
1858...	Sittana	Sir S. Cotton	6	28	896	...	Preaching Jehad.
1859...	Kabul Kheyl Waziris	Sir N. Chamberlain	2	19	91	60	Looting.
1860...	Mahend Waziris ...	,, ,,	93	286	214	27	Murdering.
1865 ..	Swatis, Umbeyla ...	,, ,,	238	908	1,300	3,000	Declaring war.
1863...	,, Black Mount,	Sir A. Wylde	20	109	176	surd.	,,
,, ...	Bezoti	Maj. Jones	11	44	523	88	Murdering our subjects.
1869...	,,	Col. Keyes	8	33	446	176	Looting.
1872...	Dewar	,, ,,	3	16	71	211	,,
1878...	Afridis, Kohat Pass	Brig. Keyes and Ross ...	18	78	86	300	,, and murdering.
,, ...	Jawakis	Gen. Commdg. Frontier	4	37	26	347	Murdering.
1880...	Maris	Gen. McGregor	1	5	2	surd.	Looting.
1881...	Bozdar	Gen. Commdg. Frontier	2	11	26	surd.	,, and stealing in British
1883...	Kurram	...	1	3	11	surd.	territory.

The Khan of Khelat has long been our staunch ally, and no raiding has taken place along the British frontier since 1857.

BILUCHISTAN.

Biluchistan has an area of 168,000 square miles; some of the western part belongs to Persia (only about 55,000 square miles). The ruler is the Khan of Khelat, who resides at the capital (Khelat). Quetta commands the Bolan Pass route, so strategically is the most important city. The revenue is about £40,000, in addition to the subsidy we pay the Khan (*vide* treaty of 1854). The Government is despotic; the Khan's rule only extended to the province immediately around his capital, but now order and law prevails everywhere, owing to British influence. In past times, a great part of the country was held by tribal chiefs, over whom the Khan had but little control, unless in times of war, when they would furnish him with contingents, but taxes they always refused to pay, unless forced. Sir R. Sandeman, assisted by able officers, is settling the whole country in accordance with the British frontier rules, laws, and regulations. The occupation of Quetta by our troops was in accordance with the terms of treaty of 1854. The people are divided into two branches, Biluchis and Brahnis. Both are pastoral, kind, hospitable, brave, and are Sunis. Polygamy is universal; all have two, and some chiefs five wives; women are obtained by purchase, and paid for in sheep, goats, mares, &c. A man is expected to marry the widow of his deceased brother. All routes throughout the country open; mineral wealth enormous; trade increasing; manufactures insignificant; produce of soil prodigious. Climate, extreme heat and cold. Population about 1,875,000.

DISCUSSION.

Col. MALCOLM GREEN, C.B., said that although he agreed with most of what had been stated by Mr. Vyse, there was one small portion with which he differed. Mr. Vyse, he understood, advocated the policy of occupying or colonising with Sikhs a tract of country contingent to one of the trade routes, which lies beyond the British frontier and between the western and eastern Suliman ranges. Now this country does not belong to the Sikhs but to Belooch, or Pathan tribes, and unless England was prepared to advance the red line to that shown upon the map, and so protect her Sikh colonists within it, he was afraid the latter, as well as those frequenting the trade route, would lead but a sorry life of it. With regard to the country in and about our Sind frontier, including Jacobabad and the district surrounding it, together with those portions of the world, formerly amongst the most lawless on the confines of India, contained between E. longitude 66 and 68, and N. latitude 25 and 30, these, for the most part are, and have been, for many years past—thanks to the policy initiated by the late General John Jacob, C.B., and encouraged and supported by Sir Bartle Frere, sometime Commissioner in Sind—as safe for travellers and traffic as the roads between this and South Kensington.

Sir JOSEPH FAYRER, M.D., K.C.S.I., F.R.S., said he could bear testimony to what had been said by Mr. Vyse as to the grandeur of the physique of the race to which he had referred, and also as to the existence of the fruits, and the various textile fabrics which the natives brought down from the higher regions. Reference had been made to the various woollen fabrics made from the animals that throve in those mountainous regions, and it might not be generally known that all the animals residing in those elevations, where the winters were severe, had a peculiar development of the soft woolly hair, which only developed thoroughly in winter, which was used for spinning those excellent fabrics used for making clothes. The paper was interesting to him chiefly from its geographical and from its natural history aspects, and he was sorry he could not enlighten the meeting by any remarks of his own on other aspects of the paper. He should be glad if Mr. Vyse could give them some information as to the nature of the road between Merv and Herat.

Mr. CHARLES MARVIN said the paper which they had just listened to was most interesting. character. The material thing which struck one in connection with the map was that you had a frontier of a great Empire of 100,000,000 of people, and another frontier of a second Empire of 250,000,000 of people, the only thing separating the two being the small tract of country known as Afghanistan, which contained little more in population than London. Through this country ran various trade routes which had been described that evening, the most important being the one running from the Caspian region to Herat and then on to Kandahar and India. Very considerable importance had been given to this trade route by the recent Russian annexation of Merv. He had lately received a paper from Tiflis in which this subject was discussed, one thing mentioned being that the measures that were taken by England in Afghanistan in the region of Kandahar to check the Russian advance, ought to be, on the part of Russia, responded to by similar measures in the region between Merv, Sarakhs, and Herat. If England kept making preparations to resist the Russian advance, and Russia on her part continued to make preparations to strengthen her frontier, the two sets of measures, one operating north, and the other south, must have the effect of wiping out Afghanistan. He thought that opinion was generally becoming shared in England. The forces which were operating on both sides were so strong that, between the two, Afghanistan must be crushed out. This question could be argued from a commercial aspect as well as from a military one. Russia, besides being a great military power, was also a commercial power, and in India we were also a great commercial power, and our present policy was to establish a sort of barrier between these two great empires which would be untraversed by the traders of either country. It might be a very good policy from a certain point of view, but it was not a practical point of view, and that opinion was, he thought, shared by a good many. So far as the Russians were concerned, they were determined that that policy should not succeed, and he could not see what England could do to prevent it. The author of the paper had not gone very much into the question of what he might call the great trade route running through Herat and Kandahar to India.

The CHAIRMAN said he might, perhaps, be permitted to point out that it was not customary at these meetings to enter into politics.

Mr. MARVIN said he would try to avoid doing so. Of late years, there had been a large development of Russian commerce in the Caspian, and it was not many years ago that the Caspian was regarded as a sort of dead sea, in fact, quite altogether out of Europe; but Russia having linked the Caspian with he Black Sea by railway, had opened a great trade route, and before many years had elapsed, they would hear a great deal about Russian traders in this region. From what he had seen when out there, he knew that the Russian trade was developing in the Caspian and trans-Caspian regions. He could not see what right the English Government had to keep the Russian trader pure and simple out of Herat, and was persuaded that before many months they would hear of the Russians penetrating into the district round Herat. At the present moment, there were large consignments of Russian goods at Askabad, waiting sale, and large consignments were being dispatched to Merv.

Mr. MARTIN WOOD said the Chairman had stated that it was not the custom at these meetings to deal with politics, but he thought it was rather entering into the domain of politics when several speakers proposed to occupy a country which did not belong to them, and over which they had no control. Mr. Vyse had referred to a very large number of routes to Afghanistan, but he was of opinion that three or four main routes were quite enough to consider. In hearing the paper read, abounding as it did with modern information, he could not but recall some of the older writers on the trade routes to and from Central Asia, amongst whom he could specially mention Major James, whose records, were popularised by Sir Richard Davies. It was very desirable that every opportunity should be given to encourage Indian trade with Afghanistan, though he did not think that the construction of the railway to Kandahar was necessary for that purpose. The country was tolerably peaceful and settled until three or four years ago, when England, in the most unwarrantable manner, overran the country; one of the inevitable consequences of the invasion being that a large quantity of mulberry and other fruit trees were cut down, just when they had reached maturity after our former invasion. With regard to the railway which was proposed by Mr. Vyse, he could not see what it was essential to; it was not essential to India, though it might be essential to the demands of British commerce, and for war purposes; but if so, that was an Imperial purpose, and the cost of constructing the railway ought to rest with the Treasury of this country. He thought if that was borne in mind, the project would be looked at with a little more care than was frequently the case. His own impression was that in Afghanistan the policy of civilisation had not yet been thoroughly tried; and as to trade generally with Central Asia, there was the old method of holding periodical fairs within our borders, to which the traders should be freely invited; he strongly advocated this being done.

Mr. TRELAWNEY SAUNDERS said he was very grateful to Mr. Vyse for moving public opinion in the direction of a just judgment upon the productibility of Afghanistan. Because the country had been overrun by war, and devastated by plunderers for so many centuries, that was no reason why it should not be other than it was at the present day, as it had the same climate, the same soil, and an industrious people who would be peaceful if under a strong Government. Its existence as an independent Government between two great and powerful nations, one an advancing and conquering one, could not be looked upon as independent. If it was to be dependent, under what power was that to be. That was the question which stood paramount with regard to the question of trade, for they must remember that so far as the Russian boundary extended, so far was the rest of the world excluded from trading inside that line, but so far as the English line extended, others could freely follow, Russians included. It required no argument or advocacy to deal with this question or promote it, for it was one that was promoting itself, and there was no stopping it. Peaceful men and statesmen might do what they could to prevent the issue which was rapidly coming upon them, but that issue would have to be met and decided, not by statesmen but by force of arms, and the more they were prepared for that, the better it would be for English interests.

Mr. HYDE CLARKE was afraid the Chairman had rather confused the mind of Mr. Martin Wood by restricting the discussion to commerce, and refusing to allow them to touch upon politics, though, for himself, he believed that it was impossible in the present case to draw any absolute line. Mr. Wood seemed to suppose that there was some notion that England was not to interfere with countries which did not belong to it; but commerce, as was well known, interfered much more with other countries than war did, and English people were greater conquerors by commercial means than warlike means. Mr. Saunders, like other distinguished men, had laid down many of the lines of this warfare, political or commercial, which was still going on. One difference between the two combatants was this, that the Russians were in every degree assisted in their invasions, while Englishmen received but scant aid from the individual goodwill of political officers, in their endeavours in the promotion of civilisation. The Armenians, who had been the pioneers of trade in the district about Merv, had worked under a Russian banner, pushing commerce wherever they could, and these people would be most willing to aid Englishmen if they could receive any help from our Government. There ought to be no compunction in occupying any country by fair means if it could be done with advantage to the population, and with benefit to the world at large, because if they remained tranquil and inert, they would allow others to occupy the place with the consequence of being excluded from trade. He had watched the progress of the Russians from the Black Sea to the Caspian, and the free trade routes there were almost extirpated. It was desirable that England should take this question up in the spirit which had just been advocated, looking upon it as a great question, or, if Mr. Wood liked, as a great Imperial question. It was scarcely possible to understand how, in looking either at Indian interests, or in the interests of the world at large, it could be considered an undue influence to do what had been recommended by Mr. Vyse, namely, to carry on a railway to Kandahar, as the railway would be the means of bringing into Afghanistan the influence of that immense instrument of civilisation, the railway system of India; and it would place at the disposal of the population, so far as it reached, all those resources of civilisation which had been created in India. So far from there being any just argument against this project, there was every inducement to introduce it. With regard to the regions between the Suliman mountains, he would go much farther than Mr. Vyse. Why should not Englishmen be employed as chiefs in such a colonisation and occupation, not in the sense of cultivators of the land? If fair scope were given to English enterprise they would probably see such a barrier created in the Suliman region as would be a safeguard against all political dangers.

The CHAIRMAN said he came to listen to a lecture upon the trading routes of Afghanistan, and he feared they had strayed a little beyond that subject into the realms of politics, though no doubt it was exceedingly difficult for them to steer clear of that in dealing with such a subject. Afghanistan was between two great powers, and everyone knew what generally happened in a country so situated. Mr. Hyde Clarke had referred to the Russians as being a warlike nation, but if they looked back to history he thought they would find there was no more warlike nation under the sun than old England. Russia would have a great deal to do in order to win Afghanistan. He was a great advocate for promoting trade, and attached the greatest importance to opening up trade with Afghanistan. He was glad to think the railway was going to be made to Quetta, and trusted that it would be carried on to Kandahar, not with any view to conquest, but merely to encourage trade. As one way of doing that, Sir Robert Sandeman had lately made an agreement to take over the revenues of the State of Quetta by making an annual payment to the chief, and there was some reason to hope that the Indian officials would before long be able to diminish, if not to entirely abolish, the heavy tolls upon merchandise which was levied upon goods going through the Bolan Pass. It had almost taken his breath away to hear Mr. Vyse say that there were 298 routes into Afghanistan from the north-west frontier, and he supposed that many of them were not of any great value. His own impression was that the Bolan Pass was the one which England had to deal with, and to open up as much as possible. In conclusion, he begged to propose a most hearty vote of thanks to Mr. Vyse, for his interesting and valuable paper.

Mr. VYSE, in responding, said he had to thank Mr. Trelawney Saunders for the loan of the excellent map which had been of so much service that evening. As to the observations of Mr. Wood, he would advise that gentleman to read the lecture delivered by General Hamley, at the Royal Institution, when Sir Henry Rawlinson was in the chair. As to the 298 passes to which reference had been made, he could assure the Chairman that the whole of them could be used by cavalry, footmen, and camels. The gradients, even now, are not difficult, and the general alignment and contours of most of the old passes through the Sulimans are capable, without much cost or engineering, of being made excellent traffic feeders. The streams might easily have weir-dams constructed across them, so as to hold, as reservoirs, the flood water in times of emergency. The rainfall along the Sulimans is uncertain, but three inches of rain have been registered in twelve hours. The whole average for the year is about equal to the rainfall at Plymouth. In the Harnai, Peshin, and Sewistan districts, however, it is much greater. With reference to Colonel Malcolm Green's remarks, the Zhob and Harnai country he knew never belonged to the Sikhs; at present it is neutral waste land, only small patches here and there are claimed. It stands from 3,000 to 6,000 feet above the sea; the soil is rich and prolific, and well watered. It would make a grand site for colonies of Sikhs and Gurkhas, where regiments of these races should be stationed. The Gurkha regiments at Abbottabad, Buckloh, Jutogh, &c., all have small colonies, and their wives and families assist in looking after their gardens and farms. Some regiments of Sikhs on the Punjab frontier do the same, and it is such a scheme he would promote and encourage here. It should be remembered that trade always follows the flag of old England. In answer to Sir Joseph Fayrer, there are five roads between Merv and Herat; two are very good ones, by the Murghab route, the distance is 240 miles, and water obtainable the whole way. The banks of the Murghab river are very fertile, and grass, fodder, timber, and some supplies are procurable *en route*. The other route, from Merv to Herat, surveyed by Lessar, is 252 miles; it is fairly open, and good, without really any engineering difficulties for a line of railway. The highest rise in the hills is under 900 ft. above the surrounding country. The climate is most enjoyable, but Merv, so O'Donovan has said, is feverish for three months in the year. Of the other three roads little is known, except that one—165 miles—is reported to be even better than that visited by Lessar. The fertility of of the Herat country is unequalled, and its supplies are practically inexhaustible. According to the old Persian legends, Herat was the Garden of Eden. From Merv to Herat is 240 miles; from Quetta to Herat is 514 miles. The Russians then are nearer to Herat by 274 miles than we are, and, of course, their influence over the trade of Herat and Kandahar will now be keenly felt, and every year will show a marked falling off unless something be done at once

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 2, 1884; His Eminence Cardinal MANNING in the chair.

The following candidates were proposed for election as members of the Society:—

Alldridge, Thomas Joshua, York Island, Sherbro, West Coast of Africa, and Old Charlton, Kent.
Allpress, Vincent Sydney, Cliefden, Eltham, Kent.
Bryce, Charles C., 141, West George-street, Glasgow.
Christie, John, Rosshead, Alexandria, N.B.
Gibson, John Merriman, Buckley, Chester.
Gothard, Frederic, 204, Ashby-road, Burton-on-Trent.
Kemp, William Joel, Copyhold-house, Redhill, Surrey.
Lovibond, Josiah W., 26, St. Ann's-street, Salisbury.
Muir, Rev. Robert H., The Manse, Dalmeny, Edinburgh.
Richardson, Frederick William, 40, Church-street, Bradford.
Rumpff, Carl, Schloss Aprath, near Elberfeld.
Wace, Rev. Prebendary Henry, D.D., King's College, Strand, W.C.
Wall, Robert Frederick, Thames Sugar Refinery, Silvertown, E.

The following candidates were balloted for and duly elected members of the Society:—

Christie, John, Clevedon-lodge, St. Margaret's, Twickenham.
Howard, Walter, Oaklands, Cricklewood, N.W.
Ince, Francis, St. Fagan's, 17, Fitzjohn's-avenue, Hampstead, N.W.
Kent, Arthur, 11, Wigmore-street, W.
Langton, Henry Currer, Docklands, Ingatestone, Essex.
Trench, George, Standard-house, Faversham, Kent.

His Eminence Cardinal MANNING, in introducing Mr. Hoole, expressed his regret that he could not remain to hear the paper, as he was suffering from a severe cold. This subject, however, was of such vital importance that he could not leave without saying a few words upon it. There were a large number of earnest benevolent people who seemed to think that houses unfit for human habitations ought to be demolished at once, and better houses erected in their stead. This reminded him of a county meeting at which three resolutions were passed—(1) that a new lunatic asylum be built, (2) that it occupy the site of the old one, (3) that the patients remain in the old one until the new one be finished. Some of these benevolent people overlooked the enormous difficulty of re-housing the labouring men of England and their families. There had been a great deal of demolition, which had only increased the overcrowding complained of. Families had been driven out into the suburbs of London, in some of which there were now as many evils as existed in central London; others, again, had been driven into neighbouring parishes, and overcrowded them; and others had gone into other houses in the same parish, and thus rendered far more intense the evils it was sought to remedy. Benevolent zeal, therefore, required to be tempered by knowledge, such as had been obtained by the evidence taken some years ago, and was now being taken again. If a man were taken to another house at a distance, he lost at least two hours a day, with a great accession of labour; he often lost his employment, and his wife lost the small industries by which she gained a few shillings a week, and thus the whole family was impoverished; whilst all articles of food were dearer in the suburbs than they were in the markets where the working man was used to buy his food. A great effort had been made to rehouse at least one-half of those who were unhoused, but the great block-buildings which were put up did not rehouse the class of whom he was thinking. They were filled by anticipation by skilled or half-skilled artisans, who could pay higher rents, and were, in other respects, more desirable tenants. The poor must not be pushed from the centres of industry where they worked, which formed one of the greatest difficulties. In the course of the evidence taken some years ago, very terrible statements had been made as to the immorality caused by overcrowding, and drunkenness which was both the cause and consequence of it. These were very grave and dark questions, but he would not dwell upon them, but would call attention to another point, which was to him even more vital, if possible. Was it possible for a man, with his wife and family growing up from infancy to man and womanhood, crowded in a room 9 ft. square, and 7 ft. high, to maintain domestic life in such a state? By domestic life he meant those feelings of affection, authority, submission, duty, and charity one to another, which bound together human and Christian families. All who had seen the life of the working people of this country, would agree with him that to cultivate the domestic life of the people was, at this moment, impossible, even in habitations which might be somewhat larger and better aired, but with only one room undivided. What was the foundation of the whole human society of mankind but the domestic life? Upon this all empires, kingdoms, and commonwealths were founded. There must be at present not less than 16,000,000 to 17,000,000 of population in the crowded centres and throughout the agricultural districts. What would be the condition of all those people, if more thought were not bestowed on their domestic life than had ever been given to it yet? He did not like to be a prophet of evil, but he felt sure that in these great centres families grew up without the relations which bound husband and wife, parent and children, together. Early in life the boys and girls began to earn a few shillings, and went and lodged by themselves. There was no domestic life under such circumstances, and it was precisely in these great centres that drunkenness was making its greatest havoc; and he looked at the future with great anxiety. Look at France; Paris was a centre liable at any moment to overflow like a volcano and deluge the whole country. By a good Providence, England had been saved from centralisation, and he looked forward to the creation of local centres, and the development of personal energy everywhere. If this were done, our great centres might become like the air-tight compartments of a large ironclad, where if one were pierced the others would be secure. There were a multitude of political questions which men were very ardent about, but as to which he cared but little; but there were three supreme questions which he believed lay at the root of the very life of English people. One was the preservation inviolate of the inheritance of the English national character in the English Christian schools. Secondly, a power whereby the enormous monopoly of the drink traffic could be controlled. Owing to the enormous amount of capital invested in this trade, it had been until lately quite hopeless to attempt to deal with it, but there seemed now an opportunity of doing so, and every social reformer ought to lay this great question to heart. He would not go into the question of what should be done, though he had very clear ideas about it. He would not commit to anybody the power of putting public houses anywhere without asking the people of that place whether they wished them or not. The third and last point was the domestic life of the people. He was no believer in State ownership or centralisation; or in social theories which would invest in the governing powers the control of houses; he would much rather that an Englishman's house should still continue to be his castle. On the other hand, he did not believe that this enormous work could be accomplished by the mere charitable, eleemosynary, or voluntary principle. But between these two extremes lay the great commercial principle which had covered the whole face of the country with the wonderful network of railroads, and by that means he hoped the housing of the poor would be accomplished.

Colonel Webber then took the chair.

The paper read was—

THE DWELLINGS OF THE POOR IN LARGE TOWNS.

By Elijah Hoole.

Happily, there is now no need to insist on the importance of housing the poor, or on the pressing necessity of putting an end to the squalor and to the degrading surroundings in which the labouring classes are crowded. Public attention is aroused, and the danger now seems to be, not that nothing will be done, but lest some great effort should be made to end at a stroke a condition of affairs which has been the growth of centuries, and has largely resulted from long-continued neglect.

It may be affirmed, without risk of contradiction, that no sudden remedy, however extensive, can possibly deal effectually with the degradation and poverty of the lowest stratum of our town populations. Could you put them all in the best-arranged model dwellings to-morrow, their condition would be worse instead of better, unless you are prepared at the same time to control and educate them by experienced and properly-qualified persons, who have themselves undergone a special training to fit them for this difficult work. The improvement of the condition of the labourer is necessarily gradual, since it depends, not on rebuilding the dwellings merely, but on dealing with the various causes which combine to produce the deplorable results which have lately had so much public attention.

In the meantime, while the work is still undone, any approach towards the solution of the very difficult problem thus presented may not be without value, especially when embodying the results of actual experience.

There are two main divisions of the subject which must be carefully distinguished at the outset—the housing of the artisan, and the housing of the labourer. These two terms may be allowed to stand for the two great divisions of the working class, the skilled and the unskilled workers.

The first half of the question has been successfully met. For the upper working class the various dwellings companies have provided decent and healthy homes which, though somewhat monotonous in appearance and arrangement, are an infinite improvement upon the courts and alleys they have usually replaced. The financial part of the problem has also been successfully treated, and it is now only necessary to repeat, with some obvious improvements, what the dwellings companies have done, and the entire artisan class may be housed in a healthy and comfortable manner, while the investment will return a fair per-centage on the capital employed. The excellent service which the dwellings companies have thus rendered the artisan is too well known, and their comfortable sets of rooms, better furnished with useful appliances than many houses of the middle class, are too familiar to need detailed description. The object of the present paper is to endeavour to point out how what has been so successfully done for the artisan may also be done for the labourer.

It appears to have been supposed by their promoters that, by providing sets of rooms in model dwellings, they would be able so to raise the condition of the labourer, that he would no longer live in the squalid manner in which he is still found, but would inhabit a set of rooms which would form a well arranged and cheerful home for his family. One can hardly believe that the class most in need of healthy housing—the lowest—would have been deliberately passed by without one effort for its improvement. Be this as it may, the fact remains that while the *élite* of the working class has been thus provided for, the squalid poor of the lowest stratum have been left almost entirely to their own misery.

In 1873, about 27,000 persons were living in the improved dwellings provided by the various companies, &c., and, in 1881, these tenants had increased to nearly 39,000, but only a small proportion of these were of the labouring class, the majority being artisans. Now, as the inhabitants of the slums of London are estimated at 200,000, it is obvious that even if all the improved dwellings were exclusively occupied by them, there would still be a great work to do. But so far from occupying the improved dwellings, the labourer is excluded from them almost without exception, both by the rent and by the kind of accommodation provided.

The dwellings companies provide a set of rooms, but he can only afford one, the rent of a set of rooms being quite beyond his means. He needs accommodation for carrying on his trade, but if they do not actually forbid its exercise, they can afford him no facilities or space for practising it. But if the dwellings do not suit the labourer, neither does the labourer, as a tenant, suit the proprietors of the dwellings. The lowest strata of our town population are the most difficult to control, and to keep within sanitary and orderly limits. There are very strong reasons for the apparent neglect of the squalid poor by the dwellings companies. They are by no means an easy class to deal with. Very destructive to their dwellings if not watched and controlled, using every artifice to avoid payment of rent, and constantly changing their lodgings, they require a special organisation for their management, an organisation which has time to inquire into the character and habits of the tenants, which recognises other crimes beside the non-payment of rent, and will either reform or eject the thief and the prostitute, though they can often pay higher rents than the labourer and the laundress.

An entirely different agency is thus required for collection, needing much more discretion and judgment than is necessary in dealing with the artisan, insisting on the payment of the rent, and yet ready to make allowance for illness, and even to distribute relief.

A serious difficulty arises from the fact that occupying rooms side by side with the honest and industrious are the vicious of both sexes, many of whom have sunk down to their present degraded position from a much higher level, and who infect their neighbours, while they themselves are debased by their own squalid surroundings.

It is hopeless to attempt to eliminate the vicious and debased from any scheme of housing the poor. If you select the deserving only, and provide for them, you merely leave the rest to a more hopeless degradation. To pick out the few good specimens that we can find, and to leave the rest, will never produce satisfactory results. The class must be dealt with as a whole. In considering how best to house the labourer, existing conditions must be accepted as fixed, since we have no power to alter them. The wages of the labourer are fixed by the supply and demand of labour in the market. House rent is fixed by the cost of building, the amount of taxation, and the value of land. To alter either wages or house rent is impossible, since they are regulated by conditions quite beyond our control.

It will be seen that the various questions with which we have to deal are thus much narrowed. We have not to make, or even to modify, the conditions under which the labourer exists, but we have to see what can be done to improve his position, while keeping strictly within their lines. Help him to higher wages if you can, help him to lay out his money to the best account, but do not offer him rooms at 5s. per week when he has only 3s. to spend, and above all, do not try to house him by charity, by giving him more than his money is worth. Such a proceeding can only be very partial in its application, is calculated to check rather than to extend the proper housing of the poor, and pauperises the recipient instead of benefiting him. In other matters beside that of price existing conditions must be accepted. It is useless to approach the subject with preconceived theories, such as, for instance, that every family ought to have three rooms, or that no room ought to be used both by day and night. What has to be done is to see how the labourer is lodged now, and how his dwelling may be improved without raising the rent above his means. As a rule, he, with his family, occupies one room only in an eight or ten-roomed house, originally planned for one family, but now containing one family in each room. When the house was built, it was provided with sanitary and washing appliances for one family, and these, in a more or less dilapidated condition, are now made to serve for eight families or more. We have had many descriptions of the state of such tenements of late. Suffice it to say that unless repairs are done by the tenant himself, at his own expense, they are often omitted altogether. Not only do families live and die in these single rooms, but in many of them trades are carried on. Tailoring, cobbling, laundry-work, and a host of small trades are practised in the single rooms, which are thus both sleeping rooms, living rooms, and workshops in one. On these trades thus exercised the livelihood of the family largely, if not entirely, depends. The rent of single room tenements in London ranges from about 2s. to 4s. per week, and includes all rates and taxes, with the cost of water supply, and of such repairs as the sanitary authority enforces.

This mode of living is by no means what could be wished for the labourer, whose exertions it might be supposed should surely procure for him some better surroundings, especially when the arduous nature of his work, and the risks and exposure he has to undergo in its pursuit, are considered.

To omit to provide single room tenements, under the plea that such a mode of housing the labourer ought not to be countenanced, is really to perpetuate the evils complained of in their worst form, since by carefnl superintendence they have been greatly mitigated, and by re-arrangement nearly, if not quite, abolished; nor would it succeed to give two rooms at the price of one, since this would be simply to make a present of so many shillings a-week to each family. It is clear that whatever is done must be done within the existing limits of wages, rent, and customary accommodation. The fact must be faced that hundreds of thousands of persons are living a family in a room, and that what is needed by them is the best room that can be had for the money they can afford to pay, with as much isolation from their neigbours, as much fresh air, pure water, and light, as we can secure for them under the circumstances in which they are obliged to live.

Two methods are thus open in dealing with the dwellings of the labouring class. Either the existing dwellings may be taken in hand and rendered as far as possible healthy and sound, or they may be demolished and rebuilt on an improved plan. The first method, that of maintenance, is being carried on with increasing success, and is substantially as follows:—Either the lease or freehold of existing labourers' dwellings is purchased, the most squalid tenement houses being selected by preference. They are taken over, tenants and all, just as they are. A superintendent is appointed to keep order, the premises are thoroughly cleansed, overcrowding is stopped, the drainage and water supply are made efficient, dangerous defects in the structure are remedied, while repairs of a decorative kind are left to be granted to tenants who pay puuctually and behave well. The tenants are not evicted, but they are put on trial, and only the incorrigible are at last displaced. This plan has worked exceedingly well, and can be quickly and easily adopted. It is also remunerative, and is often practicable where, from shortness of lease and other causes, rebuilding is impossible. The advantages to the tenants are immense and immediate. This system of management is a most valuable discovery, forming as it does the basis upon which alone any plan of improvement can safely be founded. It must, however, be regarded as a temporary measure, preparing the way for permanent improvement. This plan being eminently practical, the houses to which it is applied form an excellent training ground for superintendents, collectors, and managers, without whose experienced aid any scheme for housing the labourer must inevitably fail.

The form in which the labourers' dwellings in town must be rebuilt is decided by the price of land and by the necessities of superintendence. Cottage homes, such as have been so successfully provided near London, for a low-waged class, at Clapham, at Harrow-road, and elsewhere, are out of the question on land costing more than £500 per acre. Five or six stories must be built in London, to put enough people on the ground to pay the ground-rent; and staircases and entrances must not be too numerous, or the difficulties of management will be greatly increased. Rebuilding in large towns must thus take the form of blocks. But there is no need for the blank dismal exterior, or for the exact repetition of arrangement which characterise so many blocks of industrial dwellings. A much more homelike look might easily be given, and greater variety in the accommodation and arrangement might be secured, by the exercise of a little tact and thought. No doubt the policy of encouraging all labourers whose work will allow them to live out of town is excellent, but it is, unfortunately, inapplicable to a very considerable number who must live near their work, and it is just this part of the question that presses for solution. Rebuilding has advantages of its own which can never be shared by the old tenement houses. By rebuilding we get rid of the accumulations of filth and vermin which make old tenements so loathsome. Sanitary defects are also remedied, tenements are isolated, so that infection cannot pass from one to the other, and are so placed as to be properly inspected and controlled by the superintendent. So far from a block of labourers' dwellings being necessarily repulsive or monotonous, it is found that the more attractive and cheerful in appearance it can be made, the more eagerly are rooms in it sought after. Not merely does the value of land govern the form of building, but it has affected and will increasingly affect the position, if not the existence, of the lowest stratum of our town population. The labourer living in town is at the mercy of the speculator for his home, and probably for his very existence. An increased demand for warehouse or office accommodation would make it profitable to buy up and demolish labourers' dwellings, in order to erect a superior class of building; indeed, this is going on now, and has been going on for many years past. The labourer may thus at any time be practically evicted from London, and from our large towns, without power of resistance. Whether or not the conversion of the sites of labourers' dwellings to other purposes calls for legislative interference, is a question well worth consideration. At present there is nothing to restrain the speculator who chooses to purchase the labourers' dwelling, and the land on which it stands, from destroying the houses, and from devoting the land to purposes which will exclude such dwellings for ever. The class evicted is helpless in the matter, having no capital wherewith to secure their homes. Other classes similarly threatened can combine and purchase their dwellings, but the labouring class, by the very condition of its existence, cannot do this, and surely is entitled to some protection. Under the Artisans' Dwellings Act, accommodation at least equal to that destroyed has to be provided. It would surely be well to extend this provision somewhat further, so that whenever low-class dwellings are destroyed, an equal amount of houseroom should be simultaneously provided within a reasonable distance.

A case may be quoted which illustrates this necessity. The freehold of a court in the city is owned by a family living out of England. The number of interests in the freehold made it impossible to do anything but either to sell or to keep the old houses in repair as labourers' dwellings. To sell would have been more profitable, since the land is estimated at £2 per foot, but to sell would mean the displacement of the tenants, and through, consideration for them, the other alternative was chosen. After a time, the court is condemned by the authorities, and the tenants are turned out. But although the authorities can close the houses, they cannot compel the owner to build others for the labourer, and if things follow their natural course, the empty houses will be pulled down, and warehouses and offices will cover the site.

The rise in value of land from adjoining improvements furnishes another strong reason for securing the existing sites for labourers' dwellings from conversion to other purposes. The freeholder has usually extracted his rent from his tenants, and has expended little enough upon their dwellings. What little has been spent in repairs they have paid for perhaps several times over, but all round new buildings have sprung up, and have raised the price of land, and now it is too valuable for the purpose to which it has been so long applied. He, therefore, sells it for what it will fetch, and the tenants are turned out to crowd into slums already over full. Tenants who have passed their lives upon the soil have no claim to any part of the unearned increment which goes into the pocket of the absentee freeholder. It would at first sight appear a simple matter to secure a site for the kind of dwellings referred to, but in practice this is found to be one of the greatest difficulties which has to be encountered. Either the land is too highly priced, or is covered with worthless buildings bringing in a rental which must be paid for; or it is let on a lease too short to build on, or is the property of persons who cannot sell, or who are already pressing an undue profit from their wretched tenants. The leasehold system is a main obstacle in the way of rebuilding, and is a great encouragement to flimsy construction and scamping.

As an example of the difficulties in the way of improvement, take the case of a court in

St. Pancras, probably one of the worst in the parish, thirty houses in which have recently been purchased and are now being managed by a dwellings company. The houses contain eight rooms each, and though originally built for one family, they now contain eight each. The squalor and degradation of the tenants is extreme. One of the City companies owns the freehold, and, though anxious to do its duty as landlord, was all but powerless, as leaseholders stood between it and the miserable tenants. Every few years a raid was made upon the leaseholders by the solicitor and surveyor to the company, who, by serving notices of dilapidation and breach of covenants, enforced a number of repairs. The solicitor's and surveyor's fees for enforcing these repairs absorbed nearly the entire receipts from the ground-rent in the intervening years, and thus the City company gained little but the odium attaching to the owners of such mismanaged property. But while, as freeholders, they only received the low ground-rents of the original lease, an enormously increased ground-rent was paid by tenants, and the difference went into the pocket of a speculator. When such property as this is purchased, the outlay is usually too large to allow of rebuilding, since a price has to be paid in proportion to the rental for which the squalid tenements are let. After the purchase, a considerable further outlay has to be made in repairs. This case is one in which management only is practicable until the lease runs out.

Our building Acts contain no restriction upon the conversion of a house into tenements, and require no additional sanitary or other provision for the twenty or thirty extra people crowded into them, and no adaptation to their new purpose. Our building Acts define the size of a hearth to an inch, and they prescribe the thickness of a wall to half-an-inch, they enlarge at great length upon that sacred institution the party wall, but not one word do they say against making a house built for one family serve for ten, nor, if this is done, do they prescribe any addition whatever to the arrangements or accommodation.

The sites now occupied by the dwellings of the labourer will usually be found well placed for the convenience of the class they house, and though the existing dwellings may be overcrowded, the land now occupied, if properly laid out, would, without any crowding whatever, serve for a much larger number. For instance, in 1873, the population in some of the most crowded blocks in St. Giles was calculated at 400 to the acre. In Soho, the *Lancet* Commission of 1874 reported that there were 428 persons to the acre. Sir Sydney Waterlow, in 1875, said that it was easy enough to arrange for the accommodation of twice and thrice as many persons to the acre as there were at present. He could point to several blocks where there were more than 1,600 persons to the acre without the least overcrowding. In the sub-districts of St. Paul's, St. George's-in-the-East, and of Bethnal-green Church, two crowded East-end districts, the population, according to the census of 1871, was 281 and 202 to the acre. Mr. Moore, secretary to the Industrial Dwellings Company, says, speaking of the Whitechapel and Limehouse scheme, "The Metropolitan Association for Improving the Dwellings of the Poor, lodge 1,135 persons to the acre, including open spaces; and the Peabody Trustees have planned to lodge, on the sites they have bought from the Metropolitan Board of Works, 941 persons to the acre."

What price may safely be given for land on which to house the poor is one of the first questions which has to be considered when either purchase or rebuilding is contemplated. As the circumstances of each site vary, it is impossible to lay down a hard and fast rule to apply to all cases, but in favourable positions £20,000 per acre has not been found too high a price to yield a fair return upon the outlay. High-priced land has usually some special advantages to offer, and by utilising these, still more expensive sites may be brought well within the range of possibility. It is not necessary, or even desirable, when building labourers' dwellings, to mass a large number of this single class together and to build for them only. On the contrary, it is advisable, both from a financial point of view, and for many other reasons, not to separate the labouring class from the rest of the population. Room can be found for many of this class upon sites too expensive to be given up to them altogether. The lower floors in many places would let well as shops, workshops, or offices, and might be surmounted by an upper floor or two of labourers' dwellings, with separate access. The higher rents received for the lower floors would enable the upper rooms to be let at rents within reach of the labourer, while the buildings might be so arranged that no interference or inconvenience would result to either class of tenant from the proximity of the other. In an Italian palazzo you often find on the ground-floor a range of small shops and stables, while on the first-floor, perhaps, a duke lives, and the rents of the upper floors are gradually reduced, till the top terrace is reached. There are many buildings in London, and in our large towns, which would bear another storey or two, to which separate access and outlook could be given. In this way a large labouring population could be housed without giving up valuable land exclusively to the purpose, and the separation of class from class, already too great, would be to some extent avoided. Hand-in-hand with the provision of new dwellings must go the demolition of the old. Demolition is as important as reconstruction, and the destruction of the old is essential to the success of the new dwellings. Demolition is necessary because the existing dwellings are saturated with filth and alive with vermin; because, having been built for one family only, they are unsuitable to the purposes to which they are now applied; because inspection and control are more difficult than in buildings specially planned for these purposes; and because light and air must be let into the narrow courts and alleys where the poor are crowded together. But there is another and more cogent reason still, and that is, that, as a rule, the poor people prefer the rookery to the model dwelling. They are accustomed to the dirt and squalor which strike a visitor so painfully, and they prefer the freedom from control and inspection which the rookery affords them. Cleanliness, too, means a certain amount of additional work, which they require some stimulus to make them undertake. But control and inspection are the essential elements of any scheme for housing the labouring class, and model dwellings without them would be quite as bad or worse than the slums. It may be urged that the labourer has a right to his freedom, a right to go his own way. But this he has had, and look at his condition. Severe and repressive measures are not advocated; a friendly intercourse between the landlord and tenant is rather what is needed to restore the labourer's self-respect, and to lift him out of the degraded position in which he is so often found.

One of the most important points upon which correct information is essential before rebuilding, is that of the outlay which will be required. And here it may be stated positively, on the experience of many buildings erected during the last fifteen years, that there is no insurmountable financial difficulty. The rental received from the labourer will pay a fair percentage upon the outlay necessary to provide him with the amount of accommodation to which he is accustomed. The first cost of building labourers' dwellings in blocks in London may be taken at between 7d. and 8d. per cube foot for all expenses except land, and the cost per room, including share of staircase, laundry, sanitary arrangements, &c., would be a little under £60. The rooms can be let at an average of 2s. 9d. per week. We have then the following estimate of outlay, and of annual receipts and expenditure per room. The first cost, exclusive of land, is as above stated, £60. The annual receipts will be £7 3s., allowance being made for repairs and loss of rent by vacant rooms in the estimate for annual expenditure which will consist of these five items:—

	£	s.	d.
(1.) Dividend on first outlay, at 5 per cent.	3	0	0
(2.) Rates, taxes, and insurance, 25 per cent. on net receipts	1	10	9
(3.) Collections at 5 per cent. on net receipts	0	6	3
(4.) Ground-rent	0	18	0
(5.) Balance for repairs and loss of rent	1	8	0
	£7	3	0

The form of the building being necessarily a block, the grouping of the rooms, the access to them, and the sanitary and other arrangements have to be considered. While a certain number of single rooms are provided, it is by no means intended that families should continue to live in one room, unless absolutely compelled to do so by lack of means. Many are now living in one room, that could and ought to occupy two or three. The rooms should, therefore, be so grouped together and connected by entrances that, while they are independent of each other and can be let singly to separate families, they can also, without any alteration, be let in pairs, or three or four together. A certain proportion of two-roomed tenements should be provided. When the necessary height has been given to a room, the larger the floor space that can be secured the better. If a room is to be 12 ft. × 12 ft. × 8 ft. 6 in., it is better to make the floor 12 ft. × 12 ft. than 12 ft. × 8 ft. 6 in., the cubic content being the same in both cases.

The single-room tenement should contain a good and strong cooking range, with oven, but without boiler, a coal locker so arranged as to serve for a seat, and a cupboard to contain food and crockery. In planning the room, a comfortable corner should be reserved for the bed, with which neither window, door, nor fireplace must interfere. A broad window-sill for window gardening is desirable, and the door of each single-room tenement should open to the external air, to avoid the possibility of infection being conveyed from room to room. The balcony offers an advantageous mode of access to the one-room tenement, and should be reached by a broad stone staircase, open to the air. The staircase is apt to present great difficulties in management, if not very carefully considered. One of the great objections to converting an ordinary house into a tenement house is, that the front door being left open at night to suit the late hours of some of the tenants, the staircase becomes accessible to tramps and others. They enter the passages and sleep on the stairs of these houses, and by their vile behaviour contribute greatly to degrade the inhabitants. If the staircase is of stone, open to the air and rain, well lighted both by day and night, and overlooked by the superintendent's rooms, it cannot thus be misused. No other kind of staircase is admissible, and the fewer of these the better for cleaning and management, it being better to increase the size than the number. Outside the one-room tenement, and at a little distance from it on the same floor, or on the half-landing above or below, should be the pail service, where water can be drawn not from a cistern where it has been standing for days but direct from the main. A sink stone in the floor will take any water spilt in drawing, and will also take the waste water, which it is important should be emptied away over a sink stone, and should pass through small perforations before entering the drain, so as to separate from it the flannels, soap, scrubbing-brushes, and other things left forgotten in the pail, and sometimes, when precautions are omitted, introduced with disastrous effect into the drain. The arrangements connected with the water supply and drainage are by far the most difficult to manage, and give more trouble than any other. This trouble is increased by the regulations of the water companies, whose waste-preventing arrangements are frequently waste producers from their liability to get out of order. The screw down valve is a fruitful source of waste, as people will not take the time and trouble to close it completely. In the common laundry, the use of a copper for part of a day each week is assigned to each tenant of a single room, who also has access to a drying ground, upon the flat roof of the block. Separate sanitary arrangements cannot be given to each single-room tenement, but are assigned to every two or three tenements, and are kept under lock and key. The simpler and stronger these arrangements are the better. Iron traps and iron pipes are found to answer best. Lead is quite inadmissible, being easily damaged or stolen, besides being more costly. The drainage should be by glazed stoneware pipes, laid in straight lines and with good fall, manholes being substituted for bends and junctions, and ample means of examination and clearing being provided. Thorough ventilation of the drains, and their complete isolation from the sewer, is of course essential. A large dust-shoot, with an opening on each floor, should receive the ashes and refuse. Ventilating appliances must be provided to each room, and should be out of sight, or they will certainly be stuffed up and closed. An inlet for fresh air, without draught, can often be made over the architrave of the door. A small slot-hole, cut in the meeting-rails of the window sashes, is inexpensive and very useful, as it gives an upward current of air without draught, and imperceptibly changes the air of the room. It is also not easy to close up.

Repairs require a large expenditure when old tenement houses have to be maintained and managed. This arises from two causes. One that the labourer and his family are not very careful of their dwelling, the other that old tenement houses are often all but falling to pieces. The labourer is rough and strong, and requires surroundings not easily damaged. He usually knows good work when he sees it, and he despises and is, therefore, not careful of the miserable building in which he is compelled to live. Beside this, the materials, even if good, and the mode of construction of an ordinary dwelling-house, even before it has become so old as to have descended to the condition of a tenement house, are unsuitable in the highest degree. For instance, instead of the rooms being enclosed by brick walls able to resist a considerable amount of wear and tear without injury, the rooms in which the labourer and his family are usually lodged are enclosed with lath and plaster. This, when new, is very tender and easily damaged, but when in the state in which we usually find it, having lost its precarious hold upon the slight laths, is only held together by the layers of paper with which the walls are covered. The least touch causes this plaster to fall, and when once a hole is broken into it, the damage spreads with great rapidity, and in repairing it, it is difficult to know where to stop. Not only are the walls and ceiling in a condition very liable to damage, even when most carefully used, but the floor is usually worn so very thin in places that the legs of the furniture, and even the feet of the family, unexpectedly break through. Every other part of the room, the door, the window, and the fireplace, has long ago been worn out, and should have been replaced. Gradually, all parts of the building, except the foundations and the lower parts of the wall, have to be renewed. This process of rebuilding, bit by bit, is misnamed repair, and is supposed to be due to the destructiveness of the labourer. The fact is that the labourer is compelled, by necessity, to live in a house which is in such a state of decay that every other tenant has left it. His house is dilapidated, not because he has destroyed it, but because he cannot find a house to live in which is not in a state of dilapidation, and cannot compel his landlord to repair it. Vigorous action on the part of the sanitary authorities might easily prevent this. They have hitherto been far too chary in condemning premises unfit for human habitation.

It is not proposed to supersede the regular collector where he can deal satisfactorily with the tenants, as he probably can with the superior artisan. But at present a large proportion of tenement house property is in the hands of landlords very slightly removed from the class inhabiting it, and these landlords usually collect their own rents. The collector or agent is only called in when the property belongs to persons of a higher grade, and when the landlord is practically an absentee. It is, therefore, of great importance to train and employ collectors of education and intelligence, who can be trusted to recommend cases for relief, and who can distinguish genuine distress from that which arises from idleness and vice. The hold on the tenants is immensely increased by the knowledge that help is forthcoming in time of need. Also by shutting up other channels of relief, and by allowing it only to come through those best acquainted with the recipient, mendicancy and pauperism are much reduced. The collector receives the ordinary per-centage paid for collecting rents. In addition to the collector, there is a resident superintendent, who is by preference a retired policeman, soldier, or sailor. His duty is to keep order, to report any breach of rules, to see that the premises are kept clean, that the gas, water supply, and drainage are in proper order. Usually he is able to do some of the repairs himself, and having a pension or some means of his own, is glad to superintend in exchange for having his rooms free.

Into the entomology of tenement houses it is not proposed at present to enter. The subject is, however, both important and extensive, as those have reason to know who have seen tenement houses pulled down.

In new tenement buildings care is taken to use materials not easily damaged. Lath and plaster partitions are avoided, and brick walls are substituted for them. Iron balusters and stone steps supply the place of wood, and being incombustible, are not torn up for firewood. Everything being well chosen for its purpose, strong, and not in a state of decay, the damage of ordinary use is small, even with the labourer as tenant. Of course, whitewashing, colouring, and occasional painting have to be done, but very few other repairs ought to be required for many years, if in the first instance the buildings have been well constructed. There is no ground, therefore, to fear that the excessive amount of repairs needed in old tenement houses will also be required in new buildings.

We have heard a good deal about benevolence in connection with the subject of housing the poor; and, no doubt, those who have been longest at work in this department commenced it from motives of the purest benevolence. But has it not now outgrown this earlier stage, and having demonstrated that it has a sound financial basis, has it not passed into another phase, which fits it for larger adoption than if it were simply a work of charity? It is, of course, not to be looked at only from what may be called the stockbroking point of view, or merely as a means of getting so much annual income from so much capital laid out. It will bear the closest examination in this aspect, but there are other and important sides to the subject. It is akin both to legislation and to education. Those undertaking the management of the poor have to make regulations for them, and have to see that their laws are obeyed. They have to educate their tenants in habits of order, decency, frugality, and self-respect. We do not talk of the benevolence of a Member of Parliament, who spends the night in legislating for the benefit of the nation, or of the benevolence of the School Board member, who passes weary hours in debating the difficult questions inseparable from education. The same faculties of organision, of government, and of instruction will find a humbler, though an important, field for their exercise in making laws for, and in superintending communities of the working class.

If benevolence is really necessary in order that the labourer may be properly housed, is it not clear that he is being deprived of the fair share of the value of his labour by those above him, since, with all his exertions, he has to fall back on benevolence for several of the necessaries of life?

Superintendence is an essential element of success in housing the labourer. Without it, the rebuilt or repaired court would at once be as bad as ever. The present condition of the poor is the result of a let-alone policy, which leaves the lower working class to the mercy of the speculator, whose only consideration is how to get the most out of him with the least expenditure of time, trouble, and money. Without superintendence every kind of disorder will prevail; buildings will be damaged, rents unpaid, and any attempt to improve the condition of the tenant must fail. The work of re-housing the poor must be gradual, and cannot be done suddenly or wholesale. Experience must be acquired, and the discoveries already made must be acted upon, and the successes followed up. If the managing and superintending elements are outrun by the acquisition or building of dwellings, no success can be attained. A block of so-called model dwellings in the east of London is a lamentable instance of this. Built for a company without regard to the wants of the neighbourhood in which single-room tenements were needed, the sets of rooms did not let because they were too highly rented, and provided too much accommodation. In consequence the company failed, and the buildings came back into the hands of the builder, who let the rooms to any one who chose to pay the rent. There was no efficient superintendence, and the consequence was that the condition of the tenants was as bad as that of any we have had described of late. Now the sanitary authorities are interfering and compelling certain necessary changes. This block of dwellings furnishes a most instructive comment on the necessity of efficient superintendence.

In conclusion, there is no need to wait for further legislation to facilitate the housing of the poor, nor for some great commercial association to take the matter in hand. The work will be done, if ever it is done at all, by those interested in the well-being of the labouring class; it will be done gradually, and will grow out of what has already been successfully accomplished. As a first step, the capitalist will purchase the dwellings and the land on which they stand. Even if the movement stopped here, it would be an immense gain to the labourer to have a landlord interested in his welfare rather than in the amount of rent which could be wrung from him. Land suitable for dwellings will also be secured. By the activity of the sanitary and local authorities, unsound habitations will be condemned and destroyed, and will not then fetch the fancy prices often realised for property of this class. Those who have leisure will associate themselves with the existing agencies, will learn the secret of their success, and will be preparing to take charge of a small community of labourers when the opportunity arises. Others will assist by supporting the authorities and urging on them the administration of the existing laws against nuisances, overcrowding, facilities for intemperance and vice; they will call attention to dangerous structures, defective drainage, and water supply. All will assist by making friends with those of the labouring class to whom they have readiest access, and who will be found, despite their lack of many of the essentials to their well-being, to be far less unlike those who have all these advantages than want of acquaintance with their good qualities would lead many to suppose.

DISCUSSION.

Mr. CHATTERTON gave a description of his own experience in dwelling accommodation. He said he lived in a court near Drury-lane; in a house not a brick of which was sound, and portions of which were absolutely fastened together with floorcloth, but which produced nearly £156 a-year. For the wretched room in which he and his son lived, in which there was hardly room to turn, he had to pay 4s. a-week. He denounced the notion that this state of things could be remedied by charity or philanthropy, and said that if he could afford the rent asked in the model lodging-houses, he would not consent to live there subject to the restrictions which were imposed. He maintained that dwellings could be erected far more economically, which might be let at 1s. per week per room. The present Royal Commission was only another sham which would end in spending more of the working men's money, for they, after all, had to pay for everything by their labour.

Mr. HENRY MAUDSLAY said he had ventured on a previous occasion, when a similar subject was brought forward, to raise his voice on a question which seemed to have been overlooked, viz., emigration and the distribution of population, and he would again insist on the importance of considering this point. Population got concentrated in particular spots from local circumstances. At one time, for instance, Poplar got much overcrowded from activity in the iron ship-building trade; then, after a time, there was a strike; the trade left the district, and the population had to follow it. He was, therefore, in favour of assisting the emigration of certain classes of the population when there was no longer a need for their services where they were, and taking them to some country where there was more room for them, and less danger of overcrowding, whilst those who remained behind would also be relieved.

Mr. MUIR feared that unless great care were taken, the excitement on this subject would run the course of all epidemics, die out, and leave things as they were before. Coming from Glasgow, which had been held up as an example to other cities, it was his duty to state that the great Improvement Committee, which began work in Glasgow 17 years ago, and had not finished, had been a failure both sanitarily and financially. He agreed with Mr. Hoole that there were two modes of dealing with this question—destruction and reconstruction, and the utilisation of existing buildings. He had taken an interest in this question for the last forty years, from having observed the condition of the poor in Glasgow, when they suffered from the Irish famine fever, and he had come to the conclusion that the great source of disease, consequent on overcrowding, was the filthy condition in which circumstances compelled the people to live; and this arose to a great extent from the fact that courts, closes, and common stairs were liable to contamination by one or more filthily inclined tenants, against the wish of the majority. In Glasgow, the 'lands' or houses of flats would have, say, twelve tenants on a common stair, and the police regulation was that this stair should be cleansed once a day by the tenants in turn. But if one dirty woman neglected the duty, or was away from home when her turn came, none of the others would do it out of their turn, and so it went on until probably the whole of them were summoned. His remedy would be, instead of appointing inspectors to compel the people themselves to do these things, to appoint a man to do it. There should also be a rule requiring the walls of such tenement houses to be lime-washed once a year, for cleanliness outside induced people to be cleanly inside, whilst it required a very strong effort to keep a dwelling clean if the external surroundings were filthy. The huts of the crofters in the Highlands would not be considered fit for a pig to live in; but they were healthy because the inhabitants had only to open the door to get the beautiful mountain air. He remembered the Crimean war, and knew three gentlemen who went out as Commissioners, one only of whom, Sir Robert Rawlinson, survived; they restored the British army to health by enforcing cleanliness. It was the same in the navy, where a 4,000-ton ship would have 1,000 men on board, and their health was maintained, not by elaborate sanitary appliances, but simply by rigid attention to cleanliness.

Mr. WILLIAM BOTLY said the paper was most able and interesting, but it would have been more complete, if it had included the dwellings of the poor in the country. This had an effect on the overcrowding of the towns, because for the last half-century landed proprietors had generally been pulling down cottages and driving the poor into the towns. Some years ago he bought a small estate of some 170 acres in Wiltshire, and found there was not a cottage on the property, and the labourers upon it had to walk six miles from Salisbury. He immediately built four cottages, so that the men could live close to their work; they all had gardens, and he did not find that they frequented the public house. One question referred to in the paper was whether the conversion of the sites of labourers' dwellings to other purposes called for legislative intervention. He had advocated, twelve years ago, that all landlords should be compelled to have on their estates sufficient dwellings for the labourers employed upon it; and pointed out that if something of that kind were not done before long, some much more drastic measure would be called for.

Mr. O'LEARY said he had been a working man, and was at present connected with an organisation which was working on this question of housing the poor. One of the many evils which the working classes in London had to deal with, was having public houses placed indiscriminately in their midst. He knew one street with a number of courts leading out of it, and at the angle of almost every court was a public house, which was a source of injury to the neighbourhood. The accommodation for servants had not been alluded to, but he had seen it stated that in some of the large mansions at the West-end, the men of the servant class resided under worse conditions than many of the working population did. Again, there was the question of compensation. Mr. Hoole said it was as necessary to demolish as to reconstruct; and he knew a large railway which was about to take down a number of working-class dwellings. Many of these people had resided ten or fifteen years in the neighbourhood, and had become known there, so that if they were out of work, the local tradesmen, and even the landlords, would give them credit, which was a very substantial advantage. All these would be ejected at a fortnight's notice, without one shilling of compensation; but he contended that they had as much right to it as the leaseholder, the man of business, or even the freeholder. During the last decade, the number of agricultural labourers had decreased at the rate of 9 per cent., most of them coming to the towns, and his experience was that an unsanitary country made unsanitary towns. These men, whether coming from Connemara, the Highlands, or Devonshire, brought their primitive habits with them, and produced a general demoralisation wherever they went; whereas if they had a little social training in their own homes, much good would result. There were a large number of training schools and museums at South Kensington, but they were of no use in elevating the social habits of these men in different parts of the country. He had recently found, on inquiry, that fully 40 per cent. of the men who congregated daily at the dock-gates seeking work had to go away unemployed, and most of these were recruited from the country. What were these unfortunate people to do? Something beyond mere philanthropy was required. Emigration had been referred to, and he might say that he knew something about it, having travelled over the whole of the United States twice, and all through Canada and Manitoba. He admitted that a certain section of those who went out were benefited, but there was a very large proportion of those in London who were totally unfit to be sent across the Atlantic. Emigration might relieve the present congestion of population, but in another decade or two it would again be as bad as ever. Some remedy was required whereby the labourers should be employed on the soil instead of being imported into the towns. With regard to the dwellings themselves, he would not raise the question whether the Peabody buildings were the best, but he did think that those huge barrack-like buildings were not exactly the sort of places which high-spirited people would like to live in. He should not like to live there himself. He would rather advocate the improvement of the present dwellings, for in the suburbs, and places which were suburbs a few years ago, there were miles and miles of working-class houses which were suited to the population, if they were only taken in hand and improved by some authority, local or general. With reference to the statement made by Sir Sidney Waterlow, that 1,600 persons might be placed on an acre of ground, he believed sanitarians had considerable doubts whether it was desirable to do so, the necessary consequence being such a narrowing of streets that the free circulation of air was much impeded.

Mr. Liggins agreed with Cardinal Manning that before you could improve the dwellings you must improve the people themselves, and the best thing to do would be to deprive them of those attractive gin palaces which did so much harm both to their health and pockets. Local option in those parts of London would be the first step in the right direction. Overcrowding, particularly in the east end of London, could not be prevented, as it arose from altered conditions of trade and commerce. Some years ago, nearly all the fruit trade was carried on in small swift schooners, which were rapidly unloaded by large numbers of men; but of late those vessels had given place to large steamers, which had steam cranes on deck, and the whole of the work was done with very little manual labour, and consequently, many dock labourers—often far more than 40 per cent.—were unable to find employment. If they earned more money they would have better dwellings. The Peabody dwellings had done a great service for the better class of work-people, but they did not meet the wants of the unskilled labourers. He saw very little hope for the future, as he believed the trade of London was fast diminishing, and it would be highly desirable to establish a Government scheme of emigration. Mr. Hoole said the inspectors were too chary in condemning unsanitary buildings, but he believed this was very often because they knew that pulling down some would only cause more overcrowding in those which remained.

Mr. Westgarth said he was very sorry to hear that the Glasgow improvements had proved a failure, for he had expected better results, but it only showed that public bodies and corporations were not so well fitted to manage these matters as private enterprise. The first speaker had described the wretched accommodation for which he paid 4s. a week, which he said was not worth 1s.; but he said he abominated interference, and that was the real key to the difficulty, because it was only by the greatest order and discipline, so as to economise management, that it was possible to give the poorest classes the very cheap accommodation they required. In discussing the matter with Miss Octavia Hill, he found she was very emphatic on two points, first, that there should be no charity; and secondly, that the tightest hand should be kept over the tenants. In no other way was it possible to reduce the expenses to a minimum. He thought they were in a fair way of meeting the problem so far as the artisans were concerned, for there was a rapid increase of accommodation which was found to be remunerative, but the very poor were not provided for. The main reason for that was the difficulty of keeping them in order, and preventing destruction of property. This led to responsible people and companies shirking the duty, and leaving to speculators, who screwed out of them the last penny they could pay. The mode of dealing with this class seemed to be pointed out by the method adopted in the registered lodging-houses. In the lower part of the house there was a large common room, which served for kitchen and hall, and the sleeping rooms were above. There might also be a system by which, in consideration of a very small additional weekly payment, the tenant should eventually acquire the property themselves, and he thought it would also be a good plan to partly furnish the rooms with plain, strong, incombustible articles, which could not be easily destroyed.

Mr. E. Bayley said there was a practical effort now being made in Southwark to furnish the accommodation required. Southwark was one of the most overcrowded parts of London, and the worst part of it was the "Mint." Two years ago a piece of ground there, nine-tenths of an acre, was cleared under Sir Richard Cross's Act, which had been lying idle ever since. It was sold to Sir Sidney Waterlow's Company, but those for whom that company provided would not come to live in such a slum, and therefore the company now offered to sell it for £5,500, and a company was being formed to take it up. The architect said that 440 rooms could be erected in a building of four storeys, in the form of an E, for £20,000, with £4,500 for the foundations which had already been put in, or about £61 a room. This would enable them to let the rooms at an average of 2s., and pay 4 per cent., allowing 10 per cent. more for repairs and vacancies than was usual in artisans' dwellings, where it was usual to allow one-third of the total receipts. It was further proposed that the rents should be collected in the way Miss Hill found so advantageous, by the aid of ladies who would make friends of the tenants. The fittings would be simpler than in the industrial dwellings, and of course cheaper. This was, he believed, the first experiment of the kind, and if it succeeded, no doubt others would follow, and it would be taken up in a commercial spirit. He brought the scheme forward because they wanted not only shareholders, but also practical men to act as directors.

The CHAIRMAN said there was an enormous amount of leeway to be made up in London with regard to this matter, and anyone who felt inclined to help, must regard that leeway not only from a commercial and economic, but also from a legislative point of view. One point on which Mr. Hoole had touched as being of great importance was the deficiency of the Building Act, which had for so many years allowed buildings to be misappropriated, and to this was due the enormous crop of wretched tenements, with a common staircase. The fact that from 900 to 1,000 persons could be decently lodged on an acre which had hitherto only afforded wretched accommodation to 200, was very encouraging, for though they might agree that 900 to 1,100 per acre was overcrowding, still it was evident that the 200 could be placed in a much better condition than they now were in those wretched tenements and in the still more wretched buildings which had been springing up in some of the suburbs.

Mr. HOOLE, in reply, said they must all sympathise with the first speaker, who gave such a graphic account of his experience, but it was quite impossible to build small separate houses in the way he suggested while land in London was at its present price. The authority for the statement that cottages could not be built on land worth upwards of £500 an acre, was Lord Alwyne Compton, who held a prominent position in the Cottage Building Company. He knew of several blocks built for labourers, either by companies or private enterprise, and believed there were several others; but still they housed but a very small proportion of those requiring accommodation.

A vote of thanks was passed to Mr. Hoole, which concluded the proceedings.

Correspondence.

NATIONAL WATER REGULATION.

May I beg for a little space for some remarks on the subject brought before the Society by General Rundall (see *ante*. p. 377).

I wished particularly to have attended, but I am now hardly equal to long evening meetings, and my deafness prevents my following fully the discussion, so I trust I may be allowed to speak in this manner. I would begin with two remarks—First, I am delighted to see the subject of water regulation at last brought before the public as a whole, being convinced that it is impossible to settle anything effectively while the four branches of it are attempted to be dealt with separately. Secondly, the remark with which one of the speakers wound up his speech was very curious, that the idea of preventing floods by storage reservoirs was one that no engineer acquainted with the subject would dream of. This remark was made by an engineer whose experience was, I believe, gained from the little nullahs, trifling rainfall, and petty lilliputian works of England; while the reader of the paper is certainly, at this moment, the very first authority in the world on this subject of water regulation, having had thirty years of engineering experience on the largest hydraulic works in the world without any comparison, having himself projected and executed works for the control of one of its largest rivers, and having been for five years in charge of all the irrigation and navigation works of India. Compare its rivers, five of the largest in the world; its deluges of rain (10 and 12 inches in a night), its weirs across rivers from a mile to four miles broad, its canals, broader than the Thames at Teddington, its reservoirs, some 50,000 of all dimensions up to 30 miles round, and 100 feet deep, and containing 200,000,000 cubic yards, with anything in England, and then decide who has the best materials for forming a judgment on the subject of water regulation—the man who has had practical knowledge of a lifetime throughout India, or one who has had to deal with the insignificant rivers and works of England. The flood discharge of Indian rivers are from 20 to 80 times that of the Thames. One of them rises in one part 80 feet, and where it is four miles broad it rises 30 feet in the monsoon. These rivers have been controlled by weirs and embankments; their floods provided for; 10,000,000 acres are now irrigated, and several millions more will be when the works are completed; 3,000 miles of canals have been fitted for navigation with locks capable of passing boats of 250 tons, and drains have been cut to carry off the tremendous local rains from the irrigated lands, so that the engineer for all India must have had occasion for considerable calculation; and to talk of such a man being unacquainted with the subject is a curious mistake. General Rundall was taken from his own Presidency and placed at the head of the Irrigation Department of India, solely because he was the ablest and most experienced engineer of all the remarkable men of his time, that have executed a system of irrigation and navigation works incomparably greater than has ever been carried out in any other part of the world. With respect to the particular point of the storage of water for the control of the river floods, so far from it being one that nobody acquainted with the subject would dream of, five minutes' calculation will show that it is a matter a long way within the range of practicability in England. It is quite a small matter even in India. They have sunk £200,000,000 on railways; it would not require a fiftieth part of that sum to reduce all the floods of India. And so with England, with its insignificant rainfall. It seems strange that an engineer should say that a few inches of rise of the Thames would require 19,000 feet per second, equal to 2,500,000 cubic yards per hour. To raise the river 6 inches where it is 80 yards broad, with a current of about 2 miles, would only take about 70,000 cubic yards an hour, or 600 cubic feet a second, instead of 19,000; as anybody can calculate in five minutes. The measurement stated of a Thames flood at 20,000 cubic feet per second, or 2,500,000 cubic yards an hour, is probably very near the mark. A three days' flood would, then, be 180,000,000 cubic yards, and probably one-tenth of that retained till the river had fallen, would be quite sufficient to prevent all serious mischief. This would require a single reservoir one-tenth the size of the Poonah tank, and at £1 a 100 cubic yards, it would only cost £180,000, quite a trifle for the object in view.

I must say something about the water carriage, one of the great points referred to in the paper. How strange it seems that France should be so far ahead of us on this point. After forty years' trial of railways, France has now made the wonderful discovery that they cannot carry cheaply, and that the country dependent upon them cannot possibly contend with those who have water carriage, not even with us, who have only the imperfect and expensive transit by coast, with some few miles of effective canal carriage; and they are now spending, I believe, £35,000,000 on putting the whole internal water transit on a thoroughly effective footing. Nothing can be more certain than that, as this goes on. England will be completely beaten in a thousand productions and manufactures by France, unless we mend our water ways. One would have thought that people might have found out, in less than forty years, that railways cannot carry cheaply. The railway men have found it out, and have been compelled to buy the canals, or pay them a large per-centage on their capital, in order to compel the nation to carry at a high rate, when they could carry so cheaply by canal, even while the canals were in such a miserable state as most of them are in England. If England were provided with a system of canals suited for steamers of 150 or 200 tons, the area of her market for her manufactures and produce would be doubled or trebled; whereas if she remains in her present state as respects carriage, while the Continental countries provide themselves with effective internal transit, her area will terribly diminish. In fact her progress in wealth depends more upon this of cheaper transit than upon anything else. The progress she has made in ocean transit, of late years, has far surpassed the expectations of anybody. It is very curious that, while she has effected this far more difficult matter, she should be actually carrying internally much more dearly than she did before the railway men deprived her of her water carriage. But it is certain that the evidence published by the Committee on Canals will, before very long, rouse the manufacturing and producing classes to take effective measures to enable them to hold their own with the Continental nations. And, surely, I may fairly hope that this most able paper of General Rundall's, dealing with the whole subject of water control in a thoroughly masterly manner, will powerfully help forward so great and fundamental a question in the temporal affairs of England.

ARTHUR COTTON,
Gen. R.E., Madras.

Dorking, March 19th, 1884.

Sir Robert Rawlinson, having seen the above letter in proof, sends the following for publication :—

General Sir Arthur Cotton appears, in my opinion, to be unduly angry with me because I said that impounding reservoirs might be made for any purposes other than for preventing floods. My experience may be of a puny sort as compared with that of General Rundall, but small as it is, it may be practically useful. But are we certain that General Rundall, Sir A. Cotton, and myself, are looking on the question from the same point of view, as building weirs across rivers, forming navigable canals, and irrigating large areas of land may have little to do in preventing floods; and impounding reservoirs, unless these have the capacity of the North American and Canadian lakes, or of the Black Sea and the Mediteranean Sea, will not prevent floods; and here the sun does the work by co-operation from the vast area of water exposed to its heat influence. General Cotton alludes to deluges of rain, ten and twelve inches in one night; weirs across rivers from a mile to four miles broad; to canals broader than the Thames at Teddington; to 50,000 reservoirs, some of them 30 miles round and 100 feet deep, containing (in the aggregate I assume some) 200 million cubic yards of water; flood discharges, he states, are 80 times that of the Thames, and there are rivers rising in one part 80 feet, and where it is four miles broad, rising 30 feet, and that these rivers have been controlled by weirs and embankments, and their floods provided for; with some other overwhelming remarks about ten million acres of land being under irrigation, and some 3,000 miles of canals being navigable. Now, I fail to see how these works prove that the impounding reservoirs diminish the floods. Let me take the 50,000 reservoirs and the 200 million cubic yards of impounded water, and then, further, take the river weir four miles wide, and which rises vertically in the monsoon from 80 feet to 30 feet. The water flowing over such a weir, say three yards deep, would have a velocity and volume of water passing which, if all the 50,000 reservoirs were empty, would be filled several times over in one day. How, then, would such reservoirs diminish floods? The lakes in Cumberland and in Scotland do not prevent floods; the Swiss and Italian lakes do not prevent floods; how can they, with continuous rain after they are full? The water flows in, through, and out, as if the lake did not exist; and in this sense, the Indian streams and rivers flow into, through, and out of these 50,000 impounding reservoirs, when full, as if they did not exist.

ROBERT RAWLINSON.

P.S.—Surely 50,000 impounding reservoirs, even for India, seems to be a great number.

General Notes.

TECHNICAL EDUCATION IN NEW SOUTH WALES.—The New South Wales Government have just initiated a system of technical education, based largely upon that represented by the Department of Sicence and Art at South Kensington. Last year the amount expended for purposes of technical education in the Colony was £10,000; this year it will be increased to £25,000.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock:—

APRIL 23.—"Thames Communications." By J. B. REDMAN, M.Inst.C.E.

APRIL 30.—"The New Legislation as to Fresh-water Fisheries." By J. W. WILLIS-BUND.

MAY 7.—"Bicycles and Tricycles." By C. V. BOYS.

MAY 14.—"Telpherage." By Professor FLEEMING JENKIN, F.R.S.

MAY 21.—"Telegraph Tariffs." By Lieut.-Col. WEBBER, R.E.

MAY 28.—"Primary Batteries for Electric Lighting." By J. PROBERT.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings:—

APRIL 29.—

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings:—

APRIL 24.—"Economic Applications of Seaweed." By EDWARD C. STANFORD, F.C.S.

MAY 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R.S., will preside.

INDIAN SECTION.

Friday evenings:—

APRIL 25.—"The Existing Law of Laudlord and Tenant in India." By W. G. PEDDER.

MAY 9.—"Indigenous Education in India." By Dr. LEITNER.

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E.

CANTOR LECTURES.

The Fourth Course will be on "The Alloys used for Coinage." By Prof. W. CHANDLER ROBERTS, F.R.S., Chemist of the Royal Mint.

LECTURE IV. April 7.—Questions connected with the liability to Reduction in Weight and various Coins by Wear during Circulation.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts, "The Alloys Used for Coinage." (Lecture IV.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Capt. Wm. B. Barker, "An International System of Marine Course Signalling."

Chemical Industry (London Section), Burlington-house, W. 8 p.m. 1. Election of Local Committee. 2. Dr. Armstrong, "Preliminary Note on certain bye-products of the Pintsch Oil-gas Manufacture in relation to the question of the conditions under which Benzenes are formed." 3. Messrs. Giles and Shearer, "The Estimation of Sulphurous Acid in its Compounds." 4. Mr. W. J. Carpenter, "Further Note on the Solidification of Liquid Oils."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. F. Cheshire, "Bees as Friends of the Farmer."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. J. Hassell, "Evolution by Natural Selection."

TUESDAY, APRIL 8...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. William Foster's paper, "Experiments on the Composition and Destructive Distillation of Coal."

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Colonial Inst., St. James's Banqueting-hall, Regent-street, W., 8 p.m. Mr. Alexander Begg, "Seventeen Years in the Canadian North-West."

WEDNESDAY, APRIL 9...Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Dr. W. B. Carpenter, "Binocular Vision with the Microscope."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. T. Walmesley, "Ventilation of Buildings."

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FRIDAY, APRIL 11, 1884.

ll communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The subject of Prof. CHANDLER ROBERTS'S fourth and last lecture, delivered on Monday evening, 7th inst., was "On questions relating to the weight of coins, and their wear in circulation."

At the end of the 17th century, Rice Vaughan proposed that coins should be issued of indefinite weights, "the alloy being certain, but the weights uncertain," so that the coins would circulate solely by the value of the metal. He pointed out that this plan would have the advantage of preventing the possibility of making profits by sweating and clipping, but that, on the other hand, the objection to the method was the "extreme molestation the people would receive by its introduction," as every one would be required to carry scales to weigh the money tendered for even the smallest payments. Professor Roberts pointed out that few people bore in mind that this is exactly what the Coinage Act of 1870, the legislative enactment now in force, demands, by providing that "every person shall cut, break, or deface" light gold coin tendered to him, returning the same to the person who tenders it. The precautions adopted to secure accuracy in the weight of coins before they are issued from the Mint was then described, and it was shown how very accurate in weight individual pieces must be. The "life" of a coin after leaving the Mint was then traced, and it was demonstrated that the "fittest" coins, that is the heaviest, do not "survive" in the struggle they are specially created to sustain, as they are, for the most part, either withdrawn from circulation for exportation, or to be melted up. Experiments now in progress by Mr. R. A. Hill and Professor Roberts as to the relative rate of wear of different metals and alloys were then alluded to.

On the motion of the CHAIRMAN (Mr. John Biddulph Martin), a cordial vote of thanks was given to the lecturer for his valuable series of lectures.

SOCIETY OF ARTS PRIZES.

The Council of the Society of Arts are prepared to award the following prizes in connection with the International Health Exhibition:—

Under the *John Stock Trust*, a Society's Gold Medal or £20, for the best example of sanitary architectural construction, Classes 20, 28, 29, 30, and 32 of the Exhibition.

Under the *Shaw Trust*, a Society's Gold Medal or £20, for the most deserving exhibit in Classes 41, 42, 43, and 45 (relating to Industrial Hygiene).

Under the *North London Exhibition Trust* a Society's Gold Medal or £20, for the best set of specimens illustrating the handicraft teaching in any school—Classes 49 and 50.

Under the *Fothergill Trust*, Two Gold Medals (or two sums of £20), one for the best exhibit in Class 27 (Fire Prevention Apparatus), and one for the best exhibit in Class 26 (Lighting Apparatus).

From the *Trevelyan Prize Fund*, Five Gold Medals (or five sums of £20), for the best exhibit in each of the following Classes:—2, 3, 6, 7, and 11 (all comprised within Group 1, "Food").

The *Siemens Prize*, a Society's Gold Medal, or £20, for the best application of gas to heating and cooking in dwellings, Class 24.

Each prize will be a Gold Medal, or the sum of £20, at the option of the recipient.

The full list of the various classes referred to is given in the number of the *Journal* for March 14th.

The Council propose to ask the juries in each class to recommend for their consideration either two or three exhibits which they may consider deserving a prize. It will be assumed that all the exhibits in the Classes specified, which come under the above definitions, are eligible for the awards. It will not be necessary for any special application to be made in respect of these Prizes.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 1st, 1884; HYDE CLARK in the chair.

The paper read was—

THE RIVERS CONGO AND NIGER, VIEWED AS ENTRANCES FOR COMMERCE INTO MID-AFRICA.

By ROBERT CAPPER, A.I.C.E., F.R.G.S.,
Lloyd's Agent for the District.

Although for 200 generations and more a large traffic has been carried on around the great desert in gold dust, the greater part of African produce is of so small value in comparison with its bulk, that it will not bear the heavy cost of slave carriage, the caravans of slaves being overweighted by their own food, and requiring some two or three months to traverse 500 miles. Up to within a very few years the Western African trade was confined to the seaboard alone, and not until the trade of the rivers Niger and Congo was seriously entered upon has it made rapid strides; in the last five years it is said to have quadrupled in value, and still grows at an increasing ratio. When I visited Africa, there was but one screw steamer a month, and none to the South Coast —the imports and exports by these steamers in 1868 amounted to about 28,000 tons. A new steamship company which started at that period in addition to the old company, now possesses 20 steamers, of an aggregate tonnage of 30,000 tons; whilst in 1882, the imports and exports by steam had grown to 200,000 tons, and in addition there are several private mercantile steamers, of a tonnage of 800 to 1,200 tons, constantly running between England and the Niger and the Congo, which rivers are destined to play a much more important part in the development of African commerce, and, as long as they are free, legitimate commerce will thrive apace.

It is certain that Africa, though now reduced to a low state, once had several kingdoms and states famous for arts, for wealth, for power, and for commerce. This Society was instituted in London 130 years ago, for the encouragement of Arts, Manufactures, and Commerce, for which the natives of antiquity in Africa were once so famous. The country is so old, that it is said by some that the figures we now use, though much modified and corrected in the course of time, were first introduced into Spain and Europe by the Moors from Northern Africa. Certainly our troy weight came from Cairo, and the carat found its way across Africa from the Gold Coast to Arabia, and thence to Europe. Numerous Libyan monuments and manuscripts are to be found in the interior to-day. Five hundredy ears ago, Dieppe, in France, traded with Sierra Leone, and still treasures its craft in ivory carving.

There are many interesting facts about Africa, not the least being the statement that the survey of the seaboard of the whole continent of Africa—one-third of the globe—was made by one man, Captain Vidal, R.N., who is said to have expended three ships' companies over the operation.

Amongst the higher and more intelligent people, I met with the signs and symbols of ancient freemasonry; many of the rulers are born gentlemen; the continent is scored with native roads from sea to sea, over whi chthe internal commerce is very great—a fractional part of it only being produced and exchanged with the civilised world.

The climate in the interior is not insalubrious, and if proper cultivation and the arts of civilised life were introduced again—which can only be done by commerce—it will prove of vast advantage to the Africans and ourselves. Europeans have the conveniences and appliances for crossing the seas which the Africans have not yet; therefore, avoiding all political allusions, I have sketched out this paper from a commercial point alone. Having traversed and traded both upon the Niger and the Congo some years ago, I will address you upon what is within my own knowledge, corrected down to the present time.

My sojourn there was, of course, not without its difficulties. I fell into the River Congo, and I suppose I am one of the very few men that ever came out again. I was wrecked on the desert of Sahara, amongst the marauding Arabs. The King of Dahomey was very desirous of taking my head off my shoulders. I have been capsized in the surf amongst the sharks many times, and cannot swim. My voyages up the Niger were during what I may call the "Pen and Sword Period." My first visit lasted for a period of close upon five years without any return home, during which time I not only lived amongst and passed through all the mangrove swamps in the Bight of Benin and the twenty-two mouths of the Niger, but I also had two rainy seasons on end, and witnessed the landing of the "jigger" from Brazil at Ambriz. Notwithstanding all this, it was gratifying for me to find, upon returning to England, and going into the question of my life assurance, that when I boldly demanded to be put upon the same terms that I was on before I left England, this, after due examination was agreed to. Beyond self, I am glad to add I never lost a member of my staff; all are doing well in one part of the world or another. I have never been molested or robbed—those representing commerce are welcomed with open arms; on the other hand, natives are shy of non-trading travellers, as though they were spies in the land.

It would be, perhaps, just as well to explain in advance the pedestal I stand upon, and with what eyes I steamed up and down these noble rivers. My life, thus far, has been broken up into four septennial periods, as I suppose it is with most of us; seven years I spent at Christ's Hospital, in the City of London, where I received all my education; seven years I spent in the employment of the late firm of Messrs. Peto, Betts, and Brassey, in the management of docks and railways at home and abroad, under the direct personal supervision of the late Thomas Brassey; seven years I resided in Western Equatorial Africa; and for the last seven years, I have managed the harbour, docks, and railways of Swansea, where the trade has increased three-fold in a marvellously short time, in which there is not much sentiment or romance, so that I can look back upon the past with an unprejudiced eye.

English legitimate trade with Africa commenced in 1553, but it was suspended by the slave trade some nine years afterwards, in the days of Queen Elizabeth. It is interesting to note that the first trading vessel brought back 150 lbs. weight of gold, and 80 tons of pepper, from Elmina and Benin, refusing large quantities of the latter, but leaving behind 100 men, including the chief of the expedition. Another expedition followed next year, bringing back this time 400 lbs. of gold, of 22 carats and 1 grain fineness, 26 butts of guinea grains, and 250 tusks of ivory, some weighing 90 lbs., for which the adventurers parted with all their cloth, except two or three packs. The next year, 1555, the Portuguese began to interfere with the English trading-vessels, and some conflicts took place off Elmina. In 1556 and 1557, the English vessels were not only fitted out for trading purposes, but also as privateers against the Portuguese. About this period the Portuguese are credited with commencing the slave trade. The English followed under the Queen's flag, but only continued it a couple of years, as the voyages terminated most miserably, and legitimate commerce on the part of Englishmen then again revived.

The first article of commerce with Western Africa is palm oil, mentioned in the early voyages as oil of palms. In the year 1556, thirty-two barrels were brought home; the quantity in 1880 is estimated at 50,000 tons, representing a value of over £1,500,000.

The 16th century was the era of African companies, exclusive privileges, and legislative encouragement; as a natural consequence, private enterprise and legitimate trade declined. None of the half-dozen companies prospered; indeed the whole of them, in the course of a very few years, failed, owing, perhaps, to the fact that many of them dealt largely in slaves, the royal concession to one being issued on the condition that the company supplied 3,000 negroes every year to the West Indies. The trade grew to very large proportions, until about 100 years ago, when no less than 192 ships are reported to have left England's shores for Africa as slavers. The abolition of the slave trade had something to do in putting an end to these companies.

The Arab trader in Central Africa is not at all deterred by the hardships he meets with, or the inhospitality served out upon the road; but those visiting the seaboard from the interior can only carry gold dust down to the Gold Coast, and ivory down to the South Coast, for want of the power of transporting large quantities of bulky produce cheaply. I have known caravans of ivory arriving at one time to number 7,000 bearers.

On glancing at the map of Western Africa, it will be observed that there are no broad navigable estuaries, no secure and capacious harbours, no land-locked bays and gulfs; therefore the finger of nature points to the Congo and the Niger as the proper entrances by which to approach the continent of Africa.

At the beginning of the present century, as late as the battle of Waterloo, the Niger and the Congo were thought to be one and the same stream. A Government expedition was sent to the Niger to descend that river, and the memorandum of instructions furnished Captain Tuckey, R.N., by the Admiralty at the same date, 1816, directed him to ascend the Congo, and find out if the two rivers were identical or not.

Before the introduction of railways in our own country, about eighty years ago nearly every important town in England was connected by canal; but for the last fifty years this seems to have been lost sight of, though there exists at the present time, through the length and breadth of Great Britain, no less than 4,000 miles of canal navigation. If we reflect upon what the effect of waterways and railways in our own country has been, there is no telling what the opening up of the great water system of Africa, by utilising the Niger and the Congo as entrances, may lead to; their enormous value and growth during the last few years are beginning to receive the attention they really demand. The Congo, one of the noblest rivers known to the world, discharging four times as much water as the Mississipi, has hitherto been free to all the world. That traffic thrives when free, is evidenced by what has been done in the Niger. For the Niger river, though not discovered until 300 years after the Congo, there are Admiralty charts now corrected up to the year 1875, as far as New Boussa, a few miles above the point were Mungo Park's canoe is reported to have been wrecked. That traveller likened the Niger at Timbuctoo to the Thames at Westminster, and on reaching Sego, the capital of Bambarra, he wrote that he found the crowd so great at the ferry that he had to sit down on the river banks, and wait for about two hours for an opportunity of crossing, looking upon the extensive city, the numerous canoes upon the river, the crowded population, and the cultivated state of the country. The picture which he gazed upon was one which he little expected to find in the bosom of Africa.

It is no wonder that the Niger was a puzzle to our older geographers, for, upon descending the river towards the sea, it gets shallower and narrower till a mile or so from the Bar. Louis's creek cannot be more than 100 feet wide; in it H.M.S. *Pioneer*—in which I was a passenger by favour of the Foreign-office—took the ground. The British Government of to-day has expressed an opinion that a good entry to the Niger can be made by way of Whydah, and that it is strange nobody had ever thought of this before; and those who know the land can only smile. The discovery of the Nun-mouth, within the memory, perhaps, of many, was, however, only about fifty years ago. No time was lost in sending a trading expedition up, the first being from Liverpool, fitted out at the expense of Mr. Robert Jamieson, of that city. The first five ventures were very favourable, but the trade was found to be springing up slowly and gradually. Mr. McGregor Laird said it must be a losing one for the first seven or ten years, and, when profitable, others would come in and reap the benefits with the first adventurers. To the late McGregor Laird—who pioneered in person these five expeditions, and who, upon one of them started with 49 Europeans, and returned only with the odd figure 9—is due the results which we now see; but the sacrifice of life stopped trade. Consul Beecroft, stationed at Fernando Po, nevertheless, continued the ascents of the river, though still with considerable loss of European life in each case. At length the British Government sent up an expedition in the year 1841, under the command of Captain Trotter, R.N., and though in the river only 62 days, out of a crew of 152 men, 42 white men died. This expedition crossed the bar on a Sunday, and lifted anchor to ascend the Niger on a Friday. Bishop Crowther, who is reputed to have been born on the banks of the Niger, and from thence captured and sold, accompanied this expedition, and in his journal there is to be found a significant remark, "The first intimation the interpreters offered to the villagers, in answer to inquiry, was always, that they were not Portuguese, but that they came as friends to the black people." The disasters accompanying these expeditions seemed to have put a damper on the enterprise, but the intrepid McGregor Laird, watching for an opportunity, found one in 1853, upon the supposition that the celebrated Dr. Barth was somewhere on the banks of the Niger. McGregor Laird succeeded in making a contract with the British Government to fit and send up a small screw steamer, called the *Pleiad*, giving a free passage to Bishop Crowther a second time; and though the expedition reached a point up the Binué, 250 miles higher than Captain Trotter's, and was 118 days on the river, no lives were lost. It is also a noteworthy fact, as the Bishop observed, that though twelve years before very few people were clothed, the condition in this respect was most marked. Thus a new era seemed to be opened up in African exploration. Without following too closely the history of the river, Mr. McGregor Laird no sooner worked up the trade to a paying point than he unfortunately died, and out of the ashes of his trade sprang the West African Company, uniting commerce with missionary efforts. But the trade did not make rapid strides until the advent of James Alexander Croft, commonly called "Niger Croft," sometimes "King of the Niger," to distinguish him from the Commodore of the African Steamship Company of the same name. The qualifications of a successful African traveller are rare; plenty of men can find the sinews of war, but the character of the man who has to bear the brunt must be almost unique. The constant excitement of travelling through new lands requires that his mind should be well balanced, added o which an iron constitution is indispensable.

I estimated the value of the produce brought down when I went up in 1870 at about £30,000. I believe it now exceeds £2,000,000.

It took me twenty-six days to go up the Niger first, now the same distance is easily accomplished in two days. There were then only two factories, now there are fifty-seven. There were only two trading steamers in the river, now there are some twenty steamers, exclusive of several iron lighters, carrying from 30 to 40 tons. One company alone has £57,000 invested in small river craft, and over a million of capital in the Niger. Produce is gathered now that was never gathered before. I passed 105 towns, some with a population of 10,000, but apart from that, the banks everywhere teemed with life. The end of my expedition was Bidda, 450 feet above the sea, where salt is better than fine gold—yielding greater happiness and luxury.

The Emir of Nupè, who pays tribute to the Sultan of Sokatoo, received us, and at the first interview, after saluting us three times according to the custom of the country, he immediately plunged into questions of trade and commerce; all reference to the Queen's messengers—captains of two men-of-war forming the expedition, in full uniform—became a secondary affair. These officers felt themselves very much in the shade. The Emir, or king, called for his pass-book, which was read out before us all, showing that he was indebted to the West African Company in the sum of £765 10s., chiefly for brass and copper rods, Dane fusee, and Tower guns and gunpowder. He expressed himself desirous of paying this off, on the condition that he should get more credit, the balance against him the year before having been nearly double, viz., £1,500. It was with extreme difficulty that the Emir was got to turn his face to the naval officers, and postpone his talk about his private trading for a later occasion; he did so, however, upon the mention of the murder of Consul Fell, stationed at Lokoja. There is a letter in existence, penned at Bidda, dated from that town on the 15th September, 1870, addressed to the Queen by Masaba, calling attention to the fact that no redress had been sought in consequence of this outrage and attack upon her Britannic Majesty's representative in the Niger, and upon the Bishop and his secretary.

Education I found to be generally enforced. The streets were broad and clean, and there were regular Courts of Justice.

As a passenger on this occasion on board of a man-of-war, I could not enter much into the trade; but I was permitted to put as much cloth as I could under my mattress in the captain's room, which proved sufficient not only to pay my expenses in a lordly fashion, but enabled me to buy something like 125 pieces of ivory. The trade of the Niger is now the trade of the coast; the African steamers get their largest cargoes there, and expect to do so.

Attention has been called to the fact that there is one piece of British land at the confluence of the Niger and the Binuè which carries with it the right to navigate the river.

Some steamers have been lost, but no lives, in these mishaps.

In turning from the Niger to the Congo, it may be right to state that Lagos, a settlement belonging to our British Crown, not twenty-five years old, has a population of 60,000, whilst Loanda, the capital of the Portuguese province of Angola, between 300 and 400 years old, has only 12,000, or is one-fifth the size.

The first trader in the Congo as far as the falls, was a Scotchman named George Maxwell, who long resided there, and published a chart of the Lower Congo, from the cataracts, downwards. When Captain Tuckey's expedition was sent out in 1816, Maxwell recommended the building of boats which could be portaged by thirty people round the cataracts.

There is no record of any trade by the Portuguese except in slaves.

Though Angola was discovered before the conquest of Peru, I do not propose troubling you with the history of that province, and the land of that innocent looking instrument of death, the "Palmatore," a flat circular piece of wood, pierced with five holes, affixed to a short handle. It may be enough to refer you to my late friend Mr. J. J. Monteiro's observations upon the Portuguese and their possessions, which are true to the letter.

The only Government expedition ever sent up the Congo was that of Captain Tuckey. By the courtesy of the Admiralty, I have been permitted to read the original journals, in Captain Tuckey's own handwriting. The expedition was most disastrous, about one-third of the crew, and all the scientific men, with three of the superior officers, dying from fatigue and exhaustion in a little more than three months. Captain Tuckey's last letter was dated from Banza-cooloo-Yallalla, addressed to Mr. J. W. Croker, at the Admiralty, on the 20th August, 1816. In fact the vessels, when at sea, seem to have been left without any officers at all, a Mr. Lewis Fitzmaurice styling himself senior officer of H.M. Sloop *Congo*, appointing himself Lieutenant, in a letter which is amongst the original documents, addressed to himself, written by himself, and sent to himself.

The commerce of the Congo is of recent growth. In my time, 12 years ago, there were four English houses, one French, and one Dutch, trading up the river as far as Nursuku and Noki—there are now 49 European factories on the banks, and the exports and imports are valued at £2,000,000. The first invoice I received at Banana was for £7,025 17s. 6d. Only some 15 years ago a change in the trade came about, for up to that time the Congo was the stronghold of the slave trade, and it is credibly stated that as many as 100,000 slaves a year were sent across the sea. As long as the slave trade could be carried on, the Portuguese Government remained silent for very obvious reasons—the dealers in the slaves were their own subjects. But now the Portuguese seek to repeat what they tried 25 years ago, *i.e.*, to force all the trade in bees-wax, gum, ivory, coffee, and other valuable products, through Loanda, where they possess a good deal of property. The move then made forced the establishment of the two free ports of Kinsembo and Ambrizette. There can be no doubt the Portuguese are losing their trade, in consequence of the exactions and restrictions of their own custom-houses, passports, and so forth, the more recent extensions of African commerce being on the Angola side of the River Congo beyond the dominion of Portugal.

When the *Journal of Commerce* of Lisbon attacks the English manufacturers for their opposition to the Congo treaty, and urges that Portugal will protect the natives from all risks of spoliation by numerous adventurers and so-called philanthropists, this must be looked upon as an attempt to mask the truth for selfish purposes.

It is no secret that the abolition of slavery in the Portuguese African possessions, though decreed years ago, remains to this day a dead letter. The complete abolition was, by Royal decree, to take place in the year 1878, and it has been recorded by one of our most intrepid African travellers, Commander Cameron, that during his travels slaves were still exported from Angola, a steamer entering the ports for an hour or two, shipping the slaves, and departing for a destination unknown. If the River Congo were handed over to the government of the Portuguese, this state of things would be perpetuated. Mr. Keith Johnston, in his book on Africa, describes the government of the Portuguese as utterly untrustworthy; abuses are practised, he says, by ill-paid officials, who prey upon the defenceless population, and in this manner prevent the development of the resources of this splendid country; and he adds, "so easy and successful have been the systematic extortions and robbery of produce, and labour, from the natives, that large sums of money have been spent and much interest employed for the sake of getting the post of Chefe of the more important districts even for a short time."

Portuguese ideas of colonising countries is first to erect a fort, secondly to fix up a custom-house, and thirdly to commence a cathedral, and there it ends; they have never made a road. Their custom-house must pay something to to the State at home, and as much as possible to the officials on the spot.

On the subject of the Congo Treaty, which it is stated will not affect the trade of the upper waters, but that the interior trade will be allowed to pass to and fro free, I do not believe anything of the kind; there are more ways of killing a dog than hanging him. It is said the duties will be light, but when they are demanded in cash where none is used, the duty is at once increased; moreover, there are eighty-seven rules of the most stringent nature scheduled to the treaty; everything is to be written out in a foreign tongue (Portuguese) in a limited time, and everything English literally wiped out. The Portuguese custom-house officials will, in all probability, insist upon everything being turned out of the ship on to the quay or wharf, weighed, measured, and compared with the manifest; here is a chance for fines and forfeitures, for what Portuguese official would let slip such a splendid opportunity of enriching himself by one big haul. The result will be that the forty-nine factories, established on the banks of the Congo will return to the old system of African trade from the ship's deck. Again, it is said that the same privileges that the subjects of Portugal enjoy are to be extended to the English; but who are the subjects of Portugal there? Convicts, men thankful for small mercies, though they are the most prosperous of Portuguese traders. Men condemned to transportation for murder, and abominations ten times worse, are the largest householders and landowners in the capital—Loanda; and English traders, though they are mere pioneers of commerce, are to be put upon the same platform with such men. Read the correspondence of my dear familiar friend, the late Consul David Hopkins, issued with the treaty. The native hate of the Portuguese is very bitter, and were they strong enough, friend Menteirs said the natives would drive them into the sea. Natives will not work for them unless compelled. The latest African authority innocently states:—"A regular system of apprenticeship, tantamount to slavery, is necessarily in vogue." But why necessarily? Nowhere in the British possessions is this found to be so.

The Portuguese speak of the lighting, buoying, and the preservation of peace in the waters of the Congo, but as to what they are likely to do in the future we judge by the past. How many lighthouses are there in the province of Angola? What protection has it afforded to its own settlements? How often has Mussula, where I had a factory, been plundered, we have often thought, at the instigation of the Portuguese themselves? What improvements and works of utility have ever been carried out at Loanda? Has it a pier? Is it supplied with water? Are there any railways? Certainly an English commodore, many years ago, turned the first sod of a railway, but that Englishman did all that has been done towards that railway, for there it ended.

The Portuguese Government officials know they need not be on good terms with the natives; the trader finds it to his interest to be so, and peaceful in all his transactions. Already the trade on the Congo is very considerable, and in a few years it promises to attain vast proportions. Mr. Johnston, in addressing you a few months ago, said that the idea of Portugal on the Congo is simply preposterous, she had no interest and no commerce to defend like the English or the Dutch; if she had, she would stick on differential duties, and try to divert the trade from Liverpool to Lisbon. So say I, and I will add to this through Loanda. To hand over the Congo to the Portuguese Government that has done nothing, the results of the present mercantile prosperity being due entirely to the large investments of capital and long years of labour, would be a cruel and disastrous act. There are no visible signs of Portuguese authority. The marble pillar which is reported to have been erected by the Portuguese on Point Padrone, in 1859, was washed away by an unusually high tide, and no further attempt has been made to put up another, a significant fact worth volumes.

As a simile to explain what "navigation dues" mean at a river mouth, I may refer to the River Scheldt. The prosperity of Antwerp did not make any strides until about 1863, when the right of levying navigation dues on that river, granted to Holland by the peace of 1839, was commuted for the sum of 36,000,000 francs, one-third paid by Belgium and the rest by other Powers interested. Who can say that the navigation dues on the Congo will not be valued at the same sum soon.

I am glad, at this time, of the opportunity that has been afforded me of reading a short paper touching upon the commerce of the Congo. I have recently seen a letter which appeared in the *Manchester Examiner*, written by a resident at Ponta-da-Lenha, complaining that the authors of the Congo Treaty had never resided in Africa, or had the slightest experience of the manner in which the trade was carried on, whilst those who, through a residence of many years had become acquainted with the wonderful capabilities of the Congo valleys, declined to come forward to state what they knew. Upon this I addressed the editor of the *Times*. I should like to know what Mr. Johnston can possibly mean in his letter to the same editor, written as one acquainted with the Congo and its politics, when he says:—

"The principal objections in England will come from commercial men, who will fear that the rising trade of the Congo will be hampered when the mouths of the river are placed under Portuguese rule; Portugal being a protectionist power, and given to the imposing of export and import duties; and from those objecting to the Congo Treaty, who, from some special reason, do not wish to have their doings too closely inquired into."

Certainly, the King of Portugal has wrapped up in one article of the treaty an undertaking not to punish any inhabitants of the Congo for what has taken place in the past. But to whom can it be supposed this is to apply; not to men of England, I know, for one. Mr. Johnston says that the Portuguese are good road makers, and that if they had any spark of enterprise they would at once commence a railway or a good cart road, there being a fair field for them on the Congo. Let me remind you, however, that they have had a fairer field in Angola for the last 300 or 400 years.

Stanley has stated that any power obtaining the mouth of the Congo would absorb to itself the whole commerce of Central Africa, and supply the wants of a dense population covering a million square miles. The development will be enormous, and the heavy income and property tax and dues, varying from 25 to 125 per cent. on the value of the imports and exports, at the expense of the English merchants, would be a gift to Portugal which it is difficult to understand. What do the Portuguese traders of the Congo themselves say? "What, hand us over to the wretched Portuguese Government!"

The African does not know how thoughtfully he is cared for by the civilised world, though he knows his own interests pretty well, and is ever alive to them, and not so dull as some would have us suppose. It has been stated that those who object to the Congo treaty must do something more than find fault; they must show a better practical course, which has not been done, and will not be easy to find out. Where is the hurry? What is the imperative necessity? Who can force England to come to a solution of the difficulty? The *Times* newspaper said, a few weeks ago, that it could not be denied that the best hopes of commerce were involved in the extension of the influence of the International Association, which asks for nothing more than to be allowed to remain the peaceful instrument in bringing various articles of foreign manufacture into the numerous markets that are to be reached by means of the Congo. But before the ink is fairly dry, all good is to be counteracted by the influence of the Portuguese. Without exaggerating the importance of the interior, Commander Cameron states that Africa contains everything that can be desired to make men rich, and that it is replete with vegetable and mineral wealth; the natives make good servants, the climate is delightful, and but for the Portuguese everything would be according to the emigrant's wish.

The first time the King of the Belgians came forward in the matter, as far as my memory serves me, was in January, 1876, when his Majesty offered to pay the expenses of Commander Cameron, who was reported to be then in difficulties in Central Africa. Some nine months afterwards a Conference was called of the different Geographical Societies of Europe, and from that grew the International African Association. I have seen it stated that no less than £400,000 has been expended in the opening up of the Congo. The opening up of new countries is of advantage to trade in more ways than one. One of the first steel boats ever constructed was one specially built for Dr. Livingstone's expedition on the Zambesi. It was built of puddled steel, a laminated material which, although playing an important part in the history of steel manufacture, is now no longer made, being entirely superseded. It was not a success, for Dr. Livingstone, writing to the Secretary of the Society of Arts, stated that the plates had worn so thin, and became so full of small holes, that the wretched craft might have been converted into a coffee-strainer for the use of the entire Society.

Captain Tuckey's expedition in 1816 took out a steamboat suggested by Sir Joseph Banks, a vessel drawing 4 feet, with engines of 24 horse-power, made by Boulton and Watt. This was nearly a generation before the general introduction of steam navigation. Reflect for a moment upon the numerous industries helped forward by the African markets. Why, it comprises every one. Even Ireland contributes to the supply. Africa is one-third of the known world, and next door to England.

But the great value of the free navigation of the Niger and the Congo is the facilities they will soon afford to the utilisation of the inland waters by steamboats, connected with railways which are not difficult to construct, the interior being described as one vast table land. With a good knowledge of Africa generally, and having thoughtfully considered the proper plan of opening it up, there is no doubt the unhealthy seaboard should be avoided, and the establishment of railways projected from the interior. This is an enterprise worthy of British pluck. Extensions would soon follow north and south, and the interior slave trade be annihilated. A route for a railway across the desert of Sahara is marked the whole way with the whitened skeletons of those who have perished *en route.*

To traverse that desert in twenty-four hours, a journey now requiring four months, and placing the very centre of African civilisation within ten days of London, is a feat worthy of the present age; and after what has been done in America, England should do something. If she does not, Portugal will not. The forests of the interior would supply the necessary wood for sleepers, and such a line could be easily laid at an average rate of one mile per day. Taking the desert as 600 miles broad, it would be two years in building. Labour in the interior is cheap, and the transport of plant by the Congo and Niger not expensive.

It should be observed that the wealth of the interior has not been exaggerated; a marked change for the better is observed in its inhabitants; the people are, to my mind, not uncivilised, and dependent upon agriculture for a living, growing all things necessary to their own comfort; and there are to be found merchants who, at moment's notice, can produce £50,000 or £60,000 more readily than many European bankers.

The length of a railway from the Mediterranean to the Cape of Good Hope, direct, would not be more than one-third of the length of the whole of the railways in Great Britain to-day, and could be constructed for two millions of money, one-hundredth part only of the cost of our present English railway system, without taking advantage of the great lakes in the interior. A railway so constructed would give two sides to work from, and would form a regular spine through the land; moreover, experience has shown nothing is more defensible against semi-barbarians, when met with, than a railway in the hands of a civilised power; the line affords facilities for defence at any threatened point in a way that baffles and overawes invisible assailants, and it would be always valuable, apart from the moral effect and the political force which it would exert, through the heart and centre of the African continent, as affording new outlets for our manufactures.

The Niger and the Congo are the present entrances to Africa, and if England is true to its trust, it will not let them be recklessly thrown away. There should be no secret about the trade, for, believe me, it will shortly show results, whilst free, that will literally burst and astonish the whole commercial world. I therefore append a list of goods finding a ready market in both rivers in my day.

APPENDIX.

Niger River, 1870.—Goods there, for Sale and Returns.

From Manchester.—Madapollams; Croydons, 28 yards each, 8s. 7½d.; taffeta, 2s. 10d.; grey bafts, 28 yards, 8s. 3d.; im. country cloths; nicannees; royal checks; stripe domestics; Turkey red and white stripes; Turkey red chintz; fancy prints; fancy satin prints; brilliants, ginghams.

From Glasgow.—Madras handkerchiefs; romalls; ground scarves; silk Corah handkerchiefs; fancy cotton ditto.

From Birmingham.—Guns of all kinds; tin cups and basins of all kinds; tin cups, with handles, of all sizes; mirrors of all sizes; pewter basins; assorted beads.

From the Potteries.—Crockery and glass ware of all kinds.

From Ireland.—Gunpowder.

Miscellaneous.—150 tons salt; green cased gin, 250 c.; 450 cases brass and copper rods; 600 bags cowries; English new florins, £300.

River Congo, 1872.—Goods for Sale and Return from Manchester. Invoice Costs.

		s.	d.	
Blue baft		11	6	per piece.
Citronella	48 yds.	16	6	,,
Chilloes	12 ,,	1	8	,,
Striped domestics......	24 ,,	3	9	,,
Checked ,, ...	18 ,,	3	11½	,,
Pano da costa	22 ,,	7	9	,,
White ground prints ..	12 ,,	2	9	,,
Satin stripes	48 ,,	10	3	,,
Striped ticks..........	9 ,,	2	0	,,
Croydons	41 ,,	19	6	,,
Cretonnes	6 ,,	4	0	,,
Grey baft	24 ,,	5	3	,,
Imported country cloth ..		4	6	,,
Printados	10 ,,	4	8	,,
American ticks	9 ,,	2	0	,,
Blue serge................		16	9	,,
Silver de lane		2	10	per yard.
Striped silk		1	0	,,

From Glasgow and Elsewhere.

		s.	d.	
Red romalls	12 hdks.	2	1½	per piece.
Red madden handks. ..	24 ,,	4	0	,,
Swiss romalls..........	12 ,,	2	0	,,
Imported silk handks... ..		2	0	,,
Blue and yellow ,, ..	12 ,,	2	6	,,
Blue and white ,, ...		2	2	,,
Blankets, double white.. ..		8	3	each.
Railway travelling rugs..		6	0	,,
Scarlet caps and striped caps, single		2	1	per doz.
,, ,, double		4	9	,,
White shirts		19	0	,,

From Birmingham.

	s.	d.	
Tower muskets	8	0	each.
French guns....................	7	6	,,

	s.	d.	
Brass rods, 70 lbs. and 86 lbs.	50	0	per box 200
Padlocks	1	1	per doz.
Negro balls	4	3	per gross.
Armlets, ½ lb. each	1	2	per pair.
Matchets	0	5	each.
Blue cut beads	0	3	per 1200

SUNDRIES.

Red cased gin	7	5	per c. 1 doz
Ginger wine	10	3	,,
Cyder	8	9	,,
Soap	17	6	per cwt.
Hoop iron	10	0	,,
Salt	2	0	,,
Pipes	2	6	per gross.
Gunny bags	0	5	each.
Rum	1	4	per gal.

Earthenware.—Jugs, cane gallon, painted, hooped white, lustre, tulip; soup plates, wash basins (white and painted), decanters, tumblers, and glass covered mugs.

From Ireland.—Men, women and boys; kegs of gunpowder, 14 lbs., 7 lbs., 4 lbs., at 35s. per barrel.

STOCK-SHEET OF A FACTORY ON THE CONGO, 1872:—

	English. £	s.	d.
Merchandise of all kinds	6,277	13	4
Factory itself and stores adjoining	1,608	10	8
Furniture	452	6	8
Boats and canoes	495	16	0
Casks and coopers' stores	180	14	6
Provisions	98	6	1
Marine and other stores	182	2	4
Live stock	67	14	0
Produce in store	158	3	2
Debts outstanding either way	*Nil.*		
	£9,521	6	9

N.B.—Everything of English production.

DISCUSSION.

Commander CAMERON said that the remark which had been ascribed to him to the effect that the climate of Africa was delightful, must not be taken to apply to the whole continent, but only to certain portions of it. There was no doubt that the Niger and the Congo were the two great arteries of the country. He would not enter into the question of politics, but he was sorry to say that England seemed to be such a poor little nation that she was always afraid of treading on anybody's corns, and there-ore seemed to want to interpose Portugal as a buffer between herself, or the International Association, or the French, or perhaps the privates who were chastised eight years ago by Admiral Hewett. The mouth of the Congo had been for many years almost entirely dependent on the British navy for police arrangements; and in 1862, Sir Eardley Wilmot, as Commodore, made certain treaties, not with subjects of Portugal, but with the native nations, and now all those treaties were apparently to be abrogated. If people on the Congo committed any acts of piracy, there had hitherto been a British man of war somewhere in the neighbourhood to punish them, but in future it would be Portugal which must be looked to. He remembered being at Kinsembo when there were four or five large factories which paid no duty to the Portugese; but now, even if they were on the same footing as Portuguese factories, they would have heavy duties to pay. The Logi river was alluded to as being the northern boundary of the Portuguese, but t was in fact a few miles north of it; and though Englishmen could walk about there unmolested, the Portuguese, if they came across, had to take their shoes off, and were sometimes illtreated besides. Unfortunately they heard nearly every year of a Niger expedition, the police of the Niger being also that of English men of war. If England, recognising the growing importance of her commerce there, were to establish a Resident on the Niger, with a small steamer at command, so that he could immediately investigate any differences that arose between the traders and the natives, which in many cases caused loss of life, most of these disturbances would be stopped at the outset. But, unfortunately, England, though the foremost nation in commerce, seemed to be the most apathetic of all in any matter relating to the protection of that commerce. A false economy prevailed in all her settlements, the only idea apparently being to keep money in the chest. Some time ago, there was a street in Cape Coast Castle which sadly wanted draining, the estimate being about £1,200; that certainly seemed a large sum to spend on one street, but the result was an order that the best that could be done should be effected for an outlay of 30s. The authorities at home had little or no knowledge of Africa, and they seemed to rely entirely on the reports of a few persons only. The traders of Africa had opened up a trade rather in spite of the Government than in consequence of any aid they received. For nine months the rivers had been without a Consul, but if Consul Hewitt's health did not allow him to go out there, surely someone might have been found to take his place; and during that time the French had been making treaties with the Okrekas. He wished the English public would interest themselves more about Africa, for he was persuaded that in that country there was a market for everything we could manufacture.

Mr. J. ALEXANDER CROFT said he was largely interested in the African trade, and had spent a great many years in developing it, and he did not like to say much upon the subject, as it would seem like blowing his own trumpet. He agreed with Commander Cameron that these expeditions up the Niger might be put a stop to by having a resident agent there, or a Vice-Consul. At present, there was no protection for traders whatever except these expeditions, which sometimes took place when they were not wanted. As to the Congo, he thought we were giving up a most important and valuable river to the Portuguese, who had never done anything to develop the trade there. He was glad to see by the papers that the Americans were taking up the question, and had heard, on very good authority, that the French would not recognise any treaty of the kind.

Mr. W. E. M. Tomlinson, M.P., said he had come to listen to this paper, because it might be his duty in another place to consider the question of the Congo treaty, and he was anxious to get all possible information from those who had practical knowledge on the subject. His own knowledge hitherto was derived from the papers issued on the subject, but he thought all must concur in the remark of Commander Cameron as to the vast importance of opening up Africa, by its two great outlets, the Niger and the Congo, to English trade and commerce. At present the trade of this country was suffering from that very want which Africa was capable of supplying, viz., a market for our goods; and the question was whether it was the duty of the nation and Parliament to endeavour to secure those markets for Great Britain or not. It was not a question whether those markets should be opened to this country or to another trading country, but whether the command of the markets should be given to a nation which was not really a commercial nation, as England was. The Portuguese had no manufactures and no commerce of the kind suitable for the African market. This treaty appeared to have been negotiated, as had been said, on the basis of trying to interpose Portugal as a buffer between us and other nations; that was the only rational explanation which could be given of it. It was pretty plain that, for some reason or other, the Foreign-office had not available the knowledge which it ought to possess of the commercial wants of this country. A strong effort was being made, both in Manchester and Liverpool, to have this treaty properly brought forward and discussed in Parliament. Of course, it was the great textile and hardware centres of industry which were most interested in this matter. Lord Granville seemed to be under the impression that the application of the Mozambique duties would simply add 10 per cent. to the cost of introducing goods to that country, and also that 10 per cent. was such a trifle that it need not be regarded. It was very curious that those statesmen who seemed to cling most closely to Cobden's theory of absolute free trade being a necessity for this country, seemed also to imagine that the question of duties had no influence whatever on the introduction of British goods into foreign countries. To him, this seemed the most extraordinary notion; he could not understand it at all. What he had heard to-night confirmed him in the opinion that it was the duty of Parliament to prevent, if possible, the ratification of this treaty. He believed that a strong expression of public opinion would be made outside Parliament to assist the discussion which would have to take place there. He thought there could be very little difference of opinion in Parliament outside the members of the Government, and he hoped that discussion would tend to arouse expressions of opinion from London and other parts of the country on the question. Even if they did not succeed in stopping this particular treaty, it might prevent similar mistakes being made in future.

Mr. Masterman said he understood Mr. Johnston's view to be that it did not much matter who commanded the mouth of the Congo, because the true approach to that part of the river, above the Stanley Pool, would be some river to the north of the Congo; he should, however, like to have a little light on the subject.

Mr. Margan said he went up the Congo last summer for the International Association, and the general opinion seemed to be that the river itself was beset by so many difficulties that it could not be made available as a trade route; but that a railway approach from the coast north of the Congo, should be made through the River Quilo. At the mouth of that river the International Association had a station, and there were several others also between that and the Congo. That was the route by which large quantities of ivory now reached the coast, and no doubt if a railway were made, it might become a very important means of approaching the dense populations in the interior. He could not speak of the Portuguese from any personal experience, but they had many trading establishments on the Congo, though the principal ones were in the hands of the Dutch. The Portuguese were always civil to him, but at the same time he was quite of opinion that there was no occasion to place the future of this magnificent country in the hands of one power, and that a power of which many complaints were made. As he went along the coast he saw no signs of British authority from the mouth of the Niger down to the Congo itself. Coming home, he saw one gunboat off Sierra Leone. The complaints were very general amongst the traders that differences with the natives could not be settled quickly owing to the distance of the consular agent, who, when he was reached, had to send for a gunboat, and very often, by the time the gunboat arrived, any question there was to settle had been decided. He believed that, with due precaution, the climate on the Congo was not very bad, and those who had been above Stanley Pool praised the climate very much. He thought one mistake which had been made in the navy was in serving out rations of quinine daily when in a fever district, so than when an attack came, the medicine failed to produce its effect.

Mr. Sutton asked what was the proportion of

Portuguese exports from the Congo as compared with those of other nations.

The CHAIRMAN said it must be a matter of great satisfaction to them all that the hon. member who had addressed the meeting had found some place in London where a subject of this nature could be discussed. It was with a view to this that, at a meeting of the British Association some years ago, he proposed the formation of this Section, first called the African Section, for the purpose of developing English trade with East and West Africa, the value of which was now so generally recognised. The Council of the Society, following the principles of its charter, liberally gave authority for the formation of the Section, and this step had been a matter of gratification to the whole of the Society, as it had been the means, year after year, for some years, of calling practical attention to these important subjects, and impressing the public, step by step, with the value of regions which were considered remote and of very little importance. It also had been the means of bringing forward men of eminence and enterprise who had been engaged in various parts of Africa, and who had come to the meetings to give their experience; and the information thus conveyed had not been limited simply to the audience present, for by means of the *Journal*, it had been made known throughout the length and breadth of the land. There was hardly a man of eminence connected with Africa whose name would not be found inscribed in the rolls of this Section, and this in itself was a very useful work, for it was only by the diffusion of such information that the public could be made to adequately comprehend the subject; even in the Foreign-office, where there were men of great ability and information, a subject like this was not sufficiently understood. His interest with regard to the relations of Portugal in this matter dated from some time back. He should be the last to speak in any depreciating way of Portugal, for it was more than half a century since he co-operated in the establishment of its independence. He could not, however, conceal from himself that with all the merits of that ancient historic country, their relations with ourselves had not been always satisfactory. Generation after generation, and century after century, the independence of Portugal had been saved by the exertions of Englishmen, but for that we had had no adequate reward or appreciation. The Portuguese were very apt to stand on their sovereign rights, and their national prerogative, and we in England were too apt perhaps readily to accede to those demands, forgetting the historic relations betweeen the two countries. We were certainly not equals. Whenever Portugal had been in difficulty, it was to England that she applied as an Imperial Power to protect her. Relations of that kind had their mutual duties. There was no derogation to the prerogative of Portugal in contending that when a time like this came, her relations should be adjusted with the imperial power on an amicable footing in justice to this country also, but that, however, had not been the case; other claims had been put forward, as Mr. Capper had very well indicated. When he first remembered the income of the Viceroy of Angolo or of Mozambique was certainly not derived from the enterprise and commerce of Portugal; and with regard to the Congo as the others, the whole development of those countries was due to English enterprise. The Portuguese had not been mindful of these facts; they now woke up to the importance of these possessions, forgetting who had made them important. It was of the greatest importance to Portugal itself that she should receive assistance and guidance from this country in the management of her possessions in Africa, for it was we who had made those possessions, not the Portuguese themselves. The direct trade of Portugal was of the smallest possible character, and was hampered by fiscal restrictions. There was no suitable manufacture to support a trade. There was nothing in the conduct of Portugal which justified her being assigned more than the title of sovereignty, and beyond that the conduct of these matters should be left in the hands of those competent to conduct them. The United States, as had been said by Mr. Croft, were looking with interest and anxiety on this unfortunate treaty, and it was to be hoped that, by the discussions in the papers and elsewhere, her Majesty's Government would be enlightened so that, as in the case of the Suez Canal, it might be induced to make better arrangements. Having watched these countries long before they were objects of interest to the public, he was fully assured, as had been proved year by year in that room, that the prospects of the trade of this country rested largely on the development of the trade of Africa, and it was deeply to be regretted that neither the Government nor the public at large were adequately acquainted with the facts. It was strange that even the romantic achievements of Livingstone, Stanley, and Cameron had not stimulated the zeal of Englishmen in this matter. Whoever investigated the ancient civilisation of Africa, would find that it must have been in ancient times one of the great countries of the world, and a region which had had such capabilities was capable, under proper government, of developing those resources again. He concluded by proposing a vote of thanks to Mr. Capper, which was carried unanimously.

Mr. CAPPER, in reply, said he had been asked the proportion of the Portuguese trade from the Congo compared with other countries. He was not in possession of the figures of different countries, but nothing made in Portugal found its way into the Congo. The only trade going from Angola, at the present time, was, perhaps, sufficient to one-third fill a steamer once a month, and it had nothing to do with the Congo. As to the Quilo river, from a commercial point of view, it did not do for people to go to new rivers, and commence laying down railways.

What a man of commerce liked was that his commerce should grow as he put his hands in his pocket. The principal part of the trade of the Congo came from the southern bank, and as the Quilo was some distance to the north, the whole of the trade would have to cross the river; there would be the same difficulties as at the Falls of Yallalla, there must be land carriage of some kind. It was due to British enterprise alone that matters of that kind had been already dealt with in Africa. In the River Volta, when their capitalists found the trade growing, they built their own railway, and on the Congo, if left to British commerce, it would not be long before the difficulties of land carriage would be surmounted by British enterprise, if only the Government would leave them alone. There were Portuguese traders up the Congo, but they were simply petty traders for large houses, mostly the servants of other nations. He had had many friends in Portugal, but still he must say that since the year 1666, a majority of the Portuguese had not been well spoken of. He put in the paragraph about himself to show that he had resided in that country for some time, and held that it was not so bad as it was painted. If he were a rich man, and did not know what to do with his money, he should certainly charter a ship to go out to the Congo and back; and every poor man who liked to go out he would feed him, and take him out, and bring him back again if he did not like it. The country was so rich you need not provide for the morrow; you required very little clothing; pea-nuts grew wild; there was plenty of water, and if you wanted anything further, you could climb up a palm-tree and get some palm wine. It was some years since he left the Congo, but when he was asked to prepare this paper, and look out his old diaries and books, his feelings became so strong with regard to this question, that he had thought it well to tone down several of the expressions which he had at first made use of, feeling as he did indignant at the mere notion of so ruinous an act as the throwing away of these large markets, when England wanted them so badly.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Sub-Committees have met at the Society of Arts since the meetings last recorded in the *Journal*:—

INDIA.

Wednesday, March 5th.—Present: Sir Joseph Fayrer, K.C.S.I., in the chair; Mr. W. Anderson; Sir George Birdwood, K.C.S.I.; Mr. R. A. Dalyell; Surgeon-General Gordon, M.D., C.B.; Colonel J. Michael, C.S.I.; Mr. W. G. Pedder; Mr. A. Stirling Surgeon-General Townsend, C.B.; Mr. F. Young.

THE DWELLING.—SUB-COMMITTEE A.

Wednesday, March 26th. — Present: Captain Douglas Galton, C.B., F.R.S., in the chair; Mr. H. H. Collins; Dr. W. H. Corfield; Mr. Rogers Field; Mr. Charles Heisch; Mr. Shirley F. Murphy; Mr. E. C. Robins; Mr. H. Saxon Snell; Mr. Ernest Turner; Mr. H. Trueman Wood.

EDUCATION.

Wednesday, March 26th.—Present: Lord Reay in the chair; Mr. T. R. Ashenhurst; Mr. B. St. John Ackers; Dr. T. R. Armitage; Mr. E. N. Buxton; Mr. Alfred Bourne; Mr. W. White Cooper; Mr. C. D. Dawson; The Ven. Archdeacon Emery; Mr. J. G. Fitch; Dr. J. H. Gladstone, F.R.S.; Rev. T. Graham, D.D.; Mr. J. J. Hummel; Mr. T. C. Horsfall; Mr. A. B. Kennedy; Mr. A. C. King; Lieut.-Col. W. R. Lewis, R.A.; Mr. Philip Magnus; Mr. K. B. Murray; Mr. J. F. Moss; Mr. J. H. Rigg; Mr. Gilbert R. Redgrave; Mr. A. B. Shand; Rev. T. W. Sharpe; Mr. W. H. Stour; Mr. F. Storr; Mr. Swire Smith; Hon. E. Lyulph Stanley, M.P.; Rev. W. P. Warburton; Mr. H. T. Wood.

NOTES ON THE REARING OF SILK-PRODUCING BOMBYCES IN 1883.

BY ALFRED WAILLY

(Membre Lauréat de la Société Nationale d'Acclimatation de France).

(Continued from page 360).

The second mode of rearing the *Yama-Maï* silkworm in Japan, which is resorted to after the third moulting of the worms, is the following:—Pits are dug one foot wide, and about one foot and a half deep. These pits are filled with bales of rice, which are well watered and covered with mats, through which oak branches are plunged to the bottom of the pits. The worms previously bred under cover are now reared in the open air, and uncovered up to the time of their transformation on the branches plunged in wet rice. The bales of rice receive every day a plentiful supply of water, which allows the foliage to keep fresh for a long time. When the branches are changed, the old ones are pulled out and placed on mats, in order that no sand or dust should touch the worms, for, if they swallowed any with their food, they would become sick and die. When the old branches have been removed, fresh ones are inserted in their places, and the old ones are then tied or otherwise fastened to the fresh branches.

This mode of rearing has not, as far as I know, been adopted anywhere in Europe or in India, and I do not think it ought to be adopted at all, as the third mode, that of rearing on trees, is by far the most simple and the best, especially when the worms are reared on a very large scale.

Third mode.—Rearing on trees in the open air. This last mode, like the second, is adopted after the worms have passed their third moult, that is, when they are in their fourth stage. The place chosen is a plantation in the plain in preference to one in the mountain, and the ground, twelve months beforehand, is cleared of all weeds, also of the useless shrubs and trees. The branches of the trees which are too long are cut down, so that all on which there are worms or cocoons should easily be reached.

Without going into further details respecting the mode of rearing in Japan, it is certain that if trees were planted in rows, and the branches cut or bent down so as to form a bush, eight, nine, or even ten feet high, immense quantities of silkworms could be reared in suitable climates by taking the two following and indispensable precautions:—1st, to keep the ground clear of all weeds which might harbour insects injurious to the worms; 2nd, to have, especially when the worms are large, men to watch the worms constantly, and keep the birds away, as these in a very short time might destroy the whole crop. The worms might be placed on the trees as soon as they are hatched, which would be a great saving of time and labour, and the rearing would have no other limit but that of the plantation. I will now pass to my notes on the rearings of last season.

Hybrid Roylei-Pernyi.—On referring to my articles on the rearings of silk-producers in 1881 and 1882, it will be seen that I obtained this remarkable hybrid in 1881 by the crossing of *Roylei*, the Himalaya oak silkworm, with *Pernyi*, a north China species. The new hybrid, contrary to what had taken place previously with other hybrids, was larger and superior in every respect to the parent species; its reproduction in 1882 from the cocoons obtained in 1881 was most wonderful—many hundreds of fertile eggs from a small number of moths. I then felt most certain that I had created a most valuable silkworm, easy to reproduce and rear. But in 1883, the third year of the existence of my hybrid, I was cruelly disappointed, for it disappeared entirely.

Degeneracy was certainly the principal, and perhaps the only cause of this failure. Now, was this degeneracy due to the fact that this new silkworm was a hybrid? I could not to a certainty declare that such was the cause, for the *Pernyi* silkworms reared at the same time, and under the same conditions as the hybrid, had degenerated to the same extent; so that it may be that the cause of degeneracy was due to the unfavourable conditions under which the larvæ were bred.

The few hybrid larvæ which I reared in London in 1882 on a small scale, in torrents of rain for the greater part of the time, could not be relied upon to produce strong healthy pupæ. On the other hand, the hybrid cocoons I had from one of my correspondents in Scotland, and those I obtained in Paris, at the Société d'Acclimatation, were the produce of larvæ reared in large numbers in warm rooms. My correspondent in Scotland, Mr. Turnbull, reared an immense quantity of the hybrid worms, together with *Pernyi* worms, in warm rooms, and it is a well-known fact that worms bred under these conditions often get the germ of disease in them; the *Pernyi* worms were affected just the same as the hybrid ones.

Another difficulty came in the way of the successful rearing for 1883. The hybrid moths in 1882, in consequence of warm weather, began to emerge in April, about three weeks before the usual time, so that two generations were obtained. Most of the moths emerged in the autumn, 1882, leaving but a small number of live cocoons for the year 1883, and these were very likely the weakest; at any rate, they were smaller than the cocoons obtained in 1881.

In 1883, the moths of the hybrid did not begin to emerge till June 2nd, considerably later than in 1882, when they commenced to emerge on April 23rd, and several of the cocoons died.

The moths, which kept on emerging till July, paired with the same facility as in 1882, but almost all the eggs were unfertile. Out of a small quantity of fertile ova, I obtained about eighty larvæ, in all appearance very healthy, which were placed on small oak trees in my garden. These oak, together with some other kind of trees, were under one large framework covered partly with wire, partly with fish-netting. I made use of all the old materials I had in London for economy's sake, and I had here, only one large frame instead of three smaller ones, as I had in 1882, in London. The hybrid larvæ grew rapidly, without showing any sign of disease, till they had reached for the most part the third stage, when one day I found the fish-netting, which must have been rotten, entirely torn from top to bottom on one side of the frame, and all the larvæ had disappeared, destroyed by birds, together with some other species. The tearing of the net had evidently been the work of cats, which I had frequently seen climbing up to the top of the frame. Fish-netting is, therefore, of little use. This fatal accident prevented a rearing and study which would have been very interesting and important to me, *i.e.*, the preservation of the hybrid, or, if the worms had had the germ of disease in them, to watch and see how long they would live in such a state. As I have before mentioned, they looked remarkably strong and healthy.

After this disaster, the fish-netting was mended, and several yards of new wire-netting were added to the framework, after which the worms of the few other species in the trees were left unmolested by the sparrows and other birds.

Actias Selene.—Of this species I had, in 1883, no cocoons imported from India, but only about twenty cocoons obtained from the rearings of 1882, and of these several died. The moths emerged as follows:—June the 4th, one male moth; on the 13th, one male; on the 17th, one male; on the 19th, one male and one female, which paired on the 21st, between 2 and 3.30 a.m. On the 22nd, one male; on the 23rd, one male; on the 25th, one male; on the 26th, one male;

on the 27th, one female. On the 28th, I obtained the second pairing. On the 28th, a third female moth emerged, which paired on the 29th of June. On the 4rh of July, a female moth emerged; on the 14th, one male; and on the 7th of August, the last moth, a female, emerged. By referring to this list of births registered, it will be seen that the first three female moths, which alone had a chance, all paired, and this is the greatest success I ever obtained with this species with respect to pairings, but the same success did not attend the hatching of the larvæ.

The first female moth laid 255 eggs, which were very good, and began to hatch on the 6th of July. The second female, which was smaller, laid only 154; none of these I kept. The third female, which was the finest and largest, laid 303 eggs, but none of the eggs I had kept of this last brood hatched, and this I attribute to a sudden change of temperature at the moment the larvæ should have hatched; but there may be some other cause unknown to me. Some of the larvæ of the first brood were reared in the house on walnut leaves, others on a pear-tree in the garden under the netting. The larvæ reared in the house reached their last stage in a very short time; on the contrary, those in the garden were very slow, and did not begin to spin before the 11th of October, when I had to bring into the house the few which were on the pear-tree in the garden.

Attacus Atlas.—With a large quantity of Ceylon and a few Himalaya *Atlas* cocoons, I had no better success in 1883 than in 1882. The moths emerged from the 11th of July to the 28th of September. As usual, a number of the cocoons died, while others kept alive for the following season (1884). Only ten Ceylon and four Himalaya *Atlas* moths emerged at intervals, never giving any chance of obtaining fertile ova.

Two of the Himalaya *Atlas* moths, one female emerged on the 4th of September, and one male on the 21st of the same month, were very perfect and extremely beautiful, both measuring over 10 inches in expanse of wings. These, with a wonderful aberration of the genus *Samia* or *Platysamia*, and a large number of other specimens of silk-producing Bombyces and other lepidotera were exhibited on the 3rd of October, 1883, at a meeting of the Entomological Society of London. Among these specimens was a series of about fifteen *Mylitta* moths, showing most of the various shades of colour, from the bright golden yellow to the darkest brown or grey. Reference will be made further on to the extraordinary specimen of the genus *Platysamia*, which I consider as an aberration of *Cecropia*. Besides these specimens, I exhibited some of the living larvæ of silk-producers, which were still to be found at that time on the trees in the garden, such as *Telea polyphemus* and *Hyperchiria io*.

Antheræa Mylitta or *Paphia*.—The notes I took on this species, the most important East Indian wild silkworm, cover six pages of my note-book. Therein is registered the birth of every moth, the pairings, &c., which it would be unnecessary to reproduce at length. The first *Mylitta* moth emerged on the 6th of June, the last on the 29th of October. I had a very large number of cocoons, some of which did not hatch, and are still alive, even after having hybernated twice. These cocoons came from four different parts—Calcutta, Madras, Ceylon, and Bombay. Those from Madras, only ten in number, had already hybernated during the winter 1881-82, and had remained in perfect condition. Two of these Madras cocoons still remain alive for the year 1884.

The first moth which emerged belonged to the Bombay race; then, from the 25th of June, Ceylon moths emerged, and the first pairing was obtained during the night of the 2nd and 3rd of July, and a second pairing of the same race took place on the 6th of July. The third pairing which took place during the night of the 9th of July, was by moths of the Bombay race; the fourth during the night of the 11th, and ended at 10.30 p.m. on the 12th of July, was a cross between a female of the Bombay, and a male of the Ceylon race. The number of eggs obtained from these four pairings was:—78 by the first, 183 by the second, 135 by the third, and 128 by the fourth, a total of 524 eggs. Later on, two more pairings were obtained, one from the 6th to the 7th of August, between a male Ceylon, and a female Bombay; the sixth and last took place in the night of the 19th and 20th of August, between two moths emerged from the cocoons sent to me from Calcutta. I lately heard that these cocoons sent from Calcutta had been collected in Assam. The number of pairings, six only, is very small, considering the large number of moths obtained from the cocoons, and undoubtedly shows that the temperature was not sufficiently high for this species. The eggs from the last two pairings in August were obtained much too late to be of any use in England for rearing; therefore I sent them to some American correspondents, but as yet I have not heard of the result. The eggs of the first pairing (Ceylon race), that of the 2nd and 3rd of July, began to hatch on the 25th of July; those of the third pairing (Bombay race), of the 9th of July, began to hatch on the 3rd of August; and the eggs of the fourth pairing, a cross between the Bombay and Ceylon race, which took place on the 11th and 12th of July, began to hatch on the 4th of August. The ova of the second pairing had all been distributed, together with some of the other three pairings, among European and American correspondents, and I shall be glad to hear of the result of their experiments. Though there were great differences in the shades of colours in the moths of the different races, all the larvæ were alike. The second stage of the larvæ took place on the 9th of August, fifteen days after they had hatched; the third stage commenced on the 24th of August, and the fourth on the 10th of September. The larvæ could not be reared beyond that date, the weather not being warm enough. It may be that oak leaves are not a proper kind of food for *Mylitta* larvæ; although they have been reared on oak, they did not seem to thrive well on it. Major Coussmaker lately informed me that *Mylilta* larvæ feed well on rose branches, and these should be used in future, together with oak and horn-beam, so as to find out on which plants they will thrive best.

A description of the larvæ in its six stages has already appeared in one of my previous reports, that for the year 1879. The interesting pamphlet on "The Tussur (*Mylitta*) Silkworm," by Major G. Coussmaker, gives full particulars on the cocoon, moth, egg, larvæ, and food-plants of this valuable wild silkworm. It was published in 1873, by E. and F. N. Spon.

As I have stated, the *Mylitta* larvæ I reared only up to the fourth stage. Many died at the different stages, but some were sent in all their stages to Mr. F. Moore, of the Bethnal-green Museum, and these were beautifully drawn and coloured, together with larvæ of other species, by Mr. Moore's son.

Attacus Cynthia or *Ailanthus Silkworm.*—This silkworm is the easiest to rear in the open air in England; next to it is *Antheræa Pernyi.* Moths of *Attacus Cynthia*, in 1883, commenced to emerge on the 3rd of June, and they continued emerging till the end of the same month. Thirty pairings were obtained, producing thousands of eggs and larvæ. Having had no Ailanthus trees bearing any foliage this year after their transplantation, I had to try the rearing of the worms on various trees. I placed the immense quantity of worms I obtained on rose-trees climbing against the house, on maples, on a mountain ash, on a common ash, on lilacs, and on laburnums—alone, those which had been placed on the laburnums thrived, but not near so well as they do on the Ailanthus tree, their natural food plant. A few larvæ, out of a large number, also thrived on the lilac trees and on the common ash. The thousands placed on the other trees disappeared in the first stage, and in all probability because the foliage did not suit them, as they could not have all been destroyed by the insects that prey upon them.

The sparrows, as usual, do not seem to have touched any of the *Cynthia* larvæ, which commenced to form their cocoons on the laburnum trees on the 3rd of August, and the last on the 27th of September.

North American Species.—Telea polyphemus.—Moths emerged from the 23rd of May to the 25th of June. Only three pairings were obtained, one on the 20th, and two on the 23rd of June. On the 25th, a female *Polyphemus* paired with a male *Cecropia*, but the eggs, as usual, were not fertile. The larvæ were very successfully reared in the open air, on the small trees in the garden, in spite of bad weather, during the last stage. The first cocoon was commenced on the 18th of September, and the last on the 7th of October.

Actias luna.—Of this species I had no cocoons, but eggs were sent to me from France, and from three American correspondents. Of the latter, some were sent from the State of Iowa, which hatched and died during the voyage; some sent from Illinois hatched on the 11th of June, the day of or after their arrival. Others I received from New York, which had hatched during the voyage, and died afterwards. On the 28th of July, I again received from New York two boxes, which, on being opened swarmed with young larvæ in splendid condition; these larvæ were from the second brood of *Actias luna*, the species being double-brooded.

Want of time prevented me from rearing such a quantity of *luna* larvæ, especially on account of the difficulty I have to obtain walnut leaves, on which they seem to thrive better than on other kinds of foliage. I therefore only reared a small number in the house.

Eggs sent from America are placed, as I suggested a few years ago, in a muslin bag containing leaves of the food plant, and then the bag is inserted in a tin box hermetically closed, so that the leaves keep, and arrive as fresh as if they had just been cut off the tree, although some small portions may decay or rot. If the eggs are sent as soon as they have been laid, many of them have time to arrive in England in good condition, after a voyage not exceeding fifteen or sixteen days. If some or all of the larvæ hatch during the voyage, they feed at once, and grow during the two, three, or four days they may have to remain in the box. It takes about twelve days for the *luna* larvæ to hatch; some other eggs require more time, and therefore can be sent with better chance of success. The great risk which the eggs and larvæ have to run is this, that the droppings of the feeding larvæ, falling on the moist leaves, create at once a rot or a fungus which is often fatal to the larvæ, and also to the eggs which have not hatched. But a proportionate number of larvæ and eggs escape, and arrive in good condition, especially if there is sufficient room for them in the box. Certain species can only be sent in the egg state, and this method of sending is the only one that can be adopted, and we must be satisfied if only a few eggs or larvæ are saved.

Hyperchiria io.—Moths of this bright and beautiful little species, described in former reports, began to emerge on the 4th of June, and continued to emerge till the first of July. The moths pair readily, if they are in good condition, *i.e.*, if the wings are fully developed, especially in males. Fourteen pairings were obtained, which must have brought the number of fertile eggs to about 5,000 and even more. I bred a quantity of the larvæ very successfully in the house, under glasses. They are easy to rear, but live a long time before forming their thin cocoons. I also bred a number of them in the open air on *salix caprea*; they were larger, and grew quite as fast as those I had in the house.

Samia promethea.—Moths of this species emerged from the 25th of June to the 16th of July; twelve pairings were obtained. On the 1st of July a male *Cynthia* paired with a female *Promethea*, but the eggs laid did not hatch. The pairings of this species, which are short, are easy to obtain, and they generally take place between 6 and 8 o'clock in the evening. A small number of *Promethea* larvæ were placed on a small cherry-tree in the garden, but they were destroyed when in the first stage. As mentioned in previous reports, they feed also on lilac.

Platysamia Cecropia.—Of this, the largest North American silk producer, I received an immense quantity of cocoons from various States: Iowa, Illinois, Delaware, New York, &c. With the cocoons I had preserved I obtained 19 or 20 pairings. On the 25th of June, a male *Cecropia* paired with a female *Polyphemus*, the eggs being unfertile. I record these pairings to show that whenever the species are not closely allied, the eggs have invariably been unfertile. I have heard of fertile ova obtained by the crossing *Promethea* and *Cynthia*, but I never obtained such fertile ova, although I have had many pairings between these two species.

The *Cecropia* moths emerged from the 24th of May to the 23rd of July. Ova of *Cecropiu*, sent to me from Iowa, all hatched on the day they arrived, and the larvæ thrived splendidly.

The thousands of larvæ which I obtained were, except a few, placed on all the apple, pear, and plum trees in the garden, and also on some currant bushes, but as soon as they had reached the second or third stage, they were all destroyed by the sparrows and other birds. Late in October, I found a full grown *Cecropia* larvæ, which had escaped the eye of the sparrows, on a currant bush. The weather being then very wet and cold, I brought it into the house,but it died while attempting to form its cocoon.

From one of the *Cecropia* cocoons, there emerged in June a most extraordinary specimen, remarkable alike for its size and the exquisite beauty of its various colours. As I have been asked whether the cocoon from which the moth emerged differed from the other *Cecropia* cocoons, I must state that I did not notice any difference in the cocoons, and there were about 100 in the cage. I was then so busy that I entirely neglected to examine the cocoons; in fact, I did not think of it, and I very much regret not to have examined the cocoons. Later on, the cocoons, together with *Cecropia* cocoons from other cages, were all thrown into a large box with cocoons of other species; and some were given or thrown away. However, had there been a difference, and especially a notable difference, between the cocoon which produced the wonderful specimen and the other cocoons, I should certainly have noticed it.

Up to the present time, I have not heard that any such specimen has ever been seen, and as I stated, I consider it as an extraordinary aberration of *Cecropia*. The specimen has been photographed, natural size, and I have coloured a few copies of it, so that persons wishing to see it may have a representation of it.

On taking the specimen to Mr. W. F. Kirby, at the British Museum, he wrote the following description of it for the Proceedings of the Entomological Society of London (1883).

ABNORMAL SPECIMEN OF THE GENUS SAMIA, BY W. T. KIRBY.

"This remarkable specimen, which has puzzled every entomologist who has seen it, was bred by M. Alfred Wailly, from a cocoon received from some part of North America. It may be a hybrid between *S. Cecropia* and some other species, but if so, it is so different from all the other known species, that it is difficult to guess with what it could have been crossed. It is equally difficult to imagine that it is a new species. The specimen is a female, and equals the largest specimen of *S. Cecropia* in size, measuring $6\frac{3}{4}$ inches in expanse; and the wings are more rounded and less oblique than in *Cecropia*. The body resembles that of *Cecropia*, except that the abdomen is banded with yellowish grey and black. The base of the fore-wings is brown, thickly scaled with white towards the costa; below this is a brick-red blotch, longer and narrower than in *Cecropia*. Beyond this is a white space extending nearly from the base to one-third of the length of the wing on the inner margin, but curving up to the costa in a rather narrow stripe. This is followed by a large irregular black blotch, broad at the costa (where it is thickly dusted with grey), and the narrow end extending to beyond the middle of the wing. On this stands the large kidney-shaped central spot, which is surrounded with red, and divided by a reddish stripe at the outer end of the black blotch; it extends beyond it into a broad red white-dusted band, followed by a black one, so very thickly dusted with yellowish grey, that it appears of that colour. This is succeeded by a grey space, divided by a black line (much less indented than in *Cecropia*) into darker and lighter; above is a blue space; on the inside is a row of rather large black spots, the uppermost, and the fourth and fifth being the largest. Hind wings, white at the base, followed by a broad slate-coloured space, on the outer half of which stands a large oval white spot, slightly surrounded with red, the outer part being incomplete, and it rests on a white band, much broader than in *Cecropia*, followed by a broad red band, three or four times as broad as in *Cecropia*, but followed outside by similar markings, only paler. The under surface differs from *Cecropia*, chiefly in the much paler colour, and in the different position of the central spots."

INDUSTRIAL ART EXHIBITION.

The first Brussels exhibition was held in 1853, and this was renewed on a larger scale at the Halles Centrales in 1874, with a result, both material and financial, that exceeded expectations. In connection with the national exhibition of 1880, when Belgium celebrated her 50th year of independence, two congresses, that of instruction and that of commerce and industry, both dealt with the subject of technical education. To these two congresses was due the constitution of a society, under the presidency of M. Ferréol Fourcault, director of the Compagnie des Bronzes, the object of which was to promote technical instruction generally. The new society soon became affiliated to the Union Syndicale of Brussels, as the section of industrial instruction, and was also materially aided by funds remaining over from the exhibition of 1874. It was subsequently decided to organise periodical competitions with special exhibitions of allied objects.

The first of these exhibitions and competitions, originally limited to lace and fans, but to which embroidery, trimmings, buttons, and artificial flowers were afterwards added, was opened in the Palais des Beaux Arts, Brussels, on 31st December, 1883, by the Minister of the Interior, and was kept open for three months, being largely attended. Under the patronage of the Count and Countess of Flanders, a large and exceedingly valuable collection of ancient fans, lace, and embroidery was got together; and many articles will be reproduced by photography, &c., to serve as models for present designers. No less than 270 fans, of ancient manufacture, including some rare gems of art, and one of quite historical interest, were contributed from various collections. There were examples of embroidery anterior to the fifteenth century, ecclesiastical ornaments, tapestry, objects, such as escutcheons and flags, belonging to the old guilds, and articles of ancient costume, including buckles and buttons, and various civil objects. The various classes of lace, both point and pillow, were well represented, the whole of Madame Montefiore Levi's large and valuable collection being laid under contribution; and a series of portraits, borrowed from various collections, exemplified the manner in which lace was worn at different periods.

Whether lace was first made in Belgium or in the North of Italy, a point which has not been satisfactorily cleared up, it is certain that, about the year 1661, there existed at Brussels a confraternity of lace-makers (*spelwerkers* in Flemish), and that in 1762 there were 15,000 lace-women, the number varying from 9,000 to 10,000 under the French dominion. Notwithstanding the present want of demand for lace, this industry is still practised in many towns and villages in the North-West of Belgium. Some information as to lace furnished by M. Baert and M. Sacré, both manufacturers and medallists at various exhibitions, is appended to the catalogue. It appears that Mechlin laces, which is made entirely on the pillow, is produced at Antwerp, Louvain, and Turnhout, the manufacture having almost died out at Mechlin itself. Brussels lace, and its numerous derivatives, are made at Brussels, Alost, and even at Ghent. It is produced especially with the needle, the ground only having originally been prepared on the pillow. This variety of ground, which was called "drochel," is not made now; and the specimens which remain are rare. Black lace, called "dentelle de Grammont," is made from Enghien (in Belgium) as far as Andewarde, but especially at Grammont; it is made entirely from silk, and on the pillow. What is known as Valenciennes lace is also made on the pillow, and includes several varieties: — the *dentelles torchon*, the primitive type; the *maille ronde* (round mesh), of Bruges; the *treille carrée* (square trellis), of Ypres; the *grande maille carrée*, of Courtrai; the Ghent point, or *maille carrée raccrochée*; and the *dentelle de Bruges sans treille à fond guipure*. Of late years, certain decorative industries have brought into fashion the styles of the 15th to 18th centuries; and several manufacturers have succeeded in copying Venetian point, Flemish guipure, ancient Mechlin, &c. Another school is of opinion that modern dress does not lend itself to the revival of these old styles, and that their vogue will be but temporary. They observe that pillow lace especially is very easy to imitate by machinery, and they point to the progress shown at recent exhibitions, where artists' designs have been faithfully reproduced by mechanical means.

There were fifteen exhibitions of modern lace, and reproductions of ancient models, and twelve exhibitions of embroidery; while the Mdlles. Marcelis and Van de Wade, the directresses respectively of the Brussels and the Antwerp technical schools for girls, put in designs executed by the pupils.

There were seventeen exhibitors of fans, including the Brussels, the Mons and the Antwerp technical schools The pupils of the last named showed some highly interesting and meritorious collections of the various parts of several artificial flowers, mounted on cards, to illustrate the various stages of manufacture.

There were three competitions in designs for a lace flounce, piece and fan, to match, and for each competition prizes of 300 francs (£12) and 200 francs (£8) were offered. In the first, to be executed entirely in *appliqué*, the first was awarded to M. A. De Spiegheler; and the second to M. Van Cutsem. The last-named carried off the first prize in both of the other two lace competition, viz., designs for the three objects above named to be executed in respectively *appliqué* mingled with other styles, and in any style chosen by the competitor.

There were also three fan competitions, in the first of which a first prize of 1,000 fr. (£40), and a second prize of 500 fr. (£20), were offered, and in the others prizes of 300 fr. (£12), and 200 fr. (£8), respectively, were offered. There were twenty-nine competitors for the first, the execution of a painted fan, either mounted or with design for the mounting. The first prize was awarded to M. A. L. de Mol, and the second to M. G. A. Launean, whose sketch of the mounting is remarkably effective. The first prize for the execution of a lace fan was taken by M. L. Sacré; and that for a fan in style, with sixteen competitors, by M. Royer de Fraene for the painting, and M.M. Bantmans and Hoosemans for the mounting.

A method was hit upon for preventing the possibility of competitors' identity being disclosed by the symbol or motto chosen. The papers containing the names and addresses were placed by the competitors in numbered envelopes, issued by the committee, with tickets gummed at the edges, and perforated in the same manner as the new card letters issued by the Belgium Post-office, for the purpose of covering the motto or symbol on the works entered. Thus the jury awarded the prize to the numbers before they knew the mottoes or symbols, and still less the names of the competitors. There were only three jurors in each competition, one chosen by the committee, and the other two balloted for by the competitors.

This first effort of the Instruction Section of the Union Syndicale has been eminently successful; and is to be followed by other exhibitions and competitions. The secretary is M. Paul Davreux, assistant inspector of technical instruction.

Correspondence.

LONDON WATER SUPPLY.

In the recent discussion there was one point to which none of the speakers alluded, viz., the fact that the waters drawn from the Thames, &c., while sufficiently soft for domestic use, yet contain enough lime, salts, &c., to cover the pipes through which they pass with a coating sufficient to preserve the water from metallic contamination. London water may pass through iron, lead, zinc, copper, brass, or indeed almost any metallic pipe without risk, and may be kept even for long periods in metallic cisterns without absorbing any metallic salts. The hot water, drawn from the circulating cistern, in connexion with the kitchen boiler, is found clear and bright although it may have been in the pipes for weeks. It is difficult for Londoners to realise the enormous trouble and difficulty of getting water from private wells, free from metallic contamination. At my country house, I have been driven to have the drinking water-pipes enamelled with glass, but even so it is not an absolute success. Our hot-water supply is always more or less the colour of coffee; and while water passed through a lead pipe is positively poisonous, it is impossible to use for laundry purposes water which has passed through an iron one. In a recent Government report, it was stated that a certain proportion of the seamen suffered from copper poisoning, derived from the stills, so that it appears that distilled water is far from being safe from impurities.

EDWIN LAWRENCE.

10, Kensington-palace-gardens, W.
April 3, 1884.

Notes on Books.

GUIDE TO METHODS OF INSECT LIFE, AND PREVENTION AND REMEDY OF INSECT RAVAGES. London: Simpkin, Marshall & Co. 1884. 8vo.

This little book comprises the substance of ten lectures delivered before the Institute of Agriculture, in the theatre of the South Kensington Museum last December. The descriptions of the different stages of insect life are plainly treated of in the first and second lectures, and in the succeeding ones details are given of the various insect pests, such as the daddy long-legs, wheat midge, carrot and onion flies, &c., and the methods and extent of their ravages. Miss Ormerod's remarks on the prevention of insect injury at the conclusion of her book may be cited, affecting, as it does, all growers of crops, and those who own a garden, however small. She says:—"Slugs and snails are most terrible pests, but need not be so bad if it was borne in mind that (however urgent the need may be) the precise time when the crops are in the tender growing state, which most attracts the slugs, is the time of all others when it is almost impossible to do anything on a good scale to get rid of them. In gardens, a very much more thorough clearing of all their shelters would do good, but the remedy of sprinkling lime slightly is often a mere waste of time, on account of the lime slaking so quickly that unless it falls on the slug it very likely does little or no good at all. The slug has a power of casting off a kind of skin of slime, and thus getting rid of any obnoxious dressing not strong enough to kill it. In this way lime, soot, or other similar applications, often fail in effect. But the slug has not power to continue the process many times, and when the application has been continued at dawn and dusk for a few times it has proved successful. When land is free, a heavy dressing of gas lime or alkali waste will kill even the slugs; but, as with other pests, thorough attention to clearing out their shelters and breeding places, and cultivating the ground so as to turn up the eggs, although it might not cure, would lessen the evil."

General Notes.

NUREMBERG EXHIBITION.—An International Exhibition of Gold and Silversmiths' Work, Jewellery, and Bronzes, will be held at Nuremberg, under the protection of the King of Bavaria, from 15th June to 30th September, 1855. The object of the Exhibition is to show the present condition of gold and silversmiths' work, &c., in the different countries. Those persons who wish to exhibit should notify the nature of the objects they intend to send, and the space required, to the Bayrisches Gewerbe Museum in Nuremberg, before the 1st June of the present year.

GERMAN TRADE IN TUNIS.—With a view of developing trade in German manufactures in competition with English, French, and Italian goods in the Tunis market, it has been suggested for the steamers, now regularly plying between Hamburg and Sicily, to be continued to the coast of Africa. One of the leading organs of the German textile industry has been devoting a long article to the subject of trade with Tunis as a part of the export commerce which is now being specially worked up under the auspices of the German Government and its representatives in foreign countries.

MEAT PRESERVATION.—In January, 1871, Mr. Richard Jones read a paper before the Society of Arts entitled "How Meat is Preserved" (*Journal*, vol. xxix. p. 14), in which he described his vacuum process; Mr. Jones has now adopted a new process, the results of which are said to be quite satisfactory. The principle he has adopted is the injection of a fluid preparation of boracic acid into the blood of an animal immediately after it has been stunned, and before the heart has ceased to beat, the whole operation, including the removal of all the blood and chemical fluid from the body of the animal, only taking a few minutes. The quantity of boracic acid used is very small, and though that little is almost immediately drawn out again with the blood, the preservation of the flesh is said to be thoroughly effected. The quantity of the chemical left in the flesh must therefore be very small, and can scarcely be injurious to the human system; for, as Professor Barff has proved by experiment, living animals, either of the human or other species, do not seem to be injured in any way by its consumption. A demonstration of the effects of the process was given last week at the Adelphi Hotel, when the joints cut from a sheep, which had been hanging for more than seven weeks at the House of the Society of Arts, were cooked in various ways, and those present agreed that the meat was equal to ordinary butchers' meat.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock :—

APRIL 23.—"Thames Communications." By J. B. REDMAN, M.Inst.C.E.

APRIL 30.—"The New Legislation as to Freshwater Fisheries." By J. W. WILLIS-BUND. EDWARD BIRKBECK, M.P., will preside.

MAY 7.—"Bicycles and Tricycles." By C. V. BOYS. Dr. B. W. RICHARDSON, F.R.S., will preside.

MAY 14.—"Telpherage." By Professor FLEEMING JENKIN, F.R.S.

MAY 21.—"Telegraph Tariffs." By Lieut.-Col. WEBBER, R.E.

MAY 28.—"Primary Batteries for Electric Lighting." By I. PROBERT.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings :—

APRIL 29.—"The Transvaal Gold Fields; their Past, Present, and Future." By W. HENRY PENNING.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

APRIL 21 (Monday).—Adjourned Discussion on Dr. PERCY FRANKLAND'S Paper, "The Upper Thames as a source of Water Supply." Sir FREDERICK ABEL, C.B., F.R.S., will preside.

APRIL 24.—"Economic Applications of Seaweed." By EDWARD C. STANFORD, F.C.S.

MAY 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R.S., will preside.

INDIAN SECTION.

Friday evenings :—

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

MAY 9.—"Indigenous Education in India." By Dr. LEITNER.

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by the Oxy-Hydrogen Light.

MEETINGS FOR THE ENSUING WEEK.

WEDNESDAY, APRIL 16...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hon. Ralph Abercromby, "The Origin and Course of the Squall which Capsized H.M.S. *Eurydice*, March 24th, 1878." 2. Capt. J. W. C. Martyr, "Waterspouts and their Formation." 3. Mr. Cuthbert E. Peek, "The Weather Forecasts for October, November, and December, 1883." 4. Mr. William F. Stanley, "Certain Effects which may have been produced in the Atmosphere by Floating Particles of Volcanic Matter from the Eruptions of Krakatoa and Mount St. Augustin."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. S. M. Mayhew, "Tenby and St. David's Cathedral." (Conclusion.) 2. Dr. Wake Smart, "Antiquarian Researches at Nursling and its Locality."

Obstetrical, 53, Berners-street, W., 8 p.m.

THURSDAY, APRIL 17...Linnean, Burlington-house, W., 8 p.m. 1. Rev. J. M. Crombie, "Algo-Fungal-Lichen Theory," and discussion. 2. Mr. R. Bowdler Sharpe, "Ornithology of New Guinea." (No. 9.) 3. Mr. J. G. Otto Tepper, "Variation in Leaf of *Banksia marginata*."

Chemical, Burlington-house, W., 8 p.m.

Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

FRIDAY, APRIL 18...Medical Officers of Health, 1, Adam-street, Adelphi, W.C., 7½ p.m.

Philological, University College, W.C., 8 p.m. 1. Prince Louis Lucien Bonaparte, "Italian and Uralic Possessive Suffixes Compared." 2. "Albanian in Terra D'Otranto."

Clinical, 53, Berners-street, W., 8½ p.m.

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FRIDAY, APRIL 18, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1884, at their first meeting next month. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce." The following is a list of those to whom the medal has already been awarded:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Professor Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (now Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to M. Ferdinand de Lesseps.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to M. Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to M. Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S.

In 1877, to M. Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to M. Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

A full list of the services for which the medals were awarded was given in the *Journal* of March 14th.

Members are reminded that to-morrow (19th April) is the last day for receiving the names of such men of high distinction as they may think worthy of this honour.

INTERNATIONAL HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow Members of the Society of Arts the privilege of purchasing Season Tickets for the Exhibition at half-price (10s. 6d.). Each Member will only be allowed the privilege of purchasing a single ticket on these terms, which will be a personal admission, not transferable. Season tickets admit to the opening ceremony on the 8th May. The tickets will not be ready for issue till the end of the month, but it will be convenient if members desiring to avail themselves of the privilege will send word to the Secretary at once, enclosing 10s. 6d., the price of the ticket, which will be forwarded as soon as ready. It will be understood that all applications must be accompanied by the above-named remittance.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Mr. W. A. Barrett, Mus.Bac. (Oxon), at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 9th June, 1884.

Honours.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

First and Second-class.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3] To play a piece or portion of a piece at sight.

Full particulars can be obtained on application to the Secretary.

INTERNATIONAL HEALTH EXHIBITION HAND-BOOKS.

In addition to those Hand-books dealing with the various subjects included in the Exhibition programme which the Executive Council propose to issue already noticed in the *Journal* (see *ante* p. 427), the following have been arranged for—

Physiology of Digestion and the Digestive Organs. By Professor Arthur Gamgee, F.R.S.

Fermentation. By Dr. Duclaux. With a Preface by M. Louis Pasteur, Membre de l'Institut.

Spread of Infection. By Shirley F. Murphy.

Accidental Injuries; their Prevention and First Management. By James Cantlie, F.R.C.S., M.B.

The Influence of Schools of Art on Manufacturing Industry. By John Sparkes.

As already announced, the Executive Council propose, at the conclusion of the Exhibition, to present the copyright of the Hand-books to the Society of Arts, and the Council of the Society have readily undertaken to continue their publication after the Exhibition has closed.

Proceedings of the Society.

PREVENTION OF FIRES IN THEATRES.

The following papers submitted by Captain Shean and Mr. Ernest A. E. Woodrow, in competition for the Fothergill prize, offered for the best invention having for its object the Prevention or Extinction of Fires in Theatres, were determined by the Council of the Society of Arts to be the best of all the contributions sent in. The Council, however, were of opinion that these papers did not come within the terms of the offer of the prize, but they decided that the papers should be printed in the *Journal*:—

FIRE: ITS PREVENTION AND EXTINCTION IN THEATRES.

By Arthur W. C. Shean, Consulting Fire Brigade Engineer.

Fire, and the lamentable loss of life frequently resulting therefrom, periodically attract special attention, the periods being the occasions of serious disasters. To the terrible misfortune that occurred in the Ring Theatre at Vienna, on the 8th December, 1881, can be traced the special attention which has been directed in England, during the past two years, to theatres and music-halls.

To those, however, practically acquainted with the subject of fire prevention and extinction, the knowledge of the existing danger has been adequately appreciated.

On the 29th March, 1881, and again on the 30th September, 1881, months previous to the accident at Vienna, when nearly 1,000 lives were lost, I took the liberty of addressing the Lord Chamberlain on the "notoriously disgraceful" condition of many of our London theatres, with regard to the prevention and extinction of fire therein. In the reply of his Lordship, dated 28th September, to a letter of mine of the 27th September, 1881, the following sentence occurs:—"His Lordship would point out to you the unfairness of making vague and sweeping charges of this nature."

Mr. John Hebb (assistant architect and surveyor to the Metropolitan Board of Works), at the Society of Arts' meeting held on the 31st May, 1883, stated that the powers of the Board, under which radical improvements during the past two years have been effected in nearly every London theatre and music hall, whilst many have been entirely pulled down and rebuilt, were conferred on the Board by Parliament in 1878, in an amendment of the Metropolis Local Management and Building Act. Three years elapsed, however, and not until the occurrence of the Ring Theatre fire, and the prevalence of consequent excited public feeling and press agitation, did the Metropolitan Board of Works take any definite action. From 1855, however, Parliamentary powers have enabled certain jurisdictions to act for the safety of the public, and no theatre, by law, could perform stage plays without the license of the Lord Chamberlain. There are 472 places of amusement in London, accommodating nightly 302,000 people, and the buildings include theatres, music-halls, and concert-rooms, &c.

These places of amusement are under no less than six separate jurisdictions, neither of which powers have ever enforced such regulations as are absolutely necessary for the safety of the public.

The powers entrusted with the so-called "management" of these places of amusement, in the interest of the public, have of late years been so conflicting in their ruling, as, while causing those interested in theatrical enterprise considerable expense and annoyance, to lead to the result of little public benefit accruing.

With regard to the rules issued by the Lord Chamberlain, and supposed to be obeyed, I cannot do better than quote a statement published in the *Times* of 16th January, 1883, in a letter addressed by myself to the Editor:—

"I was at a place of public entertainment in London last Saturday night, where all the gangways were completely blocked up with camp stools and chairs. As an experiment, in the middle of a performance, I rose, with a friend, to leave the building, timing my exit. Every one assisted my egress as well as possible. I am not particularly clumsy, but I nearly fell over camp stools, lying on the ground shut up, several times; and when I reached an exit door, over five minutes had elapsed from my first rising to leave the building."

The leading article in the *Times* of 18th January, 1883, quotes the statement I then made:—

"That last Saturday night hundreds of people ran the risk of being roasted alive in a popular place of entertainment."

In the *Times* of 19th January, 1883, "A Dramatic Critic of Twenty-five years' standing," says:—

"Will you permit me not only to endorse in almost every particular the statements of Captain Shean, but to comment upon the almost systematic neglect of the orders, instructions, and regulations issued from time to time by the Lord Chamberlain?"

In a leading article of the *Evening Standard* of 16th January, 1883, the following comment is made, to the remarks made to me, by the acting manager of the place of amusement referred to, when I drew his attention to the utter disregard of the Lord Chamberlain's instructions. The reply of the acting manager was:—

"The Lord Chamberlain does not want to interfere with us, and we do not want to interfere with him."

The *Standard* says:—

"The Lord Chamberlain may be gratified to learn that he has no reason to apprehend interference from the acting managers. Playgoers, however, would like to know whether his Lordship has really entered into the affable little agreement, and whether his rules are made to be obeyed or derided?"

It may be as well to state here that Mr. Irving, in a letter to the *Times*, appearing 23rd January, 1883, with regard to my statement that the place of entertainment complained of was one that had gone to arbitration, says:—

"One of these theatres is the Lyceum, and as Captain Shean so delicately and frankly declares that in the theatre aforesaid 'hundreds of people ran the risk of being roasted alive,' he might, I think, with equal frankness, have stated that the Lyceum was not the one alluded to."

I have much pleasure in stating I did not allude to the Lyceum Theatre. With regard to the conflicting jurisdictions, I may state that a certain place of entertainment was visited by the authorities, and certain improvements ordered, which, at considerable expense, were effected. No sooner, however, were the "improvements" completed, than the Metropolitan Board of Works stepped in, and required further alterations, necessitating an additional outlay of several thousands of pounds sterling. That the soundest judgment has prevailed in respect to the alterations required at certain places of entertainment is open to question, and the following will prove this. The proprietor of the above place of entertainment availed himself of the opportunity of referring the matter to arbitration, as allowed by the Act of Parliament. The case was heard before Sir Henry Arthur Hunt, C.B., at the Institute of Surveyors, Great George-street, Westminster, and I was called upon, as a practical fireman, to give evidence. My opinion was against the Metropolitan Board of Works, who instigated the proceedings, and who ultimately lost their case, causing, it is almost needless to say, a considerable waste of public money, as the Metropolitan Board of Works had to pay the entire costs of the proceedings. As another instance of the utter disregard of the Lord Chamberlain's powers, I may mention the fact of the "Alcazar" Theatre being opened by Mr. Baum without his having first obtained a license to perform stage plays. The "house" was open nightly for some time, and a "pantomine" performed to a crowded audience. Neither had the Lord Chamberlain issued any order his Lordship may have considered necessary for public safety in the event of fire. The "Alcazar Theatre," in Holborn, opened at Christmas time, 1882, was totally unprovided with any appliance whatever for the extinction of fire. The Alcazar Theatre was in the end closed, and Mr. Baum fined, but not until many thousands of lives had been seriously jeopardised.

I lately had the honour of conducting Mr. Dixon-Hartland, M.P., and other members of Parliament, in an inspection of nearly every place of amusement in London. Mr. Dixon-Hartland, M.P., in a speech in the House of Commons on the 17th of April, 1882, says:—

"He only regretted that the Chairman of the Metropolitan Board of Works had not been with him, because, if he had, he might have seen reason to reverse the answer he had given to a question put to him some time ago, when he said he should hesitate to declare any theatre in London unsafe. He might have felt obliged to confess that he had great doubts whether many of those theatres were safe, whether, indeed, many of them were not perfect death-traps, owing partly to faulty construction, partly to the materials of which they were built, and partly to the dangers arising from the rapid shifting of scenes of inflammable materials near to unprotected lights. On a Saturday evening, at one theatre in the Strand, capable of containing 1,500 to 2,000 people, he found a workman reading a newspaper behind the scenes, near a flaring gas-light, where the least puff of wind might have set the whole house in a conflagration. As many as 187 theatres had been totally destroyed by fire during the period from 1861 to 1877, and 13 had been destroyed by fire yearly since, while the average life of a theatre was not more than 23 years."

Some few words may be said with regard to theatres actually inspected by Mr. Dixon-Hartland, M.P., and myself during the past year. The Prince of Wales's Theatre, during the performance of "The Colonel," was estimated to contain nightly fully 500 people. The "piece" had a run of over 18 months, so that during that period over 234,000 people witnessed the performance. The house was built almost entirely of wood, highly dried by the great heat from the gas, &c., nightly engendered. The exits were as bad as they could be, and the fire-extinguishing appliances were limited to a little tank on the roof of the stage, with an indiarubber pipe depending therefrom. About the time of the Vienna fire, a special exit for the use of Royalty was made at the Prince of Wales's Theatre.

As mentioned in a letter of mine appearing in the *Times* of 9th December, 1882, I suggested to the directors of the Alhambra, when inspecting that theatre, the desirability of providing extra hose for its protection. With such provision, adequately used, the late Alhambra should never have met the fate it did.

At the Park Theatre, Camden-town, also inspected, a length or two of rotten hose comprised the entire fire-extinguishing plant. At the Duke's Theatre, Holborn, also, the appliances were in anything but good order.

These theatres have since been consumed by fire—most fortunately without serious loss of life—together with the Philharmonic at Islington, where Mr. Dixon-Hartland, M.P., and myself found the exit doors so securely fastened and bolted that, on the arrival of the man with the key to open them, after waiting ten minutes, it took two or three men to force them open. At the Strand Theatre, before re-construction, the dressing-rooms of the ballet were approached from the stage up a spiral iron staircase, the heat there being so great as to compel Mr. Warton, M.P., who ascended the staircase with me, to beat a hasty retreat. It is only common reasoning to add that, in the event of fire at the Strand Theatre before re-construction, the ballet would have been burnt, as if in a cage, in the fire. The Criterion Theatre has also since been closed. The fact of its being considerably below the surface of the ground (air having to be pumped below), would have rendered the escape of an audience impossible in case of fire suffocation from the smoke, which would have filled the upper staircases, rendering breathing impossible. The late Royalty Theatre, with dwelling-house attached, and in communication, was also a notably dangerous structure; as was also the Olympic, now re-constructed. I quote such instances only as I can do so without detriment to vested interests, all the theatres I have mentioned being either burnt, or shut up, or re-constructed, at the present time; but they were open and nightly crowded at the time of my addressing the Lord Chamberlain. It may now be seen whether the term I then used as to their condition being "notoriously disgraceful," was an expression to which exception could be taken. At a theatre open at the present time—the Gaiety—conflicting authority has resulted in the bricking up of an important exit. As, however, Mr. Hollingshead has published a pamphlet giving the opinions of Mr. Phipps, the celebrated architect, and which flatly contradict many points raised by the Metropolitan Board of Works, the assertion previously made that the Metropolitan Board of Works has not allowed the soundest judgment to prevail in its dealings in "improvements" in theatres is again exemplified.* The annual inspection by the Lord Chamberlain I described at the Society of Arts' meeting on the 31st May, 1883, in the mildest language I could use, namely, as a "simple farce," The gentleman who makes that inspection knows nothing whatever of fire brigade work or appliances. The manager of a theatre receives a letter stating a gentleman from the Lord Chamberlain's office will call on a certain day, at a certain time; the fireman, or man doing duty as such, is told to put on his best coat and receive the gentleman, and escort him round the house. Whether the appliances are in good working order or not the "inspector" is unable to say, and the "inspection" serves no practical use in any sense whatever.

That the meeting of the Society of Arts so far endorsed my remarks, the following resolution, which was carried unanimously, will show:—

"That the present official system for inspection of theatres is unsatisfactory, and does not adequately provide for the protection of the public from the risk by fire."

I have called attention to the "fireman" employed at theatres, and a few further remarks may not be out of place. Having had theatres placed under my charge, I can testify to the fact of the "firemen" employed to guard such places having other employment in the day-time, and, therefore, it can only be reasonably supposed that while on "duty" at the theatre, a considerable part of such "duty" must be generally performed by most of them in a state of somnambulism. At the late Philharmonic Theatre, the "fireman," on being questioned, admitted knowing nothing whatever of the fire-brigade duties. He was gas-man, and acted as "fireman" he added, and in event of fire, he stated, he would give the alarm.

At the Alhambra, the fireman, at the time his services were of the greatest value, namely, the outbreak of the fire, instead of being able to direct all his energy to his duties, was engaged in rescuing his wife and child, who resided in apartments at the top of the building. The danger to surrounding property from such negligence of duty must be considered, as life is seriously imperilled in adjacent buildings by a conflagration such as results from the burning of a theatre.

In a paper circulated amongt firemen, styled *Police and Fire*, but now published as *The Fire Engine*, I advocated the establishment of a Fire Brigade reserve. The remarks are published in *Police and Fire* of 5th March, 1881, from which I take the following:—

"Then managers of theatres advertise for a fireman, and the man engaged is made to appear a kind of general officer of firemen in his epaulettes and paraphernalia, and acts the part of a fire policeman, and looks after fire when not otherwise engaged."

Now, why should a Fire Brigade reserve not be started in London, to band together all these men who look after buildings. Under good superintending officers, a much higher standard of efficiency in the matter of prevention could be attained, and while employers would not pay more than they now do, they would derive great benefit by being able to obtain men of known character and tried ability, coupled with the advantage of regular and stringent supervision. At present, each fireman is his own master; his employer does not understand his duties or their proper performance, and usually engages the man from his personal appearance, or some recommendation that, for practical purposes, may be worthless.

Being of opinion that the place for a fireman at a theatre is on the stage, I drew the attention of Mr. Bancroft, while I was inspecting the Haymarket Theatre, to his fireman parading the house. Mr. Bancroft's remark was, "Well, I am of opinion that it gives an audience confidence to see the fireman." "Certainly, if confidence is to be given by mere show," I

* On the 12th October, 1883, Messrs. Gatti were summoned to Bow-street, charged by the Metropolitan Board with making default in certain alterations ordered in the structure of the Adelphi Theatre by the Metropolitan Board of Works. Mr. Flowers, the magistrate, after hearing the evidence, said "that, as far as his judgment went, everything necessary had been done by the defendants." Messrs. Gatti had, however, to pay £3, the costs of the several adjournments that had taken place in connection with the matter. On October 13th, 1883, when application was made to the Croydon magistrates to renew the dramatic license for the Croydon Theatre, the Chairman drew attention to certain matters which he contended were not in accordance with the requirements of the Bench. A quantity of goods had been placed in a passage. A temporary license was granted, that structural defects might be remedied.

replied, "why not dress up a super as a fireman, and allow the man who understands the practical duties to remain where he is most likely to be required?" The fireman in charge on the stage holds a most responsible position.

It is the feeling of security amidst the greatest danger, fostered and believed in because of the comparative immunity from accident for some years, that leads to a carelessness and want of precaution that, in almost every instance, has led to ultimate disastrous results. So long as each proprietor or manager of a theatre can act independently, and be allowed to form his own opinion of what is necessary for public safety, so long will a most unsatisfactory state of affairs exist, and be dangerous in the extreme.

Whatever authority exists in the interest of the public for safety against fire in theatres, such jurisdiction should be the same, and made to apply in all parts of the kingdom. Offences against a law providing for the safety of the public in places of amusement should only in trivial instances be punishable by fine; wilful neglect, thereby involving risk to life, being made penal.

Another point worthy of consideration is the character of dramatic representations, and the attempts at realism which introduce a needless element of danger where it is so desirable to minimise risk, as accident may lead to such dire consequences.

Without diverging from the subject of fire extinction, it may well be offered as a matter for consideration whether such attempted realistic dramatic representations should, in the interest of dramatic art, be classed with stage performances of a character such as a theatre may reasonably be expected to produce. In the event of accident, with the most perfect system in every way, it is impossible safely to calculate on an absolutely safe exit of an entire audience of any magnitude. So many unforeseen circumstances are likely to occur in the best regulated houses, where so many people are assembled together under one roof, that will upset calculations made without sufficiently taking into account the great excitement and violently precipitate action of otherwise cool and law-abiding people; that danger cannot be too well guarded against.

As is only to be expected in the attempted realisation of any greatly desired end, numerous and unexpected difficulties arise that require careful study; and in regard to fires in theatres, panic may be accepted as one of the greatest dangers, as well as one of the greatest difficulties to contend with.

Panic, or terror, created by groundless fears, can only be averted by the adoption of such means in places of public amusement as will create a convincing proof of absolute safety. While absolute danger, by reason of insufficient means of exit and other causes, exists, the fear of its occurrence will remain, and the worst results will be possible from its incident.

Panic, produced from a feeling of insecurity, must be met by rendering individual personal safety a certainty, and under this condition panic is practically impossible. Until individual personal safety can be secured to the public, the danger of panic will exist with the ever probable and likely result of loss of life. Fire in a theatre completes its work with a rapidity simply astonishing.

Taking one of the last instances, namely, the Alhambra, the Chandos-street fire-engine station received the alarm immediately on the outbreak of the fire. The fire station was hardly two minutes' run from the fire. When the firemen reached the theatre, the fire had not gone beyond the dress circle, yet so great was the heat that the melting of gas-pipes in the roof was like rain on the auditorium, and the tunic of one of the firemen, which is now at the headquarters of the Metropolitan Fire Brigade, presents the appearance of a piece of metal rather than its texture, which is of course cloth. The fireman, whose coat this was, stationed in the stalls, was compelled to retire, the branch of a powerful steamer that he was directing proving useless to stop the progress of the flames.

Instances of the startling spread of fire that once gets a hold in a theatre are numerous. As I write, I notice the following in the *Times* of October 6, 1883, with reference to a fire at a theatre at Yokohama:—

> "The flames spread with awful rapidity, and in a few minutes enveloped the theatre. In the result 15 adults and 20 children were found to have been killed, and over 100 persons were seriously injured."

Modern appliances, invented more easily to extinguish fire, generally necessitate the exercise of judgment, ability, presence of mind, and even personal courage, for effective use in the moment of danger. Unless those who are to use such appliances as exist in theatres for fire extinction are accustomed to their use, and by continual practice made familiar with them, so that the full power of their effectiveness can be applied at the moment required, and with advantage, such appliances are, for all practical purposes, useless.

To attain the desired end, I have drawn up a code of "Rules and Regulations for the Prevention of Fire" for several of our leading theatres. For each theatre the code is specially adapted, and, as an example, I quote those written by myself for the Royal Comedy Theatre :—

"From the commencement to the finish of every performance, the fireman in charge must be in attendance on the stage, and must not leave for any purpose whatever.

"The fireman's duty is to keep a careful watch over the gas arrangements, and superintend the lighting-up and maintenance of all lights in use on the stage generally.

"Scene-shifters, &c., are not to block up the hydrants, free access to which must always be maintained; all branches with hose flaked must be kept ready for instant use. Two blankets on either side of the stage, well wetted, must be kept in readiness for use, and in convenient positions.

"The fire buckets on the stage must be kept full of water, and hand-pumps practically tested every night, previous to the commencement of the performance. A man in the "flies" to be entrusted nightly with the bucket and hydrants there, with instructions how to use them. No one, on any account whatever, is to make use of or tamper with any appliances kept for fire extinction.

"Fire-places and stoves must be guarded with wire screens; and gas-burners by wire-netting and protection plates. Wax and any kind of matches, other than patent safety, to ignite on the box only, must not be taken on the stage or into any dressing-room; smoking in these places is also strictly prohibited.

"The hydrants in the auditorium, pit, dress circle, upper circle and gallery to be entrusted nightly to a responsible person whose duty may require his attendance nearest to them. Windows and doors, on and near the stage, to be kept closed during every performance, strong draught being dangerous.

"'Mediums' and inflammable material used on the stage must be rendered non-combustible by the application of a solution of tungstate of soda, the fireman in charge being responsible for this being done as often as occasion may require. Highly inflammable wearing apparel, in process of washing, should, lastly, be dipped in a solution of alum.

"The fireman in charge to have free access to every part of the building.

"No one under the influence of drink to be allowed on the stage, or in the dressing-rooms.

"No intoxicating drink of any kind to be offered to or accepted by the fireman in charge of the theatre and on duty.

"At the close of every performance, and of the theatre, the fireman in charge must visit every part of the building. A signal should be known by all servants of the theatre to convey to them the presence of fire in any part of the building without giving the alarm to the public. Visitors are politely requested not to light cigars or pipes within the precincts of the theatre, or use matches.

"Absolutely careful and particular attention to these regulations being necessary and essential for the protection of the general public attending the theatre, anyone noticing any breach or non-performance of the above regulations, should at once report the same to the manager of the theatre."

The enforcement of such regulations at the present time is, unfortunately, left to the individual discretion of managers. The leading article in the *Daily Telegraph* of 21st December, 1881, however, says:—

"Captain Arthur W. Shean has submitted a set of rules for the consideration of the Lord Chamberlain, which, in conjunction with other practical suggestions, might be made to form the framework of an Act of Parliament. One of these rules provides for a signal which should be known by all servants at the theatre, to convey to them the presence of fire in any part of the building without taking the public into the secret of alarm."

Mr. Dixon-Hartland, M.P., in his speech in the House of Commons on 17th April, 1882, says:—

"Considering it his duty to become practically acquainted with the state of theatres in London, he (Mr. Dixon-Hartland) had, by the kindness and exertions of Captain Shean, a gentleman who had prepared the best rules he had seen for prevention and extinction of fires in theatres, been enabled to visit a great number of those places."

A theatrical manager of great experience addressed to me the following letter :—

"New Sadler's Wells Theatre,
"December 13th, 1881.

"Dear Sir.—On my taking possesion of this theatre, I found the fire appliances in most excellent condition—in fact, the arrangements made by you as a precaution against fire are of a more satisfactory nature than I have found at either the Drury-lane, Lyceum, Princess's, Adelphi, and St. James's Theatres.

"Yours faithfully,

"F. B. CHATTERTON.

"To Captain Shean."

The most perfect regulations, however, without actual practice, are of little use. At the fire at Cortachy Castle, reported in the *Times* of 17th September, 1883, the following occurs :—

"The castle had a complete water system for use in case of fire. The printed regulations for the manipulations of this apparatus were exposed on the walls, but none of Lord Dudley's servants made themselves acquainted with the details. To give the alarm of the fire, one of the servants seized the rope of the alarm bell, which immediately snapped."

Similarly, by reason of neglect, at the Karlsbad Theatre in Vienna, on September 10, 1883, in consequence of a panic, "the people fled through the windows and over the roof, instead of making use of the emergency exits, which were locked and bolted."

To provide against such neglect, and to ensure a proper use of appliances, I advocated and introduced a "fire drill," described by me in a letter appearing in the *Times* of 23rd November, 1882. It refers to the drill performed at the Brighton Theatre Royal, and is as follows :—

"At the close of the performance, the audience had but just quitted the theatre when the "fire drill" commenced. At a signal, known only to the *employés*, but which indicated to them the presence of fire in the theatre, the curtain was quickly dropped. At the same time every exit door opened, and a powerful lantern was held aloft by an attendant, clearly showing the way out, the gas being turned down. The stage manager also appeared in front of the curtain, and stated an accident had happened, but everyone in the theatre could leave with comfort, and without fear of anything whatever. As quick as thought the word was passed 'fire in the dressing-rooms.' The hose, with branch attached, was instantly married on to the hydrants. Hand-pumps were likewise immediately applied, and in the space of but a few seconds, such fire extinguishing appliances were brought into requisition as, under ordinary circumstances, would be sufficient to meet any ordinary emergency. And this 'fire drill' was performed by the whole staff of the theatre, and is practiced every fortnight throughout the year, a different part of the building being supposed in danger at every drill. What was done was performed in the most workman-like manner, quickly, but with no unnecessary bustle, and no confusion."

Especially in regard to fireman's work, use is second nature, the only hope of successfully attacking an outbreak of fire in a theatre being that of a simple and instant method of meeting the danger, with an effective handling of appliances, only to be attained by those on the spot being intimately acquainted with their use.

The safety of the public must, however, be studied by the enforcement of certain additional precautions that are indispensable. To describe these I propose, first, taking the auditorium, and afterwards the stage.

The seats in the auditorium should be fixed, every seat allowing at least two and a-half square feet of room for the occupant, and be so arranged as, while tending to prevent a "block," allow a free passage to the exit door. All the seats in a theatre should be licensed, and it should be an act against law for a manager to allow or permit more people in his theatre than he has licensed seats to accommodate.* All staircases should be constructed with hand-rails on either side, and where any turn of the passage may lead any one to doubt the direct way out, the word "Exit," with a hand pointing in that direction, should appear prominently. All exit doors should be distinctly labelled "Exit," and every such door should be opened nightly for egress. All exit gangways should be clear of any obstruction, and for outer exit doors, which should open outwards, carpet curtains should be used in place of doors, to prevent draught, &c. Every separate part of the building, such as pit, dress circle, gallery, &c., should have a separate and direct exit, no other exit leading into it at any junction whatever. Excepting the case of private boxes, there should be no movable seats capable of being overturned in any part of the theatre. Cloak rooms, refreshment rooms, and other public conveniences, should be situated at the farthest point from the exit door, thus leaving the exits clear of unnecessary traffic. No greater number of people should be contained in any part of the "house" than, by calculation of width of exit, &c., would allow of a clearance being effected under three minutes. Special attention should be directed to such parts of the house as are highest from the basement. Smoke ascends,

* From the *Referee*, a journal always well informed on matters connected with theatres, I quote the following, which appears in a copy of that journal of October 14, 1883. It alludes to the Adelphi Theatre :—"Boards—'standing room only'—have been out every night," &c. In a house so packed with human beings, a safe exit in case of accident would be next to an impossibility. It is as absolutely necessary for safety to license the "holding" capacity of a theatre as to limit the passenger accommodation of a ship.

and suffocation can be effected by causing insensibility in the space of one minute.

An outlet for smoke in the roof is desirable, although it may assist the spread of fire,* life being of greater value than property. All gas-pipes, &c., should be of iron, no metal piping being used. If the lighting power be by gas, it should be supplied from separate meters and mains, one for the auditorium, the other for the stage; while supplemental means, such as oil lamps, should provide against the contingency of total darkness. Where lighting is effected by means of electricity, the wires should be laid under responsible authority.

Lastly, the adoption of fire regulations and fire drill, as explained, should be enforced, and the building subjected to inspection after being closed, by constituted authority, that would ensure proper vigilance being exercised against an outbreak of fire.

The stage, a combination of wood, canvas, arrangements for lighting on an extensive scale, and properties generally of a naturally inflammable character, rendered still more so by the great heat nightly engendered, may be considered the part of the house requiring the greatest protection. The danger attending the lighting of a stage, generally effected by the use of coal-gas, must be considered.

The frequent shifting of scenes nessitates a constant re-arrangement of gas-pipes having joints of flexible india-rubber, the insecurity of any one of which, causing an escape of gas, being likely to lead to danger of the greatest magnitude. It is most desirable that lights, as much as possible, should be fixed and powerfully reflected—use being made of everything available, floor and backs of scenes—to increase the power of light, which would be advantageous from the point of view of safety from fire as well as economy.

Flexible gas joints should be under constant supervision, all pipes for the conveyance of gas throughout the "house" being of iron. No workshops of any description or "stores" should be attached to or form part of a theatre. Where scene painting is done inside a theatre, it should be executed under strict rules, provision being made, amongst other important items, against smoking. It is absolutely necessary that every licensed building should be placed under strict rules and regulations, providing for careful, vigilant, and ceaseless watching.

Stage properties generally may be rendered non-combustible by the use of chemicals, such use being approved at the Society of Arts meeting on May 31st, 1883, when the following resolution, proposed by Sir Frederick Abel and seconded by myself, was carried unanimously.

> "That it is important that attention should be given by managers of theatres to the known methods for reducing the inflammability of structural or decorative materials, and that it is desirable that more use should be made of such methods."

Practically, the recommendation is not appreciated, and little or no use is made of a valuable means of protection easily and inexpensively applied.

Water, and that of a most insufficient and scanty supply, is the only element upon which any reliance can be placed for the extinction of fire in theatres.

The pressure in the Strand district, where many of London theatres are situated together, I tested in February, 1882, and found to be under 45 lbs. on the square inch. The pressure varies from 30 lbs. to 50 lbs., the exception being a pressure of 55 lbs. This highest pressure is insufficient to reach to the roofs of many of our theatres, and there is only one remedy. Each theatre should be provided on the stage with a copper tank, containing about 100 gallons of water, with four deliveries, one for each side of the stage—"floor" and "flies." By means of an air-pump, air could be pumped into the cylinder, till, by guage, a pressure could be shown of at least 150 lbs. on the square inch—and the guage would continue to show the existence of the pressure or its decrease.

Theatre fires have, in almost every known instance, burnt themselves out. Density of volume or force of contact will alone stop a fire in a theatre, by, so to speak, suffocating it. For this reason I question the utility of a high proscenium wall as a means of stopping or preventing a "burn out" in event of fire. From practical experience, I should assert that unless fire in a theatre can be subdued locally, *i.e.*, that an outbreak can be checked within a reasonable limit by local appliances then and there at command, all hope of saving any part of the building might be deemed futile. The delivery of water from such a reservoir and with such pressure as I have named, through branches one-sixteenth of an inch in diameter, would prove an extinguishing agent of sufficient power for all ordinary purposes. Little discretion has been used, in numerous instances, in placing the hydrants and appliances in theatres

* Such outlet being made to act automatically by the action of heat.

for fire extinction. Exit gangways and similar places would, in event of fire, be crowded with a surging and excited crowd—and in these places are the appliances, in many instances, fixed. The hose is coiled, the branch and different parts of the gear laid apart "on view," the practical use of the appliances being seemingly ignored. On the occasion of accident, such parts of the appliances for fire extinction have to be joined together, and the hose rolled out, and thus the most valuable time, namely, that immediately following an outbreak of fire, would be wasted in completing work that should be kept perfect, and the appliances ready for instant use.

That part of the house used by the orchestra, if connected direct with the outside of the building by a subway, would be the most convenient for placing hydrants, &c., as the appliances, while being used, would be free from the turmoil of a crowd, and handy for use by the servants of the theatre, whose knowledge of a clear subway to the street would enable the appliances being advantageously worked for as long a time as possible in the direction of any part of the house. Supplementary aid and assistance could also, by means of the subway, gain easy access from outside the building, while the audience would be permitted to avail themselves of the ordinary exits, unencumbered with fire brigade appliances that, otherwise being got ready and used in their midst, could only tend to add to confusion, loss of time, and in every way prove highly dangerous and thoroughly inconvenient. In the event of fire occurring on the stage of a theatre, it is usual to cut away the burning portion. For additional safety it would be as well to have ready for use "trays" of close wire gauze, that might catch the material alight, and so tend to prevent an extension of the fire.

Buildings to be erected and intended for theatres or places of public amusement, should have all staircases constructed of concrete, with banisters of iron, and have a separate and distinct water servive for fire extinction. As danger is as likely to be apprehended from smoke as from fire, special attention should be directed to the gallery and upper parts of the building. At only one theatre, namely, the Savoy, has this been studied in the construction of the theatre, the gradient of the basement being utilised to afford equal advantages to the upper as to the lower parts of the house.

The Savoy being situated on the side of a hill leading from the Strand to the Thames Embankment, the pit audience entering at the bottom of the hill, and the gallery some distance up the hill, are equally well provided with an easy means of exit, the gradient of the ground saving a climbing up or descending of as many stairs as if the gradient of the basement was equally flat.

The side of the Strand above the Embankment, by reason of the gradient, offers a better site for theatres and places of entertainment than can be found equally advantageous in almost any capital of Europe.

A full and complete official investigation should follow the occurrence of any and every accident by fire in theatres, a report of the occurrence of which should be made compulsory to the duly appointed authority, the establishment of which, by the Government of the country, is a most necessary and pressing subject of home legislation. The entire English press has acknowledged the necessity for some decided action being taken, in the public interest, in the prevention of fires in theatres, and it is to be sincerely hoped the experiences of the past may not need repetition, in order to provide reasonable security in the future.

Relative to the question of expense, is not traffic in slaves less objectionable than submitting some hundreds of people to the risk of being burnt alive, from a desire to save outlay in providing adequate appliances?

Centralisation of power, and grandmotherly government, may be terms used to deride the action of Government in the matter. If placing the lives of 302,000 people nightly in safety from the risk of death by fire be called grandmotherly government, the same epithet might be applied to the sale of Food and Drugs Act, and Acts of Parliament tending to prevent the spread of epidemics and disease.

As our population increases, one of the principal moral and intellectual recreations for the populations of the large towns is that provided by the theatre under good management, and the misery and awful consequences that have attended the loss of life by reason of accident by fire in theatres have, it is to be hoped, been sufficiently well shown not to need repetition. Until what has been stated in this paper, and which is absolutely essential for safety, is properly carried out, the licenses of places of public entertainment being held subject to the enforcement of the conditions stated, buildings containing large public audiences will not be safe, and the chance of serious accidents happening at any time will be regulated by "luck," or the prospect of total immunity from any accident whatever.

If it be no concern of the State how the lives of its subjects are jeopardised and even destroyed, how very ridiculous it is to study any means whatever for the safety of the public or the preservation of life. Until such measures are passed by our legislature as will ensure the observance of such precautionary measures as alone will tend to prevent the occasion of serious accident, large audiences will be exposed to all the risks and terrors of death by fire in our theatres and public places of amusement. This fact, only too true, it is to be trusted will not afford a practical proof of my statements.

In concluding this paper, I feel it incumbent to recognise the valuable and much appreciated services of the police in the cause of fire prevention and extinction. Considering the invaluable services they have at all times rendered, and especially in our large towns, I cannot but think it would prove highly advantageous to connect all our places of public entertainment with the police stations by electric wire, that in case of need their valuable aid might be at once rendered.

I feel it necessary to draw attention to the manner in which certain theatres are at the present time being constructed. In one instance "the theatre" is contained in an inner shell, the outer shell comprising an hotel, residential chambers, and shops. The combination, through doubtless economical, is dangerous, and such a building should never be licensed for public entertainment. Risk by fire in theatres will ever be sufficiently great, but to add to the risk by enclosing such a building with an hotel, and chambers, and shops, can only be regarded, after recent experiences, as an act showing the grossest disregard of human life, and one that should never receive the sanction of the authorities.

Appendix.

The foregoing essay, in consequence of having to be delivered to the Society of Arts prior to 31st October, 1883, was written in September, 1883.

Since that date, an instance of gross abuse and neglect of all precautions for the safety of life in a large London theatre, came to my notice, particulars of which were published in a letter of mine to the Editor of the *Times*, on the 2nd January, 1884.

On the night of December 28th, 1883, I visited a large London theatre, only lately inspected by the Lord Chamberlain. The fire buckets were in their proper position, but everywhere empty, the fireman stating that 'the cleaners must have been using them.' The fireman in charge did not know the pressure of the hydrants, as they had never been tested. He stated also, on my asking what provision there was in the flies for fire extinction, that he "intended running up a line of hose there from one of the stage hydrants."

There were no hand pumps, and no fire hook for cutting away any portion of scenery that might catch fire. Three firemen were employed at the theatre, but they had no system for unity of action, and no signal to give alarm of fire without alarming the public. The few lengths of hose were, as I was informed, "just in time for the Lord Chamberlain's inspection," having only lately been delivered at the theatre.

A few remarks, may, I think, be appropriately added with special reference to music-halls. The character of music-halls (if I may use such an expression), will considerably alter if an extension be generally granted for dancing as at the present time is alone possessed by the Oxford Music-hall. The "Oxford," characterised by able management, may continue to hold the exceptional privilege; but should other places known as music-halls receive such an extension of license, greater attention will, of necessity, have to be directed to the question of fire prevention in such places. The combustible nature of music-halls may be generally held equal to that of theatres, a special feature, however, being, that whilst the audience of a theatre enter and leave the building almost at the same time, the audience of a music-hall is a changeable and continually shifting one. The entertainment of a music-hall being promiscuous, an increased attendance may generally be expected during the performance of a particular public "favourite," whose *debut* may not occupy more than fifteen minutes, before and after which not nearly so large an attendance may occur during an entire evening.

Music-halls generally, as at present licensed, have no need of moveable, side, or medium lights: but a change in the nature of the performance, placing them on the basis of a theatre, will naturally add the special danger attendant on increased light and illuminations that render stage productions often very dangerous. That music-halls will burn as quickly as theatres when once on fire, may be instanced in the case of Lusby's Music-hall, in the Mile-end-road, which was "gutted" by fire in 20 minutes, on the 20th January, this year. Music-halls in London at the present time may generally be considered fairly satisfactory as regards safety from fire. At the Oxford Music-hall, at a sudden call one night, the hose was connected with the hydrant, branch attached, and the water sent on to the roof of the building under two minutes. At the Oxford also the manager stopped suddenly at one of the bars, and said to the attendant, "What would you do in case of fire?" "Open this flap of counter sir, and shout 'this way out.'" Such care in training the servants of such an establishment to act in case of sudden emergency cannot be too highly commended. The Pavilion Music-hall, the property of the Metropolitan Board of Works, who purchased the building in August, 1879, at a cost of £109,000, and who at the present time let it to Mr. Villiers, at an annual rent of £7,000 a year, may soon be destroyed, as the Board made the purchase for the purpose of effecting certain improvements, and making a new street from Piccadilly-circus to Oxford-street, through Soho, their Parliamentary powers expiring in July, 1884. A peculiar fact, however, is worth stating, namely, that while the Board of Works have compelled numerous and extensive alterations in theatres and music-halls to be made of late years, not until November, 1883, were such alterations made by their own tenant as would give the public some chance of getting out of the Pavilion Music-hall in case of fire.

At another music-hall close to the Pavilion, namely, the Trocadero, in Windmill-street, it is satisfactory to find excellent fire-extinguishing appliances, and as good exits as exist anywhere. The exceedingly peculiar system (if such a term may be used with regard to licensing public buildings in London) that exists, whilst preventing the performance of plays, &c., on Ash Wednesday, on the north side of the Thames, not only permits their representation on the south side of the river, but the hours are specially extended to houses there situated, Last Ash Wednesday, 27th February, 1884, I visited one of these specially favoured resorts, namely, the Canterbury Music-hall, whose license on that night extended till 3 a.m. the following morning. As may be expected, the place was filled to a most dangerous limit, "packed," in fact, in every part, and "standing room" only freely acknowledged at the booking-office, whilst payment was being accepted to witness the performance. To gain as good an idea as possible of the enormous risk the thousands of people then present ran in event of accident by fire, I made my way to the gallery, approached by over fifty steps, about 4 ft. wide, and, in some places, covered with orange peel. Posters, with the following notice, were prominently displayed on the several landings:—

"Watch This.

"A reward of 5s. will be given to anyone for such information as will lead to a conviction of the person, or persons, turning off the gas on these stairs."

The gas-burners were, however, quite unprotected, and within easy reach of the lads to whom the notice may be presumed to have applied. I have visited places of amusement in London that I presume come under the category of music-halls, but of which an idea may be more correctly conveyed by describing them as public houses, with sitting accommodation for a number of people, to whom is supplied a certain amount of alcoholic drink, with a miscellaneous entertainment, including songs and dances, at a fixed price.

In many of these places no appliances whatever exist for fire extinction, and in one place in particular where there are such appliances, no one is employed with a practical knowledge of their use. Though the number of people who frequent these latter resorts are comparatively few, still, in the poorer neighbourhoods, they form the staple means of recreation, and require, by reason of the number of lives jeopardised in case of accident by fire, as much supervision to ensure safety as is considered necessary at the more refined and aristocratic establishments so popular in the West-end of London.

ARRANGEMENTS FOR THE PREVENTION AND EXTINCTION OF FIRES IN THEATRES.

By Ernest A. E. Woodrow, A.R.I.B.A.

Theatres should be entirely fire-resisting, and have nothing in their construction that will readily ignite, so that the ordinary methods of extinguishing fire will suffice. This can be attained by giving due consideration and study to the planning and the materials of which the building is constructed. How these buildings can be planned and constructed, carrying out a safer system than at present, is what I would wish to try and point out in as brief a manner as possible, touching, it is feared but imperfectly, on only some of the most important points.

When the principal material employed in the construction is thin wood, as is, or perhaps I should say was, so often the case, no possible hope of safety could be entertained either for the building or the public frequenting it.

That a theatre can be made safe in spite of the special dangers from the class of business carried on in it, there cannot be a doubt in the mind of anyone who has given attention to the subject. Like every other class of building, the special risks attending it can only be known by becoming thoroughly acquainted with the business carried on in it, and the special mode of conducting such business, with the accompanying dangers. Until this is ascertained, no one can possibly plan a theatre to avoid these risks, and ensure the safe and easy working of the house.

A theatre, of all buildings, should have a place for everything, and everything in its place; and it is necessary to know what this everything is before the place for it can be provided.

The first step to be taken, is to provide such means in the planning of the house as to enable the people to get out of the building in the shortest possible time, at the slightest provocation, in every way lessening the dangers from panic. Then the construction of a theatre, and the materials used, should be such as to render it wholly fire-resisting; this can be aided greatly by the manner in which the various departments are placed with relation to each other.

As a theatre can be made fire-resisting, no house should be allowed to remain open which is not so. It is no good to patch up the old wooden edifices with sheet iron and pugging, and expect that the buildings will be any the safer. If such theatres still exist in any part of the kingdom, they should be closed, even if the loss is sustained by the public themselves. When the slightest fire commences in one of these flimsy structures, as was seen at the fire at the Alhambra, no efforts, either from external or internal aid, can possibly extinguish it.

Judgment in the choice of materials with which to construct the building, requires such great care and study, that too much importance cannot be placed on this branch of the subject. The materials employed for the erection of places for the assembly of the public, whether for amusement, instruction, or devotion, must be in every sense of the words "the best of their several kinds." The scantlings, or thicknesses, must be far in excess of what would appear to be necessary for the actual or present work which they have to perform, so that they may resist any shock or pressure that may from any cause be brought on them.

In short, a theatre must of necessity, in comparison with other buildings, be exceedingly costly. In this, I refer only to the structural portions, leaving all decorations out of the question. In dealing with buildings where human beings are "packed," surely more care should be bestowed upon their construction than upon warehouses or factories. But as long as cheap theatres are erected danger will be rife.

Planning and Construction for Prevention of Fire.

No theatre should be allowed to stand that is "hemmed in on all sides with a narrow entrance, as a frontage in a public thoroughfare sufficient to carry a flaming gas device." The dangers accruing from the surrounding property are often as great as those in the theatre itself. In no case should people be allowed to live and sleep in or about this class of building; the many risks necessarily attending them, through their own special trade, should not be increased by the dangers generally to be met with in the dwellings of the lower class; and a building, or part of a building, not designed for the special business of a theatre, should never be used for such purposes, as it is nearly sure to be unfit for them.

The site should be isolated on all sides, wide streets running all round the building; but as this is difficult to obtain in crowded cities, a theatre might be designed with comparative safety having one side touching other buildings. To obtain perfect safety, a site isolated on all sides should be insisted on.

The most important item in the planning is what might be called the party-wall system, making every division of a theatre a separate building, with as few openings connecting the various sections and sub-sections as the smooth working of the house will allow. Commencing with the back of the building, I should place the workshop section, divided from the main building by an open area; then the stage, with dressing-rooms and wings on either side; then of course follows the auditorium, the corridors, the staircases, and the offices and saloons. Each of these many sections must be divided from the other, vertically, by strong brick walls, with the openings closed by fire-resisting doors, and, horizontally, by fire-resisting floors.

The various divisions within each section should be again separated by brick walls and strong, fire-resisting floors, so that, should one room be burnt out, no other part of the building would suffer. This system applies throughout the whole building.

The position of the workshops should be such as to ensure an entirely separate building, connected with the theatre by one opening only, which should be closed by a double fire-resisting door, which door should on no account be allowed to open during a performance. Should space permit, the open area should be made 12 ft. wide between the theatre proper and the workshops.

Where no area can be obtained, a thick brick wall passing through and above the roof should divide the workshop section from the stage section.

All stores for scenery, properties, &c., not in immediate use, should be in this building.

The painting gallery might be placed over the workshops, getting a top studio light, which should be protected by strong wire guards against falling sparks or materials. There is no special danger from scene-painting, oil not being the medium used, as is sometimes supposed.

The stage is too often used as a carpenter's shop. This should never be allowed; the many dangers thus incurred need no pointing out; yet it is strange that seldom is a special room provided for the carpenters. The work in some houses was carried on over the auditorium ceiling, but this is happily stopped. A special workshop should always be provided.

Dressing-rooms might be placed on either side of the stage for males and females, being divided from the stage horizontally by brick arches, and vertically by brick walls. Fire-resisting staircases, and separate exits into the street, are necessary for each wing, as also for the workshop.

The fire-places, where provided in the dressing-rooms, should be protected by tall wire-guards. A complete system of heating throughout by hot-water pipes is, however, preferable to open fire-places.

The stage floor and sliders must of necessity be of wood, for setting the scenes, but much of the machinery might be made of iron, keeping somewhat the same forms now used in wood, and making a stiffer stage, which could be more easily manipulated.

On a level with the stage floor there must be ample room for scene docks, for storing the scenes in nightly use, while shifting from one set to another. The mezzanine and cellars should be used only for the machinery for working the stage, and on no account should the stowage of rubbish or scenes be allowed here—it never would if proper provision were made for it elsewhere. It is here that the stage carpenter does such infinite harm with his match-board erections, after the building is out of the hands of the architect.

The band and other rooms are at times but portions of the mezzanine, match-boarded off, as if they had been forgotten when making the plans (which is more than likely). Proper accommodation must be supplied for band, band-master, stage-manager, firemen, bill-sticker, property-master, &c., &c.

The gridiron above the stage must be made sufficiently strong to carry the weight of the cloths, &c. Cases have been known where it has given way under the weight of the scenery, and let everything in dangerous confusion down on to the stage. The construction of the gridiron, flies, and fly-rails should be of iron. Communication is necessary from the flies to the stage, to enable the flymen to escape.

The stage should be divided from the auditorium by a thick, solid brick proscenium wall, which wall should go between the orchestra and mezzanine, and be arched over the opening, passing through and above the roof. There need only be one opening in this wall, in addition to the large or proscenium opening, namely, a pass door from the stage to the auditorium.

A separate fire-resisting passage-way should be provided for the exit of the orchestra, so that the musicians may avoid passing either through the audience or under the stage to gain the street.

The stage should undoubtedly be cut off from the auditorium by some sort of fire-resisting or smoke-proof curtain. The failure of some of the iron curtains used on the Continent, and in America, has shown that they are not always to be relied on, but they must be of some use in retarding the progress of the flames. A double thick felt or cloth curtain, made bag-shaped, with a water spray along the top that would damp the curtain whenever it was lowered, suggests itself as a method for shutting off the stage. Water curtains have been proposed, but as these could not be periodically tested on account of the destruction of property that would ensue, they cannot be recommended. Whatever is adopted must be in constant use, for anything designed to act only in case of need, or upon the outbreak of fire, is often liable to fail at the very moment it is most needed. Everything in and about a theatre must be always in use to be of any good. Where automatic appliances are provided, people are apt to put such faith in them that they ignore the ordinary and essential means of fighting against fire, and become careless of the importance of the great danger. An "emergency" curtain coming down unexpectedly, in the middle of a performance, would be but the signal for a panic. Appliances requiring the presence of the flames which they are supposed to extinguish before they can act, cannot be too strongly condemned.

I repeat, and cannot insist upon it too strongly, all appliances must be made so that there will be no way out of using them nightly. Therefore the smoke-proof curtain and the painted act drop should be made to fall always together.

The scenery should be protected by applying some of the numerous solutions recommended by our chemists, and all drapery should be similarly treated.

The wood-work in and about the stage should be periodically painted with asbestos paint, or other fire-resisting liquid, and no precaution left untried to mitigate the danger from fire.

In dealing with the stage, we have to contend with that portion of the house where there is the most danger from fire, the immense amount of gas used nightly, and sometimes in a careless manner, as pipes are being constantly connected and disconnected during the performance, causing small escapes near naked lights, makes one wonder that accidents occur as seldom as they do.

All lights must be protected by wire-guards, and an arrangement should always be used whereby the gas is automatically cut off at the place where the union is made during the process of shifting various battens, ground-lights, &c.

The gas should be under the control of a practical gas man, with a sufficient staff of subordinates. This man should be stationed at the gas plate, which is fixed on the stage, during the performance, on which plate each cock should be labelled indicating what section of the light it governs, so that no error can possibly be made, and the wrong part of the house put in darkness.

The mode of lighting up should be by the electric spark, and not by naked lights. The "flash" system should be applied to all battens and hanging lights, avoiding the use of the spirit, cotton, and cane moving among the scenery. When the electric light is used, many of the dangers of stage illumination will be done away with; yet great care will have to be taken in the manipulation of the light, which need not be touched on here.

The gas-meters should be placed in a specially prepared and ventilated room. The supply pipes must be of hard metal, visible, and coated to prevent corrosion. There should be a cut-off tap near the stage door, to turn off the gas from without in case of fire. Separate meters should be provided for every section of the house, and a double supply laid on to each. Every set of staircases, corridors, offices, dressing-rooms, workshops, as well as the stage and auditorium, should have a dual system of lighting.

Every burner should be protected by an incombustible guard, and fixed away from woodwork or inflammable material, with a metal flue over it. In the parts of the house frequented by the rougher class, the lights should be encased, or locked up, or placed out of reach.

Sun-burners are preferable to gaseliers; they must be periodically cleaned, and no woodwork fixed near them. Access should be provided to them from the roof.

Oil lamps should be placed about the buildings in all sections, in conspicuous positions, but out of the reach of the public, to take the place of gas on its extinction. Colza oil has been found preferable to any other. Red lamps, with the word "Exit" in white, should be placed over the exit doors. All lamps should be lit and in their places before the doors are open, and the gas, both on the stage and in the auditorium, should be lit before the audience is admitted.

Gas-burners fixed so that they can be tampered with are among the most prolific sources of producing fire. There should be no jointed brackets or swinging pendants; every fitting must be fixed, and all joints and appliances examined and approved before the house is licensed.

Proper precaution should be taken in the manipulation of the lime light, and the bags kept outside the buildings.

Provision for plenty of light should be made to enable the use of artificial light being discontinued during the day, thus avoiding one of the greatest risks in theatres, namely, the careless handling of lamps, candles, or matches. It is a frequent habit to drop the end of a semi-burnt match, and one to which great danger is attached. There could never be a greater mistake than making a theatre dark. The business could be better carried on if there were plenty of daylight, and the accumulation of the dirt of years would not then be suffered to remain unremoved, ready to flare up on coming in contact with the slightest spark. A theatre, for everybody's comfort, should be clean; but as long as it remains dark, it will be dirty and dangerous Therefore, the removal of rubbish should be insisted on daily, or an external furnace provided in which it could be consumed.

The roof should have easy access from various points, and be provided with cat ladders, leading from the different levels, to enable firemen to get about with ease. There should be a parapet wall all round to protect the firemen. The construction of the stage roof should be of iron; if of wood, the constant changes of temperature to which it would be subject, and the enormous heat, would desiccate the trusses and rafters, and convert them into something little better than touchwood, which would readily ignite.

A better mode of constructing an auditorium roof could not be cited than that of the new Alhambra Theatre, where iron and concrete, with a covering of asphalte, are the materials used. The ceiling of the auditorium should be formed of fire-resisting materials, such as Jackson's fibrous plaster, and never of canvas. There should be no space over the ceiling available for store or workshop.

The several divisions of the audience should each have their separate entrances, exits, passages, corridors, staircases, saloons, lavatories, &c. The best method of planning this portion of the house, having in view the safety of the people, would be to bring everybody as near the level of the street as possible. To do this, place the dress circle on the street level, go down to the pit, and up to the upper circle and gallery. By adopting this method, the various sections of the audience would have a better chance of gaining the street, the distances being more distributed. The fact of the building not being so high as it would be if the pit were on a level with the street, would give a better chance of aid in case of fire; and as the parts occupied by the administrative offices need not be carried so high as the main building, an intermediate roof could be obtained, whereby the principal roof could be easily reached from without. The people in the pit, being below the level of the street, would not be in any danger, as in going upstairs a crowd is not likely to stumble, there not being the same risk as when coming down stairs.

Each section of the audience should have two entrances and exits, one on each side of the house, such exits and their approaches leading directly into the street, and these should be used only by that section of the audience for which they are designed, there being no pass-doors or emergency exits leading from other parts of the house into them. A door that is known as an "emergency door" is only a trap; when opened, it, as a rule, leads into a corridor or staircase already full of people from another part of the house. All exits must be entrances, and entrances exits, and used nightly.

Staircases and passage-ways should be from 4 ft. 6 in. to 5 ft. wide. Where this width is insufficient for the number of people, an extra staircase should be provided rather than additional width being given beyond the 5 ft. The corridors immediately outside the various tiers should be of sufficient width to take the people occupying such tiers without crushing. These corridors must be divided from the auditorium by brick walls, and the openings fitted with fire-resisting doors.

There should be no winders or steps at half landings in the staircases, as all such are dangerous in a moving crowd. The flights should not be of more than eight or ten steps, and the treads and risers should be of easy and uniform go throughout. All steps and landings must have at least 4½ inches bearing on solid brick walls at both ends, and arches should be turned under the landings.

Strong hand-rails, on brackets built into the walls, should be fixed to both sides of all flights of steps and landings, leaving a space of three inches clear between the wall and the handrail. To acquire this, a chase should be cut in the wall, so as not to lessen the width of the staircase or passage-way by the projection of the handrail.

No single step, or flights of two or three, should be admitted, slopes should take their places.

The private box staircases should be made as important as the other staircases, with exits into the street, and communication at each level. As a rule, they are narrow or corkscrew staircases, only available for the private boxes.

There should be no unshipping of barriers; they should be made permanent, and hung so as to open outwards, and close against the wall.

No pay-box or barrier should be placed to obstruct the exits; the moveable box so often seen should be abolished, and the pay-box made part of the permanent building.

All doors and barriers must be hung so as to open outwards, and close against the walls, the larger doors being hung in two folds. The fastenings on the doors used by the public should be such as to allow them to open the doors from the inside with ease. Locks are bad, as keys are seldom forthcoming when most required. The danger attendant upon the ordinary barrel-bolt was terribly illustrated in the case of the Sunderland disaster. It is apt to slip and catch in the floor, fixing the doors. A fastening is wanted that will enable those inside to get out, while it will at the same time present an effectual barrier to those outside. This has been provided by an invention known as "Arnott's patent bolt," in which an ordinary spring square bolt has the lower portion knuckle-hinged. Pressure on the inside will cause this portion of the bolt to leave the socket, and become parallel with the floor, thus allowing the door to swing both ways. Pressure from the outside will only tighten the bolt. What are now known as "emergency" doors are too often found locked, and worse than useless.

If the public were acquainted with the means of getting out of a theatre, there is no doubt they would feel safer when visiting these places of amusement. A great number enter with the idea that they could never find their way out if they wanted; this is not to be wondered at, considering what some of these entrances are, and that the entrances are not always the exits, and the exits not always used nightly. Everything should be done to inspire the audience with the idea that they could save themselves without hurting others in case of accident. To do this they should be able to find their way easily about the house. Several ideas to attain this suggest themselves—placing ample notices on walls and doors, such as "Exit;" "This way out;" printing the plan of each section of the house separately on the programmes; placing large plans of the house in conspicuous positions; but above all, simplicity and uniformity in the plan at the first onset. Place the exits where they will be easily seen, and make both sides of the house as nearly alike as possible. Notices should be painted on lavatory, saloon-doors, &c., to distinguish them from exit doors. All notices should be painted in luminous paint. Never should such notices as "In case of need," "Exit in case of fire," "In case of panic," "Emergency," "Alarm exit," be seen; they only suggest danger to the people, and everything should be done to intimate safety and avoid panic among the nervous visitors to theatres.

All seats should be numbered, and the house licensed to hold that number, and no more admitted under penalty of heavy fines to manager and visitor alike, then the gangways would be left unobstructed; but until they are both equally fined, the passages will be blocked by people standing or seated on loose chairs. All seats should be fastened to the floor, and made to tip up, to allow more room between each row for exit.

As far as the contents of the auditorium are concerned, it may be presumed that it is impossible to do without carpets, curtains, and stuffing to the seats, otherwise there need be nothing inflammable in the furniture.

The floor should be laid with blocks of hard wood, over the fire-resisting floors, for comfort.

As many bodies which are incombustible under normal conditions become inflammable at a high temperature, every means should be taken to keep a theatre cool, adding to the health, comfort, and safety of all. When heat is much concentrated, it makes substances highly inflammable, which might at a low temperature be simply combustible; it is therefore necessary, to prevent fire, to provide proper ventilation in a theatre. How often is this done?

The stage should be well ventilated, and at the same time there must be no draught to cause the scenery to wave about. Metallic shafts, with gas jets burning in them, fixed in several places above the gridiron, would draw off the vitiated and heated atmosphere and smoke in case of fire; but should a fire break out, the upward draught would increase it to a very serious extent; but if the gas jets were turned out, and the proscenium curtain lowered, the draught would be greatly lessened.

Fresh air should be admitted to the auditorium as near the floor level as possible, being previously warmed. The number of inlet shafts should have some relation to the numbers occupying the seats, and the manner in which the vitiated air is drawn out of the building. Sun-burners play an important part in extracting the foul air, but, in addition, every gas-burner should have over it a funnel-shaped flue, up which the products of combustion might pass. It must be borne in mind that perfect ventilation is imperceptible; but to acquire such ventilation has been found a hard task, therefore theatres have been left to take care of themselves, and in but few cases the slightest provision taken to render them little better than death-traps. Whether the mode applied be what is known as the vacuum or natural system, or the plenum or mechanical, seems of little moment, provided fresh air is continually admitted throughout the whole house. The number of deaths occasioned through breathing the foul, poisonous, and heated air of our theatres is far in excess of those caused by fire and panic. It would be as well if some of the numerous authorities which govern places of entertainment in this country were to turn their attention to this fact; but I fear the familiar adage may only too truly be said of theatre regulation, that "too many cooks spoil the broth." Large sums of money have been expended in providing means to avert dangers that *may* occur some day, while the fact that thousands nightly breathe the poison that will bring disease and untimely death with it, even to the strong, is totally ignored.

Lightning conductors should be fixed at various points outside the building.

Materials for Prevention of Fire.

The accepted idea of what is fire-proof is a very mistaken one. Materials that are incombustible are not therefore fireproof; take iron and stone, both accepted legally as fire-proof, and both among the first substances that will succumb to the influence of heat and sudden change of temperature. To give an idea how totally mistaken some are as to the fire-resisting qualities of materials, I have known lead suggested as a substance to be used to render floors fire-proof. Lead, of all materials, is the most dangerous, and the most dreaded by the fireman.

The walls must be solid and very thick, well bonded into each other, of good sound bricks; bond timbers should not be admitted, but hoop iron bond should be used. Every opening should have an arch turned over it, the use of lintols, either of stone or wood, being discarded. The walls should be corbelled out to receive the floors.

The floors, where possible, should be supported on brick arches abutting against brickwork, but on no account against iron. When the floors are constructed of iron and concrete, the iron should be completely embedded in the concrete, and the concrete should have the aggregate of calcined material, such as broken bricks, clinkers, or broken pottery. The circles should either be constructed of iron and concrete, or of timber in large baulk, and of the hardest description, such as elm or oak, which should be thoroughly protected from the action of fire by thick coatings of plaster; gypsum, or plaster of Paris, is well adapted for this purpose.

Where iron columns are used, they should be protected by a thickness of fire-resisting plaster or cement, held to the columns with a good key. Strong posts of the harder woods would suffer less from the changes of temperature than iron, but their thickness would destroy a good deal of the sighting.

The ordinary thin iron doors are of no use to resist fire. If iron doors were placed on both faces of the walls the space between might be filled up with some wet materials to keep them cool; but it would be a very difficult task to do this to every door in a theatre. Thick oak doors would resist fire for a long time. Wooden doors, lined with sheet iron or zinc, would be more effective than the thin iron doors so often met with; none of these, however, would be *fire-proof*, although *fire-resisting* to a certain extent. A perfect fire-resisting door could be made on the same system as safe doors, having an inner case of iron packed with sawdust and alum, surrounded by a strong well-bound and well-hung outer case. These would be heavy and expensive, and as all fire-resisting doors must be hung to close automatically, they would be dangerous; but they should be fitted to divide the greatest risks, such as the workshop section from the stage, the stage from the auditorium.

Steps and landings should be made solid, of approved artificial stone, fire-clay, or concrete, whose aggregate has already been burnt. Stone should be avoided, as, in the words of Captain Shaw—a man whose opinion on such subjects is the best in the world—it yields to fire more rapidly than any other material, is the most dangerous of all materials, as at sudden changes of temperature it cracks, leaving a passage for smoke.

That unprotected iron is unsafe, owing to the risk of fracture, and the loss of strength attendant upon great heat, is a fact well known, and as it is sometimes applied, it is a source of great danger, assisting in the destruction of the building, as its contraction or expansion will thrust out or pull down the walls, and even when covered with cement, it will suffer in great heat. Wood is only a dangerous material when used in thin slices. "It will withstand a powerful dead heat upon its sides for an indefinite period without igniting, unless transverse sections of the fibre, such as a knot, presents itself to the action of fire." If used in large baulk of the harder kinds, and protected with plaster, it is infinitely safer than naked iron.

The use of plaster as a fire-protecting agent I would strongly advocate; it is light, and resists fire for an indefinite period.

It would perhaps be as well to enumerate some of the many causes from which fires in theatres have originated and become fatal, before considering the last part of our subject, namely, the extinction of fires.

Bad arrangement and planning of the various sections, and not making each an independent fire risk, and not providing separate accommodation for each department or trade.

Danger from contiguous houses, and from people living in and about the theatre.

Bad judgment in the choice of materials, and bad or faulty construction.

Foul or imperfect flues.

Darkness and dirt, and keeping rubbish, shavings, &c., on the premises.

Smoking in the theatre proper.

Overheating through lack of proper ventilation.

Unprotected gas lights, and escape of gas from imperfect fittings.

Upsetting oil lamps.

Using matches or other naked lights.

Imperfect system of electric lighting.

Accumulation of heat round the sun-burner, and not cleaning same.

Carelessness in the manipulation of the stage during a performance.

The use of firearms, fireworks, and coloured fires.

The want of a properly organised fire watch, defective fire appliances, and lack of water.

Carelessness among workmen, such as carpenters and plumbers.

Lightning, concentrated rays of the sun by means of lens, spontaneous combustion, and incendiarism.

Extinction of Fire.

When a building has been constucted that will in every way retard the spread of fire and panic, it should be considered how, should the fire, in spite of all the precautions, occur, it could be most effectually coped with.

A theatre, from the nature of its business and contents, cannot be *fire-proof*, although fire-resisting; but there is no reason why fires should not be localised and burn themselves out in the department in which they originate. Every means, therefore, should be taken to extinguish fire. Water is the element to overcome fire; it is cheap, and can be obtained in large quantities, and if there is some at hand when a fire first breaks out, a jug-full, judiciously used, would prevent the loss of much life and property.

As regards fire appliances, there should be an unsparing supply of fire-buckets, always full of water, in all parts and sections of the building; more good can be done with these, if used in time, than any elaborate appliance that may come into use when the fire has got a hold. These buckets should be made conspicuous, labelled "fire buckets," painted red, and never allowed out of their place. Hand-pumps, with and without pails, should be distributed about the building, with a few chemical engines. Hydrants should be mounted on the rising main on every floor, in every section, and every 40 feet apart, having the hose "married" and ready for action. All proper tools and implements should be near at hand, wet sponges, wet blankets, hatchets, axes, &c., &c., being distributed about the stage and other parts. There should be a cock on each hydrant to fill buckets from. Hydrants should also be placed outside the building, and on the roof.

All fire appliances in these buildings should be periodically tested by the authorities; for the lack of this they are too often, on an emergency, found to be useless. The pattern of the appliances should be similar to that of the brigade of the town in which the theatre is situated, so that the theatre and town appliances may be used indiscriminately.

Ladders should be fixed from the roof to within 20 feet of the ground, where external aid can easily reach them. Iron balconies should be provided to windows.

It seems almost needless to say that there should be a sufficient supply of water, at a pressure strong enough to reach the highest part of the building. In towers formed at a height above the roof, there should be large water tanks, as a secondary supply, supposing the main failed at any time, but too much reliance must not be placed on tank hydrants. Experience has taught us that the tanks are too often empty, or only partly full, owing to the want of a constant supply from the water companies.

So much has been said upon the desirability of employing brigade firemen, well versed in their business, in lieu of the, in more senses than one, "theatrical fireman," that I need not repeat the arguments in favour of the brigade men. Two trained firemen should be in charge of the house from an hour before the performance till daylight, and two others should have charge during the day, all four being present when the house is open. The stage should never be left during the performance, and at the same time it would inspire the audience with confidence to see firemen walking about the auditorium. By the day watch the appliances should be cleaned and kept in repair, everything being tested every day at a fixed hour, say 6 p.m., just before the audience is admitted.

It should be the duty of the firemen to keep everything in working order, and they should be required to do nothing else. Imagine a stage without a responsible fireman, if, in the full swing of a pantomime, a small fire occurred. It is easy to conceive the confusion there would be among the numerous young and nervous people employed on the stage. The noise behind, even supposing the curtain to be down, would cause fear and panic among the audience, and a stampede might be the result. But if steady, experienced men, always ready for action, are employed, and the buckets and appliances are always in their places and in order, with plenty of water at hand, there need be no fear of fires on the stage. Yet there are many theatres in which the water supply is insufficient, the appliances imperfect, and no organised fire watch in existence.

To extinguish fires on the stage, a suggestion has been made that a series of perforated pipes be fixed to the underside of the gridiron, or to the gas battens, governed by a series of stopcocks on the stage. By this means the scenery that had not already ignited might be moistened, and the spread of fire stopped, but a great destruction of property would ensue. Far better get at the heart of the fire with a hand-pump or bucket of water.

Telegraphic communication should be held with the nearest fire-station. Too much reliance should not be placed on emergency fire-alarms. People are apt to become careless when they put their confidence in these appliances; they are also liable to act when no danger exists, especially in this class of building, where the temperature at times is so high; and, on the other hand, when most needed they may be out of order through disuse.

All check-takers and attendants should wear uniform, to be conspicuous, so that they may be better able to manage the people on an emergency. They should attend fire-drills, and be able to help the firemen when needed. For the same reasons it is well to have a policeman or two about the building.

To extinguish fire, provide good and sound appliances, plenty of water, and a good watch.

Theatres are luxuries, and to enter some of them one pays dearly, both as regards money and the risk of losing one's life. If we pay so highly, surely we should be better protected while there. But the system seems to be to work the house as cheaply as possible, and to pack as many into it as it will hold, at as high a price as they will pay.

After every consideration is given to the disposition and construction of the building, and it has been passed by the authorities, the architect, under whose supervision the house has been built, hands it over to the manager for the rest of its existence, except in rare cases where the architect receives a fixed remuneration for periodical visits—which should be the case everywhere. As a rule, the manager is a man of refinement and education, who will do everything in his power to protect the public and make the house popular. But for all that there should be a further continuous inspection supervising the management, as is being advocated by Mr. Dixon-Hartland in his Bill now before the House of Commons. A staff of inspectors knowing the architectural arrangement, and the business peculiar to theatres, should be appointed, with power to visit the houses at all odd times, before, after, during the performance, in the day, and even in the middle of the night, unbeknown to the management. Reports as to the condition in which they find the house, and the way in which it is being worked, should then be made to the *one* recognised authority which should take the place of the many that now exist.

In theatres which at present hold certificates from the Metropolitan Board of Works as being structurally safe, fresh dangers may in a year or two arise, through alterations being made, perhaps trivial in themselves, but to which some risk is attached. There are other matters requiring supervision besides structural defect, *i.e.*, ventilation, water supply, and the general management of the whole establishment. Until these inspectors are appointed, the public cannot be protected as they ought to be; on the other hand, it would be useless to make managers suffer from more official inspection, unless the men can be found to fill the posts who are qualified through previous experience in the *modus operandi* of theatre management and construction.

Once more I would strongly urge that the best safeguards against fire are good planning and construction, perfect ventilation, light, and scrupulous cleanliness; that the best means to extinguish fire are a good fire-watch and plenty of water; and that on no account should "emergency" appliances be relied on in a theatre.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

Owing to the death of the Duke of Albany, the ceremonial opening of the Health Exhibition at South Kensington, on May 8, will not be performed by the Prince of Wales, but by his Royal Highness the Duke of Cambridge, who has undertaken the duty on behalf of his Royal Highness the President. Although the date remains as originally fixed, the hour at which the ceremony is to take place has been altered from three p.m. to noon. The *Times* notes that the work of preparation is going on rapidly and continuously; relays of workmen are busied day and night in some parts of the building, the electric light equalising the value of all hours of the twenty-four, and van loads of exhibits are daily arriving. The greatest activity seems to be displayed in the completion of the large octagonal building which is to be the home of the London water companies' exhibits, each company having one bay to itself; in the annexe devoted to machinery in motion, where huge fly-wheels already fill the deep excavations made to give them room enough to work; and especially in the block of Old London, entered through a reproduction of the port of one of the ancient City gates, which is distinguishable already by the figure of the good bishop in a niche over the centre. Within this walled enclosure are gabled houses, of which the shops are to be occupied, each under the direction of a City guild—a master armourer, for instance, plying his craft in one, assisted by 'prentices. Detached buildings—which, to carry out the objects of the exhibition to the fullest extent, should be model — typhoid-proof farm houses, and dairies are being erected in the open garden between the long south gallery, where the deep-sea fisheries were illustrated, and the National Portrait Gallery. In the entrance hall a full-sized cast of Mr. Boehm's large equestrian statue of the Prince of Wales, which was erected in Bombay by Sir Albert Sassoon, C.S.I., to commemorate the visit of his Royal Highness to India in 1875-6, has the place of honour.

As some dissatisfaction with the awards of the jurors in certain classes at the Fisheries Exhibition was expressed by a section of the exhibitors, a scheme has been drawn up, to give competitors a voice in the selection of the jury. His Royal Highness the Prince of Wales, as President of the Health Exhibition, has delegated to a Commission, selected from among the members of the Executive Council, the duty of making arrangements for the effective performance of the work to be carried out by the international juries. The Commission is composed of Lord Reay (chairman), Sir James Paget, F.R.S., Sir Frederick Abel, C.B., Sir Philip Cunliffe-Owen, C.B., and Dr. George Buchanan, F.R.S., with Mr. H. Trueman Wood (secretary of the Society of Arts) and Mr. Gilbert R. Redgrave (Associate of the Institution of Civil Engineers) as joint secretaries. To this Commission on juries every exhibitor is to be requested to return on a printed form the names of three gentlemen whom he would wish to nominate as jurors in the particular class or classes he himself is individually interested in. The Duke of Buckingham and Chandos, the chairman of the Executive Council, who is devoting his time to the direction and superintendence of the minutest details of the exhibition arrangements, warns exhibitors, however, that while the Jury Commission will endeavour to give full weight to the opinions expressed by exhibitors, it must nevertheless be understood that they will not feel themselves restricted to the list of names suggested, especially as the gentlemen recommended by a majority of the exhibitors may in some cases be unwilling or unable to serve.

The Executive Council have assigned a large room in the Royal Albert-hall, to be used as a library and reading-room in connection with the Exhibition. Authors, publishers, and others have been invited to send copies of works on subjects embraced in either or both of the two divisions of the Exhibition—Health and Education.

The books received will be classified and catalogued, and made available for use, in the library and reading-room, of the public visiting the Exhibition. A catalogue will be printed. All packages containing books for the reading-room and library should be forwarded, carriage paid, to the Secretary of the

Library Committee, Royal Albert-hall, W. The Executive Council cannot hold themselves responsible for any loss or damage to books sent in by exhibitors, but a reference to the regulations will show that every precaution has been taken.

It is intended to illustrate by means of models, sections, and diagrams, in the pavilion previously referred to, the water supply of all the metropolitan water companies. The Sub-Committee will specially deal with sources of supply, methods of filtration (including full-sized sections of the filter-beds) and distribution, giving particulars respecting quantity and area under constant supply. They will also show the quality of the water as supplied by each company, bringing into the Exhibition water from each company; and they will publish analyses of the same, and generally display such other exhibits as will convey to the public at large an idea of the magnitude and importance of the metropolitan water supply.

The following countries have appointed Commissions in connection with the Exhibition:—Belgium, China, France, and Russia.

Correspondence.

WATER REGULATION.

I must thank you for your kindness in inserting my long letter about regulation of water, and also for the remarks of Sir Robert Rawlinson on the subject. Perhaps you could find room for two further remarks from myself. The first is that the 200,000,000 cubic yards of water I spoke of were not the contents of the 50,000 tanks of the Peninsula, but of the largest of them, constructed by General Fyfe at Poona. The other is that the calculation about reducing floods lies in the smallest compass. In the Godavery, for instance, the discharge is 200,000,000 cubic yards per hour in extreme floods. But when the river does mischief, it is usually by the last foot overtopping the bank. A foot higher or lower makes the difference between a tremendous destruction and a harmless fresh. To keep the river down one foot, would require the retention of 10,000,000 cubic yards per hour for two or three days, or 700,000,000 cubic yards in all. Two tanks have been surveyed and estimated for on one of the feeders of the Godavery; one to contain 2,000,000,000 cubic yards, and the other, I believe, rather less; together, perhaps, 3,500,000,000 cubic yards, or sufficient to lower the river a foot for fifteen days, or, if half full when the storm begins, for seven days, but these are in one corner of the vast basin of the river, an area of 150,000 square miles. If necessary, a number of these large tanks could be constructed, so that, if required, the river could be kept a yard or two below flood with ease. The two tanks, estimated, would cost about £100 per 1,000,000 cubic yards, or £350,000. The works of navigation and irrigation on this river will have cost £2,500,000 when completed, so that the addition of £350,000 would not be so very great. These two tanks alone would not only diminish the floods, but would provide for more than 1,000,000 acres of irrigation immediately under them, and would also keep 1,000 miles of river and canal navigation in an effective state throughout the dry season, as well as irrigate 5,000 acres in the Delta at that time. If the Government would make use of the vast experience collected in India in water regulation, there would be no difficulty in perfecting the regulation in England in all its four branches. Now that ocean navigation and land transit have been brought to such a state of perfection, the next most important thing, beyond all comparison, is the establishment of effective water transit in England. The owner of a saw-mill, employing forty hands, lately told me he paid £1,400 a year for railway carriage. With steam-boat canals this could certainly be carried for £200, in saving a small work of this kind, £1,200 a year. What would be the saving on all the manufactures and produce of England with a complete system of steam-boat canals on the present lines of ineffective water transit?

ARTHUR COTTON.

Dorking, April 9th, 1884.

Though long convinced that our waters are sadly neglected, I cannot account for the rate of $\frac{1}{10}$d. per ton per mile, assumed for water carriage by Sir A. Cotton and General Rundall. Mr. J. S. Watson (Q. 1,791, Canal Committee) estimates 5s. per ton for 247 miles—about $\frac{1}{4}$d. per ton per mile; but much naturally depends on the return freight. In France (Q. 2,373) it is hoped that, after the amortization of the national outlay, the rate may be $\frac{1}{5}$d. In India, it appears (p. 264) that the charge varies from $\frac{3}{8}$d. to $\frac{5}{8}$d. per ton per mile. The tables in Messrs. Meyer and Wernigh's book on rope-towage give, I think, $\frac{1}{2}$d. for mixed river and canal navigations in Germany. How then can the United Kingdom expect lower rates?

Such an important subject deserves full discussion in your *Journal*.

WALTER M. T. CAMPBELL.

Roxburghe Hotel, Edinburgh,
April 11, 1884.

Notes on Books.

THE ELECTRIC LIGHT IN OUR HOMES. By Robert Hammond. London: Frederick Warne & Co.

This little book contains the accumulated material resulting from the author's having, at various times and various places, delivered a number of lectures about the electric light. It explains in the most thoroughly popular form the principles of the science, the apparatus and fittings used, and the arrangements to be adopted in lighting a house or other building by electricity. The advantages of the electric light are fully set forth, together with the drawbacks to our existing systems. The book is fully illustrated with woodcuts, and there are also two photographs of rooms fitted with electric lamps, the drawing-room and dining-room of the author's residence.

SHORTHAND FOR EVERYBODY: with Course of Lessons for Self-Instruction. By W. Mattieu Williams. Second edition. London: Simpkin, Marshall & Co. 1884. 8vo.

The author does not attempt to teach a system of shorthand suitable for professional reporters, but his object is "to enable anybody to write about four times as fast as he can with common characters, and above all, to read with facility what he has written." This is the second edition of a treatise first published in 1867, and the author states that the elaboration, or rather reduction, of his system to its present form has been the work of above forty years.

THE WATCH AND CLOCK-MAKERS' HAND-BOOK, DICTIONARY, AND GUIDE. By F. J. Britten. London: W. Kent & Co. 1884. 8vo.

In this volume the author has given, in the convenient form of an alphabetical arrangement, a full description of the various points connected with the art of watch and clock-making, and he has added the French and German equivalents for the different terms. In addition to the definition of technical terms, short biographical notices of the men who have advanced the art are given, and in the appendix there are some useful tables. The book is fully illustrated.

Obituary.

DUKE OF BUCCLEUCH, K.G.—Walter Francis Montagu-Douglas-Scott, fifth Duke of Buccleuch, and seventh Duke of Queensberry, whose death occurred on Wednesday morning, April 16th, at Bowhill, Selkirkshire, had been a member of the Society of Arts for forty-six years, and for several years he occupied a seat in the Council as Vice-President of the Society. He was a member of the first Council, which was elected in 1845, and the last time that he presided at a meeting of the Society was in June, 1877, when Mr. Andrew Murray read a paper on the "Extirpation of Injurious Insects." The Duke of Buccleuch was born on November 25, 1806, and on the death of his father he succeeded to the title at the age of thirteen, so that he enjoyed the Dukedom for the long period of sixty-five years. He held the offices of Lord Privy Seal and President of the Council in Sir Robert Peel's Cabinet, but after that statesman's final resignation, he never held office. He was President of the British Association in 1867, on the occasion of the visit to Dundee, and in 1878, at the death of Sir William Stirling Maxwell, he was elected Chancellor of the University of Glasgow. He held other important offices, and many honours were awarded him. When quite a young man he carried out the great work of the erection of Granton Pier and Breakwater (three miles from Edinburgh), at a cost of half a million sterling, which expenditure he bore entirely himself.

General Notes.

ROYAL INSTITUTION.—The following are the arrangements for the lectures after Easter:—Dr. Klein, two lectures on the "Anatomy of Nerve and Muscle," on Tuesdays, April 22 and 29; Professor Gamgee, five lectures on the "Physiology of Nerve and Muscle," on Tuesdays, May 6 to June 3; Professor Dewar, seven lectures on "Flame and Oxidation," on Thursdays, April 24 to June 5; Mr. Hodder M. Westropp, three lectures on "Recent Discoveries in Roman Archæology," on Saturdays, April 26 to May 10; and Professor T. G. Bonney, four lectures on the "Bearing of Microscopical Research upon some large Geological Problems," on Saturdays, May 17 to June 7. The Friday evening meetings are resumed on April 25th, when Mr. Walter Besant is to give a discourse on "The Art of Fiction."

AUSTRALIAN EDIBLE FISHES.—The coasts of Australia abound in edible fish of every description, of which the schnapper (*Pagrus unicolor*, Cuv. and Val.) is the most valuable, not for its superior excellence, but for the abundant and regular supply which it affords of a very nutritious and wholesome kind of food. It is found on all parts of the Australian coast, but most abundantly on that of New South Wales. It is a deep-water fish, found generally on or near rocky points, or reefs running out for miles from the coasts. Schnapper-fishing forms one of the favourite pastimes of the Australians, the favourite fishing grounds being in the neighbourhood of Sydney Heads. Lines are used in fishing, but the tackle has to be strong, or, if the fish be an old one, he will often escape. "The tugging, jerking motion of the schnapper," says an Australian writer, "is unmistakeable, and, when he gets his shoulder to the line, he goes off with a rapidity that makes the cord whistle again, either through your fingers or over the boat's gunwale; a steady and continuous strain, no stray line, together with some skill, enables you to land him, at which time you can realise that your patience, toil, and anxiety are rewarded with a fish from 20 to 25 pounds weight, fit to embellish a noble banquet." The aboriginal name of the schnapper is "wollomai," and it was formerly captured in large quantities by the natives.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock :—

APRIL 23.—"Thames Communications." By J. B. REDMAN, M.Inst.C.E.

APRIL 30.—"The New Legislation as to Fresh-water Fisheries." By J. W. WILLIS-BUND. EDWARD BIRKBECK, M.P., will preside.

MAY 7.—"Bicycles and Tricycles." By C. V. BOYS. Dr. B. W. RICHARDSON, F.R.S., will preside.

MAY 14.—"Telpherage." By Professor FLEEMING JENKIN, F.R.S.

MAY 21.—"Telegraph Tariffs." By Lieut.-Col. WEBBER, R.E.

MAY 28.—"Primary Batteries for Electric Lighting." By I. PROBERT.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings :—

APRIL 29.—"The Transvaal Gold Fields; their Past, Present, and Future." By W. HENRY PENNING.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings :—

APRIL 21 (Monday).—Adjourned Discussion on Dr. PERCY FRANKLAND'S Paper, "The Upper Thames as a source of Water Supply." Sir FREDERICK ABEL, C.B., F.R.S., will preside.

MAY 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R.S., will preside.

MAY 22.—"Economic Applications of Sea-weed." By EDWARD C. STANFORD, F.C.S. (This paper has been postponed from April 24th.

INDIAN SECTION.

Friday evenings :—

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER.

MAY 9.—"Indigenous Education in India." By Dr. LEITNER.

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 21...SOCIETY OF ARTS, John-street, 8 p.m. Adjourned Discussion on Dr. Percy F. Frankland's paper, "The Upper Thames as a Source of Water Supply."

Surveyors, 12, Great George-street, S.W., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m.

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Mr. W. G. Smith, "The Diseases of Corn Crops."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. F. V. Dickins, "The Rolls of Shiuten Doji, or the Liquor-laid Lad." (Translation from the Japanese.)

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. D. Mackintosh, "The Glacial Epoch."

TUESDAY, APRIL 22..Royal Institution, Albemarle-street, W., 3 p.m. Dr. Klein, "The Anatomy of Nerve and Muscle." (Lecture I.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Wm. E. Rich, "On the Comparative Merits of Vertical and Horizontal Engines, and on Rotative Beam Engines for Pumping."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Lieut. H. B. Willock, "English Express Trains in 1871, and a comparison between them and those of 1883."

Anthropological, 3, Hanover-square, W., 8 p.m. 1. Exhibition, by the Marquis of Lorne, of a Collection of Ethnological Objects from Canada. 2. Sir Richard Owen, "Note on a Portrait of an Aboriginal Tasmanian." 3. Prof. A. H. Keane, "The Ethnology of the Sudan."

WEDNESDAY, APRIL 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Redman, "Thames Communications."

Geological, Burlington-house, W., 8 p.m. 1. Principal Dawson, "Observations on the Geology of the Line of the Canadian Pacific Railway." 2. Rev. Alex. Irving, "The Dyas (Permian) and Trias of Central Europe, and the True Divisional Line of these Two Formations."

Royal Botanic, Gardens, Regent's-park, N.W. 2 p.m Exhibition of Spring Flowers.

Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.

Hospitals Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Paper on "How far our Hospitals should be Training Schools for Nurses."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. H. Michell Whitley, "Modern Locomotive Practice."

THURSDAY, APRIL 24...Royal, Burlington-house, W., 4½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "Flame and Oxidation." (Lecture I.)

Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m.

FRIDAY, APRIL 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. G. Pedder, "The Existing Law of Landlord and Tenant in India."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. Walter Besant, "The Art of Fiction."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Mr. J. C. Morison, "Caliban."

SATURDAY, APRIL 26...Geologists' Association, University College, W.C. Excursion to Guildford under the direction of Lieut.-Col. H. H. Godwin-Austen.

Physical, Science Schools, South Kensingtou, S.W., 3 p.m. 1. Professors Ayrton and Perry, "The Indicator Diagram of a Gas-Engine." 2. Mr. W. T. Goolden, "A New Speed Indicator." 3. Mr. Walter Baily, "A Speed Indicator." 4. Dr. W. H. Stone, "A Metrical Barometer, and an Immersion Galvanometer."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. M. Westropp, "Recent Discoveries in Roman Archæology." (Lecture I.) "The Colosseum."

Journal of the Society of Arts.

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FRIDAY, APRIL 25, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

INSTITUTIONS IN UNION.

The following Institution has been received into Union since the last announcement:—

East London Union for Advanced Education Evening Classes, 54, White Horse-lane, E.

SOCIETY OF ARTS PRIZES.

The Council of the Society of Arts are prepared to award the following prizes in connection with the International Health Exhibition:—

Under the *John Stock Trust*, a Society's Gold Medal or £20, for the best example of sanitary architectural construction, Classes 20, 28, 29, 30, and 32 of the Exhibition.

Under the *Shaw Trust*, a Society's Gold Medal or £20, for the most deserving exhibit in Classes 41, 42, 43, and 45 (relating to Industrial Hygiene).

Under the *North London Exhibition Trust*, a Society's Gold Medal or £20, for the best set of specimens illustrating the handicraft teaching in any school—Classes 49 and 50.

Under the *Fothergill Trust*, Two Gold Medals (or two sums of £20), one for the best exhibit in Class 27 (Fire Prevention Apparatus), and one for the best exhibit in Class 26 (Lighting Apparatus).

From the *Trevelyan Prize Fund*, Five Gold Medals (or five sums of £20), for the best exhibit in each of the following Classes:—2, 3, 6, 7, and 11 (all comprised within Group 1, "Food").

The *Siemens Prize*, a Society's Gold Medal, or £20, for the best application of gas to heating and cooking in dwellings, Class 24.

Each prize will be a Gold Medal, or the sum of £20, at the option of the recipient.

The full list of the various classes referred to is given in the number of the *Journal* for March 14th.

The Council propose to ask the juries in each class to recommend for their consideration either two or three exhibits which they may consider deserving a prize. It will be assumed that all the exhibits in the Classes specified, which come under the above definitions, are eligible for the awards. It will not be necessary for any special application to be made in respect of these Prizes.

INTERNATIONAL HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow Members of the Society of Arts the privilege of purchasing Season Tickets for the Exhibition at half-price (10s. 6d.). Each Member will only be allowed the privilege of purchasing a single ticket on these terms, which will be a personal admission, not transferable. Season tickets admit to the opening ceremony on the 8th May. The tickets will not be ready for issue till the end of the month, but it will be convenient if members desiring to avail themselves of the privilege will send word to the Secretary at once, enclosing 10s. 6d., the price of the ticket, which will be forwarded as soon as ready. It will be understood that all applications must be accompanied by the above-named remittance.

Proceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 23, 1884; W. G. Pedder, Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Beilby, George T., Midcalder, N.B.
Bridgford, Major Sidney Thomas, R.M.A., Army and Navy Club, Pall-mall, S.W.
Butler, Henry, 50, Lee-terrace, Blackheath, S.E.
Clarke, Caspar Purdon, C.I.E., 3, Sheffield-terrace, Campden-hill, W.

Gibbs, Surgeon-Major J. G., Riggindale-road, Streatham, S.W.
Guest, Rev. William, Ling Holme, Tunbridge-wells.
Morgan, William, Waverley, Albemarle-road, Beckenham.
Parlane, James, Appleby-lodge, Rusholme, Manchester.
Pearcy, Joseph, 127, Englefield-road, Islington, N.
Peel, Captain Francis, Boxted-house, Colchester.
Pleydell, F. G., Commercial Bank of South Australia, Lombard-street, E.C.
Ross, Rev. Henry, M.A., Dallas-house, Lancaster.
Samuel, Sir Saul, K.C.M.G., 15, Courtfield-gardens, S.W., and 5, Westminster-chambers, S.W.
Turpie, William, Bank-house, Derby.
Wight, Laurence Hill, M.A., 41, Chambers-street, Edinburgh.
Wilkin, Miss, Cossey-cottage, Hampstead, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Cosedge, Hiram, 16, Clifford's-inn, E.C.
Crickmay, George Rackstraw, 17, Parliament-street, S.W
Esson, William B., European Telegraph Works, Dalston, E.
Glyn, Hon. and Rev. Edward Carr, M.A., the Vicarage, Kensington, W.
Hughes, Richard Deeton, 12, Bedford-row, W.C.
James, Edward, 22, Westbourne-terrace-road, W.
Kirkpatrick, Robert, 1, Queen-square, Strathbungo, Glasgow.
Lovett, Phillips Cosby, J.P., Liscombe-park, Leighton Buzzard.
Murphy, Shirley F., 158, Camden-road, N.W.

The paper read was—

THAMES COMMUNICATIONS.

By J. B. Redman, M.Inst.C.E.

The theme now selected, treating of one of the popular questions of the day, needs little preface. Cartoons are exhibited of plans for a high-level Tower-bridge, a Blackwall-tunnel, and a St. Paul's-bridge, also a plan of the Port of London.

The advocates of what has, doubtless, become a modern demand, due to eastern extension of the metropolis, down the river, viz., more rapid and certain inter-communication from the right to the left bank of its stream, appear, in the arguments at times put forward for this accommodation, to forget or ignore the fact that these north-eastern and south-eastern suburbs, co-extensive with some of our large manufacturing towns, owe their very origin, being, and existence to the floating commerce of the first tidal port of the world, and almost appear to regard their parent and benefactor as an absolute barrier to free intercourse amongst themselves, *i.e.*, between the eastern denizens of the metropolis

Representing as I do a family of merchants and ship-owners for generations past, and amongst the first customers of some of the earliest docks (the West India for example), and having been born and lived the early half of my life in the immediate neighbhourhood of those works, besides having being engaged on numerous dock, wharf, embankment, pier, and lighthouse works on the river, and having had control, for twenty-one years, of the roads and tramways leading to these docks, I may perhaps be allowed to volunteer an opinion respecting the character of the vehicular and pedestrian traffic of the eastern metropolis.

Both classes of traffic, on each side of the Thames, may be said truly to have one common loadstone of attraction—the City of London. Foreign goods find their way up to the various above-bridge warehouses, by lighters, for transhipment or carriage to the provinces, a large part passing by waggon along the main arterial roads parallel to the river, and a considerable portion now goes direct by railway to the manufacturing districts. On the Commercial-road tramway, leading to the West India Docks, more than a quarter of a million tons of sugars, teas, and other foreign goods, find their way each year to the Whitechapel sugar-houses for rectifying (now almost an extinct industry), and to the various up-town warehouses of the Dock Companies, and the numerous private warehouses within the City for bonding foreign produce and wines.

The heads of the various ship-building, engineering, and other manufacturing firms, as well as timber merchants and other contractors connected with the trade of the port of London, were (as also many of the merchants and ship-owners, sail-makers, ship-chandlers, and brokers) less than half-a-century back, as a rule, resident in the suburbs adjoining the river and below the pool, and they and their numerous *employés* resided at, or near, the scene of their daily work, while the heads of firms and managers, and senior clerks, found their way to the City in the afternoon to attend "Change," and the various coffee-houses, such as the "Jerusalem," "Lloyd's," "Garraway's," the "Baltic," &c., frequented by the various commercial sections, for effecting sales, purchases, and obtaining orders, finding their way back, late in the afternoon, to their several establishments or residences, in two nearly parallel streams on either side of the river.

The extension of the railway system has very considerably modified, without, however, altering the main feature of the traffic, as the heads and managers of firms now reside in almost every direction, making their twenty or thirty miles daily, and as in the case of Brighton, now really a London suburb, their fifty miles' journey to the City, and visiting in addition their establishments, on or near the river, from a couple to half-a-dozen miles from the common focus or centre.

But now, as in early days, the universal desire and want is to get to and from, or from and to, the common nucleus of daily commercial operations, viz., the City of London.

Thus, under these conditions, the inclination for intercourse between the two banks is, to a certain extent, either for goods or persons, somewhat exceptional; but at the same time, if the means are afforded, vast numbers of the working classes, obeying the modern centrifugal dispersion, will look further afield for purer air and healthier tenements for their wives and families than they have hitherto been content with. This is strikingly shown by the vast crowds of the labouring class who seek the early and late cheap trains of the East London (Thames Tunnel) line, and those also of the Metropolitan underground lines. The extensive and (at least at an early period) almost unlooked-for field for railways through the suburban districts, and leading to the metropolitan centre, was never more strikingly illustrated than in the case of the North London Railway, originally laid out as a goods line, pure and simple, to connect the East and West India Docks with the London and Birmingham (now the London and North-Western) Railway, and it developed a traffic which it was not originally laid out for, but to which it entirely owes its remarkable success.

So, doubtless, with the means given by bridges, tunnels, or ferries; a numerous section of the community will avail themselves of the opportunity for obtaining cheaper, healthier, and more comfortable lodgings on the opposite side of the river to that where they may be employed, hemmed in, possibly, by docks, or situate on marshy and unwholesome ground. But when the various reaches between London-bridge and Woolwich, with their surroundings, are examined, this is a much more complex problem than those who have not paid special attention to the subject might be prepared for.

Taking two positions to be granted, viz., that London-bridge is, from six centuries' usage, the natural head of the port, and that no mode of crossing offering any obstacle to the free and uninterrupted navigation of the river can be allowed, the question becomes still more difficult. Four methods present themselves:—

The high-level bridge, with approaches, which should be not less than 1 in 40, or mechanical lifts.

The low-level bridge, fixed throughout, or combined with opening spans.

The tunnel, also with approaches, of not less than 1 in 40, or with mechanical lifts at each end.

[As regards gradients, it should not be forgotten that in the Metropolis Management Act, obtained by Sir Benjamin Hall, 1 in 60 was the gradient fixed as the minimum for turnpike roads.]

And lastly, ferries worked by steam, say, by means of a submerged chain, as at Portsmouth and Southampton.

Any form of ferry-boat must, however, at least for vehicular traffic, be usable at any time of tide from approaches of 1 in 40. There would be with them, as with the high-level bridge or the tunnel, the same approach difficulty, though in a minor degree, as there would be from one-third to one-half of the amount of difference of level as compared with the two other modes of crossing.

Then, as regards the sites for these crossings, from the manner in which either bank is bounded by floating docks, and the long detours necessary to reach any main arterial line of traffic, but very few positions present themselves for a high-level bridge, or for a tunnel. The site east of the Tower appears, for very many reasons, the best site for a bridge (if bridge there is to be) east of London Bridge; but clearly here the best solution of the difficulty would be, a bridge fixed throughout, similar in level to London-bridge, which, if made without an opening arch, would involve the purchase of certain interests between the two bridges.

This, in effect, if a low level bridge, for square-rigged ships and the larger steamers, would be moving the head of the port from one-half to three-quarters of a mile lower down the river. Clearly, cutting off three-quarters of a mile from the head of a tidal port like London, the first in the world, is a momentous proposition, and certainly as opposed to all true principles of harbour conservancy as the equally questionable proposition of bringing the lockage down the river, instead of doing all that is possible to encourage the tidal momentum and flow upwards. This was recently proposed to be effected by the erection of locks and a weir at Isleworth, for the benefit of riparian interests immediately above, thus cutting off five miles of the tidal portion of the river, and thus diminishing, *pro tanto*, the tidal storage, and also affecting the commercial interests immediately below it, by reducing the flow and ebb, interfering with the navigation to the wharves, and promoting deposit in the river bed; instead of the counter-proposition, suggested for many years, of removing Teddington Lock, and encouraging the flow of the tide up to Kingston, some two miles higher. Here, even now, with the exceptional high tides we have had during the last seven years under certain meteorological combinations, the high water, topping Teddington Lock and Weir, makes a tide of from eighteen inches to two feet at Kingston—Nature, in effect, asserting herself. The Isleworth Lock scheme is, for the present, abandoned, on account of the decided veto put upon it by the Conservancy authorities.

Any movable or fixed bridge (except at a very great height) below the Tower site would be quite inadmissible, for very many obvious reasons, as prejudicial to the free waterway of our national river, which, when crowded with the commerce of the world, all intelligent foreigners assert, gives a more striking idea of the power of this country than aught else to be seen in the United Kingdom.

A high-level bridge over the Thames at Blackwall was proposed towards the end of the last century by Dodd, or some other equally sanguine projector, and perspective or birdseye views, with approaches pointing to the Essex and Kentish hills, were printed and published, and displayed in shop windows, as views of the "Duplex Tower Bridge" are at the present day; and this last is really in principle similar to a plan to be found in the large folio Report on the Port of London of the Commons Committee of 1793. How the traffic was to be got on to or off this Blackwall bridge was not illustrated, but the ships were shown with their royals and studding-sails set, sailing with unimpeded course under its lofty soffit.

Before directing attention to the best sites for crossing the river, it will be well to consider what are the difficulties barring the adoption of the very many ingenious plans that have, from time to time, been brought forward.

Either for a bridge or a tunnel, suitable approaches must be provided, or some mechanical means, by hydraulic or other machinery, adopted for raising and lowering the vehicles passing over. The Snow-hill incline down to the valley of the Fleet is now almost forgotten, since it was bridged by the Holborn Viaduct and its level approaches; but the effect of such a gradient on heavy vehicular traffic can be well studied now at Tower-hill, which should never have been opened to waggon traffic, with a gradient between Thames-street and Tower-street of 1 in 18½, to 1 in 20; but the severity of such an incline can be even better seen at the curved approach from Smithfield down to the metals of the underground railway, well adapted to its locality in one respect, being, as it is, a veritable instrument of torture. The excessive steepness of the incline require the addition of "leaders" to the teams of the heavily laden waggons, kept there for that special purpose.

This difficulty of approaches was one of the great objections to the high-level Tower-bridge promoted by the Metropolitan Board of Works, a few years back; and the same objection, in a less degree, tells against a tunnel, as the difference in level would be somewhat less than with a bridge. It was the absence of approaches for vehicular traffic that made Brunel's well-known tunnel at Wapping a dead letter for so many years, till it was utilised by the East London Railway; and it was the indifferent, tortuous, and narrow means of access to the ferry erected recently near the same site, which made it practically a failure, or at least one of the causes of its shipwreck.

With modern experience and appliances, a tunnel under the Thames may be constructed at any spot; but the cost would be very variable, from the great changes in the geological formation along the metropolitan river valley. Brunel's tunnel was mainly in sand and gravel, and so near the river bed that an artificial one was formed by throwing in clay in bags over the crown, and the excavation partly through it was effected by means of Brunel's well-known shield, the alternate compartments of which were pushed forward, after the material in advance of the polling boards had been removed by excavating from within. The frames, all connected at top by shafting, and provided with broad bases or feet, were pushed forward alternately, like (as Brunel used to say) a man's legs in walking.

A large per-centage of the material brought into the tunnel from the heading in advance of the shield, was clay with pieces of the bags adhering. This I have frequently seen when periodically measuring up the work with Mr. James Walker (the leader of our profession at that day) under whose certificates the Exchequer Loan Commissioners' advances were made.

This variability of substratum is well illustrated by the various attempts made to cross the river by tunnelling. Early in this century a tunnel was commenced at Gravesend; the large quantities of water met with in the chalk, were, it is said, the cause of the abandonment of the undertaking. Still, at the present time, with our enlarged experience and improved plant and apparatus, such a work is within the limits of possibility, and an Act of Parliament has been obtained for a railway tunnel in the chalk, to connect Gravesend with the county of Essex. Now, when it is remembered that there are from 40 to 60 feet depth of water, at low water in Northfleet Reach, upon a chalk bottom, it will be seen how great an undertaking such a work would prove, but still one that is practicable with the boring and air-compressing machinery of the day, at a certain cost.

An Act has been obtained for a tunnel or subway at Woolwich, and the works were commenced, but stopped from the abundance of water met with, mainly in sand and gravel.

In effect in certain portions of its valley, it amounts to attempting to pump the river dry—unless the work is done by pneumatic air—compressing tackle converting the tube or tunnel into one long diving-bell, provided with air-locks at one or each end, or by the dredging of a low water sub-marine channel, into which sectional lengths or compartments might be lowered, and the fixing all done by divers.

At Greenwich, for instance, a tunnel or subway to Millwall has been advocated in influential quarters; but when we have the broad fact before us that the river-bed, and down to the chalk substratum, is gravel and running sand for fully 100 feet in thickness, some idea of the character of such a work may be formed.

This is no mere theoretical speculation. About forty years back, Frederick Braithwaite, an engineer well-known for such works, sank a well at the hospital brewery, then situate within the hospital enclosure, behind the pier, but which has since been removed. So much sand was pumped up in sinking this well that serious settlements of the brewery walls commenced, and the hospital authorities became alarmed, and called in additional assistance. The well was ultimately sunk to the chalk.

I had again practical evidence of all this, being called in, some years back, by the directors of the Greenwich-pier, to advise them on the condition of that work, for in carrying out certain works of reparation to the pier and outfall drainage works, and tidal reservoirs for the "Ship" Hotel drainage, convincing evidence was afforded of the open porous nature of the soil, charged with water, increasing remarkably in volume after rains from the high ground behind.

The remarkable success achieved by Mr. Peter Barlow, with his small iron foot-subway west of the Tower, again shows how fickle are the surroundings of these works, and it has been quoted at times in support of projects whose surroundings are totally different. Mr. Barlow's tube passed through solid blue London clay, very much as a cheese-taster passes through a ripe "Stilton," and was, as the "navvies" say, as regards excavation, as "tight as a bottle."

Encouraged by its success, powers were recently sought for a carriage-way tunnel by enlarging the "Tower Subway," and the scheme had well-known responsible supporters, but the mechanical lifts, or at least the disposition of them, wrecked this seemingly taking project, for, on the Middlesex side, a very large area of Great Tower-hill was absorbed, coincident with the frontage of Myers' warehouses, impinging on, and rising above, the roadway level north-west of the Tower moat, and abutting on what must become a great line of traffic from the end of the new Tower-street, across Trinity-square to the Docks; this, undoubtedly, proved fatal to the project, as interfering with its development, besides almost sealing up the approaches to a lofty stack of warehouses and vaults, and taking a large part of the last, in which the late Mr. Myers, the well-known contractor, had invested a fortune. The practical difficulty with mechanical lifts appears to be this—how would a timber wain and long team of horses be accommodated, and such vehicles as sugar waggons, brewers' drays, &c., though the same difficulty, in a minor degree, applies to ferry-boats; but it really is these exceptional vehicles and teams that would be most likely to avail themselves of a short and practical crossing place

Proceeding down the river, the first site that presents itself with any reasonable prospect of reaching the arterial lines of traffic on either bank is the Nightingale-lane site, a narrow (only 30 ft. including footpaths) and by no means straight road between the boundary walls of the St. Katherine Docks on the west, and the London Docks on the east side, more than a quarter of a-mile in length, and leading from Wapping, or Lower East Smithfield, just west of the upper disused Hermitage entrance lock of the London Docks up to the main entrance gates to the London Docks in Upper East Smithfield. On the Surrey side it would be near Dockhead, Bermondsey, a favourable point for communicating with the main lines of traffic. This is the site chosen for a tunnel by the Metropolitan Board of Works, and if the idea of a bridge between the Tower and St. Catherine's Docks, with connection with the broad main avenue (the Minories), leading up the east side of the City, and connecting with the Aldgate approach into Essex, be abandoned (but not otherwise) it is, all things considered, a favourable site; but it must be remembered that it is only five hundred yards, or about one-third of a mile, lower down than the much-contested site just east of the Tower.

Owing to the insulation of the Wapping neighbourhood by the London Dock basins, there is no convenient site for a tunnel or ferry for three quarters of a mile futher down, until near the site of Brunel's tunnel, showing his sagacity in its selection; and also near the steam ferry recently opened, and still more recently closed.

Old Gravel-lane on the north side, leading to Ratcliffe-highway, and the projecting northern bend of the Lower Deptford-road on the Surrey side, might be approached with new inclined streets of approach within a moderate distance, and, either for a tunnel or ferry, the site is a fairly good one. It would also involve passing under the inner lock or cut of the London Docks. By crossing lower down, as proposed by Mr. Dunch, a site might, however, be selected for a vehicular tunnel, avoiding any crossing of dock property, being just east of the London Docks and west of the Surrey Commercial Docks.

Three-quarters of a mile lower, at Ratcliffe-cross, an admirable site for a foot subway or ferry presents itself from its propinquity to the Stepney Station of the Great Eastern Railway system, and with the neighbourhood surrounding, and interlaced by the Surrey and Commercial Docks, Rotherhithe, our main entrepôt for timber and grain.

Two and a-half miles lower, we have the Greenwich site (at present a ferry by steamboats); and from one and three-quarters to two miles still lower, the Blackwall and East Greenwich site at Lea Ness, or Blackwall Point. The feasibility of constructing here a carriage-way tunnel, with long approach roads, at an easy gradient for vehicular traffic, has been discussed for many years, from the transparent fact that it is the first site below London Bridge at which such approaches could be attained at anything but a fabulous outlay; and again its claims are great, arising from the fact that, on the north side, the property required from Blackwall Stairs to the East India Dock-road, east of Poplar Church, is of a very inferior character; and, that on the south side, across Bugsby's and Greenwich-marshes, to the Greenwich and Woolwich-road, opposite the workhouse, is almost entirely open land; but unless time be taken by the forelock, this will soon cease, as the promontory has recently been divided by the South Metropolitan Gas Company for a southern Beckton, and the South-Eastern Railway for a now somewhat visionary wet dock.

Mr. W. H. Barlow, F.R.S., the well-known engineer, at the instance of Mr. Richardson, of the Greenwich Board of Works, who has for so long advocated this site, examined and reported on the formation of a carriage-way tunnel for two lines of vehicles and footways as far back as the year 1874. It was urged at the time that here every facility existed for two main north and south arterial thoroughfares parallel to the river, viz., the East India Dock-road on the northern Middlesex side, and the Lower Woolwich-road on the southern Kentish side, presented themselves, which, connected, would form a new road or highway between these important home counties; and it was urged that, as a line of new road between the South Metropolitan Gas Company's eastern portion of the East Greenwich peninsula, and that of the South-Eastern East Greenwich Dock project on the western side, had been adopted by these two corporate bodies, the approach to the tunnel might be carried under it. But the necessity again of passing under the entrance locks of such docks appeared to be lost sight of. The land cleared on the north side by the Poplar Board of Works would have been admirably adapted—with a rearranged plan for artisans' buildings—for a north-west line of approach, and the necessary distance would have been afforded for an easy gradient to the eastern side of Poplar-churchyard.

Another special feature of this site is that a large proportion of the works would be in clay, which is found at a reasonable depth on either side of the river, and is, doubtless, continuous under the river bed.

This, in effect, will prove the touchstone of success as regards tunnels for vehicular traffic, or smaller subways for foot traffic alone, *i.e.*, whether at the site proposed, within reasonable depth, clay is met with, or whether it presents only for a great distance below the river bed the alluvium of the river valley covering the London clay. The difference means comparative ease of execution at a reasonable expense, or, on the other hand, a complex and difficult engineering work, at a proportionately enhanced rate of outlay. The question is, in effect, as much a geological one as it is a mechanical study, and the judicious selection of sites—bearing in mind this great variability of the London basin along the line of the river—means the avoidance of excessive expenditure, coupled, in some cases, with absolute disappointment.

As regards the surcharged traffic over London-bridge, viewed as a separate question, the greatest relief to it would be effected by a bridge between Blackfriars and Southwark bridges, opposite the eastern side of St. Paul's-churchyard; this I have for some years advocated; it was also proposed by Mr. Bennoch some twenty years back.

Shortly stated, its claims are these, viz.:—The diversion of the northern traffic to the southward and eastward, by avoiding the choked-up City streets. This traffic is quite separate from that flowing over Blackfriars-bridge by Farringdon-street, as it does coming from the higher level of Aldersgate-street, and over the Holborn-viaduct, whilst that passing over Blackfriars-bridge is at a level twenty to thirty feet lower, and runs under the Holborn-viaduct. These two north and south streams of traffic are separated from each other by the precipitous Ludgate-hill, with approaches of 1 in 24.

The traffic over a St. Paul's-bridge would be essentially from north and north-west to south and south-east, and would represent a large fraction of what now passes over London-bridge, with a Surrey approach of 1 in 20½ to 1 in 35.

Blackfriars - bridge presents two long gradients from the centre of the bridge, north and south, averaging about 1 in 40, and meeting at the centre of the bridge, a long dead pull on either side.

The St. Paul's north approach, for 500 ft. from St. Paul's-churchyard to Queen Victoria-street, would descend southward at 1 in 45; thence for 925 ft., to the centre of the bridge, would be level; and after that, for 1,025 ft., to Great Guildford street (to be raised 4 ft.), would descend southward, at 1 in 40; and for 600 ft. in continuation to Southwark-street, by Great Guildford-street, (widened westward) at the rate of 1 in 300. The combined lengths—bridge 850 ft., north approach 1,000 ft., and south approach 1,200 ft., amount to 3,050 ft., or nearly ⅝ of a mile.

A high-level Tower-bridge and approaches would be about double the length, and the cost would be proportionate; *i.e.*, at 87 ft. 6 in above high-water from road surface, inducing the necessity of passing over the railways on each side of the river. The viaducts, as warehouses, would, however, lease well. A Tower-bridge would divert the specially north-east and south-east traffic, and would be a great boon to the manufacturing interest of those quarters, but the great relief to the swollen north and south stream would be afforded by the St. Paul's-bridge.

The patent objection to a high-level Tower bridge and its approaches is the great length so that a large amount of the lateral riparian traffic—which more especially seeks accommodation—would not reach such distant points as the Whitechapel-road, or the Grange-road, Bermondsey; and, consequently, a large proportion of the traffic from the wharves would still take the present route.

It is this convincing objection that has resuscitated the advocacy of mechanical lifts, but to manipulate such a traffic as that to be expected over such a bridge, with long waggons and longer teams, must, to say the least, be allowed to present all the elements of a very complicated problem.

The approaches to our above-bridge bridges, are, with the bridges which may be termed low-level, from that fact not of extraordinary length, viz.:—

Vauxhall	1,680 feet.	Approaches—	1 in 30 to 1 in 46
Westminster	1,703 ,,	,,	1 in 35 to 1 in 56
Waterloo	2,700 ,,	,,	1 in 31 to 1 in 42 (Middlesex side level).
Blackfriars	1,783 ,,	,,	1 in 32 to 1 in 48
Southwark	1,990 ,,	,,	1 in 15 to 1 in 40 (recently improved).
London	1,930 ,,	,,	1 in 21 to 1 in 100
St Paul's site	3,050 ,,	,,	1 in 40 to 1 in 300
Tower high-level site	7,550 ,,	,,	1 in 40 to 1 in 80

From which it will be seen that the St. Paul's length is only 350 feet greater than Waterloo.

Such are the conditions surrounding what really is a very complex, though, at the same time, an exceedingly popular problem. Will its solution be found in what has been last put forward under authority? Will it attain the "El Dorado?" or, as a *Times* leader put it, is the land of Beulah to be found beneath the Thames at Nightingale-lane—sweet sounding cognomen of a tortuous and narrow thoroughfare. The proposed approach would, however, do away with all this, but an incline of 1 in 25 for over 2,000 feet is somewhat serious. The steep part of Waterloo-bridge, Surrey approach, at 1 in 31 to 1 in 35 is about half the length. The same remarks applies to the steep approaches to the "Iron Bridge" over Bow Creek.

Should powers be obtained for such a work on this site—should it be carried into effect —and, above all, should the traffic be conducted by steep approaches or mechanical lifts without let or hindrance, to the satisfaction of the public, and, above all, to that of contractors for team labour, the tunnel has gained the day, and that at Blackwall may quickly follow.

Pending such a solution, would not the establishment of interim ferries at the sites, or some of them now indicated, be a reasonable concession to what is, no doubt, a pressing public demand—assuming always that such ferries, like the mechanical lifts, are of a nature to avoid the possibility of break down, and of so simple a character that interruption to the traffic would be avoided. This appears to be proposed by the Metropolitan Board of Works at Stepney, Greenwich, and Woolwich.

These remarks are offered as possibly suggestive of discussion to illustrate the bearings of a modern metropolitan want.

It may occur to some minds that a defined plan for overcoming the difficulties surrounding this question might be put forward, but no attempt to do this has been essayed, from the fact that this is purely a metropolitan question, to be dealt with by the authorities who alone have the power of raising the necessary funds from the pockets of the ratepayers, for no toll-bridge or tunnel can be thought of at the present day, though ferries may, perhaps, be excepted, as of a more temporary character, and for these, at frequent points, the metropolitan pedestrian would doubtless willingly pay a small toll; but the Metropolitan Board of Works having freed all the toll-bridges, it is extremely improbable they will ever attempt to renew or perpetuate so obnoxious an impost for the maintenance of such colossal works as high-level bridges, or deep subaqueous tunnels.

I have the opportunity of exhibiting, through the liberality of the authors, various models, showing how diverse has been the treatment of the subject, and the ingenuity brought to play for the solution of the difficult demand for interchange between the river-banks, without hindrance to navigation.

The Duplex bridge by Mr. Barnett, with an oval, double road at the centre, alternately opening so as to have one road open at all times whilst a vessel is passing; the same idea is to be found in the House of Commons report of 1793.

A low-level opening swing bridge, by Mr. George B. Rennie, the leaves of several spans moving simultaneously, so as to leave 200 ft. free waterway, equal to that between the port tier moorings.

A rolling tray roadway on isolated piers, leaving always a majority of the spans open to navigation, by Mr. George Barclay Bruce, jun.

The Bascule bridge with lifting girders, by Mr. Horace Jones, similar in principle to those met with in the Low Countries, and to be seen on the canvases of the old Flemish painters.

An iron bridge on this principle was erected across the river Ouse for the Hull and Selby Railway, at Selby, in Yorkshire, and one was erected across the north-end of the haven of Great Yarmouth, where it joins Breydon lake, a few years back.

The plan for the high-level Tower-bridge, with road surface 100 ft. above high water, necessitates passing over the Great Eastern and South-Eastern systems, but the inclined approaches are no longer than had they started from the margins; but the entire length is rendered very great, and the junction with arterial lines of traffic far distant. The same remark applies to the East Greenwich tunnel, and both have been prepared with the object of showing how serious is the question of obtaining convenient and gentle approaches.

An ingenious combination of swing bridge and tunnel has been proposed by Messrs. Kinipple and Morris; this would involve descending from the upper roadway to the lower tunnel surface on one side, and re-ascending on the other side, at periods when the navigable span was open, so that the road traffic would never be interrupted, or the river navigation either. But here, as with the high-level bridge, or with the tunnel, we are met with the same difficulty of accommodating long wains and waggons, and longer teams, on the mechanical lifting trays prepared for their reception, circumscribed, as they would be in this case, by the horizontal sectional area of the two bridge piers.

The various authors of these ingenious designs, who have so liberally lent their models, will doubtless add to the obligation incurred, by explaining, *viva voce*, what they conceive to be the special merits of their inventions.

It may be added here that Captain Douglas Galton, R.E., and Mr. Armstrong proposed a single and double swing-bridge.

An old heathen proverb, *vox populi vox dei*, reverently interpreted the expressed and fulfilled will of the people as providential in character. Is the "Thames Communication" question of this nature? If so, the sooner it is met the better, by a low-level bridge, east of the Tower, or a tunnel at Nightingale-lane, nearly opposite Cherry-garden-stairs, names redolent of the past rather than the present, to be followed, say by a Blackwall tunnel with southern approach across the euphonious "Bugsby's" marshes.

My object has been alone to direct attention to the extremely difficult physical and topographical conditions by which the subject is hemmed in, and if I can induce a more practical and earnest consideration of these surrounding circumstances, discountenancing to ill-considered projects, my object is attained.

Drawings showing the application of hydraulic-lifts to a high-level bridge and to a tunnel, with trays 100 feet in length, have been sent by Messrs. Clark and Stanfield. Sir Joseph Bazalgette has also courteously lent his model of a Tower Bridge and large cartoon, showing the important arterial lines of traffic leading to the Nightingale-lane Tunnel.

DISCUSSION.

Mr. G. B. Rennie said this was perhaps the first time that all these different schemes had been brought together publicly, and they showed how difficult the subject under consideration was. Some seven or eight years ago, the City invited propositions to be sent in for crossing the river near the Tower, and amongst others, he submitted a plan. It then occurred to him that if too much consideration were given to the river, the roadway was damaged, and *vice-versâ*, and he therefore attempted to effect a compromise by giving a partial communication during sixteen hours of the day, opening the bridge two hours before and after high water, thus allowing eight hours communication to the river, which, practically speaking, was all that was required for the larger class of vessels. He then explained the model in detail, both when the bridge was open and shut; in the former case the only obstruction to the navigation was four piers, the centre span clear 200 feet, the next being 130 feet, and those at each margin 115 feet; in these latter there was a height of 30 feet under the crown of the arch, or 10 ft. more than at London-bridge. The communications on the Tower side were nearly level up to the abutments; on the other side the incline would be about 1 in 33, which was no doubt rather more severe than desirable, but still not so bad as was found in many parts of London He was inclined to think that unless very large sums were paid for compensation, some such mode of compromise would be the only one which could be carried out with advantage.

Mr. G. F. Blackmore apologised for the absence of Mr. Stanfield, and said he would endeavour to give a few additional details of the scheme for a rolling tray roadway described in the paper. The objection arising from the length of timber waggons, &c., was amply met; the trays could be easily made 100 ft. or 120 ft. long, which would take four or five waggons of the largest kind. The firm he represented were now engaged in constructing hydraulic lifts for the French and Belgian Governments, for canal purposes, the length of the tray being sufficient to hold a barge of 400 tons, viz., 130 ft., constructed of wrought iron. This tray would be balanced on a central hydraulic press, 2 metres in diameter, constructed of steel, the vertical lift being about 43 ft., and the traverse being effected in three minutes. In the case of the Thames communication, where the load would be variable—not spread uniformly over the whole length of the tray—they would prefer to use two or four hydraulic presses to each tray, provided with special appliances, which had been very carefully thought out, and, in some instances, carried into effect already, for maintaining the horizontality of the trays, and ensuring synchronous action, and safety generally. One special feature would be that in no case would it be necessary to interfere with the existing gradients; the existing approaches could be utilised, and the hydraulic lifts so arranged that the level on the opposite sides of of the river need not even be on the same plane.

Mr. Morris said his firm were asked last year to furnish a design for a means of crossing the river. On going into the matter, they found that the bulk of the traffic came up the river about one hour before high tide, and they, therefore, proposed the arrangement shown on the drawings, being a draw-bridge, each half of which was drawn back on the main portion when necessary. This, it was proposed, should be opened one hour before high water, and during that time the vehicular and passenger traffic would come up to the towers, and there be lowered by hydraulic power to the subway, and lifted again at the other end, so that the traffic would not be in any way interrupted. He agreed with Mr. Redman that the question of the hydraulic power would be a difficulty if it had to be employed throughout the day continuously, but in this case the bridge only being open for an hour or so at a time, it would not be so serious. During the remaining 22 hours the bridge would be fixed, and the traffic continuous, whilst the level of the bridge would allow of the ordinary traffic of small steamers being continued without interruption. He agreed with Mr. Rennie that the only way of meeting the case was by a compromise of some kind, and the plan suggested appeared to his firm the simplest and cheapest mode of providing for both the street and river traffic.

Mr. Henry Maudslay remarked that all engineers must have had their attention called to this question, and have recognised the muddle into which the public had got with regard to it. The number of schemes now described would show some of the difficulties which surrounded the subject, but numbers of others had been brought forward for the purpose of affording accommodation to the general passenger traffic, and, at the same time, to the river traffic, which was so important to the City of London. At the present time people seemed in such a complete state of confusion as to what should be done, that hardly anything could make it worse. There was such an enormous diversity of opinion that hardly any two engineers, commercial men, or even members of the ordinary public, would agree on any one plan as being the best. Still, taking the question as a whole, the necessity for communication between the right and left banks of the river was so great, and the commercial interests at stake so enormous, that almost any plan would, to some extent, improve the present condition of things. His father years ago suggested the throwing out of cantilevers on London-bridge, so that the foot passengers should have accommodation outside, and the width of the footways be thrown into the road; but, at that time, the idea was rather laughed at. Now there was a proposition put forward for an additional bridge between Southwark and Blackfriars. At the time when the Government took up the Thames Tunnel, it was considered a great blunder, and for years it was only used by a few old women who sold ginger-bread, and by people who paid 6d. to look at it; but now a railroad ran through it, and it was used by thousands. A ferry-boat going from side to side, if disconnected with everything else, became a comparative failure, but now they were talking of a hydraulic lift 150 ft. long, with a ram 6 ft. 6 in. in diameter, rising 34 ft. A much simpler thing would be a sort of half-swinging bridge, rising and falling with the tide, and admitting of the traffic being carried by a ferry-boat. It was said that this would necessitate a floating wharf of great length, but still the same thing was done, on a smaller scale, in bringing passengers off the steamers, and why should it not be done on a larger, as it was very effectively at Liverpool. He could not help thinking that one or other of these schemes ought to be carried out, but unfortunately, the great obstacle was that so many people were always concerned who thought not of the benefit to the community, but of how they could put money into their own pockets.

Mr. Duckham then explained, in detail, the model of the lifting presses of the Thames Steam Ferry Company, which was opened in 1877, between Wapping and Rotherhithe. One difficulty the company had to contend with was the limited distance they were allowed to project the piers into the river, and another was the great rise and fall of the tides, which was about 20 ft. 6 in. Again, there was a distance of 100 ft. between the lifts and the shore, which, by the rules of the Thames Conservancy, had to be kept 8 ft. above Trinity high water mark; so that if the traffic were coming at low water there would be a lift of about 26 ft. from the vessel's deck to the level of the quay. It was calculated that with quarter of an hour trips there would be from eight to twelve vehicles each trip, and it was thought better to transfer those bodily from the high to the low level, rather than take them separately, and the lift was constructed accordingly. There were four hydraulic rams, the lift was 70 ft. long by 35 ft. wide, which would take four ranks of vehicles, three in each rank. The hydraulic machinery was on shore, connected by pipes with the rams, which were so tied together by connecting rods and chains, as to equalise the pressure upon them, supposing the load to be much heavier at one corner of the lift that at another, thus ensuring that it should work horizontally. The lift itself weighed sixty or seventy tons, and it was at first intended to have two rams connected directly with the accumulator to act simply as a counter weight, whilst the two others would operate in lifting; but owing to the company not raising sufficient capital, it was decided to use a dead-weight counterbalance, as shown in the model. It was arranged that vehicles coming on to the lift from the vessel were placed in one rank, whilst those passing on to the vessel went off from the other. The lift worked perfectly well, but the scheme was a failure from two principal causes; one, the deficiency of capital, only about one-fifth of that originally contemplated (£100,000) being raised; and the other, the defective approaches on each side. At the beginning, there were two or three breakages in the chains, owing to defects from over cheapness, but thanks to the safety grabs devised by Messrs. Maudslay, which acted immediately on safety bars at the sides, the lift was simply held fast until the tide rose to the level at which it happened to be. The iron chains were afterwards replaced by steel ones, and during the last twelve months the machinery was at work, not the slightest hitch occurred, and it was finally stopped from causes entirely unconnected with the mechanical arrangements. The ferry boats were 80 ft. long by 6 ft. beam, fitted with double engines and independent paddles, and as a rule the passage was made in four minutes; he had known vehicles pass from High-street, Wapping, to Rotherhithe, including the lifting, in nine minutes. The capital of £100,000 was intended to provide also for building some large warehouses, but even if the whole were required for a ferry, it compared very favourably with the one or two millions required for a bridge. In fact, 30 or 40 ferries could be started for the cost of one bridge and if it were not found exactly suitable at one place, it could be readily shifted at a small expense.

Mr. MARTIN WOOD referred to the lecture given by Sir Frederick Bramwell, at the Royal Institution, on the same topic as that dealt with in the present paper, in which he spoke eloquently of the scandal it was to the metropolis that the whole east of London should be left without communication across what he described as a puny stream. In one sense that was quite true; but, as Mr. Redman had pointed out, the whole commerce of the City was owing to that puny stream. It seemed to him the common-sense mode of meeting the difficulty was to take advantage of the river itself, in the manner pointed out by the last speaker. The principal difficulty was the rise and fall of the tide, but that had been got over in other places by very simple methods, and without machinery except a stationary engine, by having movable approaches or landing stages, which could be adjusted within the limits fixed by the Thames Conservancy. He hoped the public would look at the subject in a reasonable way, going back to first principles, and not allow themselves to be baffled and kept waiting year after year, for unless this great river were properly utilised, trade would go elsewhere, and London would lose its supremacy.

Mr. LIGGINS said the whole importance of this subject was with regard to vehicular traffic, because there were ferries at very many points which were available for passengers. He had known the river all his life, having traded to the West India Docks forty years ago, and he considered that if a communication were made across the river anywhere, it should be at Limehouse Hole; it would be approached through very inexpensive property on the north side by Bond's, the mast-makers' premises, and would be easy of access from the Commercial-road, and convenient to all the warehouses. But it was a question with him whether such a communication was required at all, considering the altered circumstances of the trade of London. Going down the river to Greenwich, it would be seen that nearly every warehouse on each side had boards up "these premises to let," and the extent of the trade in the upper portion of the river was nothing to what it used to be. When he was a boy you could scarcely get through the Pool to London-bridge, but the development of railways had entirely altered the course of trade. The coal barges were far less numerous, and they were towed, six or eight together, by small steamers. Owing to the increase in the size of ships, again, St. Katherine's Docks, which were formerly crowded, were now often empty, and the company had constructed larger ones lower down the river, viz., the Victoria and Royal Albert Docks. But goods going to be loaded in these docks did not go by waggon but by lighter, and thus there was not so much heavy road traffic. With regard to a bridge, he was sure that it would be impracticable to put one at all, however cleverly it might be constructed, below London-bridge. Two hundred feet was wide enough for a ship to pass through, but you had to swing the ship, and there might be three or four ships coming up the same tide, and to swing a ship in a flowing tide, when others were coming out to go to sea, was no easy matter. There would be such a complication with three or four large ships, and their attendant steam-tugs, that it would be quite impracticable; no pilot would take the responsibility of attempting it. The process of moving the docks lower down was going on very fast, and everything tended in that direction. The West India Dock Company's trade was seriously affected by the Albert and Victoria Docks, and the directors were now going to Tilbury, and providing for still larger ships; and all this was destroying the vehicular traffic to and from those ships. If merchants would submit to sending their goods as far as Tilbury, he thought it highly probable the shipping would go to Southampton, whereby 300 miles of navigation would be saved; and the railway companies now charged the same rates from Manchester to Southampton, as they did to London. He had often advocated the widening of London-bridge, and throwing the whole of the existing breadth into the roadway.

Mr. JOHN SPARKS observed that if ships no longer came up the river to deliver their cargoes, it would seem to remove the objection to a bridge at the Tower, near to which place all the great railways on the northern side now had depôts. If, therefore, any communication were made across the river, that seemed the most suitable place. He should also say that if they were going to make a road-way, it should be level, as had been found so necessary in the Holborn valley, and the City were now proposing to fill up another valley at George-street and Postern-row, near the Tower. This communication—which in all probability would be used to four or five times the extent of the Holborn-viaduct—certainly ought to be a level roadway also. It seemed to him that, in this matter there must be a compromise between the shipping and the road traffic, and he did not see how that could be effected better than by a low-level bridge, with an opening to let ships through, when they wanted to come up. By doing it in that way the present generation would be accommodated, and if in the next generation it happened that all the shipping remained at Tilbury, it would not be found that they had made a gigantic mistake by causing every ton of goods to be taken up 100 ft. above the level of the river. Some of the plans suggested would, perhaps, be useful lower down the river, but he did not think a steam ferry at the Tower would be of any service at all.

Mr. REDMAN said there seemed to be such a concensus of opinion that he had fairly treated the different schemes put forward, that it was not necessary for him to add anything further to the discussion.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Redman for his paper, which was carried unanimously, and the proceedings terminated.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Monday, April 21st, 1884; Sir FREDERICK ABEL, C.B., F.R.S., in the chair. The adjourned discussion on Dr. Percy Frankland's paper on "The Upper Thames as a Source of Water Supply," was resumed.

Mr. E. K. BURSTAL said, from the title of the paper, it would appear that it was not of any great interest to engineers engaged in the construction and management of waterworks; but when the paper itself was considered, the title appeared to some extent a misnomer, for it was, in reality, an attack on the London waterworks. The statements of Dr. Frankland were, to some extent, a re-production of a paper of his in the August number of the *Nineteenth Century*, where he stated that the sewage from a population estimated at upwards of half a million entered the river above Teddington, and that it was Thames water mixed with the sewage of that half-million of human beings which the companies abstracted for the consumption of the ratepayers. To anyone acquainted with the Thames, such a statement could only be described by the word "monstrous." To imagine that the sewage of a population of half a-million persons, some of them living miles from the river, without any system of water carriage drainage, could ever reach the Thames, was what no human being would ever believe. Passing to the statistics given of the water supply to towns in the Upper Thames basin, he must impugn the veracity of the diagram, for the simple reason that he found statements in the report of the Royal Commission on Urban Water Supply, published in 1879, which did not accord with it. For instance, at Aldershot, at page 2 of that statement, an artesian well had been lately bored, but was not yet in action; in fact, the well was only just constructed, and the greater number of houses took their supply from shallow wells there. Again, at Oxford the supply was stated to be a spring in the gravel, but turning to the report he found, at page 20, that Oxford was supplied with water from a lake formed by the Great Western Railway Company, excavated for gravel, and partly from the River Thames. That showed that it could not be called a spring in the gravel. Then coming to Richmond, he thought the artesian well there was a thing of the future. Reading, again, took its water from the Kennet, and Banbury from the Cherwell. Therefore there were three or four large towns which did not bear out the statement made in the diagram. Tottenham was said to draw its supply from a well in the chalk, and on that he should like to say something. The water supply of Tottenham had been considered exceedingly good, but it appeared from Professor Frankland's returns, that from May up to August, 1883, during six months it was of excellent quality, but on the 27th of May, 1883, they actually took a large portion of that supply from the East London Water Company, which fact was never discovered by the analyst until his attention was drawn to it. If, therefore, the difference could not be discovered by the analyst, it showed that the supply taken from the East London Water Company ought, at any rate, to be above suspicion. The statement also which Professor Frankland made in his remarks on the paper, that the Royal Commission which sat in 1869 gave a modified derogatory opinion of the Thames as a source of water supply, was hardly correct, for that Commission spoke exceedingly favourably of the Thames water supply. In the commencement of Dr. Frankland's paper there was a letter from the Vicar of Staines, one of the chief points in which was the increase of house-boats on the river which were likely to cause contamination. Now, only ten days ago, he came down the river from Oxford to Windsor, and had occasion to see several house-boats, and without exception, he found they were supplied with earth-closets, and, therefore, they did not foul the stream. That was only a small point, but it was these small points which were brought up against the Thames water, and which so much influenced the mind of the public, who did not know the real facts. Passing to the results of the analyses of the A B C Company's process, those were taken from a paper fourteen years old. Of course, every undertaking at its commencement must have some failures, but speaking from a knowledge of

Aylesbury, having constructed the works there under Mr. Hawksley, and knowing something of the Company, although he was not interested in it in any way, he must say that the results were very satisfactory, and were very different to those given in the paper. Dr. Frankland said, that so far as he was aware, the only places where precipitation was in operation on the Upper Thames was at Aylesbury and Aldershot; but at Windsor, the works had been in work over five years employing precipitation supplemented by filtration, and they had given very good results, at any rate they had satisfied the Thames Conservators, and anyone who knew the Thames, and was in the constant habit of being on the river, knew how different the state of the river now was to what it was when the Conservators took it over in 1866. With respect to the analyses of the water given in the paper, the organic carbon at Windsor and Chertsey, or Hampton, and the organic nitrogen, he would compare with the analyses of the Antwerp water. Now Antwerp had recently had a supply afforded by a river a short distance from the town. The state of that river was so unsatisfactory, that they were only allowed to take it about one hour each tide. The sewage from a population of about 40,000 entered the river above it, and went down with the flood, and the sewage from an equal population below went up with the ebb. Dr. Frankland had visited Antwerp, and on examining that water, after filtration through spongy iron, he described it as being very good. He did not know the exact terms of the report, but in a paper read at the Institution of Civil Engineers, about a year ago, they were informed that filtration through spongy iron destroyed all the lower organisms, and rendered the water perfectly safe for consumption. Now, when he compared the state of the Antwerp water before and after filtration through spongy iron, there was certainly a very great improvement, but even after filtration in that manner, it did not compare favourably with the Thames water. For instance, the organic carbon at Hampton was ·285 as compared with the Antwerp ·24. The organic nitrogen of the Thames was ·061, at Antwerp ·05. Therefore, if at Antwerp the water was considered good, and so reported upon by Dr. Frankland, he could not see why similar water in the Thames should create such alarm. If spongy iron had this effect—which he did not pretend to know anything about—how was it that it was not recommended for the Thames water companies? The cost of the process at Antwerp was stated to be £7,000 or £8,000, which, if correct, would show that an expenditure of £350,000 in London would give the same results; and he could not see why they could not have such a system in London, and then all this excitement would be allayed. If any improvement could be made in the Thames water by a comparatively small expenditure like that, it ought to have been mentioned in the paper; the closing sentence of the paper, however, contained the gist of the whole matter, viz., "The great obstacle in the way of a similar supply being obtained for the metropolis is the great capital invested." Persons had subscribed their capital in past years to do that which public bodies had not done; they had done an immense deal of good, as Dr. Frankland had fully recognised, for he said he did not wish these companies to be disestablished and disendowed. But that was not what the current feeling was. He thought that, when the companies had, by the expenditure of capital, enabled a very large population to be supplied with water, some little justice was due to them; and that would have been meted out if Dr. Frankland had pointed out how the water could be improved.

Mr. HOMERSHAM said he could speak from full knowledge on some of the points mentioned by the last speaker. In the first place, he thought Dr. Frankland had been under the mark in giving the quantity of population residing on the drainage-ground of the Thames. He had carefully taken out the population residing on the drainage-ground above Hampton, and found it to be about one million; Dr. Frankland estimated that the population of certain towns draining direct into the Thames, in round numbers, was a little over a quarter of a million, and he put another quarter of a million for the suburban districts, only giving the sewage of half the total population as going into the Thames. It was all very well to say that some of these places were situated some miles from the river, but no town could be drained, no place could get rid of drainage, unless it went into a river of some kind. The natural drainage of the district was by small streams which ran into the Thames, and it was the same thing in the end as if it went direct into the Thames itself. He was not very well acquainted with some places which had been mentioned, but he could speak certainly with regard to Richmond, where nearly the whole of the water used in the year was supplied from an artesian well. This well yielded from 220,000 to 230,000 gallons a day, and had done so for years, and the remainder was made up at times from subterranean water that came from gravel. Therefore, to say because newspapers had published reports about Richmond which were utterly untrue, that the supply did not come from artesian wells, was wrong. They all knew what could be done by persons who had the ear of a newspaper. With regard to Tottenham, it was quite true to say that they took their water for some time from the East London Water Company; it was only for a short time while the well was being sunk deeper. When he heard Dr. Tidy speaking the other evening, it took him back to some thirty years ago, for he remembered the time when the question was not between the Thames water above Teddington Lock, and spring water, or water from the chalk, but between Thames water below Teddington Lock and above it, for all the companies at that time took their water below, some from Hungerford, others, like the Grand Junction, a little higher up; and the West Middlesex, which was the highest, about Hammersmith. Then chemists of equal eminence with Dr. Tidy, said in the most absolute manner that the water was perfectly pure and would create no illness of any kind. The chairman of the Southwark Company said, in a report in 1849, "of this I am certain, that water taken either at Kew or Barnes, at any time of the tide, or at Battersea during the ebb, and properly filtered, cannot be shown either by sight, taste, or smell, or by the most careful analysis, to be inferior in any respect, while in some respects it would be superior to water taken at Henley or Oxford." Now he knew the late Sir William Clay, who wrote that, very well, and a more conscientious man did not exist; of course he stated it, not on his own knowledge, but on the faith of analyses made by chemists. In 1853 or 1854, there was a visitation of cholera, and 3,467 deaths took place in the district of the Southwark Company, which was proved in the most absolute manner to arise from drinking that water. At this time the Lambeth Company had moved their intake from Hungerford to above Teddington Lock, and it was found on examination that the cholera existed to a much greater extent in the districts supplied by the Southwark Company than those supplied by the Lambeth Company; a very able report was drawn up by Mr. Simon at that time, which proved the case conclusively. Therefore some of the statements made now must be taken with the same reserve as those made by Sir William Clay in earlier times. Putting aside the sentimental part of the question, there were important points in the difference between river water and spring water, if taken from proper sources. In river water, do what you would with it, there was a great difference of temperature between summer and winter; in winter it was frequently as low as 34° and rarely less than 38°, and thus very readily got frozen and burst pipes; in the summer it was up to 70°, and with water at that temperature there is naturally a less quantity of oxygen gas, and the quality was inferior, and it nursed insects and ova of different animalcula, which colder water would not. Again, river water after rain was always opaque and devoid of transparency; when the blossoms fell from the trees and when the leaves fell in autumn it was necessarily contaminated. Then again you could not prevent the manures on the land, independently from sewage of towns, being washed into the river. It was not a pleasant subject to speak of, but sewage consisted of fluid matter as well as solid, and how could that fluid matter be got rid of. If persons were ill in the district of typhoid fever or cholera, the water necessarily became contaminated, and there were no known means by which it could be prevented. On all these grounds river water was not desirable for a public supply. Comparing that with spring water, what did you find; the water was of an even temperature all the year round, generally about 52°, and, therefore, even in winter it was very difficult to freeze. It was well aërated, and had more oxygen gas in solution, and was always bright and clear. It wanted no filtering, and was entirely devoid of animalcula. He had it tested over and over again by the most eminent microscopists and others. If, then, this water, so superior in all its qualities, leaving alone the question of sewage, could be got, why not have it; there was no difficulty about getting it; the whole of the Kent water company's supply was entirely derived from well water, and it was not an inconsiderable quantity. In the north of London the water from these springs represented one-twelfth of the whole supply, and in the south of London one-fifth, or, taking the whole of London together, one-eighth, and though this was all that was pumped, a great deal more could be got. The Kent Company, which in the summer supplied 11,000,000 gallons a day, had the means of giving 14,000,000, therefore the difficulty of getting water from the chalk did not arise from any physical difficulties; it was simply because they were not allowed to have free competition. If London were divided into eight districts, and there were butchers and bakers to supply the whole of those eight districts from eight central establishments, with shops in different parts, no one being allowed to compete with them, what what would be the price of bread and meat? The companies had contrived, not by honest means, but by Parliamentary means and Parliamentary influence, to prevent any competition in their districts. If he were asked how to avoid this, he should say it was the easiest thing in the world. When Diogenes was asked by Alexander what he could do for him, he said, "Get out of the sunlight;" and if the Government asked what they could do for the people of London, as regards water supply, the answer would be simply, "Get out of the way, and let the London people manage their own affairs," then they would soon get a good supply. The Kent Water Company used to supply water from the Ravensbourne, but under competition it abandoned that source, and adopted the chalk well supply; now they supplied the whole district with water from the chalk, and their shares at the present moment stood, in proportion to their original cost, higher than those of any other company in London, so that the company, in the long run, was really not injured by this competition.

Dr. THUDICHUM said the question of supplying water to the metropolis had been surrounded by so many fallacies that it was necessary to clear some of them away. For example, it was constantly said that the supply to the metropolis was thirty-five gallons per head per day, but this was quite erroneous; each individual in London received on an average only about twelve gallons a head, and he could bring his authority for that statement if it were challenged. In fact, there was no arrangement which could supply that large quantity; even if it were possible to deliver such a quantity, the people could not receive it. Then another fallacy was that Thames water was sufficiently pure to be supplied with safety to the public. He would take, not one place in the Thames Valley, but twenty or thirty, where water was defiled in such a manner that it was as disgusting as could be. He had not relied on books, or on other persons' statements, but had followed some of the tributaries of the Thames from their sources to where they entered the Thames, and what had he seen? The River Wey rose above Alton out of clear springs, but as it went through Alton, it received a vast amount of Alton sewage; of course you could not see it from the street—you must go into the houses and see the closets, and see how the sewage went direct into the river. Then, again, in the Basingstoke Valley, there were splendid springs of every kind. Some time ago the water closets were placed on the borders of those fine springs, and the ordure went direct into the water which went into the Thames. The local sanitary authority objected to that, and compelled the people to build privies; the result of it was that what formerly flowed away fresh was now collected, and created an abominable nuisance; but below the privies the proprietors made a little hole, and through that hole the rotten stuff now flowed into the springs; the only difference was that formerly it went in fresh, and now it went in putrid. The springs irrigated watercress beds; the cress lived on this sewage, and we lived on the cress, and there was another source of danger. It was utterly unsafe that this putrid sewage should be allowed to flow into the water-cress bed, for it was certain that, at one time or another, infection would be conveyed to the persons who ate that cress. Were there any remedies for this state of things? Of course there were. The precipitation processes were very useful, though they did not purify the water, so as to make it fit for drinking. He had been up the River Lea, and had taken water from the Lea after the Hertford sewage was mixed with it, and looked at it in various ways, and he could only say it was perfectly unfit for drinking water. Speaking not as a chemist or a physician, but as a simple man of sense, if he were asked whether water so defiled was fit for drinking, he should say, No, and three times No. If anybody flattered himself that with the progress of culture, the science of health, propriety, and cleanliness, this defilement of water with sewage, and its supply to people's houses for them to drink, would be allowed for any length of time, he was mistaken, the people would insist upon having pure water. But could they have pure water? Of course they could. It had been shown over and over again that they could have it. The springs which Mr. Homersham had mentioned gave water which was not open to suspicion; but they could have it much more easily if they went a little way up the Thames valley to the North Downs; that was a high plateau formed of chalk rocks, on which the water which fell from the hills soaked into the ground. On an average from 25 to 35 inches of rain per annum fell on those Downs, and sank into the ground, where by a natural process it was filtered, and at the bottom of those Downs, in the valley, the water rose in the shape of most magnificent pure springs, and all that was necessary was to catch them and lead them to London, in order to have the purest water possible. That was a perfectly practical problem, and it had been so recognised by the best engineers the country could produce. Why should not consideration be given to the plans of the Metropolitan Board of Works, which had been formed by those three distinguished engineers, Sir Joseph Bazalgette, Sir Frederick Bramwell, and Mr. Easton; they made a plan for supplying London with drinking water. They would take the water out of the wells constructed according to Mr. Homersham's excellent precedent; but they need not rely upon them, because every day you had over 25,000,000 gallons of the purest water in the valley of Basing; the Metropolitan Board of Works only required 8,000,000. If they wanted more they could go a little further, say to King's Clere, and could get 70,000,000 of gallons perfectly pure. Having stated that the water was defiled, and remained dangerous, that pure water could be obtained, and that the authorities had formed a plan for supplying it, why should the question be surrounded with so much collateral talk about confiscation? They did not want to confiscate anything. These who had expended their money would have it back with a fair profit, therefore there would be no confiscation. On the contrary, they were defending themselves from confiscation, for they were now compelled to pay more than the value of the water they received. They wanted to get that which belonged to them as citizens, their liberty, with power to make such domestic and sanitary arrangements as they desired. There were plenty of places in the world where such arrangements had been effected. For example, no country in the world was supplied with water like the kingdom of Wurtemburg, partly by the action of the communities, and partly by the action of the State. Even the poorest villages in the mountains brought a supply of pure water to their houses, and in some towns, as in Stuttgart, where water pure enough for drinking was not to be obtained in sufficient quantity for all purposes, there was a double supply, one for drinking and domestic purposes, and the other for cleaning, &c. If that could be done in a small state like Wurtemburg, and in poor villages, could not the richest city in the world afford to bring to perfection a system which would for once and all put an end to this perpetual wrangling about the emperor's beard. To hear the fallacies quoted again and again, on one side or the other, was perfectly intolerable. Comparisons were drawn between the health statistics of districts supplied with one water or another; but it was absurd to quote London vital statistics in support of any proposition whatever; there was an immense number of immigrants into London annually, not only of the English but of other nations, from the ages of fourteen up to the prime of manhood and womanhood. Some of the statements made in the paper were open to the objections which had been taken to them. For instance, it was stated that Basingstoke was supplied by a well; there was no doubt one well in Basingstoke which supplied a few houses, but the majority of the population were supplied with water drawn from ground soaked with sewage. He hoped that this paper would have some influence in inducing people to unanimously demand that their water should be pure, and free from all suspicion.

Mr. Baldwin Latham, M.Inst.C.E., remarked that the last speaker was entirely under a mistake in his estimate of the quantity of water delivered by the companies. There was abundant check upon the companies' own figures in the gauging of the London sewers, and the evidence was all confirmatory of the volume reported by Sir Francis Bolton. With regard to the general question, any one who had studied the history of the question must know that the London companies had been far a-head of the public on all these questions. There had never been an improvement carried out by the companies which had not met with the most strenuous opposition, occasioning very large expenditure. The Lambeth Company began to move its works above the tidal influence in 1848; but it was not until 1852 that a general Act was passed, compelling the whole of the water companies to take their water above Teddington Lock. Again, when the Lambeth Company found that the water which they took just below the Mole was liable to become turbid from the influence of that stream, they, at their own instance and cost, moved their own intake farther up the river, to get a more perfect source of supply. That was only one of many instances. There was no doubt the words quoted from Sir William Clay, in 1849, with regard to the Thames water at Kew and Barnes, were absolutely correct. Those who knew anything of the tidal movement of the water in the Thames, knew that there had been a considerable alteration in the tidal currents, and that formerly the water was quite as good in those neighbourhoods as it was now above Teddington, for tidal action had greatly increased in recent years. At an earlier period still, the water at London-bridge was remarkably good, and for generations the City of London was supplied from the old water works at London-bridge. In fact, it was partly owing to the pulling down of old London-bridge that the tidal influence had been increased. There was not one of the water companies but what would have done still more to improve the supply if they had only been permitted, but the strong opposition they had always met with, when going to Parliament, had curtailed the schemes many of them had in hand. For instance, the East London Company were desirous of taking their supply from the upper reaches of the Lea, but were prevented doing so by the opposition of the Government, who declared that nothing would compensate them for the interference with certain water rights used in connection with powder mills. With regard to the supply of water from the chalk, he would say that the million of population which were supposed to inhabit the watershed of the Thames, only came to about 270 per square mile, and he thought it would be difficult to find any square mile on the chalk which had not as many inhabitants as that. The only difference would be that in the one case the sewage was purified, and the effluent only passed into the stream direct; in the other case the sewage would percolate through the ground, to the subterranean water supply. He should prefer to take the effluent which had been exposed to the influence of light and air in the body of a river to that pollution which took place underground, under the influence of darkness. There was no security with reference to wells in the chalk. He would draw Mr. Homersham's attention to a well, or rather series of wells, which had been sunk by that gentleman himself, at Caterham, to supply 200,000 gallons a day, but that supply had never been obtained, and only recently another small company in the valley had been bought up, in order to be able to furnish a supply to the district. Again, they had been told that Richmond was supplied from an artesian well, which supplied 180,000 gallons per day, and the balance had to be made up from water from the gravel, which was the same gravel which Dr. Thudichum spoke of in the neighbourhood of all populous towns as being soaked with sewage. They had heard a great deal in the newspapers with regard to the very deep well which had been sunk which, after an expenditure of many thousand pounds, yielded eight gallons a minute, or about 11,000 gallons a day; and they had had to call in the aid of the Southwark and Vauxhall Company to give them an auxiliary supply. All these things showed that this question of supplying water from chalk had to be considered with a good deal of caution. Before sitting down, he would say a word with reference to the sewage portion of the paper, for he had never been more surprised than he was in seeing some of the results tabulated. When, however, Mr. Cresswell explained that the analysis of the sewage of the A B C process was really a very ancient document, the whole secret was out. He might say that, just about that time, he recollected going to the Leeds Sewage Works to see the process, when he thought it was such humbug that he recorded that opinion in the visitors' book. Since then, however, he had carefully watched the A B C process; it had made very considerable strides of improvement, and he was bound to acknowledge that, on visiting the works of Aylesbury, it did produce an effluent which contained a green confervoid growth, which was a great mark of its purity. He, therefore, confessed himself a convert, and had himself carried out the process with very great satisfaction at Wellington College, where some of the most perfect works for the purification of sewage ever seen were carried out entirely by the process. Not only so, but in the interests of the health of the people of the college, he thought it was desirable even to do away with irrigation, because he found that there they had a very deep well into which there was a chance of the water, after irrigation, percolating; and, therefore, in order to avoid all suspicion, he deemed it extremely important that this sewage should be treated by some chemical which should destroy any noxious properties in it, if they did exist. The result had been that, since the works were carried out, the health of the college had been better than at any previous time. He himself was a great believer in statistics, he thought they did show whether or not a process was beneficial. If you found the sanitary arrangements of a town were not good, you would be sure to find it out, probably not in the general death-rate, but in the zymotic death-rate, not only amongst young children, but even those of mature age being effected. Mr. Norman Bazalgette quoted some tables he had prepared with reference to the health of various parts of London, which showed at least that there was no difference whatever in the health, judged either by the general death-rate or the zymotic death-rate, in those districts supplied from the chalk or from the river, but, if anything, the difference was in favour of the river supply. When they came to know more about the effect of these particular poisons on health, he believed it would be found that there were influences at work, such probably as light, which Professor Tyndall had shown, a little over twelve months ago, was unfavourable to the growth of bacteria, so that if merely by the influence of light, such an exposure as that obtained in a river might be the means of checking and destroying bacterial life, it showed how these noxious properties which were supposed to abide in sewage might be removed; and the experience of various towns fully confirmed that. Wakefield had its waterworks below its own sewage outfall; Dewsbury and Halifax were on the same river above it; their water was supplied from a collecting area, that is, it was impounded on moorland; but at Wakefield, bad as its conditions were, its other conditions would compare favourably with both Dewsbury and Halifax, and judging by the health statistics, it came out much more favourably than either of those towns. That was a case where they had the highest degree of impurity in the water supply, but a most perfect system had been adopted for the filtration of the water, and the result had shown that, although it might be very objectionable—for he was not going to say it was not very improper to turn the sewage into rivers, and means ought to be adopted in every instance to prevent it—still it showed that Nature had not left us in the unprotected state which many people supposed. In fact, if it were so, there would be no such thing as wholesome water to be found, whereas experience showed that the public were not subject to those evils which were so frightfully depicted in the paper.

Mr. HOMERSHAM, without detaining the meeting at length, said he must ask leave to protest against the statement made by Mr. Latham with regard to the Caterham wells.

Mr. BISCHOF said the question raised by the paper was the supply of the metropolis from deep wells versus a supply from the Upper Thames, and he should endeavour to keep to that question, though others had travelled a good deal beyond it. What were the respective merits of these supplies? It must be borne in mind that all water pumped out of deep wells must come from the surface, and therefore the question resolved itself into this, how far could we expect that water was purified in passing from the surface to the bottom of the well. They had heard a great deal about exhaustive purification, when water filtered through a hundred or more feet of solid rock. He did not know that such filtration had been proved conclusively. Most of them had seen in quarries long yellow lines resembling ribbons, which in fact were the deposit of ferric hydrate and calcic carbonate by the water which passed through fissures, and not through the solid rock. What would be the effect if water did actually pass, year after year, through the substance of permeable rock. Just the same as took place when a leaky water-butt was made tight by passing through it water in which lime or some similar matter was suspended; the further passage of the water was prevented by the suspended matter which was taken out of it. In his father's "Geology," he found a description of a deep well at Tours, in France, which was 364 feet deep. It quite penetrated the limestone, and yet the water brought up numbers of seeds, and the stems and roots of certain marsh plants, proving that it could not have passed entirely through the solid substance of rock. Again, at 156 feet deep, at Bochum, in Westphalia, the water of a deep well brought up fishes two or three inches long, and shells. These, again, could not have passed through solid rock; in fact these instances led Sir Charles Lyell to conclude that deep wells were, in all probability, very frequently fed by the leaky beds of rivers; and this would make one pause before deciding to incur a very large expense in sinking such wells, the more as the danger of contaminating the deep well water was increased in proportion to the pumping, and the consequent lowering of the ground water. Apart from what chemical analysis could show, most people agreed that the main point was how far certain low forms of organic life, which were believed to constitute the zymotic poison, might be removed in the passage of water from the surface to the bottom of a deep well. He was not aware of a single fact which would show that these low forms o life were thus removed. If they were, the water ought be altogether free from germs, but this had not yet been proved. It would not be so very difficult to take water from the bottom of the deep well before it was contaminated by atmospheric contact in the well itself, and then subject it to a test; he might refer to the proceedings of the Royal Society, where a test would be found which he applied in a similar instance, and he ventured to say that, if tried, the result would be that 100 feet of filtration through the solid substance of rock of any kind, or however this might take place, were not as efficient in separating or destroying the low forms of organic life, as filtration through a few inches of spongy iron. A great deal was said about the exhaustive chemical purification of deep-well water, but he could conceive that this might be only a multiplication of the action of the ordinary sand filter. If instead of 6 ft. or 8 ft., we had 60 ft. or 80 ft., or still more, we would get a proportionately increased purification, but then the fact would remain, as Dr. Frankland himself pointed out, that even after the passage through 100 ft. of sand, germ life would still be detected. In conclusion, he would ask Dr. Frankland two questions. First, whether he would give an explanation of the comparatively large fluctuation in the contamination of deep-well waters, which, though nothing in comparison to that shown by the river water supply, yet did show considerable increase at certain periods, in one case amounting to nearly seven times what it was at another time? He referred to the Kent water, which—taking the average amount of organic impurity contained in a given volume of the Kent Company's water, during the nine years ending December, 1876, as unity—showed an organic contamination on one occasion, in 1877, equal to only 0·3, while in the same year it rose to 1·7, and in 1882, even to 2·0. The second question was—On what theoretical grounds did Dr. Frankland consider the filtration which water underwent in its passage from the surface to the bottom of a deep well, made the separation of any zymotic poison more certain than the unusually efficient natural filtration which the water underwent at Lausen during the epidemic of 1872?

Professor Dewar, F.R.S., said he should confine himself simply to certain ideas which had occurred to him with reference to the conduct of this debate, and the admirable paper of Dr. Frankland, not having much personal knowledge either of the individual companies or the individual supplies. In the first place, t seemed to him that they were all liable either to be misinformed, or that the facts were placed before them in a very curious way. The report on the London water supply for this month contained the following statement:—"According, however, to the eporter's own figures, the mean amount of organic matter in the five samples only of the Thames-derived water examined by him during the month was a little under four-tenths of a grain per gallon, and the maximum found in any one sample five-tenths of a grain. That maximum fell far short of the one-thousandth part of 1 per cent. of organic matter in the case even of the worst of the two waters, both reported to be considerably polluted by the presence of a very large proportion of organic matter." He presumed that was intended to convey the impression that one-thousandth part of 1 per cent. did not mean very much; but, unfortunately, in this particular case, it meant a very great deal, and they could easily arrive at the maximum or minimum value. They had heard it said on the one hand that there was the something like 250,000 persons draining into the Upper Thames Valley; and Dr. Tidy, some years ago, unhesitatingly said that there was something like 1,000,000. Assume a population of 500,000, and supposing a large dilution of the sewage, it might be taken to be at 20 gallons per head. The question was, how were they to estimate the average amount of Thames pollution. He would point out that they had the means of doing that, and he believed it had not been co-ordinated in this way before. Take the minimum supply of water during a dry period; that would be represented by between 400,000,000 and 500,000,000 gallons passing over Teddington Weir; consequently, if you took the average daily pollution, you could easily find the percentage of impurity. 20,000,000 gallons of dilute sewage are mixed with between 400,000,000 and 500,000,000 gallons of water, the consequence being a potential impurity represented by what might be from 2 to 4 per cent. of this dilute sewage. The difficulty was that on one side it was said all this impurity is as nothing, because it is removed in a very short period of time by natural oxidation; whilst, on the other hand, Dr. Frankland said that rivers had very little power of transforming organic impurities. Then it was only in exceptional cases that the sewage got into the river, namely, in the case of floods. But, again, there were some results which, on being examined, would give another definite basis to go upon. A few years ago, when this discussion was little more rampant than it was now, there were a series of analyses made by Dr. Tidy to represent the effect of the natural purification. He would abstract these analyses in a simple way. Dr. Tidy's object was to add different per-centages of London sewage to one of the London waters, passing from 1 per cent. to something like 8 or 10 per cent., and to ascertain what was the effect on various runs after exposure. The object of adding these different per-centages was that there might not be one analysis, but a mean deduction from a curve which represented the actual impurity registered from a given per-centage of sewage. Now he found, after plotting these numbers, that the amount of impurity was proportional to the amount of sewage added, but the actual amount was that a single per-centage of London sewage added to water gave a very definite increase, equivalent, in simpler language, to one-twentieth of a grain of organic carbon per gallon. Now, in accordance with the representation that a thousandth part of 1 per cent.

did not mean very much, one-twentieth of a grain of organic carbon increase in the London water was equivalent in the case of London filtered sewage to an increase of 1 per cent. in the sewage contamination—he did not say actual, but potential. That was conclusively proved from results which Dr. Tidy had so carefully recorded. Consequently the oscillation of one-twentieth of a grain of organic carbon in the London water supply might come from the addition of 1 per cent. of sewage, and it was sufficient to look at those curves to show that there was an alteration which corresponded very often to at least 2 per cent. That being the case both from the statistical and analytical point of view, they were on tolerably firm ground; it was undeniable and also undesirable that this impurity should be even potentially present, and that a variation, corresponding to such a large increase of that amount, should occur. All chemists, at some time or other, who had had to deal with these matters commercially, had formed different opinions, and even Professor Frankland and himself had differed on some occasions, but still the present occasion was not one for individual opinion, the question was, what was the real position of this problem? Was river water to be absolutely condemned? Was there really no purification, or was there not a great amount of purification? A great deal could be said for Dr. Tidy's view. If they applied the same method of calculation to the percentage of organic nitrogen which ought to be present in Thames water, the organic carbon represented the organic elements, but what had become of the nitrogen? If the nitrogen of the sewage went into the river, the calculation, which was as fair as the other, would represent an amount of ammonia in Thames water which would be perfectly surprising; and if there was one fact admitted by all analysts it was this, that Thames water contained, on many occasions, no free ammonia, that is to say, no ammonia got from bodies like urea, &c., which were discharged with the sewage. What had become of it? Another remarkable fact, which was proved by the analyses of Dr. Frankland, was this, that between Oxford and Hampton the increase in the nitric acid was represented by one-tenth of a grain per mile; yet there was no free ammonia to represent anything like the amount of sewage which went into the river. Therefore, they must admit, in fairness, that it must have been taken out by some agent; it was not there in its oxidised form—at least they could not account for it all, and the result was that five-sixths of the nitrogen, which was easily transformed, had disappeared. He presumed it had not passed into nitric acid, and, therefore, it must have been transformed into something else, and he could only presume that it had passed into vegetable life; that it had been assimilated and fixed by plants. Therefore, from this point of view, there was an enormous purification taking place. It was undeniable that the natural operations going on in the river, apart altogether from the modern applications for the purification of sewage, had tended towards improvement taking place in the Thames. The serious matter to be considered was this, was not the Thames very much in the condition of many streams in Scotland, which he knew more about, which had become most seriously contaminated from modern methods of disposing of sewage? Forty years ago, they were very pure streams, and no one complained of them, but the modern mode of disposing of sewage had contaminated them very much, and something had to be done in order to meet this difficulty. This improvement might be very much greater than it was. In the few years since this application of irrigation or some chemical treatment had been applied, the water certainly had been much improved, and as we were progressing much more quickly in knowledge of sanitary improvements now, amelioration ought to go on at a much greater ratio. With regard to the question of the vitality of these germs, Dr. Frankland said they were almost indestructible, that no chemical agent would kill them, they resisted enormous pressure, and that even cyanogen could not do anything to kill them. But that was hardly a fair view. It was true they resisted many very powerful chemical agents, but at the same time science had been continually proving, in the most remarkable way, that even these particular germs, which were recognised as invariable concomitants of disease of the most persistent kind, were readily destroyed by very slight differences of acidity or alkalinity, or by very small differences in the composition of the fluid in which they were. Now what did that mean in the case of a river? He had often put this problem to himself, in order to explain this purification. He could quite understand the difficulty of ascertaining the facts, but what had occurred to him as the explanation, was that in the case of a river receiving sewage, as the Thames did, from the main source, even the pernicious germs —because Dr. Frankland said the healthy germs did no harm—would never be in any constant environment for even a short period of time. The composition of the river was always altering; chemical interactions took place, variations in the dissolved oxygen, and there was a complete difference in the composition of the river from part to part. All this was entirely antagonistic to the active growth of many of these products. When you combined that with the fact that the modern treatment of disease was very much like the treatment given to sewage, not only in the separation of the solid matter, but also in the employment of chemical agents, and that in the treatment of infectious diseases, the discharges, for the sake of those around, not for the sake of the river, were disinfected, it was evident there were other agents at work which were likely to prevent any serious result arising from the growth of these deleterious micro-organisms. No doubt it was desirable to get a pure water, and some persons, perhaps, would prefer rain water; but if they were to look into the average composition of rain water, they would find it was a good deal worse than the London water as far as the amount of organic carbon, nitrogen, and even nitric acid was concerned. To place the problem in a simple light, would Dr. Frankland or Dr. Tidy tell him, if he gave them two specimens of the same London water, which of the two had been operated upon. The simple experiment was this; he had done it to undeceive himself. Take two litres of London water, and after boiling one, test them, not of course, for the hardness of the water, nor the dissolved oxygen, but merely the organic carbon and nitrogen. To his surprise, he was wrong in selecting the water which had been boiled. He said the water which had been boiled was the worst water, which, at first sight, seemed far from reasonable; but no doubt the fact was, the boiling did destroy the germs and the probability was a million to one it destroyed the whole of them, but the organic matter remaining was more readily oxidisable, and, consequently, was more easily detected by the permanganate test. He at first thought he had made a mistake, but after a little consideration he saw the reason of it. Therefore, people's minds must not be prejudiced by imagining that this problem was one which could not be met. He thought a great deal might still be done; for instance, he thought if they had a guarantee that the London waters were stored for a longer period, if the reservoirs were large and open, so that vegetation might actively develop, it would be a great improvement; and there were other suggestions which might be brought forward which would be found a very sufficient guarantee, because the mere question of organic carbon or nitrogen did not show that the water was positively deleterious, but merely that it was inferentially, from its source, one which might be liable to cause injury. At the same time he was not prepared to say, as a chemist, having given the most unbiassed thought to the matter, that it would be correct to absolutely condemn a river supply as unsuitable for the supply of the metropolis.

Mr. Liggins said that Sir Francis Bolton, in his last official report, stated that the state of the water in the Thames, at Hampton, Moulsey, and Sunbury, was bad throughout the whole month of February, and he unhesitatingly declared, in his opinion, that the water was bad because it was highly contaminated with sewage. The purity of water to the eye had nothing to do with its quality as drinking water. Therefore they could not judge by the effluent water that the A B C, or any other process allowed to run into the river, that it was fit to drink. He went to Windsor to hear a dissertation on the A B C process, which seemed a very favourite way of getting rid of the sewage, but how many towns had adopted it? Only Aylesbury. The sewage of every large town, such as Uxbridge, ran into the Colne, only seven miles from the Thames, and the refuse of stables and piggeries, and the washings from hospitals. London was determined to have a better supply of water, and there were organisations forming in every parish of London for the purpose. Only a few evenings ago he was at a large meeting where a resolution was carried unanimously on the subject. He accepted the authority of Sir Joseph Bazalgette, Sir Frederick Bramwell, and Mr. Easton, and what did they say in their report to the Metropolitan Board: that it was because of the quality of the Thames water and the Lee water, that complaints were made by the public. It was urged that the best system of filtration was only a palliative, and, even if it were more, it could not disguise the fact that the water being drunk was derived from rivers that had received the sewage of a large portion of the residents in the Thames Valley above the intakes of the water companies, as well as the drainage from the highly-farmed and manured surfaces around those basins. Therefore, it was not unreasonable, in the wealthiest city in the world, and the healthiest for the inhabitants, to demand as pure as a supply as any other cities were able to obtain, and they were determined to have it. The water companies had done their best, and the A B C Company had done its best, in stopping a very large amount of mechanical impurity; the foulest matter, no doubt, was precipitated by the process of filtration and subsidence, and the A B C process did this chemically; but still, if the water consisted partly of sewage, no chemical or mechanical process could change it.

Mr. Maignen said he was prepared to show that liquid sewage could be removed from water. He could put on the table in five minutes a system of filtration, by which water containing 25 per cent. of pure sewage should be so purified that it would stand the permanganate test.

Dr. Percy Frankland, in reply, said as the discussion had occupied the greater part of three evenings, it was with some little embarrassment that he rose to deal with the multifarious remarks that had fallen from the many distinguished gentlemen who had taken part in it, and if he appeared to treat any of those remarks too briefly it was not from want of appreciation of their value, but from lack of time. There appeared to be no less than four distinct parties in this controversy. First, those who had been kind enough to support the opinions expressed in the paper, and who agreed with him in thinking that the Upper Thames was not a desirable source of water supply; secondly, those who did not deny that sewage and other pollutions entered the river, but who were of opionion that such pollutions could have no influence on those drinking the water; thirdly, those who maintained that no sewage practically did enter the river at all; and, finally, there was a fourth party to whom it was perfectly immaterial whether the river received sewage or not, because they asserted unhesitatingly that any amount of pollution which the river might undergo in its course, must of necessity be destroyed before it reached that particular point where the water companies chanced to have pitched their intakes. The first speaker, Mr. Norman Bazalgette, said he had done great injustice both to the Thames Conservancy and to the riparian towns, because he said in the paper that no measures had been taken for excluding sewage from the river; but if he had read a few lines further on, he would have come to the passage where he stated very distinctly that numerous improvements had been made, both on the banks of the river, and to a less extent on the tributaries, but that these improvements had been one and all in the direction of sewage purification, and not of sewage exclusion. He could only refer Mr. Bazalgette further to the diagram representing the numerous expensive improvements which had been made. Mr. Bazalgette did not appear to apprehend the difference between sewage exclusion and sewage purification. The Thames Conservancy did not require the riparian towns to exclude sewage, but only to purify it by some means before discharging it into the river, and he therefore failed to see where he had been guilty of any injustice. Mr. Bazalgette then went on to speak about the germ theory, and asked whether he had discovered by chemical analysis such germs in the Thames water at the intakes, and if not, what right he had to infer that the water taken by the companies could at any time contain that which was injurious. He gathered from this that Mr. Bazalgette had no acquaintance with the germ theory beyond its name, because the detection of germs was not a chemical problem at all, and, except in a very few cases, they had never been detected, even by microscopists, in whose province their discovery lay. According to Mr. Bazalgette, it would be equally unreasonable to attribute any dangerous properties to the fresh excreta of a typhoid patient, because even there neither chemical nor microscopical analysis could detect anything specifically injurious. He then expressed himself on the subject of the self-purification of river water, about which he appeared to have made up his mind, although he did not say on what grounds. He (Dr. Frankland) should like to point out to Mr. Bazalgette that if oxidation were really such a great power as he seemed to believe, it was rather surprising that his eminent father, Sir Joseph Bazalgette, in carrying out that vast scheme of the metropolitan main drainage, should have been obliged to take the metropolitan sewage all the way down to Barking and Crossness before putting it into the river. If self-purification really took place to the extent which some persons would make believe it did, it would have been rather cheaper to turn the sewage into the river nearer home; but even at Barking and Crossness the sewage was not sufficiently remote from the metropolis, in the eyes of the present Royal Commission sitting on the subject, as not to create a nuisance within the metropolitan area. Then, Mr. Bazalgette brought forward mortality statistics since 1868, showing that the mortality varied in an inverse ratio to the proportion of organic matter discovered in the water supplied to London. This had become a stock question with the advocates of a sewage polluted water-supply, and betrayed entire ignorance both of the scope and meaning of water-analysis. A chemist was able only to discover whether water contained a large or small proportion of organic matter, and sometimes to say whether this was derived from an animal or vegetable source, but he could never say that a particular sample was dangerous to human health, because even if he found the water contaminated with sewage, healthy sewage was probably perfectly innocuous. They all knew that water highly impregnated with excremental matter was constantly drunk without any injury to health. Was the chemist on that account to advocate the use of such polluted water? The chemist could furnish far more important information than merely whether the particular gallon of water submitted to him was dangerous at the time of analysis. There was absolutely no relevancy between the quantity of organic matter supplied to London and even the probability of an increased death-rate. No one, as far as he knew, ever attributed dangerous properties to Thames water on account of the quantity of organic matter it contained; it was on account of the origin, and not the amount of the organic matter, that the water was regarded with suspicion. There might not occur in a whole century a striking proof, by death-rate statistics, that a particular sewage-polluted water was capable of working mischief; such a proof had been furnished by the Lower Thames at the time of the cholera epidemics, and the difference between the Lower Thames and the Upper Thames was great no doubt, but it was only a difference in degree. Sir Frederick Nicolson also objected that he had not done justice to the important work carried out by the Board of which he was the distinguished representative; but all who had listened to his remarks would, if they had closely followed his observations, see that they coincided with the contents of the diagram illustrating the numerous and expensive improvements that had been carried out. He must, however, urge that the term "sewage diversion," which Sir. F. Nicolson had used, was somewhat misleading; to divert the sewage of a town would be generally understood to mean excluding the sewage of that town from the river, but the Thames Conservancy had nothing to do with sewage exclusion; they simply required that these riparian towns should purify, by some means more or less efficient, the sewage before passing it into the river. From Sir Robert Rawlinson's remarks, his opinions on the subject of the Upper Thames as a source of water supply, and, indeed, his opinion regarding the importance of a pure water supply generally, seemed to have underergone a very marked modification since 1865, when he was chairman of the first Rivers Pollution Commission, in whose report were these words:—"The Thames, polluted by the sewage of the inhabitants of the river basin, is open in kind, if not in degree, to the same objections as well-water infiltrated by liquid from an adjoining cesspool. Well-water, so tainted, may appear to sight, taste, and smell, to be harmless, and has been known to have been drunk for a length of time without apparent mischief, but beyond all doubt that same water is liable, under particular conditions, to become poisonous. The London drinker of Thames water may be drinking with it some remnant of the filth of Oxford. Again, it is the general opinion of medical men, that what causes the presence of organic matter in water to be poisonous, is not its quantity, but its quality, and this special quality cannot, as yet, be detected by either microscopic or chemical analysis, and is indeed at present known only by its occasionally noxious effects." Then Mr. Bryan, engineer of the East London Waterworks Company, endeavoured to convince them of the incontestable quality of the London water supply, by comparing the mortality of the metropolis with certain towns in Lancashire, which were provided with water of undisputed quality, but whose mortality was much greater than that of London. But was there not very good reason for those towns having a very high rate of mortality? The enormous population concentrated in Lancashire was owing to the large development of the manufacturing industries; and it was only surprising to him, considering the habit of life of these multitudes of factory-hands, that the death-rate was so low as it was. Mr. Bryan's reasoning seemed to be exceedingly dangerous, and to lead to the conclusion that London should not contemplate any further sanitary reform until its death-rate exceeded that of those Lancashire towns. Then Mr. Burstal said he had over-estimated the population draining into the Upper Thames. It was only necessary to refer again to the report of Sir R. Rawlinson's Commission to show that, on the contrary, he had very much understated it. The population draining into the river at the present day was much greater, not because the population had increased, because in some places it had diminished, but because the sewerage system, which was then only in very partial operation, had been greatly developed since. The same gentleman criticised the diagram with regard to the source of the water supply, and with regard to that, he must say that he was not acquainted personally with many of those towns, but took his statement from the latest edition of the Water Companies Directory; but probably he knew as much as Mr. Burstal about Richmond and Tottenham. With regard to the latter, it was a perfectly erroneous statement that the samples of water reported upon to the Registrar General and the Local Government Board last year were mixtures from the Tottenham well and the East London Company's water. He had the authority of the engineer of the Tottenham Local Board, and he had sent this information to the daily press, though probably Mr. Burstal had not seen it, that all those samples were derived solely from the well, and were not mixed with the East London Company's water. Then he spoke about the Antwerp water. The supply there was an excessively foul one, and the only ground on which it could be considered at all satisfactory, and he did not consider it satisfactory then, was that it was filtered through spongy iron, not through sand only. During the last few years, it had been proved that this spongy iron possessed properties which were altogether absent in sand. In the paper, he referred to an experiment with columns of sand 100 ft. in depth which were quite inadequate to remove bacterial life, but such was not the case with spongy iron, which seemed to exert a poisonous influence on bacteria. Whether this action was successful in the case of the Antwerp water, where it was carried out on a large scale, it would be rather venturesome to say; but, at any rate, it was more satisfactory than filtration through sand only. Mr. Baldwin Latham said that bacteria did not develop in sunlight, which seemed to be quite contrary to every day experience. If you put a leg of mutton in the sun, would it not putrify? and that process was only due to the development of bacteria. Dr. Bischof spoke about deep wells, and the impurities contained in some sunk in limestone districts, where fish and other large bodies had been extracted. But these sources of supply did not seem at all similar to the chalk round London; there must have been subterranean rivers which possibly passed underground in large cavernous fissures, as was not uncommon in limestone districts, but he believed that was not at all the case with the chalk. The filtration of water through this vast mass of chalk took several months to accomplish, because, when heavy rains took place on the downs, it was a considerable time before the deep wells were influenced by it. Then he put two questions, first as to the comparative contamination of certain deep well waters, and next with regard to the case of Lausen. With regard to the contamination of the Kent water; on one or two occasions the Kent Company's water did contain more organic matter than appeared normal; that was in 1882, and at that time the samples of water were collected at a place which was afterwards found to be supplied from a cistern, and not direct from the main. Since the place of collection had been changed, the quality of the water had been almost uniformly pure. As to the filtration which appeared to have taken place in the case of the Lausen water, which yet communicated typhoid fever, he did not think it could have been anything like as efficient as in the case of chalk, because although it was sufficient to remove flour, as had been proved, yet it distinctly partook of the nature of a subterranean river. With regard to Dr. Tidy, whatever might be their opinion of the value of his remarks, they must all be grateful to him for having so much beguiled the dreariness of a technical debate. He commenced his attack with the oxidation theory of organic matter, a doctrine which he had learnt from the late Dr. Letheby. He asserted without any hesitation that in the flow of a river two things took place; firstly, the removal of organic matter; secondly, the destruction of disease germs, or *materies morbi*. The organic matter he maintained was oxidised or assimilated by plant life, whilst the *materies morbi* was devoured by fish. They had heard all this before the Chemical Society over and over again. But the upshot of those discussions had been to show that there was evidence, indeed, of slight oxidation taking place in the flow of a river, especially during warm weather, but an examination of all those cases which were alleged to prove that this process took place to any very marked extent, had shown that the reduction in the proportion of organic matter was due to some other cause, in nearly all cases to mere dilution, some to precipitation, by means of clay and suspended matters in the river, or even to filtration through a porous river bed. The analyses, which he (Dr. Frankland) had placed before the Society, clearly showed that the process of oxidation, in the case of the Thames, was insufficient to compensate for the ingress of fresh pollutions during its course, the water reaching Hampton with more organic matter than it possessed at points higher up the river. The experiments made by the Rivers Commission on the Rivers Mersey, Irwell, and Darwen, proved that in those rivers, at least, no marked self-purification took place; but Dr. Tidy claimed some of those experiments in supporting his theory, for he said that in one case the organic matter was reduced by 41 per cent.; in another by 31 per cent.; but, characteristically, he omitted to state that in those two cases the reduction was obviously due to dilution, because the chlorine was also reduced. Indeed, he felt that those results did not really answer his purpose, for he said, "rivers more preeminently unfitted for determining oxidation in running water it would be impossible to imagine;" and he then went on to say that they were "rivers which along their whole course were receiving constant supplies of impurities." He believed that to be absolutely contrary to fact. In the case of the Darwen, the Commissioners walked over every inch of the course, both of the main stream and affluents, and he had their authority for stating that the amount of pollution gaining access to the river during the flow was practically *nil*. Again, the case of the Shannon had been cited by Dr. Tidy, as affording a striking instance of this oxidation. Above a certain fall the Shannon was absolutely black with dissolved peaty matter, but below the fall in the same river the colour was almost destroyed. That case was brought forward in great confidence, but it was subsequently investigated by Professor Noel Hartley, and the results of his investigations were brought before the Society twelve months ago. Dr. Tidy said:—"Certain it is the peat could not have evaporated, and I confess I can invent no possible explanation of its disappearance except by believing that, in the course of its flow, it has been oxidised by the oxygen held in solution by the water." Upon this Mr. Noel Hartley remarks:—"Dr. Tidy's results, which I conjecture were obtained from an examination of the waters on the Limerick side of the river only, above the falls, may be easily reconciled with the fact that the lessening of organic matter is not caused by oxidation. When we consider that the ferruginous mineral matter, free from bog waters, is discharged on the Clare side, that when mingling with the bog drainage it precipitates the peat. It is nothing more than the mixing of two waters, followed by a precipitation of organic matter contained in one of them." He did not hesitate to say that the evidence of this experiment of Mr. Noel Hartley, and those of the Royal Commission on the pollution of rivers, together with those of his own on the Thames—undertaken, as they all were, quite independently, and in a truly scientific spirit, for no other purpose than the service of truth—were worth more than the whole mass of evidence which Dr. Tidy had paraded. What were they to think of the statement that the *materies morbi*, which he acknowledged might be present in sewage, was destroyed by being swallowed up by fish. A few years ago he said they were at once destroyed on entering the river by bursting their envelopes, owing to the dilution of the medium in which they were suspended. On another occasion he heard him say he did not believe in germs, that he believed the so-called zymotic diseases were communicated by some specific poison, like cyanogen; indeed, he said he would not say it was not cyanogen. The fact was Dr. Tidy was bound to get rid of these morbific matters somehow, and it mattered to him little how he effected their removal. If there was no guarantee, and there was absolutely none, that this *materies morbi* was destroyed, what mattered it whether the other organic matter was removed or not? In fact, the question of the self-purification of a river was, from a sanitary point of view, a wholly idle one. But was this self-purification ever practically admitted by those who had charge of the rivers? To their credit, be it said, it was not. The Thames Conservators did not believe in it, or why did they condemn riparian towns to spend hundreds of thousands of pounds in purifying their sewage before passing it into the river? Not long ago, he had visited the sewage farm of one of these towns in the Upper Thames basin. He had there seen a quantity of stationary machinery, which, he was told, had been put up at great expense to the town, by an eminent engineer, for the purpose of treating the sewage by some chemical process, after which it was to be discharged into the river, there to be rapidly oxidised, but the Thames Conservators stepped in, and said they must purify it by some more efficient means, and it was now being purified by irrigation. From what Dr. Tidy said the other evening, they might imagine that he was pledged to the process of oxidation as the most perfect means of purifying water, but he did not always think as highly of this process as was shown by a report of his on a private well, where he said, "The water is much polluted by sewage or animal contamination. It is true that this sewage is at the moment undergoing oxidation, but even this action is incomplete, whilst as a process it cannot be relied upon. Were it for a moment to fail, the water would be dangerous in the extreme. The well ought not to be allowed to remain open a day." In that report he entirely concurred, having analysed the same water afterwards. That really expressed Dr. Tidy's unbiassed opinion concerning the efficacy of oxidation to destroy organic, and more especially morbific, matter. Again, Dr. Tidy had quoted from the report of the Royal Commission on sewage discharge; but did that Commission countenance the process of oxidation as an efficient means of river purification? He did not think so; for, although they admitted, as did everyone else, that some oxidation took place, yet they pronounced the opinion that the process was wholly inadequate to deal with the nuisance occasioned by the metropolitan sewage discharge. Dr. Tidy read a passage from their report stating, "the net result of these complex processes—pollution by sewage, oxidation of the sewage, consumption by minute animals, and re-oxygenation of the river by the action of vegetable life, and by renewed absorption of oxygen from the air;" but he stopped there, and did not finish the sentence, which concludes:—"That in cold weather, and in cool wet summers, the pollution of the river water exists indeed, but does not increase; the above processes being adequate to prevent that. But during hot, dry weather, the pollution increases, exceeding the purifying power of the agents for its removal; and the river then becomes a nuisance, more or less great, and within greater or less limits." Moreover, Dr. Tidy gave evidence before the Commission in favour of the Port of London against the Metropolitan Board of Works, and in his evidence asserted that he found at Hammersmith sewage matters which had been imported into the river at Barking and Crossness. That was a distance of twenty-one miles, so that this sewage was not oxidised at the same rate as the Uxbridge sewage, which took only half a mile. But it was given in evidence before the Commission that it took thirty days for the sewage-water to get out of the Thames, so that in that thirty days it did not get oxidised, because Dr. Tidy found it at Hammersmith. There was, therefore, this extraordinary phenomenon of Dr. Tidy upholding the efficiency of oxidation above Teddington Lock, and denouncing it below. Dr. Tidy had told them that history repeated itself, and so it did, for thirty-three years ago chemists were engaged by the metropolitan water companies to bolster up the supply from the tidal Thames, at Hungerford-market and Battersea-bridge. "Oxidation" was the dust thrown by them in the eyes of those demanding reform. To-day Dr. Tidy was propping up a source of water supply which, although pure as compared with that, was not of the quality which present scientific knowledge demanded, and it was this sickly cry of oxidation which he revived for the purpose. But all who heard Dr. Tidy's words the other evening—"I unhesitatingly assert that Dr. Frankland has not proved his point, and that no better supply of water can ever be found for London than the supply which at present is drawn from the Thames and Lea"—must have felt that the water companies had more to fear from the exaggerations of their own chemist, than from the Parliamentary measures of the Corporation of London, or the Metropolitan Board of Works. In conclusion, he begged to express his thanks to the Chairman and the Society for the patience with which they had listened, not only to the paper, but to the discussion which followed.

The CHAIRMAN said it remained for him to move a vote of thanks to Dr. Percy Frankland for his very elaborate paper, which had elicited a most valuable and interesting discussion. For himself, as a chemist, and one of the body for whom Mr. Liggins entertained but small respect, he had listened to much that had been said almost as in a dream, he had heard it so often before; but, at the same time, he regretted that whenever these water discussions came up, chemists, to some extent, did warrant the statement which occurred at the commencement of Dr. Frankland's paper (when he referred to ithe nquiry of the First Royal Commission), that their evidence and opinions "were highly conflicting, as usual." Chemists were supposed to deal only with facts concerning which, if properly determined, there should be no difference of opinion, and if chemists would only deal with facts conscientiously, and to the best of their power, it would be better. If they were to allow those who wished to make use of those facts to do what they themselves were generally anxious to do, to build theories and start assumptions upon, they might after a time come forward with very valuable aid, and, from their knowledge of the true bearing of accumulated facts might guide those who speculated. He had often noticed how the very best amongst them had a tendency, when once they had established in their minds a theory, to go out of the way to produce numerical results, which would appear to support the theory. He had also often noticed how dangerous a thing in the hands of chemists was the reasoning upon average results, and how difficult it was to withstand the temptation so to collect material for the attainment of facts from which to deduce those average results, that these could not be considered absolutely honest. Facts coming to the knowledge of chemists which appeared to support their views were quoted on every occasion, while other facts which almost went alongside of them, but were unfavourable to the theory, were comparatively speaking, neglected. As an illustration of the danger of basing important general conclusions upon a limited series of observations in one particular direction, he might be allowed to refer to the statement which had been so frequently made, and repeated during this discussion, that bacteria were endowed with very special indestructibility. He did not in the least doubt what was stated, that bacteria could be boiled for any length of time without feeling uncomfortable; that they would exist comfortably in hydrocyanic acid, or that they rather liked sulphurous acid than otherwise, but he wished to point out that this was no peculiarity of those little animals. There were much more highly organised creatures which would stand quite as much as that. He had lately a letter from a well known chemist and accurate observer, Mr. Frederick Field, which presents a good illustration of this fact. When in South America, he was interested in preventing the incrustation of the growth of animals on ships' bottoms, and tried a variety of coating materials upon them, assuming that metallic compounds would act as poisons, but he said, referring to barnacles, which grew there in great luxuriance, that a coating of red lead was quite useless, for these animals throve wonderfully upon it, and he had taken basketsful off the bottom of vessels, although they were rooted and grounded in the poison. This led him to place some of these gentry in a strong solution of cyanide of potassium, but he found that it had not the slightest effect upon them. There was, therefore, not much difference between their tastes that way and those of bacteria. But it happened that as soon as a vessel covered with barnacles came into fresh water, the barnacles died; and, that being so, how could they say that this supposed indestructibility of bacteria had any reference to their powers of resisting such changes of the conditions under which they had to exist, as Professor Dewar had pointed out they were constantly exposed to? They were all desirous of having pure water, and if they could have a water from which sewage was excluded, they would hail it with delight. They did not desire to be supplied with a water polluted with sewage, and, supposing they could obtain a sufficient unlimited supply from deep wells, they would hail it with satisfaction, provided it could be relied upon as being pure under all conditions. But here, again, he would refer to facts which were used sometimes, and dangerously used, in order to support theories, and which rather told against wells than defended them when properly considered. They had just heard in the strongest terms a condemnation of the so-called self-purification of water; but to those who utterly opposed the views of Dr. Tidy he would say this, that he had occasion, quite independently of that chemist, to look into the question of the oxidation of sewage matter in running waters, and he could positively state that this oxidation took place continuously, and to a very considerable extent. He drew no conclusion as to a river being absolutely purified within half a-mile or ten miles of its flow by such oxidation, but that oxidation was unquestionably very important in extent. The disappearance of oxygen constantly absorbed by water, and the disappearance of organic matter, *pari passu*, would be admitted by all to be proofs of the oxidation of organic matter. At any rate, he thought if Dr. Percy Frankland would look carefully into the results which he and his colleagues had furnished to the Royal Commission, he would admit that there was considerable oxidation taking place continuously in running water. Reference had been made to polluting matter in water of certain wells not being oxidised, but the cases were not parallel, and he did not think the example Dr. Frankland had brought forward with regard to a particular well was at all similar to the case Dr. Tidy defended, namely, the oxidation of polluting matters in water being continually exposed to conditions favourable to the continuous absorption of oxygen, as in a stream. This led him to another instance of what he termed the dangerous, because illegitimate, use of facts. They were constantly told, almost *ad nauseam*, of the case of well-pollution at Caterham. No doubt the facts were as stated, but then the water was not under the same conditions as the water in a river, which was continually being reoxygenated. That water passed through pipes, or through small culverts, and consequently there was but a very remote chance of any great portion of polluting matter in the water being oxidised. It was a dangerously misleading illustration to quote, because it fed alarmist views; things were bad enough as they were, and they were all more or less alive to them, but that was no reason why they should make up their minds that it was impossible that these bacteria, which were so indestructible when exposed to active chemical agents, might not be destroyed more or less by oxidation in running water. At the same time, he must say at once, that there could be no security that such destruction would take place. Granted there was considerable oxidation, they could not know that that oxidation was so complete that, supposing dangerous organisms to exist, they could rely on their removal by such self-purification. But even when they had recourse to well-water, could they be sure that it would always be delivered undefiled? Dr. Bischof's remarks seemed to lead to the belief that they could not, however perfect or deep the well. He himself had had some experience of deep wells, for there were a large number most carefully constructed in the Arsenal at Woolwich; and for a reason which was perfectly explicable, those wells were always defiled. That was because there was a great "fault" in the chalk in that neighbourhood; but the same thing might occur in other places; and if the whole supply for the metropolis were drawn from the chalk, wells would have to be very numerous, and then he feared there would be still more danger of their being defiled. Dr. Percy Frankland had given one instance, in the case of a brewery, where one well was defiled by another; it was true they were in close proximity, but they could not tell how far that contamination might have extended; nor could they be sure that deep wells, however carefully constructed, would not be contaminated by surface water. But, supposing all means within human power were adopted to secure the supply of pure water, what would this avail if little care was taken—as had hitherto been the case—how it was dealt with after it was delivered into the houses? In a similar discussion recently held at the Society of Chemical Industry, the case of Millbank-prison was mentioned, where the mortality was very high until it was supplied with water from the deep wells at Trafalgar-square, when the mortality sank considerably. But he could mention an opposite case. The Government buildings at the Horse Guards, like many others, were supplied from those same wells; but not so very long ago, a sad death occurred, from typhoid fever, of one of the most talented engineer officers, who used to work there constantly, and other cases of illness having occurred, they were unmistakably traced to the regular consumption, by the sufferers, of drinking water from a tank in that building, which, though supplied from the Trafalgar-square wells, was contaminated after delivery by sewer gas. So that, although they discussed and fought these battles over and over again of self-purification, or of the absolute impossibility of removing sewage from water, but little advance would be made towards the attainment of the conditions which should ensure a supply of pure water to the community, if they did not attain absolutely, under every possible circumstances, the maintenance of that water perfectly free from any chance of contamination when delivered. No doubt a constant supply would effect very much in this way; but other reforms with regard to houses and their sanitary arrangements were absolutely necessary if they were to rely upon the enjoyment of that pure water which Dr. Frankland maintained could not be obtained from the Upper Thames, which some people thought they could obtain from deep wells, whilst others shook their heads even at that proposition, and thus left the people, whose confidence in the whole soundness of the present supply they had destroyed, in a sad dilemma.

The vote of thanks was carried unanimously.

Major-General A. de C. Scott, R.E., writes:—

"There is a proposition regarding water which I will venture to lay down, and which, I think, will be accepted by practical men. It is, that water for domestic use, if it is to be considered satisfactory, ought to be above suspicion. People may by circumstances be condemned to use water which may have been exposed to pollution, and which may contain the elements of danger, but they do not, if they are prudent, use such water, if they can avoid doing so.

"The danger of polluted water, the extraordinary vigour of the specific poisons which produce disease, and the common-sense view that domestic water should be above suspicion, are the premises which the body of consumers may accept and apply to the case presented to them.

"The first part of the question is that which relates to the pollution of the Thames, and the effects of Conservancy in preventing the entry of polluted matter. It seems to me that Dr. Percy Frankland has detailed in moderate language, and yet with conclusive effect, the various causes which inevitably led to the pollution of the river. It is not difficult for any one of ordinary discernment to grasp the physical condition of the Upper Thames basin. The knowledge that about one million human beings live within the area in question, most of them on the banks of the Thames or its tributaries, and that, in addition, there are there about one and a quarter million of the lower animals, such as cattle, horses, sheep, and pigs, affords in itself an indication of the degree of pollution of the soil which must exist, except in so far as it is reduced by periodical washing by rain, which carries the impurities into the river.

"The general conclusion which consumers should draw from the evidence relating to the condition of the river is, I think, that it is considerably polluted, and that no possible legislation can prevent the entry of polluting matter.

"It seems to me that the consumers cannot but come to the conclusion that the assertion, that the water of the Thames is sufficiently purified by oxidation to render it safe for use, rests on no satisfactory evidence, and that the Thames is not a proper source of supply. This common-sense view of the question was taken by Mr. Simon, the Medical Officer of the Privy Council, and Sir Benjamin Brodie, in their evidence before the Royal Commission on Water Supply, in 1869. The former gave it as his opinion that a source of public water supply should be incontaminable with sewage. The latter stated emphatically that no chemical analysis could inform us whether the deleterious quality of polluted water had disappeared.

"Space does not admit of my doing more than allude very briefly to the suggestion made by Dr. Percy Frankland, that recourse should be had to the spring and well water of the chalk for the metropolitan supply. The summer flow of the Thames at Teddington Lock represents the leakage by springs into drains and water-courses, of the subterranean reservoir over an area of 3,676 square miles, and comprising the drainage basin of the Upper Thames. This flow amounts to about 500,000,000 gallons a-day, and the water companies take toll of it to the extent of about 70,000,000 gallons daily. It is argued that, instead of drawing water from the river after it has been polluted, the supply should be intercepted (by tapping springs and sinking wells) before it reaches the river.

"Those who speak in support of the present system of supply often conclude their remarks by observing that to seek a new source would be merely wasting the money of the ratepayers. It is difficult to see how that argument applies to the present case. The ratepayers of London are now paying the water companies about £1,600,000 annually, the condition of such payment being, under the Act of 1847, a pure and wholesome supply of water. Surely it is the duty of the companies to incur any expense which may be necessary in order to comply with the conditions on which they draw their revenue?"

Mr. A. Le Grand, of the Magdala Works, 100, Bunhill-row, E.C., writes as follows:—

"From what has transpired in the course of the discussion upon Dr. Frankland's important paper, it would almost appear as though some hold it a condition precedent that water should, as a preliminary stage, be diluted with sewage in order to be subsequently purified by either natural or artificial processes, while others consider that nothing but deep well water is safe to drink; but from whatever source it may be obtained, the common sense desire must be to keep all possible pollution away from it; in other words, if we are compelled to travel along a dangerous road, instead of trying to see how near we can drive to precipices with safety, we should give them the widest berth possible.

"I happen to have sunk some hundreds of tube wells along the banks of the Thames, between Windsor and Gravesend, and have thus become acquainted with the water obtained. Many people are under the impression that because a well is sunk near a river, the water drawn from it must of necessity come from the river; whereas, under certain commonly existing conditions, such as a porous subsoil in communication with the adjacent higher ground, the conclusion arrived at is erroneous.

"I have met with numerous instances where the present water has been obtained at no great depth, close alongside the Thames, the foulness of which latter, as it flowed by, needing no analysis to prove it. The fact is, instead of the river supplying the wells in question, the very converse of this frequently is taking place, springs from higher elevations flowing steadily into the river, and thus, in sinking the wells in question, you are simply intercepting the springs which go to swell the volume of the river. I would, therefore, here remark that the analyses of samples of water drawn from the river at various points may lead to erroneous conclusions, if any of the samples in question happen to be taken at spots where these unseen tributaries of pure water are flowing with considerable strength into the river, and thus largely diluting its foul water.

"The foregoing facts further point out that, if we are obliged to take the bulk of the London water supply from river sources, it would be far better to intercept the clean underground springs flowing into the Thames, than to take the water after it has been mixed with the many pollutions to which the stream is so liable. The adoption of such a course, while not only securing greater initial purity, would largely, if not entirely, do away with the work of filtration. An experiment in this direction was made upon a somewhat large scale about two years since, at Shrewsbury, where the river is polluted and turbid. Fifteen three-inch tube-wells, about 22 feet deep, were driven upon a small island, which is at times covered with water; these were connected to one receiver, or main, about a hundred yards long, and yielded a supply of about three-quarters of a million gallons per diem. The quality of this water was rather harder than that of the river, but otherwise it was not only perfectly clear, but remarkably pure.

"Referring to the theory of purification by atmospheric influence, the following circumstance, which came under my notice a few years back, may be of interest as bearing upon the subject. The water from a more or less polluted river formed the supply of an important town in the north of England, and samples drawn direct from the stream were from time to time sent up to London to be tested by a well-known analyst, so that he was quite familiar with its characteristics; upon one occasion the engineer caused the water, as drawn from the river, to be forced up into the air, in a jet, and falling in a spray was caught and a bottle of it sent up to the analyst. So great was the change effected by this simple process, in the direction of purity, that the analyst was with difficulty convinced there had not been a mistake made as to the source from whence the sample was derived.

"Dr. Frankland mentions the deep well water supplies of several towns near the river, and I must say, from my experience of a large number of artesian tube wells I have sunk in the London basin, ranging from 150 feet to nearly 500 feet deep, the water so obtained is extremely pure and wholesome, and there can be no doubt whatever that such sources (where proper care is taken to exclude surface drainage, to which dug wells are liable) are the most reliable for purity; still, as the case of Ballard v. Tomlinson goes to show, ignorance or carelessness may jeopardise such a source, though incidentally I may observe, from an intimate acquaintance with all the facts of this particular case, they have perhaps been magnified much beyond its actual merits; not so, however, with regard to its bearing upon the whole question of the pollution of underground sources of water, which is a subject that unquestionably demands the urgent attention of sanitarians with a view to effective legislation.

"It may hardly be generally realised, but it is none the less certain, that deep cesspools are daily being sunk, as the readiest, but none the less most improper, means of getting rid of sewage, not only for isolated dwellings, but in populous districts. In some cases these cesspools are dug 50 ft. or 60 ft. deep, and in others borings are actually made to considerably greater depths for the same object, and I have more than once drawn the attention of the Local Government Board to this practice, which is fraught with much danger to the community at large."

Miscellaneous.

NOTES ON SOME MALAY TIMBER TREES.

By James Collins.

The subject of a regular and large supply of timber is a most important one, and a few notes on the question as regards the Straits Settlements will, it is hoped, be found of use. These will be but brief and preliminary, as the materials at command are too scanty at present to deal with the question otherwise. Johore, although an independent State, under the rule of his Highness the Maharajah of Johore, K.C.S.I., &c., is also included in the present note.

The extent of forests has been variously stated, but the following figures may be taken as an approximation:—

Singapore	20 to 30	square miles.
Malacca	160 to 170	,,
Penang and Province Wellesley	110 to 120	,,
Johore and adjacent Islands..........	10,000	,,

To this must be added Selangor, Perak, and the other native States of the Malayan Peninsula, some of which are more or less under British Government control.

The forests of the Straits Settlements, properly so called, are the sole property of the Government, as is the case also with those under the Maharajah's rule. They are, however, in all cases rapidly decreasing, and no means are taken to stop this. The system of working them is as follows:—A person wanting a tract of land applies to the land office, and pays tenths on the value of the timber cut. Forest rangers, and occasionally the police, have to see that none but those having this license or permit cut timber.

This land may be required for the timber on it, or for clearing for the cultivation of various products, and the forest supply of timber suffers most materially if the occupation of the land is not permanent but temporary. Thus a tract of land having been secured, the primeval forest is cut or burned down, and the timber left to rot. Between the fallen trunks, gambier, pepper, rice, tapioca or other products are raised, and after a few crops have been taken off, the ground becomes exhausted. To procure and clear a fresh spot is often cheaper than manuring the old soil, so the previous plantation is abandoned to white ants, secondary jungle—as a rule of lalang grass—low scrub, with here and there small and useless trees. This lalang grass *(Andropogon caricosus)*, when once it gets possession of the ground, stifles everything else, and its long fibrous and tough roots resist all native efforts to eradicate it; even a prairie plough would possibly reclaim the land at too great a cost.* The pretty little sensitive plant *(Mimosa)* soon carpets the ground with its flaming yellow flowers, and it is most difficult to eradicate.

Singapore hardly cuts any timber at all for her own use, being chiefly supplied from Rhio and the adjacent islands, and also from Johore. In Malacca a greater quantity can be cut, but from want of roads or streams, it is very difficult to get timber from a greater distance than fifteen to twenty miles from the town. Penang and Province Wellesley cannot cut much timber, unless the risk of climatic disturbance be run. The Straits Settlements exports no timber to speak of; what little Tampinis and other hard woods which have been shipped occasionally to Ceylon and Mauritius, being chiefly from other islands.

With the territory of Johore, the case is different. Some years ago, H.H. the Maharajah erected extensive steam saw mills, and these mills, under the enlightened and able management of Mr. James Meldrum, have placed in the markets a large quantity of fine timber.

The following figures have been supplied me by Mr. Meldrum. Exports of timber from Johore, 1864-1874:—

	Loads.		Value.
To British India	15,000	..	$115,000
,, China	7,000	..	84,000
,, Mauritius	3,000	..	36,000
,, Java	2,700	..	27,000

Taking in "sundry places," about 40,000 loads of hard wood has been exported, principally in the form of logs or railway sleepers; the trade in the latter has fallen off, through the more general employment of iron cradles. About 60,000 loads of soft woods, in the form of logs, planks, boards, &c., have been exported. Of these soft woods, 25,000 loads were taken by Singapore, at a value of $270,000.

Mr. Meldrum states, as the result of about twenty years' experience, that the Johore forests are diminishing rapidly, that the sea-shores, islands, and other easily attainable localities are cleared, and that a good supply cannot be hoped for, till the rivers are made more navigable, and good roads pushed into the interior.

As will be seen, no steps have been taken as to conservancy or cultivation, and this calls for immediate attention. As to how this is to be managed, need not be entered on here, but in parenthesis, we may state that following in the lines of the Indian Forest Conservancy, with a few modifications, would amply meet the case.

As to the climatic changes brought about by the clearance of forests in this part of the world, very little can be said. The late Dr. Randell, Principal

* The lalang would, I believe, prove one of the best sand-binding plants. When coming through the Suez Canal, I could not help thinking that if this were planted along the banks, much dredging would be saved, and render the passage through much more endurable

Experiments on the Stiffness of some of the principal Woods of Singapore, Malacca, and Johore.*

Name of Wood. I.	Average weight per cubic foot. II.	Deflection in inches. III.	Weight producing deflection in lbs. IV.	Breaking weight in lbs. V.	Remarks. VI.
Krangee	77	$\frac{5}{8}$	980	1,339	Very hard, close-grained, well adapted for beams of every description. White ants or other insects do not touch this timber. It is well adapted for piles for bridges in fresh or salt water; it is also used for junks' masts; stands well when sawn, ranks with Tampenis for durability. Fracture long, fibres tough, colour dark red.
Panaga	72	$\frac{5}{10}$	688	1,310	Is a bright red wood, very hard and durable, well adapted for roofing timbers, joists, and timber work of bridges; is very cross-grained and difficult to work; can be obtained in any quantity to 9'' square. Fracture short.
Tamboosoo	67	$\frac{5}{10}$	306	548	Is a capital wood for piles, or for any wood-work which is exposed to the action of fresh or salt water; is not attacked by worms or white ants. Fracture short.
Billian Wangy	72	$\frac{5}{10}$	473	1,038	Is a very hard, durable, and heavy wood, close-grained, fibre long, is not liable to be attacked by worms or white ants; beams of 50 ft. long and 18 in. square can be obtained. Very suitable for roofing timber, girders, joists, and timber bridges.
Billian Chingy	60	$\frac{5}{10}$	408	913	A hard, close-grained, fine-fibred wood, but very much inferior to Billian Wangy, of a brownish grey colour; readily attacked by insects and dry rot; is used for flooring joists.
Marbow, Murboo, or Marraboo	61	[illegible]/10 to $\frac{5}{8}$	399 to 578	894 to 987	Is a durable wood, principally used for furniture, is readily worked, and takes polish well; it is also used for flooring beams, timber bridges, carriage bodies, and framing of vessels. Trees 4 ft. in diameter are sometimes obtained. It is not readily attacked by white ants, but is by worms. The colour is almost like English oak.
Johore Teak, or Ballow	73	$\frac{5}{8}$	737	1,210	Well adapted for permanent sleepers, beams, piles, shipbuilding, engineering, and general purposes where strength and durability are required. Piles which have been in the ground for 100 years have been found in a good state of preservation. It is one of the few woods which will really stand the climate of India. Colour dull grey.
Johore Cedar	$40\frac{1}{2}$	$\frac{5}{8}$	410	616	Well adapted for house-building purposes, as in the manufacture of doors, windows, and flooring planks. Fracture short, timber open-grained, and is not liable to be worm-eaten.
Kruen	50	$\frac{5}{8}$	472	$625\frac{1}{3}$	Close-grained, tough fibres, and resembling yellow pine. Used for native boats, planks, &c. Contains a kind of dammar-like oleo-resin.
Darroo	61	$\frac{7}{10}$	840	1,300	Is much used for beams of houses and door frames; is durable, if kept either wet or dry, but rots soon if exposed to sun and rain; colour white, close-grained, fracture long; has an agreeable smell.
Tampénis	67	$\frac{7}{10}$ +	802	1,599 +	Very hard, close-grained, red-coloured, long-fibred, and tough wood. Well adapted for beams of every description; white ants and other insects do not touch it. Used largely for bridge piles in fresh or salt water; considered one of the most lasting timbers; it warps if cut in planks.
Kulim, or Johore Ironwood	73	$\frac{5}{8}$	706	1,141	Somewhat similar to Ballow (*vide ante*). Used for planking cargo boats; fracture short; makes superior beams and telegraph posts, as it lasts well in the ground.
Johore Rosewood, or Kayu Merah (two samples)	38	$\frac{5}{8}$	583	952	Resembles rosewood in appearance, and used largely in cabinet work and household furniture.
Samaran	42	$\frac{5}{8}$	326	532	Well adapted for doors, windows, moulding, and other house-building purposes; is close and even grained, dull red colour, short fracture, but liable to attacks of white ants.
Jolotong	29	$\frac{5}{8}$	280	732	Well adapted for patterns and mouldings, excellent for carving purposes, grain very close, scarcely any knots, colour whitish yellow, fracture short, but the wood is not very durable.
Seriah	47	$\frac{5}{8}$	438	$737\frac{1}{3}$	Of a dull red colour, close-grained, and largely used in house-building, for boxes, boards, &c.

* From the Tables of Dr. Maingay, Captain Mayne, R.E., Mr. W. D. Baylis, of the Public Works Department, Strait Settlements, and Mr. J. Meldrum, Manager of the Johore Steam Saw Mills. The billets of wood tried were 3' × 1½' × 1½'. The average three billets of each kind is given.

Medical Officer, S.S., in his Annual Meteorological Abstract for 1873, has the following:—

"The only causes that appears to me to exist, or have existed, to which this great decrease of rainfall may be attributed, is the extensive clearing of forest on the mainland of Johore, contiguous to this island (Singapore), which has been effected principally during the period under notice; and I would suggest that the conservancy of portions of forests may be taken into the consideration of Government."

Certainly, many old inhabitants have informed me, that the heat is greater and the rainfall less in the Straits Settlements than it used to be. One thing, however, has done largely to mitigate and render less apparent the great destruction of forests, and that is the enormous extent to which the cocoa-nut palm and other fruit trees are cultivated.

AUSTRIAN STATE AGRICULTURAL ESTABLISHMENTS.

It appears from the last report of her Majesty's Secretary of Legation, at Vienna, that great attention is paid in Austria to the proper education of agricultural teachers; in 1881, there were 69 schools, State, provincial and private, but all under the supervision of the Agricultural Department. They consist of 1 university, 13 middle, and 55 lower schools. In the State University there were 38 teachers, in the middle schools 126, and in the lower schools 265. In these schools the attendance of scholars averaged 2,721, and those who passed amounted in 1881 to 1,014. Those students who have passed through these schools as teachers are distributed throughout the Empire, and assist the farmers, instructing them as to the best means of increasing their production, advising them on all points where knowledge is required, as to the best machines in use, and in respect to the best and most useful breeds of cattle, &c. There is a class of teachers called "wandering teachers," who travel about giving instruction to poor farmers and to those whose farming is bad; in many cases, however, but little attention is paid to the advice given. The candidates for teachers have to possess a knowledge of climate, soil, geology, agricultural chemistry, plant production, technology, animal physiology and production, forest planting, use of and protection of forests, practical geometry, forest science, vineyard, fruit and silk cultivation, wine and cellar handling, also a knowledge of brewery and distillery work, according to their respective callings. There are, besides the agricultural schools, six mining schools with fourteen teachers and a hundred and ten students. Agricultural exhibitions are held in the provinces at different seasons, when prizes are given both in coin and medals. Subventions are given for drainage and irrigation purposes, and for assisting those districts where inundations have occurred; seed is also given and machines lent to agricultural societies when necessary. State grants are given to societies to buy and plant trees; grants are given to agricultural societies to enable them to purchase good breeds of cattle, which are then sold by auction, the surplus proceeds going to a general fund to purchase again later. Great attention is paid to bee and fish cultivation. Publications are issued and distributed to those interested in the best means of eradicating phylloxera, the potato disease, and fungus on the roots of vines. Great consideration is shown to the improvement of the breed of horses in the Austrian Empire, the establishment for which, and the studs, are on a very large scale, giving employment to many. There are also private breeding establishments—but which have to conform to statutes imposed by the Agricultural Department—which is in communication with the different Land Commissions, for the purpose of assisting the improvement of the different breeds of horses in the Empire. At Vienna, there is a central weather station, and a regular telegraph weather report issued and sent to all societies and private individuals who choose to subscribe to it; the Empire has been divided into weather districts for this purpose, the Ministry of Commerce aiding by permitting telegrams to be sent at half the usual cost; it appears, however, that the Austrian agriculturists have not availed themselves of this benefit to any great extent, in Moravia, Lower Austria, and Bohemia they have a little, and in the other provinces not at all. This, says Mr. Victor Drummond, is greatly to be regretted, as the prognostications show that 70 to 85 per cent. are correct. All decisions in water, forest, and shooting rights are determined by the Ministry of Agriculture; appeal, however, can be made to the High Courts of Justice, but this is seldom required. All provincial laws concerning fishing, forest, and shooting rights, must be subjected to the sanction of the Emperor.

THE PRODUCTION OF OIL IN GREECE.

According to a consular report, made to the German Government from Athens, the production of oil is, for the most part, effected in Greece by a primitive kind of oil mill, which exists in thousands, and is of similar construction to those of ancient times. Small presses are also sometimes to be found in the houses of peasants, which are worked by hand or by horses. The first steam oil-press was introduced into Greece in the year 1857. These are now to be found in various parts, but the people as a rule favour the old style of mill.

On account of the imperfect character of the oil-mills, it is not surprising to learn that much oleaginous matter remains behind, and that the cakes are an article of commerce, besides being used for feeding pigs, &c. Of late years, however, a process has come into use by which the residue is subjected to chemical action, and the oil extracted is used for soap. Several soap works are in existence where the oil thus obtained is used. One factory was started on a large scale in 1879, at Eleusis, and last summer a factory was started at Piraeus of less importance, but on the same general plan.

Greek olive oil is powerful in its nature, of agreeable taste and aromatic smell, being in the opinion of experts quite comparable with the products of Italy and France. In its unpurified state is is, however, disagreeable in smell. It is remarked that the absence of oil refineries in Greece is explained by the fact that the need for such has not been felt. Hotels and the best families import French and Italian oils, while the people at large use the native product, to which they are accustomed. It is, however, remarked, that if refineries existed there would probably arise a demand for their productions, as living is gradually become more in accordance with Western tastes.

SILK MANUFACTURES IN SWITZERLAND.

The periods from 1850 to 1860, and from 1860 to 1870, were specially favourable to the prosperity of the silk industry in Switzerland, demand being steady for the articles produced, and there being no special necessity for Swiss manufacturers to introduce new features into their industrial activity.

Exports to the United States were naturally affected by the outbreak of civil war in 1861, but this was not productive of appreciably injurious results, inasmuch as the free trade measures taken by England in 1860, and the similar action of France in 1864, opened important European outlets for Swiss goods. With the restoration of peace in America, the transatlantic relations of Swiss manufacturers again became active, and the years 1866 to 1872 have been recently described by a Swiss authority, as displaying "an unbroken chain of conjunctures favourable to the silk trade."

The tendency of public taste in American and English markets to prefer the heavy tissues called *failles*, to the lighter and more brilliant taffetas makes, began to act unfavourably on the Swiss manufacturing industry after the year 1872. This branch of the trade having considered the change of fashion only temporary, refrained, at first, from carrying out the needful alteration of looms. When the necessity of such a measure was no longer a matter of doubt, and Switzerland produced the class of goods in question, fashion had already begun to take up other articles. The important development of the satin trade, which took place towards the year 1880, has resulted in about one-third of the hand-looms in Switzerland being devoted to that class of tissues. The fancy articles made on Jacquard looms, which have within the last few years taken up such an important position in the silk trade, have not been produced in quantities of any importance by Swiss manufacturers.

In bringing forward the above facts, and other details of interest affecting the subject referred to, the *Central Blatt für Textil Industrie* calls attention to a project for introducing into Switzerland the manufacture of velvets. It is stated that the alteration of looms would not be very expensive, while the favour enjoyed by the article gives the proposal a fair chance of its realisation being a commercial success.

Obituary.

Jean Baptiste Dumas.—This distinguished chemist, who received the Albert Medal of the Society of Arts in 1877, in recognition of his researches, which have, in the terms of the award, "exercised a very material influence on the advancement of the industrial arts," died at Cannes on Good Friday, the 11th inst. Dumas was born at Alais, July 14, 1800; and, in 1823, was appointed Assistant Professor of Chemistry in the Ecole Polytechnique, Paris. In the following year he founded the *Annales des Sciences Naturelles*, in conjunction with Brogniart and Milne Edwards. In 1849, he was appointed Minister of Agriculture and Commerce, but retired from the Ministry in 1851. In 1855, he became President of the Municipal Council of the Seine, and in that position he worked hard to obtain for Paris proper drainage and sanitary works. He was Vice-President of the Senate from 1861 to 1863; and, in 1868, was elected Permanent Secretary of the Academy of Science. In 1876, he succeeded M. Guizot as Member of the French Academy. As far back as 1840, the Royal Society elected him one of their Foreign members; and, in 1843, they gave him the Copley Medal.

Philip Palmer.—By the death of Mr. Palmer on the 17th inst., the Society of Arts loses its oldest member. He was elected as far back as 1829, and for many years was a constant attendant at the meetings, and a frequent speaker in the discussions. He was in the 73rd year of his age at the time of his death.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock :—

April 30.—"The New Legislation as to Fresh-water Fisheries." By J. W. Willis-Bund Edward Birkbeck, M.P., will preside.

MAY 7.—"Bicycles and Tricycles." By C. V. BOYS. Dr. B. W. RICHARDSON, F.R.S., will preside.

MAY 14.—"Telpherage." By Professor FLEEMING JENKIN, F.R.S.

MAY 21.—"Telegraph Tariffs." By Lieut.-Col. WEBBER, R.E.

MAY 28.—"Primary Batteries for Electric Lighting." By I. PROBERT.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings:—

APRIL 29.—"The Transvaal Gold Fields; their Past, Present, and Future." By W. HENRY PENNING.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings:—

MAY 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. ALDER WRIGHT, F.R.S., D.Sc. Prof. W. J. RUSSELL, Ph.D., F.R.S., will preside.

MAY 22.—"Economic Applications of Seaweed." By EDWARD C. STANFORD, F.C.S. (This paper has been postponed from April 24th.)

INDIAN SECTION.

Friday evenings:—

APRIL 25.—"The Existing Law of Landlord and Tenant in India." By W. G. PEDDER. The Hon. Sir ASHLEY EDEN, K.C.S.I., will preside.

MAY 9.—"Indigenous Education in India." By Dr. LEITNER.

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. NORMAN LOCKYER, F.R.S., F.R.A.S.

LECTURE I. April 28.

LECTURE II. May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 28...SOCIETY OF ARTS, John-street, 8 p.m. (Cantor Lectures) "Mr. J. Norman Lockyer, "Some New Optical Instruments and Arrangements." (Lecture I.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. E. O'Neill, "Journey from Mozambique to Lake Shirwa, and Discovery of Lake Amaramba."

Actuaries, the Quadrangle, King's College, W.C., 7 p.m. Messrs. Francis William White and William J. H. Whittall, "Extra Mortality."

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Professor H. Tanner, "Variations in Food."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. W. Henry Penning, "The Transvaal Gold Fields; their Past, Present, and Future."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Klein, "The Anatomy of Nerve and Muscle." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Wm. E. Rich, "The Comparative Merits of Vertical and Horizontal Engines, and on Rotative Beam Engines for Pumping."

Institute of British Carriage Manufacturers, Westminster New Town-hall, S.W., 7½ p.m. Mr. H. Julian, "Art applied to Coachbuilding."

Zoological, 11, Hanover-square, W., 1 p.m. Annual Meeting.

WEDNESDAY, APRIL 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. W. Willis-Bund, "The New Legislation as to Freshwater Fisheries."

THURSDAY, MAY 1...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. A. Rolfe, "Flora of the Philippines and its derivation." 2. Mr. George Brook, "Embryology of the Weever Fish." 3. Mr. George C. Druce, "*Melampyrum Pratense*." 4. Prof. M. Duncan, "New Germs of Fungida allied to Micrabacia of Cretaceous Age."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. H. Perkin, jun., "Benzoylactic Acid and some of its derivatives." (Part I.) 2. Mr. W. R. E. Hodgkinson, "Fluorene."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "Art in America."

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

Royal Institution, Albemarle-street, W., 1 p.m. Annual Meeting. 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture II.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. M. Georges Marié, "The Consumption of Fuel in Locomotives." 2. M. Paul Decauville, "Portable Railways." 3. Mr. Michael Longridge, "The Moscrop Engine Recorder, and the Knowles Supplementary Governor."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, MAY 2...United Service Inst., Whitehall-yard, 3 p.m. Captain Samuel Long, "Libraries Considered as Subsidiary to Education: and on the Best Means of Diffusing Information among the Officers and Men of H.M. Navy."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. J. W. Judd, "Krakatoa."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Paper by Mr. Henry Sweet.

Mechanical Engineers, 25, Great George-street, Westminster, S.W., 7½ p.m. 1. Mr. A. Slater Savill, "Description of the Automatic and Exhaust-Steam Injector." 2. Mr. Robert Gordon, "Description of the Apparatus used for Testing Current-Meters, at the Admiralty Works at Torquay, for Experimenting on Models of Ships." 3. Mr. Edgar P. Rathbone, "Description of the Francke 'Tina' or Vat Process for the Amalgamation of Silver Ores."

SATURDAY, MAY 3...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. M. Westropp, "Recent Discoveries in Roman Archæology." (Lecture II.) "The Forum."

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FRIDAY, MAY 2, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first of Mr. Norman Lockyer's course of Cantor Lectures, on "Some New Optical Instruments and Arrangements," was delivered on Monday, the 28th inst. In this first lecture, Mr. Lockyer dealt with some of the recent improvements in telescopes. The two principal pieces of apparatus which he described were the dome for an astronomical observatory, designed by M. Eiffel, and the bent equatorial telescope of M. Loewy. The dome, instead of being supported on wheels or rollers, as in the ordinary form, is floated in an annular trough, filled with a solution of chloride of magnesium. A caisson surrounding the base of the dome fits in the trough. From the dome is hung the observatory floor, which carries the observing chair. The effect of this is that, on motion being given in the ordinary way to the dome, the floor, together with the observing chair, all partake of the same movement, which is timed with that of the telescope. If for any reason the dome, &c., should be lowered a couple of millemetres, the whole structure is then received on wheels, properly mounted below the floor, and then runs upon them. This provision is only intended for use in case of the floating arrangement not working properly. Mr. Lockyer compared this with the ordinary arrangements for the observer's comfort, and dwelt on the effect which the fact of the observations being made in comfort had upon their accuracy.

In the equatorial, instead of the eye-piece and object-glass being mounted at opposite ends of one continuous tube, the tube is bent at right angles, about its middle, and a mirror placed in the angle, so as to direct the rays received by the object-glass into the eye-piece, which is at the upper extremity of the part of the tube, parallel to the earth's axis. On a rotation being imparted to the tube in the usual manner, the other limb of the tube of course moves through an arc, extending from the horizon on one side to the horizon on the other. Beyond the object-glass is fitted a mirror capable of being turned to any angle, so that a combination of the motion of the mirror and the motion of the telescope itself consequently enables the whole sky to be brought within the range of observation. The special advantage of this arrangement is that the necessity for a costly dome is done away with, as only the eye-piece end of the telescope required to be covered; the rest projected beyond the walls of the building, only requiring a rolling hut or similar arrangement to protect it from the weather when not in use. Mr. Lockyer defended the arrangement from the criticisms which has been brought against it, and stated that there was no difficulty in constructing mirrors of the size required, nor did their use at all interfere with the accuracy of the observations; in fact, he believed the beauty of the images, and the condition of precise observations in the "equatorial coudé," as the new instrument is to be called, to be unsurpassed.

INTERNATIONAL HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow Members of the Society of Arts the privilege of purchasing Season Tickets for the Exhibition at half-price (10s. 6d.). Each Member will only be allowed the privilege of purchasing a single ticket on these terms, which will be a personal admission, not transferable.

Season tickets admit to the opening ceremony on the 8th May.

The tickets are now ready, and have been issued to all who have already applied. Members desiring to avail themselves of the privilege should apply to the Secretary. It will be understood that all applications must be accompanied by a remittance of the price of the ticket. Tickets at the reduced rate can only be obtained through the Secretary of the Society of Arts.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Mr. W. A. Barrett, Mus.Bac. (Oxon), at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 9th June, 1884.

Full particulars can be obtained on application to the Secretary.

PRELIMINARY REPORT ON COLLISIONS OF STEAMERS IN FOGS.

The following Report has been drawn up by Admiral A.P. Ryder, Chairman of the Committee of the Society of Arts on Collisions in Fogs, for the consideration of that Committee :—

To the Council of the Society of Arts.

1. This Committee was appointed by the Council on March 12th, 1883, to consider the question of collisions at sea. On further consideration it was determined that the work of the Committee should be confined to the question of collisions in *fogs*. The first action of the Committee was to insert a notice in the Society's *Journal*, inviting communications and suggestions from persons interested in the subject. In response to this notice they have received sixty-nine communications. A summary of all these will be given as an appendix to the final Report. The Committee feel much indebted to the many gentlemen who have submitted these suggestions, but they do not consider themselves in a position to recommend any one of the systems described in preference to the others.

2. Nearly all the methods proposed assume the desirability of a code, international or not, of fog signals, and in many of the inventions great ingenuity has been displayed. Supposing the objections to an elaborate code to be got over, there can be little doubt that several of the systems proposed would be very well adapted for the purposes required. The Committee, however, after giving special attention to the question of an international code of fog signals, have come to the conclusion that the introduction of an international code for use by merchant ships would be more likely to cause confusion or disaster than to conduce to safety, first, because the difficulty of making intelligible signals in a fog is very great; and, secondly, because it is to be feared that the authorisation of such a code would foster a fancied feeling of security, and encourage the practice of steaming at high speed under dangerous circumstances. The Committee believe that the utmost that could be done would be an indication of the direction of the ship's head as regards the vessel she is signalling to, as proposed by Mr. Rothery; and, in crowded channels, the indication by steamers of the fact that they were outward or homeward bound. At the same time the Committee are fully sensible of the desirability of increasing by all possible means the power of fog horns, and the general adoption of some form of "siren" (an improved steam whistle) for use on board ship.

3. The Committee on Collisions in Fogs has confined its attention, in this preliminary report, to collisions of *steamers* in fogs. The Committee has examined orally, and by aid of printed questions widely distributed, a considerable number of witnesses, including shipowners, officers of the Royal Navy, and of the merchant service.

4. It has been the Committee's aim, among other important questions, to ascertain what is the general practice in *steamers*, including both Men-of-War and merchant ships, as to the *very* important question of the *speeds* maintained by steamers during fogs, both in the *open ocean* and in *narrow waters*.

5. The law laid down in the International Regulations for Preventing Collisions at Sea,* is that every ship shall in a fog go at "moderate speed."† The Committee has no doubt, judging by the evidence, that the illegal practice, pursued by many steamers, of proceeding in fogs at speeds other than "moderate," is not only very common in the merchant service, both in the "open ocean" and in "narrow waters," but is the almost invariable practice in the "open ocean" by many of the most important lines of steamers.

6. The Committee has no reason to doubt that the 'law' is fairly well observed in Vessels of War. The Naval Regulations prescribe *four knots* as the speed of vessels in a fog in a fleet, and this appears to be rarely exceeded

* The Regulations for Preventing Collisions at Sea have been prepared by the English Government, and submitted to all foreign mercantile nations, and adopted by twenty-eight of them, and thus made international. These nations are:— Austria-Hungary, Belgium, Brazil, Chili, Cochin, Denmark, Ecuador, France, Germany, Great Britain, Greece, Hawai, Italy, Japan, Kattywar, Khelat, Kutch, Netherlands, Muscat, Norway, Portugal, Russia, Spain, Sweden, Travancore, Turkey, United States, Zanzibar. These Regulations can be obtained of J. D. Potter, 31, Poultry; and of E. Stanford, 55, Charing-cross, for twopence.

† Art. 13 urges that "every ship, whether a sailing ship or steamship, shall, in fog, mist, or falling snow, go at a moderate speed."

in fleets. In single ships-of-war the assumed urgency of the sailing orders would probably in some cases lead to the speed being in excess of a "moderate" speed, but the International Regulations are as binding on captains of Men-of-War as on the captains of merchant ships, and damages have been recovered in the same way from captains of Men-of-War as from the captains or owners of merchant ships.

7. In a great deal of the evidence the Committee has obtained from captains of merchant vessels, the witnesses have not hesitated to state plainly to the following effect, viz., that the practice of proceeding in fogs at speeds other than "moderate" is very common, if not universal, in the *open ocean*, in the principal lines of steamers. This evidence has been given to the Committee on the understanding that the names of the witnesses should not be disclosed.

8. The readers of this report must, therefore, take the above statement on trust, as also that evidence has been invited and obtained from officers of the principal lines of steam packets, with consent of the directors or owners.

9. The question that the Committee had to determine, so soon as it arrived at the conclusion that many of its witnesses were confessedly engaged in deliberately and frequently breaking the law, is not a little embarassing. It appeared to the Committee that the question submitted to them had now assumed a very grave aspect, and that it might be well to record all the circumstances of the case in a *preliminary* report, and place it before the Council of the Society of Arts, for their decision as to the further pursuit of the inquiry by this Committee; or whether, after careful consideration, it may not be better that such an important inquiry be transferred to some official body clothed with wider powers, and enabled to examine witnesses on oath.

10. If loss of life were caused by a collision of ships in a fog, and was followed by a civil action, and it was proved that one or other of the captains was driving his vessel at a speed other than "moderate," it would be open to the jury to bring in a verdict of manslaughter against the captain. The Courts that take cognisance of collisions are given below.*

11. The Committee has no reason to doubt, after receiving the evidence alluded to above, that numerous vessels belonging to some of the most important steam-ship companies—ships of great value, crowded with passengers—are daily and hourly being driven through fogs in the open ocean, by captains who are knowingly breaking the law, and in danger of the above punishment. Now if the "law" is a wise one, or, in other words, if "moderate" speed in a fog be the safest to all concerned, and if speed other than moderate be dangerous, these captains are wrongly imperilling the lives of their passengers and crews, and should be restrained in so doing.

12. It is evident that even the fear of the penalties incurred for manslaughter, when added to other punishments, such as forfeiture of "certificate," loss of position, &c., has no sufficient deterrent effect in this case. Whether the captains referred to share the opinion of the law-makers, that there is more danger of collision, and from collision, when going *fast*—or rather at speed other than "moderate"—in a fog than there is when going at "moderate" speed; or, on the other hand, entertain the opinion that there is more safety in going at a higher speed than "moderate," their practice appears to be the same.

11. But even in the former case, viz., in that of captains whose opinion (as seamen) is in favour, as a matter of prudence—of prudence apart from law—of limiting their speed to "moderate" in a fog, other considerations step in—the *requirements of the Post-office*, the *passengers' anxiety for a quick passage*, the *desire of the owners of the cargo for quick transit*, or the *owners' wishes*; and full speed in fogs in the open ocean is the rule, moderate speed the exception.

12. For whatever reason, the practice appears to be almost universal to break the law, and maintain full speed in fogs in the *open ocean*. Is this satisfactory? The Committee is unanimous in opinion that it is not satisfactory.

* The proceedings in collision cases are as follows:—

A quasi-*Criminal* proceeding in the Wreck Commission Court, in which the question to be decided is whether the master or officers of one or both ships were to blame, and whether it would be proper, under the circumstances, to suspend or cancel their "certificates."

2. A purely *Civil* proceeding in the Admiralty Division of the High Court, before the Judge and two Assessors, as to which vessel was in fault, and by which of them the damage should be paid.

3. A purely *Civil* proceeding before any of the Judges of the High Court, and a jury, to decide precisely the same question.

4. A *Criminal* proceeding before a Judge and jury, to determine whether the master or officers, whose conduct is impugned, shall be punished criminally.

In the *first* of these cases, there is an appeal to a Divisional Court, thence to the Lord Justices. In the *second* and *third* there is an appeal to the Court of Appeal (with sometimes an intermediate hearing before the Divisional Court), and, finally, all three to the House of Lords. In the *fourth* case, the criminal trial, there is an appeal, only in certain cases, to the Court of Criminal Appeal. The findings in all the Courts may differ.

13. Three courses appear to be open to the Legislature, if the evidence this Committee has received is confirmed on oath.

(*a*) To preserve the "*status quo*."

(*b*) To make the punishment for infringement of the law more stringent and deterrent, and define more clearly the word "moderate"; as, for instance, say, not exceeding 6 *knots*, or the lowest speed at which steerage-way can be maintained, if in any case that speed be more than 6 knots.

(*c*) To alter the law, and free the captains from the existing obligation to lower the speed to "*moderate*" in *fogs* on the *open ocean*; leaving the existing law applicable to ships in "*narrow waters*." N.B.—The the latter expression is defined further on.

14. The Committee need hardly say that there are difficulties surrounding each of these courses—it is, and must be, a choice of evils—and in the Committee's opinion it will be well that this, their *preliminary* report, should be submitted to the Admiralty, to the Board of Trade, and be made public. So that, after the question has been well ventilated, it may be re-approached either by this Committee or by some other body.

15. The Committee do not hesitate to say, however, that they are unanimously of opinion that to adopt the *first* course, the "*statu quo*," would be most objectionable; and that without giving any positive opinion at present, they are more in favour of the *third* course than of the *second*, and see no fatal objection to certain large open portions of the ocean being defined in the new Regulations, say all positions outside 50 miles' distance from land, as by implication exempt from the obligation on steamers in such positions to go at moderate speed in fogs. N.B.—The distance, whether 50 miles or more, is a detail, but requires careful consideration. Any land such as the Madeira, Azores, &c., would be protected by a 50-mile limit, within which the privileges of "open ocean" should not extend.

16. There are objections of course to such a modification of the existing law; but the proposal, in the opinion of the Committee, without binding themselves to its approval, is well deserving of consideration by shipowners, seamen, &c. Large tracts of the ocean would be, so to say, privileged in fogs as "open ocean," and in much smaller tracts, under the designation of "narrow waters," ships would be protected from vessels at "immoderate" speeds. Its effect on the navigation of steam vessels would probably be this, that captains on passing in fogs from "open ocean" to "narrow waters," or in other words when within fifty miles from land, would either comply with the law, and proceed at "moderate" speed, or would redouble their precautions and multiply their "look outs;" for if they did not comply with the law, and there and then "moderate" their speed, and a collision with loss of life ensued, the jury (in view of the alteration of the law into a closer conformity with almost universal usage) would probably not hesitate to award the full penalty attached to manslaughter.

17. At present, the practice of running at full speed in fogs in the open ocean is so nearly universal, and so ably defended and ingeniously justified, that it is very possible no jury would convict.

18. Were the above suggestions adopted, the offences now constantly practiced against the law imposing "moderate" speed in fogs, would be confined to vessels *not on the open ocean*, would be infinitely diminished in frequency, and therefore more controllable. The new law would probably be regarded by shipowners, captains, owners of goods, passengers, the Post-office, as *reasonable*, or at all events more reasonable than the present law, and obedience would be more readily given. Vessels that had crossed the Atlantic at full speed in a fog, under sanction of the amended law, would be more likely to "moderate" the speed in "narrow waters" than would be the case under the present law.

19. Vessels would still occasionally be run in "narrow waters" at higher speeds than "moderate:" collisions would still occur, and some loss of life, but the whole question would have advanced a stage, and the minds of the public would be prepared for further changes if found necessary. At present, and this is a very important consideration, the infraction of the law as to "moderate" speed in fogs is *never* taken cognizance of *except in cases of collision*, but if the proposed changes were made, the evidence of the logbooks might procure conviction at the end of the voyage, which, if followed by a fine levied on the captain, even if paid by the owners, would have a deterrent effect, especially if the fine were increased at each conviction.

20. The Committee have had the advantage of receiving the evidence of shipowners of wide experience, who look upon the question from a different point of view from the Committee, as also from that of their own captains, &c., and

the opinions on this matter of the former class viz., shipowners require careful attention.

21. The managing director of a very important line of steamers produced the printed orders issued by the directors to their captains. In *one* set of regulations, said to specially apply to the management of the ship in fogs in "narrow waters" the official international regulations were emphasized with great stringency; no language could be stronger than the orders of the directors that reduction to "*moderate*" speed, down to "*stopping*," should be always practised in fogs." In another set of orders, from the same directors, applicable to the *open ocean*, the directions were confined to a few words, saying, "the captains were in fogs to "*comply with the law*."

22. The directors of these companies are well aware that their captains break the law constantly, in fact that they navigate their vessels on almost every voyage, and sometimes throughout whole voyages, with, metaphorically speaking, ropes round their necks, and at first sight it might be supposed that the directors of a company whose ships were so conducted in defiance of the law would welcome the prospect of a change in the law; or would, at all events, when in the *open ocean*, wish to see their captains relieved of this inconvenient appendage; but, surprising to state, it is not so, these directors wish for the *statu quo*, and the reason may probably be as follows, and although it is not likely that they would assert it, they might admit it if pressed.

23. The general purport of the evidence from shipowners, directors, and captains of merchant steamers in the most important "lines," may be summarised as follows:—Our 'Company' is able to build *first-class* vessels of *great speed* and *handiness*, and *perfect* in all their fittings, *lights*, *sirens*, &c., and able to pay such salaries as to secure the *best captains* and *numerous* and *efficient crews*. The present law is wrong, is absurd, is unseamanlike, and more calculated to produce collisions than to prevent them; nevertheless, let the law remain as it is." But why? this Committee asks. The following is the outspoken answer of some of the captains, the implied answer of others:—"There ought (but we know it is impossible) to be two laws, one for vessels like ours, *of great speed, perfectly handy, thoroughly well found, commanded by men like us of great nerve and vast experience, with subordinate officers like ours, all with masters' certificates*, &c. Such vessels should not be interfered with or embarrassed by any law against full speed under any circumstances; but slower, less handy, less well found vessels, commanded by comparatively inexperienced nervous men, become a nuisance if they attempt to go at full speeds in fogs — and, therefore, in theory, there should be a *second* law, constraining such vessels not merely to go at '*moderate*' speed but to '*stop*' in a fog, and *keep on signalling their position;* they are dangerous to themselves and to us if they attempt to move in a fog, and some of them are aware of the fact, and do stop.*" Finally, *we must break the law*, or we shall lose our positions, and our company will lose its *freight*, *passengers*, and *mails*. On the whole, therefore, recognising the impossibility of there being two laws, one for well found, handy vessels of great speed, and one for other vessels, we prefer the *status quo*, and will take our chance of collisions, and convictions of manslaughter, loss of certificates, &c."

24. This view of the matter the Committee believes, judging by the evidence, to largely prevail among the directors and captains in first-class lines of steamers. The evidence given by many persons in this inquiry is liable (very often quite unconsciously to the witnesses themselves) to be twisted by oblique motives, whether personal or caused by *esprit de service*, and this must be carefully borne in mind on any future inquiry.

Proceedings of the Society.

INDIAN SECTION.

Friday, April 25, 1884; the Hon. Sir ASHLEY EDEN, K.C.S.I., in the chair.

The paper read was—

THE LAW OF LANDLORD AND TENANT IN INDIA.

BY W. G. PEDDER.

I had, last year, the honour of reading before this Society a paper in which I endea-

* A blindfolded man, walking about in a room, would much prefer that all other blindfolded persons should stop and indicate their positions instead of continuing to walk about. A person obliged to move quickly in a dark room would rightly consider his chances of collision with the furniture increased if the articles were also moving instead of at rest.

voured to sketch the history and nature of proprietary rights in land in India. It was then suggested to me that it would be useful to show, in a somewhat similar form, the relations of the proprietors and their tenants. I attempt this task to-night with diffidence, but I hope that, as circumstances have led to my paying much attention to the subject, a general view of it may be useful, even to those who are far more intimately acquainted with it than I can pretend to be, as regards the particular provinces in which they have served. I shall confine myself to a description of existing tenancy laws, and of the circumstances which led to their enactment; and this paper will not deal with the ryotwari provinces, not that tenant-right questions have no existence in them, but that they are of minor importance where the majority of the actual cultivators are proprietors, not tenants, of their holdings, and pay revenue to Government, not rent to a landlord.

The most experienced Indian officials have always held that, in whomsoever the proprietary right might be vested, at least one very large class of the cultivators, variously described as permanent, hereditary, or settled ryots, have from time immemorial enjoyed a customary right of retaining their holdings as long as the fair or usual rent is paid. This proposition lies at the very root of the landlord and tenant question in India, and I think it well, therefore, to cite a few among many authorities in support of it, selecting those which are of earliest date, and which, therefore, relate to the position of the cultivator before it was modified by many years of British law and administration.

The Instructions to the Supervisors of Revenue, in 1769, laid down among the objects at which they were to aim, that the ryot should be secured in the enjoyment of his property, subject to the legal due of Government. In 1779, Warren Hastings said that his purpose in certain measures was to secure to the ryots the perpetual and undisturbed possession of their lands, and to guard them against arbitrary exactions. And in a subsequent controversy with Sir Philip Francis (the reputed author of the letters of Junius) regarding those measures, Hastings explained that the words just cited were not meant to imply "any positive or exclusive right of possession, contradictory to the rights of property vested in the zemindar;" but that, "while the ryot pays his rent, the zemindar has no right to dispossess him, nor can he by any legal right exact a higher rent than the 'potta' prescribes." Francis, who opposed these views, still admitted that "though the ryot has no direct permanent property in his land, it does not follow that he has no right." Mr. Shore, in his celebrated minute on the permanent settlement, remarked that, "it is generally understood that the ryots, by long occupancy, acquire a right of possession in the soil, and are not liable to be removed;" though this right did not carry the right of sale, and was, so far, short of what Mr. Shore called a "right of property," evidently meaning the *plenum dominium* of the Roman jurists. Lord Cornwallis, in 1790, while arguing against Mr. Shore in favour of the immediate enactment of the permanent settlement, observed that "the privilege which the ryots in many parts of Bengal enjoy of holding possession of the spots of land which they cultivate, so long as they pay the revenue assessed on them, is by no means incompatible with the proprietary rights of the zemindars." In sanctioning the permanent settlement in 1792, the Court of Directors said that they reserved to themselves the power of future interference, "to prevent the ryots from being improperly disturbed in their possession, or loaded with unwarrantable exactions." In 1808, Mr. Hodgson, a high authority, remarked that "two rights can exist under the words 'proprietary right,' of the regulations; the zemindar could possess one right, the ryot another, yet both be distinct rights." In 1812, Mr. Colebrook, another high authority, spoke of "the ancient and undoubted privilege of the resident cultivator, of retaining the ground occupied by him, so long as he pays the rent justly demandable for it." These citations relate to Bengal proper; the following refer to other provinces also. In 1815, the Government of India observed that, "It is a principle, equally applicable to the whole of India, that the resident ryots have an established permanent hereditary interest in the soil they cultivate, so long as they continue to pay the rent justly demandable with punctuality." In 1822, the Government of India, in a resolution on the settlement of the North-West Provinces, recognised "the possession by the great body of resident ryots of a permanent right of occupancy." In 1825, the Court of Directors observed that "the cultivators or ryots" in Guzerat, a province in Western India which had lately come under British rule, "have this in common with the same class in most other parts of India, that they consist of two classes, one proprietary, and one not proprietary," and that "the former class cannot legally be dispossessed of their lands as long as they pay the Government demand." The author of "Land Tenures," a book of authority in Upper India, published about 1830, says that "under the ancient *régime*, hereditary cultivators, as long as they paid the prescribed amount of tax leviable upon the crop they might raise on the land, could not be ousted from it." Finally, in his evidence before the Select Committee in 1832, Mr. Bird said that the class of ryots who, in Bengal proper, are usually called "khoodkasts," were "cultivators possessing a fixed hereditary right of occupancy in the fields cultivated by them, their tenure being independent of any known contract, and they could not justly be ousted as long as they pay the amount or value demandable from them, that being determined according to local usage."

These quotations, covering the first half century of British rule in India, though they have not all precisely the same meaning, still, I think, sufficiently establish the truth of the general principle I have stated. Before, however, proceeding with my argument, I must make one explanation. I have used the phrase, "customary right" of the cultivator. This expression, it has been pointed out by, I think, Sir H. Maine, is an inaccurate one. Rights, as Bentham says, are the creatures of law; a right is an advantage which may be enforced by law; a custom is something regarding which there is no positive law. Now, one of the principal difficulties which encompass the question of the real position of the Indian cultivator is that, before British legislation, there was no law to which he could appeal to maintain him in possession of his holding; his security depended not on positive law, but on the force of the opinion of his neighbours, the sense of justice of his chief or zemindar, and the relative power of the body of cultivators and of the Government or superior holder. I once asked a peasant, on the estate of a petty chief in Kathiawár, if the Thakur could eject him as long as he paid his rent according to the village custom. "Of course he can," he replied; "is he not 'dhani,' (the lord); who can prevent him?" "But," he added, "it would be 'zulum,'" or injustice. In the same way, one of the leading zemindars in Bengal, while arguing during the discussions on the proposed Bengal Rent Law against the existence of any legal right of his tenants in their holdings, admitted that they possessed what he called a "moral right" of occupancy.

It must, then, not be forgotten that the occupancy right of the ryot, though a real, was a vague, undefined, inchoate right only. But it must also be remembered that, previous to British rule, the right of the zemindar himself was very little stronger. In 1789, the position of a Bengal zemindar was thus described by one of the highest authorities, Mr. Harrington. He was entitled to the management of his "zemindari," or estate; yet was liable to be set aside at any moment at the will of the Government. He was privileged to inherit, yet was obliged to renew his title at its demise, on payment of an arbitrary fine. He was authorised to fix (subject, however, to the customary standard of assessment) the rent or revenue of his ryots, yet was liable to have it fixed for him by the ruler. He was entitled to the profits of his management during the period for which his "jama" or revenue demand was fixed, yet was bound to account for all his receipts.

Such was the position of the class whom the legislation of 1793 made proprietors of the soil of Bengal, yet with limitations in respect of the subsidiary rights of the ryot which, as will be seen, were not very clearly defined.

We have now ascertained that, by what may be called the common law of India, certain classes of ryots enjoyed a certain occupancy right. Who were these classes? This is by no means an easy question to answer, especially as the answer must vary in different provinces. Mr. Halhed, in 1832, enumerated eight classes of the agricultural community as generally distinguishable in the North-West Provinces and Behar, the lowest of whom alone could be said to have no connection with the lands they tilled, independent of agreement with the superior holder or landlord. But, perhaps, the classification adopted by Lord W. Bentinck and by Mr. Thomason, when the principles of the settlement of the North-West Provinces were under consideration, may be accepted as generally accurate. These authorities divided cultivators all over India under three great classes.

First, those who cultivated land in a village to which they did not hereditarily belong; cultivators of the "seer" or domain land of proprietors; sub-tenants of permanent or occupancy ryots; cultivators of land newly reclaimed by the proprietors; and persons generally of the lower castes or classes who did not depend solely on cultivation, but supplemented the wages of their labour or the returns of their handicrafts by tilling a little land. Such persons were tenants at will (or, more correctly, since by universal custom any man who ploughs land may reap the crop, tenants from year to year) entirely dependant on the proprietor, and claiming no right not derived from him.

Secondly, the great mass of ryots hereditarily belonging to a village, permanently settled and resident in it. These ryots had acquired by prescription "a sort of possessory title" or occupancy right, not necessarily transferable, terminating if the ryot ceased to cultivate, at a rent liable to enhancement, but still not to exceed what was usual or established, but indefeasible as long as that rent was paid.

Thirdly, those who had a proprietary right, entitling them (save when they held free of revenue) to have the settlement of the Government revenue made with them or their representatives, whether in respect of the lands they themselves cultivated only, as the "mirasdars" of the Deccan, or in respect of the whole village, as the members of a proprietary community, or the village zemindars of the North-West Provinces.

To decide to which of these classes each ryot belonged, which was never done in Bengal, was one of the most difficult and most important duties of the original settlement of the North-West Provinces. And it must be remembered that a process of interchange between the classes was always going on. "Paikhasts," or new ryots, were first induced by the proprietors to settle on an estate; then, by uninterrupted residence and occupation for two or three generations, they acquired a prescriptive right to the fields they tilled, and rose into the second class. On the other hand, proprietors who lost their estates by sale for arrears of revenue, or under decree of court for debt, retained, as hereditary ryots of the second class, the occupancy right in their own domain lands or the fields they themselves cultivated, and are the "ex-proprietary tenants" of modern law.

Finally, it is important to notice that Bengal differs much from Upper India in this, that whereas in the latter provinces the settlement was generally made with the class of proprietary ryots, in the former it was made with the totally different class of zemindars, and that, consequently, the ryots of the third class, so far as they existed in Bengal at the time of the permanent settlement (which, from the long prevalence of the zemindari system there, was probably to no great extent), lost their proprietary rights. In Bengal, consequently, ryots are generally now of either the first or second classes only.

The second question involved in the proposition which we have established is also a difficult and obscure one. What is the usual, customary, or fair rent which the occupancy ryot is liable to pay to his landlord; and how is it limited?

In my former paper, I hope I made it clear that the large landlords of India, the zemindars, talukdars, jaghirdars, &c., as distinct from the cultivating proprietors, are of two classes. Either descendants or representatives of ancient chiefs to whom the Government share of produce—in native revenue parlance, the "Raj-bhag"—belonged; or collectors or assignees of the Government share. It follows that the rents they received from the ryots were originally neither more nor less than the Government revenue. It is a curious proof of this that the early Bengal authorities whom I have quoted speak indifferently of the ryots' legal rent or legal revenue. As I showed before, rents in kind are derived from the old Hindu produce due of the ruler; rents in money from the Mahomedan "bigoti," or cash commutation of that due. These payments, of course, underwent, during the troublous times which preceded the establishment of British rule, all sorts of changes, from local circumstances, from individual caprice, and especially from the rapacity of the Government or of the landlord. Still, it is generally true that, a century or less ago, every village had its own recorded or acknowledged custom of rents, which could not justly be exceeded, and if exceeded, was so by the imposition of some burden extra to the established rent.

Many years ago, I was employed on settlement work in Ahmedabad, a district of Western India, which had suffered terribly during the 17th and 18th centuries from successive waves of Mahomedan and Mahratta conquest. I found that, soon after the introduction of British rule, a paper had been drawn up for each village, showing, from its records and the information of old Patels, its history and customs. Among other curious information was a detailed statement of the customary rates of rent or revenue, whether, as the case might be, shares of produce, cash crop-rates, rates according to the quality of the soil, or any of these varying with the caste of the cultivator. But almost always these rates were supplemented by the cesses or extra imposts which, in Bengal, are called "abwab," and in Western India "veeras," or "babtis;" some directly on the land or crop; some on the plough; some on the house or family; and each for a particular purpose, as to provide for the marriage of the lord's son; for the travelling expenses of the district officials, and the like. Now, the meaning of these cesses, which have always formed an important feature in the rent question in Bengal, was that the people preferred to pay a new exaction in this shape rather than in that of a direct enhancement of the rate, hoping that at some time the lord or ruler would remit the extra demand, avowedly imposed for a special and temporary purpose.

It must be observed that the customary rates regulated or limited the payments of tenants at will as well as those of permanent or occupancy cultivators. These rates were, as Lord Cornwallis observed, commonly quite as high as any ryot could afford to pay. In fact, the rents paid by tenants at will were usually not more but less than the customary rates. A tenant at will bargained for the temporary cultivation of a field at a rate lower than the established rate; when by prescription he acquired its permanent occupation, his fixity of tenure enabled him to pay, and justified his landlord in demanding, the full rate.

I now come to an inquiry, the answer to which will probably explain the shape assumed by British rent-law legislation. Since the rents received by private landlords were based on customary rates derived from State authority in some shape, and since a probable result of the establishment of regular tribunals is that custom, interpreted and enforced by them, hardens into legal right, why did not the earlier British rulers adopt generally the principle of the Judicial Rent?

In the first place, while they felt strongly the difficulty of Government fixing the rent of particular holdings, or even laying down any standard by which rents in general might be adjusted, they believed that usage was strong enough to regulate rents, that the relations of landlord and tenant were sufficiently defined by popular feeling to enable the courts to ascertain individual rights in case of dispute, and that, therefore, the people might safely be left to settle rents themselves. This view was strongly urged by Sir P. Francis as long ago as in 1771, and has often prevailed in more recent times, notably, when the Oudh rent-law was enacted. It was overlooked, I think, that the increasing pressure of population on the land would tend to strengthen the landlord; that the desire of immediate advantage would generally influence him more than a traditional sense of justice; and that British courts would lean to English doctrines of landed property.

Next, an opinion, now unfashionable enough, was held half a century ago as hardly admitting of question, that the English notion of the contract relation of landlord and tenant is economically preferable to the Indian notion of the status relation. Lord W. Bentinck, when rejecting, in 1832, Mr. Bird's proposal that the rents of all resident cultivators in the North-Western Provinces should be fixed by Government for the term of the settlement, cited with approval a dictum of the Government ten years earlier, that "the system which attaches to the land various permanent interests, independent of any contract between the parties, though it cannot without cruel injustice be destroyed where it exists, is not one desirable to establish." It is not surprising that the earlier British authorities, holding this view, should have contented themselves with refraining from direct interference with rights which they thought economically injurious, and should have left them to take care of themselves, not without some hope that they would gradually give place to a preferable system.

I now come to the second part of my subject, and shall attempt to show how far the rights I have tried to describe are protected by existing enactments. The law differs considerably in different provinces, and because the Bengal law is the foundation of much other legislation, I must begin with Bengal, though its land law has lately been treated of before this Society by a much higher authority than I am, Mr. Seton-Karr.

The Code of 1793, which gave legislative force to the permanent settlement, acknowledged the zemindars to be proprietors of the soil, and, at the same time, declared it to be their duty to "conduct themselves with good faith and moderation" towards their tenants, and reserved to Government the power of at any time legislating for the protection and welfare of the latter. It is, however, a mistake to suppose that the Government of Lord Cornwallis confined themselves to the expression of a hope that the zemindar would respect the rights of the cultivators. On the contrary, they, at the same time, enacted elaborate provisions for the protection of those rights, which, believing as they did that the fixing of the Government revenue, the mutual interest of the parties, the popular sense of justice, and usage if reduced to writing and made enforceable by the Courts, would all operate in that direction, they were perhaps justified in anticipating would prove fully adequate for the purpose.

These provisions are contained in the "Potta" Regulations, VIII. of 1793, and IV. of 1794. I must explain that the word "potta" is sometimes rendered "lease," and on this mis-translation an argument that the ryot's tenure depends on his lease, and, therefore, on contract, has been founded. In fact, as what follows will show, a "potta" is an instrument defining an existing tenancy.

The regulations enacted that every ryot was to receive a "potta," containing either a specific sum as the rent of the holding, being the "usul," or customary rent, consolidated with the existing established cesses; or, where rents in kind or crop rates were usual, an exact specification of the terms. That no new cess was to be imposed on any pretence. That the form of "potta" was to be subject to the collector's approval. That if a dispute arose between landlord and tenant as to the amount or rate of rent to be entered in the "potta," it was to be determined in the Civil Court, according to the rates established in the 'pargana' for similar lands. That "pottas" were to be perpetually renewable at rates not exceeding the established pargana rates. That regular receipts were to be given for all rent payments; and that village accountants and village accounts were to be maintained.

In these rules, it will be observed, there are no provisions relating to either enhancement of rents or transferability of ryot's holdings. As regards the latter point, I do not think that it was intended to confer on the ryot the power of transfer, which, Mr. Shore distinctly held, he did not then possess. But the subsequent action of the Courts, which will always sell in execution anything in possession of a debtor which anyone will buy, has since, I believe, made transferability of a ryot's holding the usual rule. As regards the first point, it has been plausibly argued that the "established rate" was not meant to be enhanceable. I cannot discuss the grounds of this opinion, regarding which Mr. Justice Field has an argument which seems to me conclusive, but would point out that the fact of rent and revenue being originally identical shows that rent was always, though within certain limits, liable to enhancement. But I cannot but suspect that the framers of the regulations overlooked the question of enhancement. They knew that, in Lord Cornwallis' words, the established rent was generally equal to the utmost the cultivator could afford to pay, and it is not surprisiug that they did not foresee the economic causes which would soon render it inadequate.

If the potta regulations had been enforced, they might have afforded to the permanent ryot all the protection he could justly claim. But "never," says Mr. Justice Field, "did a legislative measure fail more absolutely." The chief among many causes of this failure seem to have been these. It was not the interest of the zemindars to give pottas which would limit their power over their tenants; they declined to do so; and the district officers were not powerful enough to enforce obedience. The ryots did not demand pottas for reasons to which I have already referred. They thought that to accept a written potta would weaken their status right, and they objected to the consolidation with the established rates of the cesses, which they looked on as illegal exactions. It was found impracticable to enforce the maintenance of the authoritative village records, contemplated by the regulations, and in their absence the Courts found it impossible to determine the prevalent pargana rates. Hence, rents and holdings were never defined, regular reeeipts were disused, illegal cesses continued to be exacted, and evictions and arbitrary enhancements became common.

Subsequent legislation all tended to weaken the rights of the ryots. Regulation VII. of 1799 gave the zemindar summary power of distraining for rent, and the effect was that, in case of a dispute regarding the amount of rent, the ryot was compelled either to pay at once the sum demanded, and thus to admit that he owed at that rate, or to enter on expensive and doubtful litigation. Regulation V. of 1812, abolished the collector's control over the form of pottas, and, in effect, the principle of determining the amount of disputed rents in accordance with established pargana rates. The Sale Laws, Regulation XI. of 1822, and Act XII. of 1841, under which existing pottas were made cancellable on the sale of an estate for arrears of revenue, and the latter of which, for the first time, made it legal for a purchaser to enhance at discretion the rents of, or to eject any ryot, save one who had held at a fixed rate from a period anterior to the permanent settlement, practically placed it in the power of a purchaser, or even, by means of a collusive sale, of any landlord, to get rid of all rights of his ryots but those of the few holding at fixed rates. The practice of sub-infeudation, which, always common in Bengal, received in the early part of the present century a calamitous extension, placed the ryots under the control of speculators in land whose only object was to exact the highest possible profit on their bargain. Finally, not only was the law greatly in favour of the landlord, but the cost, trouble, and complication of legal proceedings, and the power of wearying out an opponent by appeals, gave the richer party so great an advantage in litigation, that to refer the ryot to Court for a remedy against his landlord was tantamouut to a denial of justice; while the power of compelling the attendance of a recusant ryot at the zemindar's office, where he was liable to all sorts of ill-usage with practical impunity, afforded to the landlord a tremendous engine of illegal oppression.

During the whole of this period, while local legislation and practice were rapidly destroying the rights of the ryots, the Government of India and the Home Government uniformly acknowledged and regretted the injustice of this result. And, in 1859, a determined and not altogether unsuccessful effort was made to remedy the evil.

The following are the most important provisions of Act X. of 1859:—

Every ryot is entitled to a potta, showing the area of his holding, the amount of his rent, and its instalments. Ryots who hold at rates unaltered since the permanent settlement, are entitled to pottas at those rates, and the rate having been unaltered for twenty years, raises a presumption of its having been unchanged since 1793. Ryots having occupancy rights are entitled to hold at fair and equitable rates, and the existing rates are to be presumed fair till either party shows the contrary in a suit. Every ryot (not being a sub-tenant of an occupancy ryot) who has cultivated or held land for twelve years, is to have occupancy right in that land (not being domain land of his landlord) so long as he pays the rent payable on account of it. The rent of an occupancy ryot is liable to enhancement on three grounds only; (*a*), that the existing is below the prevailing rent payable for similar land by the same class of ryots in the neighbourhood; (*b*), that the value of the produce, or the productive power of the land, has been increased otherwise than by the agency of the ryot; (*c*), that the actual area of the holding is greater than the ryot has been paying for. An occupancy ryot is entitled to claim reduction of rent on two grounds, the converse of the two latter grounds of enhancement. The acquisition of occupancy right can be barred by written contract. A ryot not having occupancy right is entitled to a potta only at such rent as he may agree on with his landlord. The exaction of cesses, or of anything in excess of the rent specified in the potta, is prohibited. All ryots and sub-tenants are to receive detailed receipts. No ryot or sub-tenant is liable to enhancement unless served with notice of enhancement for the ensuing year, and is entitled to contest such enhancement in Court. Any ryot is entitled to relinquish his holding on notice. A ryot is liable to ejectment if in arrear of rent at the end of the year, but if an occupancy ryot, or holding on an unexpired lease for a term, he can be ejected only under a decree of Court. The rent is recoverable either by suit or by distraint of produce before it is stored, but only of the land on which the arrear is due, and for one year's arrear.

This law, re-enacted in substance by Act IX. of 1868, is the existing land-law of Bengal. It must be allowed to be, on the whole, fair and just in principle. Some of the reasons why it has failed, at least in great parts of the province, effectually to protect the rights of the cultivator, and why the fresh legislation now in contemplation has become necessary, will be seen when I come to the law of the North-West Provinces. I will now mention two only. The first is a cause peculiar to Bengal. In that province alone of India there has never been a general cadastral survey, nor any regular record founded upon it of holdings, rents, and payments on account of rent, while, as has been stated, it was found impossible to maintain the village accountants and village records, contemplated by the Code of 1793. Now it will have been seen that the decision of almost all suits under Act X. turns upon one of three points, whether the tenant has actually possessed the land in dispute for a certain period; whether he has paid the rent for it; or what is the existing rate of rent for that land, or similar adjacent land. These points, in default of an authoritative record, such as that which exists, for instance, in the permanently settled districts of the North-West Provinces, the Courts can decide only on evidence adduced by the parties; and Bengal has long been notorious for the prevalence of perjury, a character which it has in no small degree obtained from the temptation which the absence of public records has given to the people, both landlords and tenants, to strengthen their cases in land suits by false evidence. Hence the Courts have commonly failed to do justice in rent suits, because all the evidence on which they can decide is either oral, commonly false, or documentary, produced by the parties, at least under a strong suspicion of being forged.

The other reason is this: Act X. has been interpreted (wrongly it has lately been decided) to mean, not that a tenant who has held continuously for twelve years has occupancy right, but that an occupancy tenant is one who has held continuously for twelve years. This interpretation has deprived of their customary rights the permanent ryots, khoodkasts, kadims, and the like, who could not prove continuous possession, and has enabled landlords, by shifting the tenant's fields within twelve years, to bar the accrual of occupancy right.

I now proceed to the land law of the North-West Provinces.

It has been stated that it was originally proposed by Mr. Bird that the settlement officer should, when making a settlement, fix for its term the rents of all permanent tenant cultivators. This proposal was rejected by the Government of Lord W. Bentinck, but still what were considered to be existing occupancy rights were recorded by the settlement officer. In course of time, however, the necessity for a more definite law on the subject became apparent, and Act X. of 1859 was made applicable to the North-West Provinces. After a few years' experience of the working of this law, it was found to be defective in several particulars. A landlord could worry his tenants by bringing enhancement suits at short intervals. The rights of occupancy tenants as regards inheritance, transfer, and sub-letting, were not clearly defined. There were no provisions for compensation for tenants' improvements. No power was given to the settlement officer to fix the rents of occupancy tenants, and consequently, landlord and tenant were obliged to settle—by tedious, expensive, and irritating litigation—the adjustment of rents which a revision of settlement made necessary. Finally, there were no provisions for the protection of ex-proprietary tenants. A proprietor who had lost his proprietary right by sale under decree of Court for debt still cultivated his "seer," his domain land or home farm, and considered it in the highest degree cruel and unjust that the new proprietor should be able to evict him from it, or to enhance his rent at discretion.

Acts XVIII. and XIX. of 1873 were passed to remedy these defects, and are still the land law of the North-Western Provinces, though the former Act was repealed and re-enacted with some modification by Act XII. of 1881. This law retained in substance the provisions of Act X. of 1859 regarding tenants at fixed rates in permanently settled districts; regarding the accrual of occupancy right by twelve years continuous possession; and regarding the grounds on which the rent of an occupancy tenant may be enhanced or reduced. But it added many new and important provisions, the chief of which are the following:—

A person who loses his proprietary right in any estate is entitled to occupancy right in his "seer" land, at a rent of 25 per cent. lower than the prevailing rate payable by tenants at will. Occupancy rights (except of tenants at fixed rates, which are heritable and transferable), are declared generally heritable, but not transferable except between co-sharers. If a tenant holds on a written lease for a fixed term, the period of twelve years, possession during which confers occupancy right, begins to count from the expiration of the lease, and neither enhancement nor reduction of the rent stipulated is claimable during the currency of such a lease. Otherwise, the rent of an occupancy tenant once fixed by the settlement officer or on suit, cannot ordinarily be enhanced for ten years, or until a revision of settlement; but, during the period of fixation, the landlord may sue to enhance on two grounds only, increase of area of the holding, as by alluvion, and increase in its productiveness, effected otherwise than by the agency of the tenant; and the tenant can sue for reduction on the converse grounds. The record of right made on the revision of a settlement is to specify every tenant, the area and details of his holding, and the conditions of his tenure, whether he is a tenant at fixed rates, an exproprietary tenant, an occupancy tenant, or a tenant without right of occupancy. As regards the latter class, the existing rent, and the number of years for which the tenant has held, are to be recorded. Occupancy rents are to be fixed at settlement, for exproprietary tenants at 25 per cent. lower than the prevailing rates of similar adjacent lands held by non-occupancy tenants; for occupancy tenants, if there is any claim for enhancement, or reduction, or dispute as to the actual rent, with reference either to the standard rent-rate of the circle of villages, or to the customary rate paid by the same class of tenants in the circle. Rents in kind are commutable to cash rents by the settlement officer, on the application of the landlord or tenant. Occupancy rents may, after ten years from the date of fixation, be enhanced or reduced by written agreement recorded in the village accounts, or by suit, on the grounds of enhancement laid down by Act X. of 1859. And the collector may, on the application of a tenant, determine at any time the class to which he belongs. The rent of a tenant at will is determinable solely by agreement with his landlord, but he cannot be called on to pay rent higher than that paid the previous year, unless an agreement to that effect has been recorded in the village accounts. Non-payment of rent renders any tenant liable to eviction, but an occupancy tenant only by decree of Court; a tenant at will, only by written notice for the ensuing year, which the tenant may contest in Court. If ejected, any tenant is entitled to compensation for the value of any improvements he has made which have permanently increased the letting value of the land. Any tenant, not holding on a lease for a term, may relinquish his land by written notice for the ensuing year. And rent is recoverable by suit or distraint. The number of tenants is not stated in the North-West Provinces returns. But of the total occupied area, $37\frac{1}{2}$ per cent. is cultivated by tenants having some occupancy right, $38\frac{1}{2}$ per cent. by tenants at will, and the remaining 24 per cent. by proprietors.

The existing law of the North-West Provinces is, it will be observed, based upon Act X. of 1859. This is not the case with the land law of the Punjab, which I will now describe.

Upon the annexation of that province, no law defining all rights in land was enacted, but the principles of the settlement of the North-West Provinces were, in general, applied; and tenants who had held continuously for twelve years were recorded as possessing occupancy right, and their rents were fixed for the term of settlement. In 1855, however, the Chief Commissioner, Sir J. Lawrence, expressed some doubt of the accuracy of this practice, observing that it was rather the nature than the length of a tenancy which entitled the cultivator to privilege. To understand the controversy which followed, one which greatly divided opinion in India, and even in the Council of the Secretary of State, it must be borne in mind that the Punjab is a country of small cultivating proprietors, and that, therefore, nearly all the ryots, who elsewhere would be occupancy tenants, are there themselves landlords. In 1868, there were over 1,700,000 proprietors, some representing each several co-sharers, while there were only 1,650,000 tenants, of whom only about one-fourth were recorded by the original settlement as possessing occupancy right.

When, in 1863, the first original settlements in the Punjab came to be revised, the Settlement Commissioner, Mr. Prinsep, proposed to strike occupancy rights generally off the new settlement record, considering them to have been unjustly admitted at the first settlements. In three districts he reduced 46,000 out of 60,000 tenants, originally recorded as possessing occupancy rights, to the position of tenants at will. His arguments were briefly that, in the times of Sikh rule, a proprietor had an undisputed customary right of ejecting any tenant, no matter what his length of possession; that if this right was then seldom exercised, the reason was that there was nothing to be gained from it, as the Sikh revenue assessment absorbed the full rent of land; but that it was unjust to forbid its exercise when, under moderate assessments, it had become profitable to its possessor. It was replied that a customary right of the exercise of which there were no instances was no custom at all, and could not be established; that under Sikh rule tenants of long standing had a reasonable expectation of continuing to hold as long as they paid their rent; that as a matter of fact, the Sikh Government did sometimes interfere between landlord and tenant; that, therefore, the original settlement was right in protecting the tenants of long standing from the eviction which only the limitation of the Government demand on the proprietor rendered likely; and that it would be unjust, on a revision of settlement, to take away rights which had been acknowledged for twenty years.

So strong, in 1868, was the feeling in favour of the unrestricted rights of proprietors, a feeling which, as will be seen, had just found expression in the Oudh rent-law, that it was probably only the great authority of the Viceroy, Lord Lawrence, "*Clarum et venerabile nomen*," and the powerful advocacy of Sir H. Maine, which secured the enactment of the existing Punjab law, Act XXVIII. of 1868, which was a compromise between the conflicting views. Its general principle was that of confirming the occupancy rights recorded by the first settlements, but of preventing the accrual of fresh ones. Its chief provisions are the following.

In the future, no occupancy right is to accrue by mere lapse of time. But ex-proprietors, and certain other small classes of cultivators, are entitled to occupancy right at privileged rents, 30 per cent. to 50 per cent. below full prevailing rates, and tenants recorded at the original settlement as having occupancy right were to be presumed to possess such right, at rents 15 per cent. below prevailing rates, until the landlord should rebut the presumption in a regular suit. The landlord can sue, once in five years, to enhance the rent of an occupancy tenant, up to the amount limited by his privilege. The occupancy right is heritable, and the tenant may sub-let, and may alienate, in the case of ex-proprietors, &c., subject to a right of pre-emption of his landlord, in other cases with his consent. An occupancy tenant can be evicted only by decree of Court; in the case of ex-proprietors, &c., only for non-payment of rent; in that of others, also on payment of compensation, the amount of which is to be settled by the Court. Tenants at will are entitled to compensation for their improvements; they can be ejected only on written notice for the ensuing year; and their rent can be enhanced only by decree of Court, or on written agreement. There are now in the Punjab about 1,640,000 tenants, about 540,000 of whom possess some occupancy right.

The history of the Oudh tenancy law I can describe only very inadequately. When Oudh was annexed in 1856, two-thirds of the province belonged to a landed aristocracy, the taluqdárs, who, however they had acquired it, actually possessed the ownership of the soil, limited only by certain ill-defined subordinate rights. A settlement of the province was immediately introduced, which, professing to be based on the principles of the North-West Provinces settlement, was, in fact, opposed to the first of those principles. Instead of taking the actual state of property as the basis of operations, and ascertaining, defining, and maintaining existing rights, the policy then in vogue of favouring the cultivator (a policy which, after a violent revulsion of opinion after the Mutiny, appears again to have become predominant) led to the taluqdárs being set aside as mere middlemen, collectors of revenue whose services were no longer needed; and to the settlement being generally made with the actual occupants of the soil, village zemindars and co-parcenaries. The taluqdárs, thus deprived at a blow of their position and their incomes, rushed into revolt in 1857, and were joined by the classes whom the settlement was intended to benefit. On the recapture of Lucknow, early in 1858, Lord Canning issued his famous proclamation, confiscating, with some exceptions, all proprietary rights in the soil of Oudh. But, with a view to the pacification of the province, he granted in the same year to the taluqdárs who submitted an absolute permanent hereditary and transferable right of property in the estates they possessed at annexation, subject only "to any measure which the Government might think proper to take for the purpose of protecting the village occupants from extortion, and of upholding their rights in the soil in subordination to the taluqdárs." This policy, however necessary, was perhaps not much more just to some of the subordinate proprietors and ryots than was the previous policy to the taluqdárs. It is no part of my subject to describe the arrangements ultimately made with respect to sub-proprietors; but as regards the ryots, the present Act (XIX. of 1868) is the outcome of the power reserved by Lord Canning to interfere in their behalf. It is, in fact, the result of a compromise between the view of those who, with Lord Lawrence, held that the reserved power ought to be exercised to give hereditary ryots a large measure of tenant right, and those who, with Sir C. Wingfield, believed that such a policy would both be in violation of the pledges to the taluqdárs, by which the pacification of Oudh was effected, and would be inexpedient, all interference between landlord and tenant being politically and economically undesirable. As will be seen, the latter view prevailed in the compromise, but the Act, as passed, had the great advantage of being assented to by the taluqdárs. It gave occupancy right, heritable but not transferable, at a privileged rent—12½ per cent. below the prevailing rates of the vicinity paid by tenants at will—to a very small class of ex-proprietors, not exceeding 2 per cent. of the whole number of tenants. All other tenants are tenants at will, liable to ejectment or enhancement on written notice from the landlord, but entitled to compensation for their own improvements, to written detailed leases, and to regular receipts.

The last tenancy law of importance is that of the Central Provinces. Here the settlement made certain persons, the Malguzars, proprietors of villages, and gave large classes of the ryots occupancy rights, either absolute or conditional, while the Bengal Law, Act X. of 1859, was extended to the province as its land law. This Act, however, which is inappropriate to the circumstances of the country, did not work well; and, in 1883, a new Act, No. IX., was passed, which differs materially from other Indian tenancy legislation. Its principle is that of confirming occupancy rights already acquired, but of forbidding their accrual for the future by mere lapse of time, while it gives a certain protection to all tenants. Its chief provisions are these:—

An absolute occupancy tenant is one already recorded as such. His rent is fixed by the settlement officer for the term of settlement; he cannot be ejected, and his right is heritable and transferable, subject to pre-emption by the landlord.

An occupancy tenant is either an ex-proprietor, a person who, when the Act came into force, had held continuously for twelve years, or an ordinary tenant, who may hereafter exercise his power of purchasing occupancy right. He cannot be ejected, except on suit for non-payment of rent; his rent is fixed at settlement by the settlement officer, but may be enhanced every ten years, under certain limitations; his right is heritable in the direct line, but not saleable in execution, or transferable without the landlord's consent.

An ordinary tenant is liable to pay such rent as may be fixed by agreement with the landlord; he cannot be ejected, except on suit for non-payment of rent, or for refusing to an enhancement demanded by written notice once in seven years, and, in the latter case, is entitled to compensation for disturbance. He can claim to purchase occupancy right at any time, on payment of two and a-half years' existing rent, and his tenancy is heritable, but not saleable. A sub-tenant holds only on terms of contract. But all these tenancies are subject to certain general provisions, which are these:—

Except during the currency of a lease for a term, any rent is enhanceable at any time, on the application of the landlord, on account of the landlord's improvements. A contract rent may be altered by the revenue officer on a revision of settlement. The revenue officer may, on application of landlord or tenant, enhance or decrease any rent at any time, on account of natural alterations in the land, such as alluvion or diluvion. Rents in kind are commutable to cash rents on the application of either party. An occupancy tenant is entitled to improve his own holding; the landlord, the holding of an ordinary tenant; but in either case, the party not entitled to improve may call on the other party to make the improvement, and make it himself if he declines; and any tenant is entitled to compensation for improvements he has legally made. Rent is recoverable only by suit, and in a suit, the rent payable the preceding year is to be presumed the rent due till the contrary is proved. Distraint is forbidden, but the landlord may prohibit the removal of a crop pending a suit. The details of all tenancies are recorded in the village papers. There are now about 940,000 tenants in the Central Provinces, about 465,000 of whom possess some occupancy right.

No one who candidly examines the laws I have tried to describe, can doubt that they are the outcome of a sincere desire to do justice between proprietor and tenant. At the same time, it may, perhaps, be thought that the ancient rights of the cultivators have not always been maintained to a sufficient extent. The modern occupancy tenant has all he could justly expect; but, perhaps, all the ryots who ought to have had occupancy right do not now possess it. I am myself inclined to this view, and wish that at the introduction of British rule a greater extension had been given to the principle of tenant right. But it does not follow that this would now be expedient or just. Nothing can be more dangerous than to be always tampering with people's property, in accordance with the economical views which may happen to be in the ascendant. To modify rights which have long had a legal sanction, and in accordance with which the relations of the agricultural classes have adjusted themselves, is a serious matter. And it must be remembered that cultivation in British India has doubled itself in the last century, and that the new lands have, to a great extent, been taken up on contract terms.

In what I have just said, I must not be understood as referring to pending legislation in Bengal. The justification for that legislation is that tenant rights, which have been acknowledged by the law ever since the introduction of British rule, the law has hitherto failed effectually to secure.

DISCUSSION.

Sir GEORGE CAMPBELL, K.C.S.I., M.P., thought they must all be exceedingly obliged to Mr. Pedder for having brought into a focus the different tenancy laws existing in India. In India they were apt to be a little provincial. He did not use the word "provincial" in a bad sense, but India was a great Empire, and they were apt to be a good deal confined to particular provinces. So far as he was able to judge with regard to all the greater provinces of Northern India, Mr. Pedder had focussed them in an excellent way. If he might express any disappointment with the paper, it would be that Mr. Pedder had not thought it worth his while to tell them the state of things with regard to tenancy in Bombay and Madras. The prevailing tenures in those presidencies were proprietary, but still he believed there were some considerable tenures, the proprietary right of which was not held exclusively by the cultivators. In Madras there were large tenures under the name of ryot tenures, and he should like to know whether in Bombay and Madras a considerable system of sub-letting had grown up, and if so, upon what terms and conditions, whether the rights of the sub-tenants were regulated by law or by custom, and what had been the outcome of that system. As regards Bengal, the North-West Provinces, and the Punjaub, he could not add anything to what had been said by Mr. Pedder, though he might, perhaps, be allowed to express his entire concurrence in what had been said as to those presidencies. It was sad indeed to find the oscillation of opinion which took place in India, but experience in this country had led him to believe that such oscillation was not peculiar to India. It was almost incredible that, with regard to Ireland, an Act was passed by a Liberal Administration in 1860, which by statute abolished all status tenure, and provided that tenure should be by contract only; that ten years later an Act was passed which took a totally opposite view, and ten years after that came an Act which revolutionised English ideas upon these subjects. Oudh and the Central Provinces had suffered under the system of extreme oscillation of opinion, and the result was very peculiar, but, to a certain extent, Mr. Pedder had scarcely realised the position of things in Oudh. In the beginning of the present century, the modern Oudh was almost identical, with regard to the Government, and population, and tenures, with the North-West Provinces. When Oudh was annexed at the end of Lord Dalhousie's reign, and the beginning of Lord Canning's reign, an order was issued that, in case of doubt, preference should be given to the village zemindars, the larger talukdars being left to prove their right; but when the Mutiny broke out, the talukdars were, for the most part, in possession of their forts and powers, and it was not until sometime later that this class went into rebellion. In order to put a stop to the rebellion, the estates were confiscated; they were re-granted to the talukdars upon the terms stated in the paper, and he thought it was very lamentable that a different settlement had been made from any other part of India, the claims of the ryots being ignored. As regards the Central Provinces, the position was the converse of Oudh. In Nagpore and the Mahratta country everything was identical with that which existed in Bombay, where the ryotwari system existed; and in the Nerbudda Provinces the rights of the ryots were maintained. When the Central Provinces were united under one Chief Commissioner, the wave of opinion had oscillated on the side of great proprietors, and, contrary to facts and justice the headmen were turned into proprietors. Then it was felt that an injustice had been done, and the arrangements which had been described by Mr. Pedder were made. No doubt there was a considerable quantity of rent laws now existing which it would be desirable to revise and consolidate. Taking all the provinces of India, except Oudh, he might accept Mr. Pedder's proposition that so grave an injustice had not been done that it was desirable to abandon the principles of the existing state of things, but that they should proceed in the main on the lines which had been established on the laws which had been in force for some time. He was strongly of opinion that great injustice had been done in Oudh, and that justice should be done to the ryots there.

Mr. E. Kimber said he had looked upon Sir George Campbell as an authority upon Indian affairs, and consequently he came to that meeting for the purpose of ascertaining what was the state of the law in Bombay and Madras, but, unfortunately, he was quite in the dark after having listened to the observations of Sir George Campbell, and also the paper which had been read that evening. Sir George Campbell said he understood that such tenancies had grown up, that such proprietary rights had increased in Bombay and Madras, but there was nothing definite about the statement. The reader of the paper had disclosed something of which the great majority of that audience was ignorant before—he had told them of the difference between the Government and the talukdars. After the Mutiny the talukdars made a demand which was not granted, but something was granted on the condition of their laying down their arms; and if it was just to refuse the demand in the first instance to the talukdars, he should like to know why it was not refused. First they made a demand, then came the Mutiny, and then the grant of the demand. They had that night heard the truth of the matter from Mr. Pedder. Then they were told by Sir George Campbell that there was oscillation both in India and in England, but why was that? Simply because a law was passed, some thirteen or fourteen years ago, making the ryot's interest not only heritable, but transferable, and then another law was introduced in 1883, making it only heritable, but not transferable. Why that law was introduced they had not been told, but he supposed the producers of it were reasonable people, and he should like to know how it was the law was made.

Mr. Pedder wished to point out that the Act which had just been referred to never gave any right to transfer property in the Central Provinces.

Mr. Kimber said he certainly understood Mr. Pedder to say that thirteen or fourteen years ago transferable rights were given to the ryots in some provinces, and that they were taken away in 1883. He had no knowledge himself upon the subject, never having been to India, and he should like to know whether the gentleman who introduced the law thirteen or fourteen years ago in those particular provinces, understood the law as it was then introduced and regulated by the natives themselves. Similar things had occurred in England, where distinguished Judges had interpreted the law as they had understood it, and the House of Lords had afterwards held that the law thus administered was wrong. Having had occasion to discuss the law with the Advocate-General of Madras, he found out that even that gentleman did not understand the law as it was commonly received among the natives themselves.

Mr. Seton-Karr said he never approached this subject without being reminded of an anecdote he had heard many years ago. M. Jacquemont, the French traveller, said to Mr. Holt Mackenzie, "I want half-an-hour's talk with you, to make me understand clearly the land tenures of India." Mr. Mackenzie replied, "I have studied them for the last twenty-five years, and I am not sure that I understand them yet." Without pretending to know as much as Mr. Holt Mackenzie, he (Mr. Seton-Karr) did know more than M. Jacquemont, and he had been struck by Sir George Campbell's remark as to the oscillation of opinion in India. About the time when the Bengal zemindar system had taken root, it was deemed advisable to extend it to Madras, but the revenue authorities there had taken fright, and the ryotwari system was introduced. In his younger days, he heard of nothing but the wonderful system which had been introduced into the North-West Provinces, which, no doubt, in the hands of Mr. Thomason, was a marvel. Then came the Mutiny, and then the indigo disputes occurred, after which a strong wave of opinion set in for substantial zemindars having a stake in the country, but now the tide had turned against the zemindars. When districts were large, and communication imperfect, the zemindars, if they were tolerably strong, had it their own way with the ryots, but if the zemindars were weak, the ryots had it their own way, and consequently the zemindars could not get their rent. The zemindar had power to summon his ryot to his local *kutcherry* for the rent, but it was understood that he had not the power to compel his attendance; and so if the man, when summoned, was strong enough, he turned round and broke the bearer's head; and if he was not strong he had to pay *abwabs* and *dustoori*. That state of things had been considerably altered, though not entirely, by Act X. Act X. might need revision, but at the time it was passed it was no doubt a fulfilment of the pledge made by Lord Cornwallis. That Act was passed by such able men as Colvile, Grant, Currie, Harington, Le Geyt, Sir Barnes Peacock, and, he believed, Mr. A. J. M. Mills, all of whom were most competent men to deal with such a vast and extensive subject. The Act, no doubt, had not done all that was expected, and it might very well be amended; but it was an instalment of the justice due to the ryot.

Mr. J. M. Maclean said he did not possess sufficient technical knowledge to enter into a discussion of the question on the lines laid down by Sir G. Campbell and Mr. Seton-Karr, but he should like to attempt, having heard the paper and listened to it with great interest, to draw the moral of the paper as regards the mistakes that had been made in the land legislation of India. He could not help thinking that the cause of the failure might be summed up in the expression of Mr. Shore, that the most mischievous person in India was the zealous revenue official. Almost all the mistakes had arisen from this cause, that the persons charged with the government in the different provinces had some preconceived theory of their own to carry out, and had set about attempting to provide one uniform system for the settlement of the land throughout India. In Bengal, no doubt, a great mistake was made at the time of the permanent settlement, by creating the system of landlords holding great estates, with tenants holding under them. In Oudh, the pendulum had swung to the opposite extreme, and large landlords were deprived of their estates, because some people had got hold of the fixed idea that it was necessary to create a great system of tenant right. That system had to be abolished, because the talukdars took up arms against the authority of the British Government. In the Southern Mahratta country, the idea prevailing amongst the modern settlement officers had been not very different from that which found favour with Mr. Henry George, that was to say, in favour of the nationalisation of the land. The effect of a good many of the recent revisions of land assessment in that part of the country had been to raise the Government demand to a point above what the tenant ought to pay. So far had it gone that the State had been actually obliged to pass a law to exempt certain property of the ryots from attachment, the result of the law being naturally that capital had been driven away from the land, the ryots being more pauperised than ever they were, and the State would have to collect its rents from a pauper tenancy. These were all mistakes which arose from the same cause, the adoption of some fixed idea that a particular system of land legislation must be the best for all countries. What they had to do was to recognise the existing rights of landlords and tenants as far as they could. The Government ought to have regard to its own prospects, and what would be the result of making revolutionary changes. The great danger now was with regard to the zemindars. Bengal had no permanent settlement at all, owing to the way in which power was reserved to the Government to interfere in favour of ryots, and so long as that power was left in the hands of the Government, the ryots would never be satisfied until the whole of the property of the zemindars was transferred to them. He hoped the Government would divest itself of the power of interfering, on behalf of the ryots, and give Bengal a permanent settlement.

Sir William Rose Robinson, K.C.S.I., observed that Mr. Pedder was much to be commeserated in his study of the history and of the provisions of British legislation on the subject of landlord (or "proprietor" as he terms the zemindar) and tenant. The expressions, of course, traverse Hindu agrarian common law, whose language has no equivalents for the terms "rent," "tenant," "occupancy," and the like, throughout the various provinces of North India. Mr. Pedder's precis may be accepted as accurate and exhaustive, so far as it goes, but it presents a sad hotch-pot of confused and provincial enactment, characterised throughout by the same alien and hybrid strain, with modifications in different provinces to suit the taste of local promoters; but everywhere likewise by the same wide divergence from (perhaps from contempt of) the true prescriptive conditions of Indian agrarian law, and the institutions of Oriental society. Now there is, he observed, no provincialism or isolation about the ancient agrarian common law of India—of all India, he held, because, broadly speaking, the ancient land law was homogeneous and all-pervading in respect to the ryotwari ownership of land, and the regulation of the burdens its holders had to bear, and as to the position of the zemindar as a hereditary owner, collector, or assignee of the land tax; and no more assured, wise and equitable law ever ruled the relations of all the constituents of rural life in any country than that which governed the prosperous civilisation of India from times far prior to the Christian era. By withdrawing what he calls the ryotwari provinces from his own consideration, and from the contemplation of the meeting, Mr. Pedder shuts off the best evidence in respect to the legal bearings of this matter from a national standpoint, and closes the most important field of research and means of correct judgment. He would remark incidentally that a ryot is not as a rule a cultivator, as apparently assumed by Mr. Pedder, but a prescriptive proprietor with tenants (properly so-called) under him. As proprietor, he pays the State taxes; but under the prescriptive law of the country he possessed a title of the most complete character to his land. It is not the fact, as frequently alleged in this paper, that the ryot of India held his land on the condition of paying either taxes to the State, or rent to some superior claimant in this respect. Eviction and ouster are absolutely creations of British legislation, so far as India is concerned. Under moderate taxation, such as characterised legal Indian fiscal adjustments, the contingency did not arise, and rack-rents had no existence under the conditions of its rural society. A fee, or regulated per-centage on the collections (termed in the south the Poligar's "merah" or some equivalent expression), was the only due which the hereditary chief, collector, or assignee of the public demand, could rightfully claim; and the "abwâbs" which he added to his income were a direct acknowledgment that he was not entitled to increase the regulated fiscal assessment of the ryot's property to public taxation—call it "tumâr," "tiruvah," "kandâyam," or what we may. In short, it would be impossible to conceive a more complete and indefensible title to property than that recognised by the ancient Hindu common law on behalf of the ryot of India. It would be impossible to employ language wider from the fact than the terms used by Mr. Pedder, when he tells this meeting that "It must not be forgotten that the ('occupancy' is not a Hindo legal term) right of the ryot was vague, undefined ,inchoate right only." At no time was this the case; and the instructions to the superiors of revenue in 1769, as well as Mr. Hastings's minutes, *passim*, clearly show that it was not the case, even in Bengal, when the British rule intervened towards the end of last century. Mr. Pedder had failed, he observed, to apprehend the object and nature of the "potta," which he describes as "an instrument defining existing tenancy." It was an instrument intended to distribute the recognised revenue demand proportionately amongst the prescriptive owners of land, and not a muniment of title or "defining existing tenancy."

Mr. Seton-Karr said it was so in Bengal.

Sir William Robinson gathered from the remark, that the misapprehension is more wide-spread than he was prepared to learn. The "potta," where it existed, might be received in courts of justice as evidence of occupation, because there is a presumption that the person who pays the taxes is in occupation, but under what conditions it was not intended to show. But this is the only function which it fulfils. The legislation in respect thereto proved wholly inoperative, and was, he understood, early removed from the statute book. Zemindars had no intention to extend to ryots the benevolent limitation of the public demand accorded to them by the permanent settlement of the revenue; and the ryots were slow to believe that their prescriptive legal rights had been abrogated, and did not seek a new and unintelligible title deed for property which their own prescriptive law already held sacred.

Mr. Martin Wood objected to the title of the paper, "Landlord and Tenant," those names being entirely inapplicable to India. The terms were exotic, and could only have been used in deference to the superstition that the plutocratic system in this country was the only proper land system in the world. The proper title, in his opinion, should be "Landowners and Cultivators." With regard to what had been said about oscillation and changing of opinion, he thought the oscillation has been a deviation from the original law of India, which had been established for many centuries, that the first right in the soil was that of cultivators to reap a beneficiary interest in it. Nearly all the troubles about land in India had arisen from disregarding that ancient right of the Indian peasant, which, though often grossly encroached upon, still remained the only true basis of landed rights in India.

Mr. T. H. THORNTON, C.S.I., thought that the land law in the Punjab had been very accurately described by Mr. Pedder. That land law was the result of an "oscillation," which occurred in this way; the first settlements were made under the Irish Chief Commissioner (Sir John Lawrence) with strong feeling in favour of Ulster tenant right; the second settlements were commenced under a Scotch Lieutenant-Governor (Sir Donald McLeod) with a strong predilection in favour of proprietary despotism. Then came a four years' struggle between the advocates of tenant rights on the one hand and landlordism on the other, and ultimately a compromise embodied in the Punjab Tenancy Act of 1868. The result, on the whole, has been very satisfactory. In the case of the tenant, nearly 600,000 agricultural households have been secured from liability to rack-rent and arbitrary eviction. As for the landlord, when the Act was passed, it was asserted that his rights were confiscated and that the whole agricultural community would be plunged into litigation. But litigation had been extremely moderate in amount, and as to the alleged confiscation of proprietary rights, since the passing of the Act, the average selling price of agricultural land had more than doubled. In the last report of his administration, Sir Robert Egerton, the late Lieutenant-Governor of the Punjab, after fifteen years' experience of the working of the Punjab Tenancy Act, described it as "the bulwark and charter of a con tented peasantry." Adverting to the remarks of Sir William Robinson, Mr. Thornton remarked that if the principles advocated by that gentleman had been followed in the Punjab, that is to say, if we had accepted and stereotyped the land system we found existing at the time of annexation, we should have stereotyped one of the most oppressive systems ever known; for the land system of the Sikhs was this—that the State, as proprietor-in-chief, took all that it could get, that is to say, it confiscated, so far as possible, all private rents, and reduced proprietor and cultivator to one dead level of poverty. One of the first acts of the British Government was to reduce the oppressive taxation of the Sikhs, and thus leave a margin for rent, and the revival, under altered conditions, of the status of proprietors. Such was the situation in the Punjab, when the first settlements of land revenue were made, and the first records of rights in land were prepared under the administration of Sir John Lawrence. In such circumstances, the equitable determination of the relations of proprietor and tenant was a matter of extreme difficulty. But the difficulty could not be solved by antiquarian researches into the land system of the Vedas, nor by reference to agricultural custom, for custom had been more or less in abeyance for years. The only way of properly dealing with the situation was the way which was adopted, viz., by making as equitable a settlement as was possible under the circumstances—following custom, where custom was in existence, and where custom was no longer applicable, the law of common sense.

Mr. DATTA wished to point out that the condition of the tenants in Bombay and Bengal was not of the miserable nature which had been described that evening. A great deal had been said as to the tenancies being made permanent, but he should very much like to see the condition of the people of Bengal mitigated.

Mr. PEDDER, in reply, while thanking Sir G. Campbell for his remarks, would point out that the Oudh tenancy law was enacted under the influence of Sir C. Wingfield, afterwards an eminent Liberal member of Parliament. With regard to the statement of Mr. Kimber that the account given in the paper of the origin of the Oudh tenancy law was new to him, he would remark that a Blue-book on the subject had been issued, which could be purchased by anyone for a trifle. He could not, at that hour, attempt to reply to the arguments of Sir W. Robinson, but he thought he had ground for complaint against some of the remarks of that gentleman, whose criticisms of some of the statements in the paper were founded on misconception of their meaning. The paper had distinctly stated that the rents payable by tenants are based upon, or derived from revenue rates, and that a "potta" is an instrument defining the conditions of an existing tenancy, and this was nearly what Sir William said himself. Mr. Maclean had somewhat exaggerated the incidence of the land revenue in Bombay. Under the old native system, the revenue was usually one-third or one-fourth of the gross produce, which from careful estimates lately made, it appeared not now to exceed $7\frac{1}{2}$ per cent. of the gross produce. As to Mr. Wood's complaint that the title of the paper was misleading, it might be an unfortunate title, but still it was the title by which the law on the subject in India is known.

The CHAIRMAN, in proposing a vote of thanks to Mr. Pedder, said that he considered the paper a very valuable one. Mr. Pedder had had the good fortune to be placed in a position in which he had a kind of bird's-eye view of all the systems in India, and, therefore, he knew no one better qualified than he was to give an instructive sketch of the whole subject. It was true that Mr. Pedder did not appear to have satisfied all his critics, but he thought some of the criticism was hardly just. The land laws of the different provinces of India, though they have their origin in the same principles, have, by the force of local circumstances, grown into separate systems, and, as a consequence, have produced a number of different schools of land revenue officers, who, probably, from want of an intimate acquaintance with the working of the system of any other province than that in which they serve, are apt to think theirs the only good system, and to condemn all others. Mr. Pedder had been blamed because his paper did not deal with Madras and Bombay, but it should be remembered that he had commenced his paper by saying that on this occasion he proposed to confine himself to the non-ryotwari provinces, and that the expectation that he would have dealt with the ryotwari provinces, Madras and Bombay, was hardly reasonable. Then he had been blamed because he had not given us a history of the ancient Hindu land system, but his paper was on the existing land laws, and not upon the land laws of the Hindus; in fact, if Mr. Pedder had dealt with all the matters which it was said he should have dealt with, his paper would have extended over several nights. Mr. Pedder had alluded to the position of the zemindar as a landed proprietor under the permanent settlement, and had explained what was clearly the intention of the framers of that measure in respect to the proprietary right then conferred. It was very unfortunate that the word proprietor was ever used, because it has a meaning to English ears entirely different from that which it was intended to convey, and English writers could not get over the idea that the zemindar had the same proprietary right over the land in his estate that an English landlord had. The Bengal proprietary right was, however, much restricted. It was limited on both sides; on one side by the rights of the ruling power, on the other by the rights of the cultivator of the soil. When the settlement was made with the zemindars they contracted to take their estates, subject to a liability to pay to the State the collections calculated on the existing rent-roll, a certain proportion of the collections being left in their hands. They were to get all receipts in excess of this, and would profit by all new collections, but if they did not have the amount by sunset of a certain day the estate was put up to auction by Government. That is the existing law, and it is difficult to say how anyone can see any analogy between such a proprietor and the English landlord. Then the right, as explained by Mr. Pedder, was limited by the right of the resident cultivator to hold the land he cultivates so long as he pays the rent justly demandable for it; the unadmitted existence of this right is fully supported by the extracts just read to them. On the whole, therefore, it seemed to be a great pity that the zemindars were declared proprietors of the land when they were really created proprietors of only a limited interest in it. He might take exception to Mr. Pedder's statement as to the two causes why, in his opinion, the legislation of 1859 had not answered its purpose. He stated that in Bengal "there had never been a general cadastral survey, nor any regular record founded upon it of holdings, rents, and payments on account of rent, while, as has been stated, it was found impossible to maintain the village accountants and village records, contemplated by the Code of 1793." That seemed to imply that at the time of the permanent settlement these village records and establishments really had existed, and that a complete system was made over to the English officers, and that it was through their carelessness that the system had been allowed to disappear, but this was not the case now. A reference to the report of the Parliamentary Committee of 1812, would show that at the time of the permanent settlement in Bengal Proper there were no traces of the village system, and that even in Behar, there was only a nominal trace of the village system. It was shown in that report, that the system, where it existed, had fallen into disuse under the Moghul Government. Therefore, it was clearly impossible that the Bengal revenue officers could have allowed a system to fall out of sight which really never existed. It was entirely on account of the absence of the village system that no cadastral survey had been made up to the present time, and no such survey could now be made, as they would have to begin with a quasi-law suit for every little holding in Bengal. The right in each holding would have to be determined before it could be recorded. The framers of the permanent settlement, if they failed in anything, failed in want of foresight as to the success of their own measure; they did not foresee that in the course of half a century the population would become so prosperous, and the cultivation so far increase, that the whole condition of the country would be changed; they relied upon the state of things which they found when the land was far in excess of the requirements of the agricultural community, and believed that the zemindar, in his own interest, would maintain the old law under which the ryot was left in the possession of the land which he cultivated. They did not foresee that sixty years of peace, prosperity, good government, and freedom from harassing resettlements, would lead to such an increase of the agricultural population that the land available would not suffice for all, and that the consequent competition for land would lead to a frequent enhancement of rent, and a tendency to get rid of ryots who would not pay the highest rent.

The vote of thanks was carried unanimously.

FOREIGN & COLONIAL SECTION.

Tuesday, April 29, 1884; F. W. RUDLER, F.G.S., in the chair.

The paper read was "The Transvaal Gold Fields; their Past, Present, and Future," by W. HENRY PENNING.

The paper and discussion will be published in next week's *Journal*.

NINETEENTH ORDINARY MEETING.

Wednesday, April 30, 1884; EDWARD BIRKBECK, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Barclay, Robert, 17, Major-street, Manchester.
Bishop, Frederic Sillery, M.A., Welwyn-lodge, Swansea.
Ellis, Herbert, 62, New-walk, Leicester.
Francis, George Bult, 5, Coleman-street, E.C., and 21, Taviton-street, W.C.
Guttmann, Charles, 16, Brownswood-park, South Hornsey, N.

The following candidates were balloted for and duly elected members of the Society:—

Alldridge, Thomas Joshua, York Island, Sherbro, West Coast of Africa, and Old Charlton, Kent.
Allpress, Vincent Sydney, Cliefden, Eltham, Kent.
Bryce, Charles C., 141, West George-street, Glasgow.
Christie, John, Rosshead, Alexandria, N.B.
Gibson, John Merriman, Buckley, Chester.
Gothard, Frederic, 204, Ashby-road, Burton-on-Trent.
Kemp, William Joel, Copyhold-house, Redhill, Surrey.
Lovibond, Joseph W., 26, St. Ann's-street, Salisbury.
Muir, Rev. Robert H., The Manse, Dalmeny, Edinburgh.
Richardson, Frederick William, 40, Church-street, Bradford.
Rumpff, Carl, Schloss Aprath, near Elberfeld.
Wace, Rev. Prebendary Henry, D.D., King's College, Strand, W.C.
Wall, Robert Frederick, Thames Sugar Refinery, Silvertown, E.

The CHAIRMAN, in introducing Mr. Willis-Bund, said the subject on which he was to speak, the Freshwater Fisheries Amendment Bill, was one of great interest and importance to anglers not only of London but especially to those in the country; and they were very fortunate in having it explained by the highest authority in England on freshwater fishery legislation. This Bill, which was introduced by the Government early in the Session, was a very short Bill, having at first only two clauses, but as passed on Monday last it had nine, and only now awaited the Royal assent to become an Act of Parliament. He had every reason to hope that it would have the effect of putting a stop to the extensive system of poaching which had hitherto been carried on, and which no previous legislation had been able to cope with. From the very introduction he had taken a deep interest in this Bill, and thought it was a good opportunity for introducing such clauses as would remedy the defects of existing legislation. He had been guided in the attempts he had made to improve the Bill, by his experience of the working of the Norfolk and Suffolk Fisheries Act, 1877, under which poaching had been, to a considerable extent, put a stop to, and the supply of fish had been greatly increased in the Eastern counties. He was confident that under this Bill the same thing would, to a great extent, be carried out throughout the country. There might be some disappointment felt that no clause was introduced with reference to undersized fish, a question which was discussed at a large meeting in that room two years ago. He knew that this subject had been brought before the authorities by several gentlemen, but Mr. Hibbert, who had charge of the Bill, after giving the matter his deepest consideration, could not see his way to introduce any such clause, and after several interviews with him, he found that if any such attempt was made to force such a clause, it would jeopardise the passage of the Bill. His own opinion was, therefore, that existing legislation with regard to salmon and other freshwater fisheries in England was so complicated, that it would be indispensable for the Government next year, or the year after, to introduce a consolidation Bill, and that that would be an admirable opportunity for introducing, with due care, and possibly after a Select Committee had gone into the question in order to satisfy all parties concerned, a clause with regard to under-sized fish. He would take this opportunity to express not only on his own, but also on behalf of all the anglers of England, his deepest obligation to the Home Secretary for the great assistance he had rendered them, and especially for his desire, as expressed to him both publicly and privately, to make this Bill what anglers really required. Mr. Hibbert was also entitled to their special thanks, for the able manner in which he had carried the Bill through the House of Commons amidst many difficulties.

The paper read was—

THE NEW LEGISLATION ON FRESH-WATER FISHERIES.

By J. W. WILLIS-BUND.

One of the most striking features in modern fishery legislation is the re-enactment of provisions that were formerly law, but which have from time to time been repealed as useless and mischievous. A few years ago, it was considered that the true principle in fishery legislation was to allow perfect freedom to all parties to take fish when and as they thought best. The old laws, which had placed restrictions on the size of the fish it was lawful to take, on the times at which, and the mode by which, fish might be taken, were considered to be absurd restrictions on the liberty of the subject, and were repealed. It was said—I believe it is still said—that the natural fecundity of fish is so great, that it is impossible to over-fish our rivers, and that any laws that placed restrictions on fishing were useless, or worse than useless. That from time immemorial complaints had been made on the decrease of fish in our rivers, but that on these complaints being investigated, they had turned out to be groundless. So Act after Act was repealed, and every one was, in fishery matters, legally allowed to do as he liked. These repeals were carried out in two ways. (1.) By consolidation Acts, such as the salmon Fishery Act, 1861, which repealed some twenty-six public Acts and seven local Acts relating to fisheries without re-enacting any provision in their place for fish other than salmon. (2.) By statute law revision Acts, which repealed a number of statutes that their framers, who knew nothing about fish or fishing, were pleased to consider obsolete and useless merely because they were old. No one took any interest in the matter; the revision Act made the Statute-book more symmetrical, and passed almost as a matter of course. Hence, no general law existed to protect freshwater fish. Salmon were, it is true, protected, but salmon only; all other fish were delivered over to the tender mercy of the poacher, and our only ource on which we could rely for keeping our rivers stocked with fish was the natural fecundity of the fish themselves.

In old times the law as to the protection of fish was enforced by the Court Leet in each manor, and in many of the Court rolls of our manors are curious entries showing the way in which the law and local customs were applied; but Court Leets gradually went into disuse, and there remained no body whose duty it was to carry out the law. For a time voluntary effort endeavoured to supply the place, but in most instances voluntary effort failed, and the fisheries were wholly neglected. In 1865, a change was made. Boards of Conservators were appointed for salmon fisheries, and power given to form fishery districts; certain powers as to trout were given to these Boards, but, with this exception, the powers were limited to salmon, and salmon alone. It did not seem to have occurred to Parliament that if the fisheries of a district are to be properly looked after, the body in whose care they are placed should have power over all the fisheries, not only over one class. Under the Act of 1865, numerous Boards of Conservators have been formed, but these bodies are confined, with the exception of three small Boards in Kent and Sussex, to the north of England, Wales, and the west of England. The Thames fisheries were under the jurisdiction of the Thames Conservancy, and their Acts enabled them to make a series of bye-laws prohibiting netting, restricting the time at which fish can be caught, and the size of fish that may be caught, but beyond this no protection existed. A further advance was made in 1873, but only indirectly. The Salmon Fishery Act of that year gave Boards of Conservators power to make bye-laws fixing the mesh of nets, regulating the mode of using nets, and the kind of net that might be used, and prohibiting night fishing. But still these provisions only applied to fishery districts. In 1877, the Norfolk and Suffolk Fisheries Act constituted a Board of Conservators for those counties, and gave them very large power to protect all fish in the public waters in their district. In 1878 came Mr. Mundella's Act, which fixed a general close time for freshwater fish, and gave power to form Boards for trout and char, as well as for salmon. I believe that the last power has not been exercised. In the present year the Government introduced a Bill which, as originally drawn, simply gave to Boards of Conservators power to fix by bye-law the mesh of net for fish other than salmon. Fortunately, advantage was taken of the opportunity to obtain far more extended powers for the protection of freshwater fish, and to make the Bill a means for giving protection to freshwater fish throughout the country. Shortly, what the Bill does is this, it applies to all fish other than salmon that are found permanently or temporarily in fresh water. It enables a Board of Conservators to be appointed for every river in the country, and such Board, when appointed, will be able to to employ watchers, who will have the large powers for the protection of fish given by the Salmon Fishery Act, 1873. They will also be able to say what nets may be used on any river, what shall be the size of the mesh of net that may be used, and in what way it shall be legal to take fish. As I read the Act, it will be within the power of a Board to say that no nets shall be used in the district but landing nets; that the only modes of taking fish shall be by angling with a rod and line. I do not offer any opinion whether it would be wise or not in a Board of Conservators to make such regulation, all I say is that they have power to do so, subject, of course, to the confirmation by the Secretary of State.

Throughout England and Wales, therefore, the law as to freshwater fish will now be—

1. That it is illegal to take or sell fresh-

water fish during the close time between the 15th March and the 15th June.

That where there is a Board, fish can only be taken during such time and in such manner as the Board permits.

That the water bailiffs have power to search for and seize all fish illegally caught, and if they find any illegal fishing at night, to arrest the offenders.

Although by no means a perfect code, still I think the very large powers here given to Board of Conservators, if properly used, will be the means of effecting a great reform in our fisheries. One provision is omitted, and one that should be supplied at the earliest possible date, namely, a prohibition on the possession of undersized fish. It was the law of the land until 1861, and I fail to see the reason why it should not be law now throughout the country, especially as it is still law in certain parts of the country.

Having stated what the powers given by the new Act are, I may, perhaps, be allowed to say a word on how I think they should be exercised. I feel that I am treading on very dangerous ground. Probably every one who hears me has his own ideas on the matter, and consider that any one who differs from him must be wrong. At the risk of offending some of my audience, I will venture to put forward my views for what they are worth.

The first thing to point out is the absolute necessity of using the powers with discretion and moderation. Two things should be remembered, that they apply equally to public and private property, and that they impose very serious restriction on the enjoyment of the rights of property. Those of you who have had any experience in the working of the Salmon Fishery Acts will remember the opposition that one continually meets with on the ground that the powers thereby given are an interference with the rights of property. For migratory fish, such as the salmon, of course much may be said in support of those powers, but many of these arguments will not apply to non-migratory fish. I breed a number of trout; I turn them into my pond; may I not take them in any way I please? No, says the Act, only in the way the Board of Conservators allow. I am far from saying that a man ought to be allowed to take his own fish as he likes, but what I want to point out is, that unless great discretion is used in exercising these powers, the Board will infallibly make the landowners their enemies, and protection will be impossible. The object of the powers are to stop poaching, not fair fishing, and they should be, as far as possible, confined to this. I have long ago come to the conclusion that the ideal state of fishing is to allow no freshwater netting at all for any sort of fish. I am quite aware such a state of things is impracticable, but yet when I look at the Thames, I think that some approach may be made towards it. At all events, certain kinds of nets can be done away with; the old legal maxim, that a man has no right to use his own property to his neighbour's prejudice, can be safely acted upon, and all those modes of taking fish that really injure the stream should be and ought to be forbidden. For instance, netting after floods in backwater should be put down with unflinching severity. Again, I think a Board might not unfairly prohibit new netting stations being opened. Existing rights should certainly be secured; but a man who has never used a net should not, some few years hence—when, by the labour and expense of his neighbour, without any effort of his own, the fishing has become valuable—be able to reap the benefit of his neighbour's industry. So again, dragging fords, the use of nets by barges, the use of nets at night—all these should be prohibited. The principle seems to me to be that no attempt should be made to interfere with the exercise of the rights of property, as long as such exercise does not interfere with the enjoyment of his property by a neighbour. Netting is an evil, and the object of all regulations should be to minimise the evil as much as possible.

Assuming that netting is necessary, the question arises whether it is possible to fix upon one or more forms of net that should be the legal modes of netting. Power is given to do this—can it be properly carried out? I think it can; and I also venture to think that if only two forms of net were legal—the ordinary sheet or draught-net, and the trammel or armoured-net—much poaching would be done away with. Of course, if a draught-net could be used in all rivers, that net would be the best; but in certain rivers its use is, from the nature of the bed of the stream, impossible, hence recourse must be had to the trammel, a much more deadly and destructive net. I am strongly of opinion that an attempt should be made to put down all fixed nets in freshwater absolutely, and to limit the kinds of net that may be legally used. A difficult question will arise as to casting-nets. They are largely used as a means of taking live bait and, if legitimately used for this purpose, are harmless, and perhaps necessary; but I am convinced that more poaching is done by the use of casting-nets than by anything else; they look so fair, no one suspects that they are so deadly, or that in experienced hands they can undo the result of the work of years. If they are to be allowed at all, it should be under the most stringent regulations as to the time and place where they are to be used. Of course, it will be borne in mind that legitimate netting must not be interfered with; but, I think, regulations should be made even for this. By legitimate netting, I understand netting, by the owner, or his agent, of a stream, either for the purpose of sport, or for sale, or for bait, or for scientific purposes, or what is perhaps the most important of all, for the purpose of destroying fish unsuited for the river. There is not much difficulty as to all but the last, in case where a person is the owner of the whole stream. When a person owns only half the stream, it would not be fair that he should net to the prejudice of his neighbour who does not. What I have already said as to regulating the netting would apply very forcibly to the case. As to destroying unsuitable fish, grave difficulties arise; in a Hampshire trout stream, it is imperative to kill down the pike, and whatever form of netting would kill them down in the quickest and most effectual way, should be the mode employed. But it would never do to allow indiscriminate netting; or, otherwise, in killing the pike, the trout would be killed also. To me it seems that some such system as that now adopted on the Usk would be the true way of meeting the difficulty; there the Association do all the netting, and give the riparian owners a share of the fish. If the Board of Conservators took in hand the duty of keeping down the pike, then there would be no objection—at least if the Board did their duty there should be no objection—to the most effectual means being taken for the purpose, however objectionable the means might be in other hands.

This brings me to a point that it seems requires further legislation. It is impossible to make all our streams salmon or trout streams, even if such a state of things were desirable. But each river can produce fish of some sort, and the duty of the Board is to find out for what fish the stream is best adapted, and to stock it with those fish. Having done this, they should have power to prevent any kind of fish they do not approve of being placed in the stream. I will give an instance of what I mean. Some gentlemen went to considerable expense in stocking a mountain lake of about five or six acres in extent with trout. They got a good supply of fish, and very good sport could be had in that lake. It had a rocky bottom, and could not be netted, and the few who were allowed to fish it looked forward to its being a piscatorial paradise. A discharged keeper had his own ideas of serving out his employers, and placed in the lake a bucketful of small pike; he had committed no offence for which he could be punished, but he had ruined the fishing in that lake. It seems to me that Boards should have power to make it an offence for a person to turn any kind of fish into a river or lake without their assent. I am one of those that think all fishing is good, even fishing for frogs if I cannot get any other; but I also think that each stream should be devoted to produce the fish that will thrive best in it, be they what they may, and that one of the duties of Boards of Conservators should be to carry this out. The *raison d'être* of these Boards is to produce the greatest and best quantity of fish in each river, and it may be equally necessary to restrict the kinds of fish in the river as to restrict the modes and times of taking them.

Another most important power given to Boards of Conservators is to determine the mode in which nets may be used. Perhaps the mode of using the net is even more important than the kind of net that may be used; a draught-net improperly used may be the most poaching of instruments, as, for example, a draught-net dragged over fords; a draught-net placed at the end of a mill race, and the wheel being suddenly stopped. The mode of using nets will depend, of course, greatly upon the place where the net is used, but I trust that the Boards will be most stringent in placing restrictions on the mode of using nets. I may mention, as to this, a mode of using nets for salmon that, to my opinion, does more harm than anything else to the Severn. Between Gloucester and Tewkesbury, just as the tide begins to run, and the fish ascend with the tide, the fishermen shoot the net right across the river, and thereby stop and catch all the ascending fish. This mode of using the net is not now, but I trust soon will be, illegal; yet had the Board not power to make bye-laws to determine the mode of using nets, nothing short of an Act of Parliament could stop it.

I am rather unwilling to say anything about the mesh of nets; it is a subject on which I never found two persons agree. All I will venture to say is this, that it appears to me most desirable that a standard mesh should be arrived at, that would be available for all fish and all nets. Nothing that I know is more vexatious and gives more trouble than the necessity that at present exists for two sorts of nets, one for the migratory salmonidæ, the other for all other fish. It is also mischievous in that it leads to nets for fish other than salmon being made of a smaller mesh than would otherwise be the case. With the kind of net fixed, a uniform mesh of net for all nets fixed so that all other nets of any kind would be illegal, a water bailiff's duties would be greatly simplified, and a stop put to much illegal netting.

A most valuable power is given to Boards by which they are enabled to prohibit the use of any mode or instrument of fishing that appears to be prejudicial to the fisheries. It is to be hoped that the Boards, will promptly use their power to make an end of the use of night lines, trimmers, eel spears, and pike snares, and other poaching instruments. The habit of lading out hooks in dry weather, causing the wholesale destruction of the fish, and grouping or tickling trout, should also be made illegal. The same principle that prohibits taking game by certain modes, equally applies to taking fish, and the reason which justify the one will also justify the other. A more difficult question arises as to use of traps at mills. Any one with any experience in fishing knows that more poaching is done at mills than anywhere else on the river, and that the traps so often found at mills are usually most destructive. On salmon rivers, regulations as to these traps have already been made by statute, but on non-salmon rivers they can be used as the owner pleases, and the mode that most pleases him is the mode whereby most fish are caught.

It will have been gathered from what I have said, that all the regulations I have recommended are in favour of angling as opposed to other modes of fishing. I have done this, as angling has become the most important and nearly the only legitimate means of taking freshwater fish. Very few, if any, persons make a living, or even profess to make a living, by fishing for freshwater fish apart from angling, and those persons who do, only use fishing as a cloak for poaching. Year by year the number of professional fishermen for freshwater fish, other than anglers, have decreased, until at last they have become as rare as Thames salmon. The number of anglers has, on the other hand, largely increased, and angling has become a most important interest in the country. It is difficult to estimate the number of anglers; over 5,000 last year took out licenses on the Severn alone, and the anglers in London, Nottingham, and Sheffield are legion. It is therefore only right that the restrictions and rules as to freshwater fish should be framed in the interest of the most important body connected with the fisheries.

There are various other points in connection with the new Bill upon which I should have liked, had time permitted, to have said something, but those I have mentioned seem to me the most important. The whole question whether the Act will be a great success or a great failure, turns upon the way in which these powers are exercised by the Boards. I cannot urge too strongly that it is all important that the powers should be so exercised as to procure harmonious relation between the Fishery Boards and the riparian owners. The amount of water in which the public have a legal right to angle is exceedingly small, and if any bad feeling arise between the Board and the riparian proprietors, the result would most likely be that the public would be refused leave to fish in water where leave is now given, and hence the general body of anglers would suffer. Speaking, after eighteen years' experience of the work of a Fishery Board, I say most emphatically that harmonious relations with the land owners will do more in the way of preservation than any amount of Acts of Parliament, bye-laws, or rules. The great mistake that the Salmon Fishery Boards made at the start was that they tried to force the law down the proprietors' throats and act on their utmost legal rights; they used their powers as the policeman used his staff—break someone's head as soon as possible, in order to show they are entitled to do so. And hence it is that these Boards have not been so successful as they ought to have been. I hope I shall not be thought impertinent in urging the Boards that will be constituted under this Bill to take warning by the example of the Salmon Boards, and attach the utmost importance to being in harmony with the riparian owners. Fishing we know was an apostolic pursuit, and in no case is the apostolic maxim, "If it be possible, live peaceably with all men," more required.

In conclusion, I would venture to make two practical suggestions that it seems to me will tend to facilitate, if they do nothing else, the enforcement of the powers given by the new Bill. First, that as it is desirable to have the same law applying, as far as possible, to all rivers, a conference of the different Boards should be held to settle, if possible, the kind of net it should be lawful to use, and the mesh of net, to prohibit certain modes of using nets, and to determine what modes and instruments of fishing are prejudicial to the fisheries. Let each Board add, afterwards, such additional rules as local circumstances require; but as the great object of all Boards in the suppression of illegal fishing, let those illegalities that are common to all the country be put down by all Boards. A conference, such as I propose, would at least do this, it would show what is the opinion of those who know each locality, and the necessities of each locality in the protection of the fisheries. Secondly, it might lead, unless some other body will take up the work, to what we so greatly need, an executive society in London, charged with the duty of watching and protecting the interests of fishing in general, and angling in particular. As has been said, while Parliament is sitting, no interest is safe, and as we see every trade and every interest has a protection society, it is time the great angling interest also had one. The work would be the protection of fishing interests, by opposing all measures detrimental to fish, by promoting any measures that tended to help and encourage the fisheries. There is much work to do. The fishing laws want reducing from their present unintelligible chaotic state into a form that he who runs may read it. Amended powers and increased powers are required by Boards of Conservators to enable them properly to do their duty. The anomalies in the existing law require to be abolished, and, above all, there is the greatest and most important question—the prevention of the pollution of streams by some cheap, summary, and effective means. There are numbers of persons ready and willing to embark in the work, and all that is required is unity of action to accomplish two most important objects—the increase of the health and enjoyment of a great number of the public, and the increase in a valuable supply of food for the public.

DISCUSSION.

Mr. Marston asked whether eels were protected by the new Act; and also whether the Board would be constituted on an application being made, irrespective of the wishes of the owners of the river. He mentioned that, because in the case of the River Lea there were many private fisheries on which anglers could go and fish even through the close season; and he should like to know whether that could be stopped.

Mr. Willis-Bund thought eels were certainly included in the definition of "all fish which are found temporarily or permanently in fresh water except salmon." The question about the Board was one of more difficulty; but as he understood it, it would be the same thing as under the Salmon Acts. If the Quarter Sessions of any county through which a river ran, chose to apply to the Secretary of State to have a fishery district formed, the Secretary of State could do so; and then quite irrespective of the opposition of landowners or any one else. The first step was to put the Court of Quarter Sessions in motion, as that was the only body which could apply to the Secretary of State.

Mr. J. A. Youl, C.M.G. said he had no personal knowledge of freshwater fishing in England, but he had come there to thank Mr. Willis-Bund publicly for the many millions of salmon eggs which he had contributed, and which he (Mr. Youl) had sent out to the Australian colonies. He intended to send out a copy of the paper to Tasmania, which colony had just appointed Mr. Saville Kent their inspector of fisheries, and he thought it would be useful to him to have this paper, and a copy of the new Act, as soon as passed, as a guide for his own operations.

Mr. J. C. Bloomfield said he had been a conservator in Ireland for some years, and he must say that there the system was somewhat different from what had been described. There were three inspectors in Dublin, who formed districts all over Ireland, and constituted Boards altogether independent of the riparian proprietors. Those who had fishing rights in the estuaries had a certain number of votes and so had other parties interested in other parts of the rivers, but a certain number of conservators must be elected, and they looked after all other fish as well as salmon. In his early days eels were of very small account, and he had seen them sold in London at 2d. or 3d. a lb., but this was not the case now. He formerly had an eel weir which brought him in £120 a year, and the present owner was making £600 a year by it. Eels were to be found in every bit of water, however small. There was the migratory or silver eel, which went down to the sea, and sometimes weighed two or three lbs., and another kind which did not migrate, which now sold for 1s. 2d. a lb. A very small mesh would be required for them, if they were to be taken in a net at all. In Lough Erne they were taken by long lines, sometimes up to three miles in length, laid zigzag, and he had known of five stone being taken in a day in that way. Last year Major D'Arcy took three tons at one particular part of the shore. In Ireland they did not dream of having nets in rivers, but in ponds and lakes he thought they were necessary, if fish were to be taken as a source of food supply, though that point had not been alluded to. There were twenty-seven lakes to be seen from one hill in the neighbourhood of Lough Erne, which might all be made to produce food, if means were taken such as had been adopted in America. There they had imported carp from Germany and distributed them to about 860 different points some 1,500 miles from the coast, where fresh fish would have been otherwise unattainable. A friend of his, Sir Victor Brook, had a large river running through his estate which was a pure salmon-breeding river, and no fish ever went into it that was not killed before it came down again; but he induced Sir Victor to pay attention to the matter, and now no fish were allowed to be killed there. The extent of salmon fishery was the extent of water you could have for their breeding, and that could only be secured by the upper waters being protected. This new legislation seemed to be in the right direction, but there were still several things required to make it perfect.

Mr. C. S. Bentley agreed with the view taken in the paper that netting should be put down altogether; and to avoid difficulties with regard to catching bait, suggested that certain waters should be set apart for the cultivation of bait fish. There would then be no excuse for smuggling large fish on the pretence of getting bait.

Mr. William Botly remarked that there were many rivers which ran through property owned by different proprietors on the opposite sides, and sometimes they divided different counties, and he wished to know whether, in such cases, the regulations made by a Board would apply to both sides; if not, it might give rise to considerable disagreement.

Mr. Senior said they must all be greatly obliged to Mr. Willis-Bund for having so clearly explained the provisions of the new Bill, which after the amendments and resolutions and re-amendments, had become somewhat complicated. The day would no doubt come when the various complicated laws affecting freshwater fisheries would have to be codified, but meanwhile he was sure that he repeated the feelings of every freshwater fisherman, in throwing out the suggestion that Mr. Willis-Bund should publish a cheap and comprehensive work, explaining all the details of the new system about to be inaugurated. By so doing he would not only confer a boon on all anglers, but would do a great deal to ensure the proper working of the new Act. So far as he understood it, the new Act would be something like a local option measure. First of all, there must be a petition from a public meeting, or some resolutions passed by which the Court of Quarter Sessions might be persuaded that a conservancy was required in the district, and then the Quarter Sessions must make their recommendation which would require the Secretary of State's approval. It seemed a very simple arrangement, but it was hedged about by a great many provisions which would prevent abuses. Ireland and Scotland were excluded from the Act, and so were Norfolk and Suffolk, but he presumed they would be included when any comprehensive legislation on the subject was undertaken. He would take the opportunity of thanking the Chairman for all the efforts he had put forward in piloting this Bill through the House of Commons, for although it was a Government measure, he thought it ought to be known as the Birkbeck Bill, for it bore his mark on almost every one of its nine clauses.

Mr. Dipnall said he had a great respect for anglers; but he thought the real ground for legislative interference should be the improvement of the food supply, and if there were any great expense attending the machinery of this new Bill, there should be some productive character given to the industry which might provide for those expenses, and should tend to preserve in the rivers and lakes such a head of fish as was essential to the welfare of the population. Without wishing to criticise the Bill too closely, it seemed to him to go rather far in the way of nursing and protection; and he should like to know whether a gentleman could not have his own private fish-pond, and fish in it when he pleased; if not, he thought the legislation was carried rather too far. At the same time he was quite of opinion, with regard to fisheries in rivers of any importance from a food point of view that a close time should be established, that restrictions should be placed upon the use of nets, and poaching prevented. With regard to the great estuaries lakes, such as those of Norfolk and Ireland, it was of great importance that there should be some general laws governing the mode and time of fishing.

Mr. Marston said he had been often asked by fishing-tackle makers whether they might sell live bait at this season. He should like to know whether the new Act would cover that point.

Mr. Willis-Bund, in reply, said he had the gravest doubt whether it was legal to sell bait at all, now. Under Mr. Mundella's Act, the capture of bait would appear to be legal, but he thought the sale would be illegal; certainly the safest plan would be not to sell it. He did not think there had been any decision on the point, but, in his opinion, you might catch bait for your own use during the close time, but not sell it. He knew of no way in which Mr. Mundella's Act was more evaded than this. Men went out fishing with nets, and if they were caught, they said they were only taking bait. The capture of bait at this time was an abuse, which ought to be put down. It was generally used for catching pike, but, in his opinion, pike ought not to be caught now; the bait used for trout fishing was quite different.

Mr. Bloomfield remarked that in Ireland small perch were used as bait for trout, but the bait were not to be had early in the season, and therefore they were caught in the autumn and kept in trenches dug on purpose, through the winter, until they were wanted in February.

Mr. Senior said that bleek and small dace were mainly used in the Thames for trout fishing, and it was probably that to which Mr. Marston alluded.

Mr. Willis-Bund said the words of the Act were —"If any person during the close season, buys, sells, or exposes for sale, or has in his possession, any fresh-water fish, he shall be liable to a penalty of 40s.," and there was no exception to that at all. Therefore he took it that it was illegal to sell live bait. With regard to the formation of Boards, any magistrate could move at the Quarter Sessions that any river flowing through that county, or that the whole of the rivers, or any one of them, should be formed into a fishery district. If the motion were agreed to, it would be forwarded to the Secretary of State, and he acted simply on his own discretion, and said how large or how small a district should be formed. It did not matter whether the river formed the division between two properties, counties, parishes, or anything else. He had in his mind a river, part of which was under a Fishery Board in one place, and the whole of it in another, and it was very puzzling. He referred to the Avon between Stratford and Evesham. So much of it as was in the counties of Gloucester and Worcester was under the Severn Fishery Board; but in one part it formed the division between Gloucester, Worcester, and Warwick, and sometimes they had the whole river, then for half a mile half the river, the next mile the other half, and so on. Whenever the Acts were amended and consolidated there ought to be some provision for cases of this kind. But it rested wholly with the Secretary of State. The district being once formed, very large powers were given under the new Bill to water bailiffs, quite as large as could be desired. They had power to traverse the banks of all streams in which fish were found; to arrest at night any person they found taking fish illegally, or whom they suspected of so doing, or who had fish upon him suspected to have been illegally taken; if they had authority from the chairman of the Board, they could remain upon lands for a limited time to detect offences, and they had powers of searching suspected persons. With regard to the application of the Act to fish-ponds, he could only say he believed the Act applied to all ponds that had any communication with any stream, so that you could say they were tributaries. The question what was a tributary had been much discussed, in two cases in the Court of Queen's Bench. One of the Judges said a tributary was what contributed, but afterwards the same learned Judge took a different view, and said it depended on other circumstances. One Judge said that if that were so, the ornamental water in St. James's-park might be a tributary of the Thames. He might mention one case which had occurred. A noble lord in a Western county had a son who was Clerk of Assize, who, on one occasion, took two friends over to fish in his father's pond, which was full of trout. The Act of 1878, provided that Boards of Conservators might issue licenses for trout fishing, and any-one fishing without a license was liable to a penalty. This young gentleman and his friends, one of whom was the Recorder of a borough in the west, and the other a barrister on the circuit, caught some trout which had been bred by this nobleman, and they were summoned for fishing without a license, and convicted. There was an appeal, but they thought discretion was the better part of valour, and dropped it; and he had no doubt the conviction would have been affirmed. He mentioned that to show that if there were any communication whatever, as there was in that case, with a stream or river, the Act applied. As the Chairman reminded him, all dykes, ditches, or backwaters of any kind, which communicated with a river in which fish were found, were within the Act; and these were the great places where fish were poached after a flood. When any water came down them, the fish worked up them to spawn. These were protected under the Act, and the water-bailiffs would have power to go up and down them, and arrest and search people as he had described. He was very sore on the subject of netting. Only recently he was told there was a deal of bait-netting going on in the neighbourhood of Shrewsbury; and he was informed that one gentleman, under the pretence of taking bait, had caught 110 dozen samlets, part of which he disposed of in the neighbourhood, and the remainder were sent to Birmingham for sale. With regard to eels, he might say, that part of his income was derived from eels, and he had some experience of eel fishing. They only caught them in the autumn, either in large fixed nets, or in traps, but they did not think anything of half a ton of eels in a night during the short time they ran. Eels were a poor man's fish, and any quantity could be disposed of in the Black Country. He thought eel fisheries ought to be promoted in every possible way. He also thought it most important to settle how far netting in freshwater ought to be allowed; and he hoped the angling societies, who were most interested in it, would endeavour to meet and discuss the question. Illegal netting must be put down, and, in public fisheries, strict legislation should be enforced. With regard to setting apart certain water for bait, there was this practical difficulty, that as soon as you began to net any place regularly the fish left it; consequently, unless a very large stretch of water were set apart, the complaint would be that it was of no use fishing in the fixed places. The only way he could see of regulating it would be to say that in certain places bait nets should not be used under any circumstances. Lastly, he might say that he had partially prepared, and hoped soon to publish, a little book showing what the Freshwater Fisheries Acts had done, and how the new Act amended it; and he intended to make it rather a popular than a legal book, so that people might know what they might and might not do. He only hoped these new powers would be used with discretion, so that not only would they all be grateful to Mr. Birkbeck for what he had done, but that he would be proud of the work he had accomplished.

The CHAIRMAN said there were many points which not only those present, but people throughout the country, had been in doubt about, with regard to this new legislation which Mr. Willis-Bund had now made clear, and they must be very grateful to him for the information he had given. He attached great importance to the suggestion he had made that there should be a conference in London, with a view of drawing up such bye-laws as should be best adapted for Fishery Boards to be formed under the new Act, and it was very desirable that such conference should be held as early as possible after the Royal assent was given to the Bill. Some might think that the machinery in connection with these Boards would be very expensive, but that was not the experience in Norfolk and Suffolk, where the Board had been in existence nearly seven years. £80 or £100 was subscribed at the outset for the expenses which were anticipated, but he was glad to say that no further appeal whatever had been made, and he believed that, beyond the expense of printing the bye-laws, and a few post-cards for summoning the Conservators, there had been no expense whatever, and the fund originally raised was almost intact. In many districts licenses were issued, but that course was not adopted in Norfolk, and he anticipated that in many other districts it would be unnecessary. He might say that the food supply had been enormously increased by the stop put to poaching practices, and he was confident that wherever a district was formed, and these powers put in force, similar results would follow. He concluded by proposing a vote of thanks to Mr. Willis-Bund for his valuable paper, which was carried unanimously.

Correspondence.

WATER REGULATION.

Colonel Walter Campbell, after quoting certain rates given in evidence before the Select Committee on Canals, asks how can the United Kingdom expect lower rates than those now obtaining on the Continental and other lines of canals, and adds, that he cannot account for a rate of d. assumed for water carriage by Sir Arthur Cotton and myself. In his memorandum, at page 289 of the Canals Committee Report, Sir A. Cotton has given the data by which he arrives at the rate at which canals may be worked. As regards my own calculation, I assume that the items which go to make up the rate are—

1. A toll sufficient to pay the interest on the capital cost of the line.
2. Cost of maintenance.
3. Cost of haulage, inclusive (*a*) of interest on cost of plant, and (*b*) working expenses; in the case of independent carriers (*c*) a margin for profit.

It will not be disputed that the lower the charge the greater will be the traffic, especially in goods of very small value, which cannot, at present rates, be moved except for very short distances, but could at low rates be carried to any part of the United Kingdom when required.

In an address given by Sir James Caird, some few years ago, to the Statistical Society, he observed, as quoted by the *Times*, "a $\frac{1}{2}$d. a ton per mile is now the average railroad charge, and this will be further reduced by the competition of water carriage—by the rivers and canals. Wheat can be carried from Chicago to New York at half this rate, or $\frac{1}{8}$d., and by barges on the Mississippi from St. Louis to the sea board an equal distance, the same work is now being done for $\frac{1}{5}$d. of it or $\frac{1}{10}$d." As carriage by canal can be conducted more cheaply than by river; a rate of $\frac{1}{10}$d. per ton is perfectly practicable. I have not the rates charged on American waterways now at hand, but I think I am right in saying that they are in some cases as low as 1·5 millimes. per ton per mile, which which would be only $\frac{1}{20}$d.

But by way of illustration, let it be assumed that the cost of a first-class steam navigation between London and Liverpool would cost £15,000 per mile.

	£	s.	d.
1. Interest on capital, say 4 per cent., would be	600	0	0
2. Maintenance at $1\frac{1}{2}$ per cent. would be	225	0	0
Total toll	£825	0	0

A traffic of 4,000,000 tons, with a toll of $\frac{1}{20}$d., would cover those items.

3. The cost of haulage, at the rate obtaining on the Aire and Calder Canal, need not exceed $\frac{1}{30}$d., so that a charge of $\frac{1}{20}$d. × $\frac{1}{30}$d. = $\frac{1}{12}$d., would suffice to yield the requisite return.

I gather from Mr. Watson's paper (p. 230 of the Canals Committee Report) that if the carrier owned his own plant, the cost between London and Liverpool could be reduced to 2s. per ton or $\frac{1}{10}$d. At very low rates, it is certain the traffic would very soon assume proportionately large dimensions.

F. H. RUNDALL.

April 23rd, 1884.

M. Gobert's analysis of the Willebroek canal (10 ft. deep, and running through sloping country from Brussels, seawards) gives:—

	millimes.
Steam-traction on sunk chain (allowing 4 per cent. on cost of appliances, for interest and depreciation) ..	3 per tonne kilometrique
Boats (if full each way) and their personnel, going 10 miles a day including stoppages	5 „ „
Add, as boats probably return empty each alternate trip	1·6 „ „
	9·6

Besides this (equal to about ·155d. per ton-mile), *for boat costs alone*, there are interest on construction-money, maintenance of canal, and pay of lock-keepers, &c., expenses which vary inversely with the tons carried.

With a mean annual traffic of 900,000 tonnes per kilometre; interest at 4 per cent. on 180,000 fr. (the estimated average cost of a kilometre); and 1,450 fr. for its annual maintenance, we get a total of about ·31d. per ton-mile.

There may be errors in the above estimate; but reference to other foreign authors seems to show that *we* cannot well carry under ·4d. per ton mile.

An analysis of the cost of carriage on the Lea (given by Mr. Conder, C.E., at ·33d. per ton-mile) would be interesting.

It may be safer to adopt the following approximation:—

		s.	d.
Glasgow to Grangemouth	about	1	0
Leeds to Goole..............	„	1	3
Sheffield to Goole	„	1	6
Wolverhampton to Gloucester	„	2	3
Birmingham to Gloucester....	„	1	11
Dublin to Limerick	„	5	0

Such possibilities seem worth thought. Very slowly, the public mind is realising that waters should be freed from railway control; but the question goes much further than that. When railways were introduced, a reduction of one-twelfth on the cost of road-transport would not have sufficed; and, in the parallel case of steam being applied to waterways, the public weal requires that loads be transported as skilfully as possible, at rates based on customary interest. Much is said about *uniformity* of locks; but in these wet isles they can seldom be too large. It is usually size that they want.

WALTER M. T. CAMPBELL.

Edinburgh, 28th April, 1884.

CORRECTIONS.—Mr. G. F. Blackmore writes that his remarks (see *ante* p. 551) "referred only to the two proposals submitted by Messrs. Clark and Standfield, *i.e.*, a high level bridge and a double iron tunnel, both fitted with hydraulic lifts." Mr. Le Grand's letter (p. 569, col 1, line 38) *for* present *read* purest.

Notes on Books.

Manuals of Technology, edited by Professor Ayrton, F.R.S., and R. Wormell, D.Sc., M.A. London: Cassell & Company. 1882-4.

These manuals are intended as text-books for technical students, in which the language of the professor is translated into the language of the workshop, with the design of making workmen thinkers, and not merely human tools.

CUTTING TOOLS WORKED BY HAND AND MACHINE. By Robert H. Smith.

Mr. Robert Smith does not attempt to enumerate all the cutting tools in use, nor to explain all the details of construction of the machines referred to; but he states that his chief object is "to guide the mechanical student into a correct scientific way of thinking about tools, so that he may able, aided by practice, to judge intelligently whether a tool is good or bad, to criticise its details, and eventually to design new tools scientifically."

PRACTICAL MECHANICS. By John Perry, M.E.

Professor Perry adopts in his treatise a method which he has tested in practice for twelve years, which is to approach the subject from the point of view of the workman rather than to compel the workman to approach it from that of the scientific man.

STEEL AND IRON: comprising Practice and Theory of the several Methods pursued in their Manufacture, and of their Treatment in the Rolling Mills, the Forge, and the Foundry. By W. H. Greenwood.

Mr. Greenwood, without entering into minute detail, gives an account of the several processes connected with iron and steel, and states the scientific principles upon which the success of these processes depend.

SPINNING WOOLLEN AND WORSTED: being a practical treatise for the use of all persons engaged in these trades. By Walter S. B. McLaren.

Mr. McLaren in his work, while dealing with woollen and worsted spinning, pays special attention to the latter, upon which, he says, no book had previously been written.

All these hand-books are fully illustrated with diagrams.

WORLD LIFE, OR COMPARATIVE GEOLOGY. By Alexander Winchell, LL.D. Chicago: S. C. Griggs & Co. London: Trübner & Co. 1883.

The author has attempted to construct, from the standpoint of a nebular cosmogony, a scheme of the constitution and the course of nature in which the processes of world formation, world growth, and world decadence, shall find a place. The book is divided into four parts, the first dealing with cosmical dust and nebular life; the second with the origin of the solar system, the condition of the planetary bodies, planetary decay, and the question of the habitability of other worlds; the third with general cosmogony; and the fourth with the evolution of cosmogonic doctrine.

The Art of Soap-making: a Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps, &c. By Alexander Watt. London: Crosby Lockwood & Co. 1884.

The first patent for improvements in the manufacture of soap was obtained in 1622, by Messrs. Jones and Palmer, but it was not until the present century that Chevreul raised soap-making from empiricism to the position of a scientific art. The author describes the various processes in use, and has added to his book a chapter on the recovery of glycerine from waste leys.

Obituary.

Michael Thomas Bass.—Mr. Bass, the head of the great brewery establishment, died at his residence, Rangemoor, Burton-on-Trent, on Tuesday, the 29th inst., at the age of 84. He was Member of Parliament for the town of Derby from 1847 to 1883, and he had been connected with the Society of Arts since 1863.

Sir Michael Costa, who died at Brighton on Tuesday, 29th inst., was elected a member of the Society of Arts in the same year (1863) as Mr. Bass. He conducted the series of concerts at the Royal Albert-hall in 1871, which was organised by the Society in aid of the National Training School for Music. Sir Michael Costa was born at Geneva on February 4, 1810, and obtained his musical education at the Royal Academy of Music, at Naples. At an early age he began the composition of cantatas and operas, and he was only eighteen when his opera "Il Carcre d'Ildegonda" was publicly performed at the Teatro Nuovo, Naples. In 1831, he was appointed conductor of Her Majesty's Opera House, and here he continued till his secession to the Royal Italian Opera, Covent-garden, in 1847. He composed several operas, but his fame as a composer chiefly rests on his two oratorios, "Eli" and "Naaman." In 1849, he became conductor of the Sacred Harmonic Society, and the success of the Handel Festivals, at the Crystal Palace, was largely due to the renown of Sir Michael Costa as a conductor.

General Notes.

Carpentry Exhibition.—At the Exhibition of Carpentry and Joinery to be held at Carpenters'-hall the Council of the Royal Institute of British Architects have promised to exhibit some of the drawings, &c., illustrative of those subjects in their library. The Royal Architectural Museum will exhibit the well-known drawings of the Flèche of Amiens Cathedral, by the late William Burges, and Mr. Street will contribute his father's drawings for the roof and flèche over the Law Courts.

Ancient Leather.—The Leathersellers' Company propose to exhibit specimens of leather manufacture in one of the shops in the street of Old London, now in course of erection at the International Health Exhibition, and will be grateful to any possessors of articles of leather of ancient or mediæval date who may be willing to aid the Company by the loan of them for the purpose of exhibition. The Clerk of the Company, at the Hall, St. Helen's-place, Bishopsgate-street, will give any further information, and he announces that the greatest possible care will be taken of any articles lent.

Grape Seed Oil.—Grape seed oil is (according to the *Corps Gras Industriels*) used in Italy for purposes of illumination. The extraction is principally effected at Modena. It has also long been used for similar purposes in Germany and the Levant. Thirty-three pounds of seed yield about 13 quarts of oil (or about 18 per cent.). The seeds of white grapes yield less oil than those of the dark variety, and young vines are said to be more fruitful in this respect than older ones. As to the French varieties, the Rossillar, Aube and Herault seeds yield 2 per cent. more than Bordeaux seeds. The colour is a golden yellow, and the oil loses about 25 per cent. in purification.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

May 7.—"Bicycles and Tricycles." By C. V. Boys. Dr. B. W. Richardson, F.R.S., will preside.

May 14.—"Telpherage." By Professor Fleeming Jenkin, F.R.S.

May 21.—"Telegraph Tariffs." By Lieut.-Col. Webber, R.E. Dr. Cameron, M.P., will preside.

May 28.—"Primary Batteries for Electric Lighting." By I. Probert. W. H. Preece, F.R.S., will preside.

Applied Chemistry and Physics Section.

Thursday evenings:—

May 8.—"Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues." By C. R. Alder Wright, F.R.S., D.Sc. Prof. W. J. Russell, Ph.D., F.R.S., will preside.

May 22.—"Economic Applications of Seaweed." By Edward C. Stanford, F.C.S.

INDIAN SECTION.

Friday evenings :—

MAY 9.—"Indigenous Education in India." By Dr. LEITNER. Sir LEPEL GRIFFIN, K.C.S.I., will preside.

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

CANTOR LECTURES.

Monday evenings, at eight o'clock :—

The Fifth Course will be on "Some New Optical Instruments and Arrangements." By J. NORMAN LOCKYER, F.R.S., F.R.A.S.

LECTURE II. May 5.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 5...SOCIETY OF ARTS, John-street, 8 p.m. (Cantor Lectures.) Mr. J. Norman Lockyer, "Some New Optical Instruments and Arrangements." (Lecture II.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C. 4 p.m. Mr. H. M. Jenkins, "Ensilage."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. H. Stopes, "The Engineering of Malting."

Chemical Industry (London Section), Burlington-house, W. 8 p.m. 1. Dr. Percy Frankland, "The Composition and Illuminating Power of Coal Gas." 2. Mr. W. J. Dibdin, "The Estimation of the Illuminating Power of Gas Burners, especially those of large size "

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. T. Chatfeild Clarke's Paper, "Improved Dwellings for Labourers and Artisans."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Institute of Agriculture, Lecture Theatre, South Kensington Museum, S.W., 8 p.m. Professor H. Tanner, "Science Teachers, and Colonial Life."

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

National Indian Association, Council-room, Exeter-hall, Strand, W.C , 4 p m. Mr. Narendra Nath Mitra, "Child Marriage in India, and its Remedy."

TUESDAY, MAY 6...Victoria Institute, (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Vice Chancellor J. W. Dawson, "Prehistoric Man in Egypt and the Lebanon."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gamgee, "The Physiology of Nerve and Muscle." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. S. B. Boulton, "The Antiseptic Treatment of Timber."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. Dr. Theo. G. Pinches and Mr. Ernest A. Budge "New Texts in the Babylonian Character, principally referring to the Restoration of Temples."

Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. V. Boys, "Bicycles and Tricycles."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 4½ p.m. Annual Meeting.

Obstetrical, 53, Berners-street, W., 8 p.m.

Shorthand, 55, Chancery-lane, W.C., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. General Meeting to receive Report, &c.

THURSDAY, MAY 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical and Physical Section.) Mr. C. R. Alder Wright, "Cupro-Ammonium Solution and its use in Waterproofing Paper and Vegetable Tissues."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 8 p.m. Conversazione, at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly.

Royal Institution, Albemarle-street, W., 1 p.m. Annual Meeting. 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture III.)

Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Mr. Henry C. Mance, "A Method of Eliminating the Effects of Polarisation and Earth Currents from Fault Tests." 2. Mr. Latimer Clark, "Some Supplementary Remarks and Illustrative Experiments."

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. E. J. Ronth, "Motion of a Network of Particles with some analogies to Conjugate Functions." 2. Mr. J. Griffiths, "A Subsidiary Elliptic Function."

FRIDAY, APRIL 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p m. (Indian Section.) Dr. G. W. Leitner, "Indigenous Education in India."

United Service Inst., Whitehall-yard, 3 p.m. Mr. A. F. Yarrow, "Torpedo Boats; having special reference to those built by Messrs. Yarrow and Co."

Royal Institution, Albemarle-street, W., 3 p.m. Weekly Meeting. 9 p.m. Prof. W. Robertson Smith, "Mohammedan Mahdis."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. A. R. Sennett, "The Electric Light."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. A second Selection of Shakspere Madrigals, Glees, and Songs, in chronological order, under the direc- of Mr. J. Greenhill.

SATURDAY, MAY 10...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. M. Westropp. "Recent Discoveries in Roman Archæology." (Lecture III.) "The Palatine Hill."

Physical, Science Schools, South Kensingtou, S.W., 3 p.m.

Botanic, Inner Circle, Regent's-park, N.W., 3.45 p.m.

Geologists' Association, University College, W.C. Excursion to the Crystal Palace under the direction of Dr. David Price.

Journal of the Society of Arts.

No. 1,642. Vol. XXXII.

FRIDAY, MAY 9, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

In his second lecture on "Some New Optical Instruments and Arrangements," delivered on Monday, 5th May, 1884, Mr. Norman Lockyer, F.R.S., laid great stress upon the want of proper arrangements for the manufacture of optical glass. The great want for instruments such as those described in the last lecture, was a mirror of sufficient size; and if it were possible to cast a disc of glass of eight feet diameter, and of the necessary thickness (which would be for a disc of that size about one foot) there was no difficulty whatever in silvering the surface. The largest amount of glass which could be run at the present time was about a ton, and this amount would not give sufficient thickness in a disc of the size mentioned. Mr. Lockyer laid great stress upon the importance of this point, and expressed a hope that the Society of Arts would take the matter up. He then proceeded to give some account of the progress which had been made in photographing celestial objects, by Mons. Janssen in photographing the sun, by Mr. Huggins in obtaining photographs of spectra of the stars, and by Mr. Common in obtaining photographs of the stars and nebulæ themselves. He exhibited and described the instantaneous shutter arrangement used by Mons. Janssen, and described the methods employed by the two other observers in their work. In the case of the long exposure rendered necessary by the faintness of the light of the stars, the motion of the clock was not sufficiently accurate to keep the image of the star always in the same position on the photographic plate, and it was necessary for the observer, by means of apparatus which Mr. Lockyer described, continually to regulate the position of the photographic plate by hand. Mr. Lockyer pointed out the importance of these photographic observations, which were not influenced by the idiosyncrasy of the observer, and which possessed the advantage of dealing with larger portions of the heavens, and more rapidly than the observer's eye. He expressed the view that it was now a waste of time to employ the eye in astronomical observations, and sketched an instrument having an aperture of eight feet, and costing only half the price of the domes now being built in Paris, by which photographic plates exposed by electro-magnets should be alone employed. By this means a complete reference library of the heavens at the present epoch could be secured for the benefit of those who come after us, giving forms of nebulæ and clusters, photometer star maps, double stars, and stellar and nebular spectra. He had suggested this idea to the French astronomers, and the matter was being discussed in Paris. He believed the permanent records to be secured by such a comparatively inexpensive instrument as this, would make the results obtained by other telescopes ridiculous, and that it was sure to be largely employed in the future if glass could be procured. At the conclusion of the lecture, a cordial vote of thanks to the lecturer was unanimously passed on the motion of Dr. R. J. Mann, F.R.C.S.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Mr. W. A. Barrett, Mus.Bac. (Oxon), at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 9th June, 1884.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 29, 1884; F. W. Rudler, F.G.S., in the chair.

The paper read was—

THE TRANSVAAL GOLD-FIELDS; THEIR PAST, PRESENT, AND FUTURE.

By W. Henry Penning, F.G.S.
(Late of H.M. Geological Survey of England.)

In submitting the following remarks to the consideration of the Society, I may state that this paper was "written with a purpose," to bring prominently before the public certain facts relating to these fields which are, or ought to be, quite beyond question, and to remove, if possible, some wide-spread false impressions in regard to them. These false impressions I find to be numerous, but not always adverse; those, however, that are favourable should, I consider, be modified in accordance with the truth quite as much as those which are unfavourable, and which sometimes amount even to prejudice. For what is essential at this juncture is a just understanding and a true appreciation of the wealth of the Transvaal, from which alone can a reliable opinion be formed as to its future. In this future, Europeans cannot fail to play an important part; they may be misled by too glowing reports, and, in search of wealth, find poverty and disappointment; or, through apathy and ignorance of the true state of affairs, may fail to realise the wealth which undoubtedly lies before them in the Transvaal.

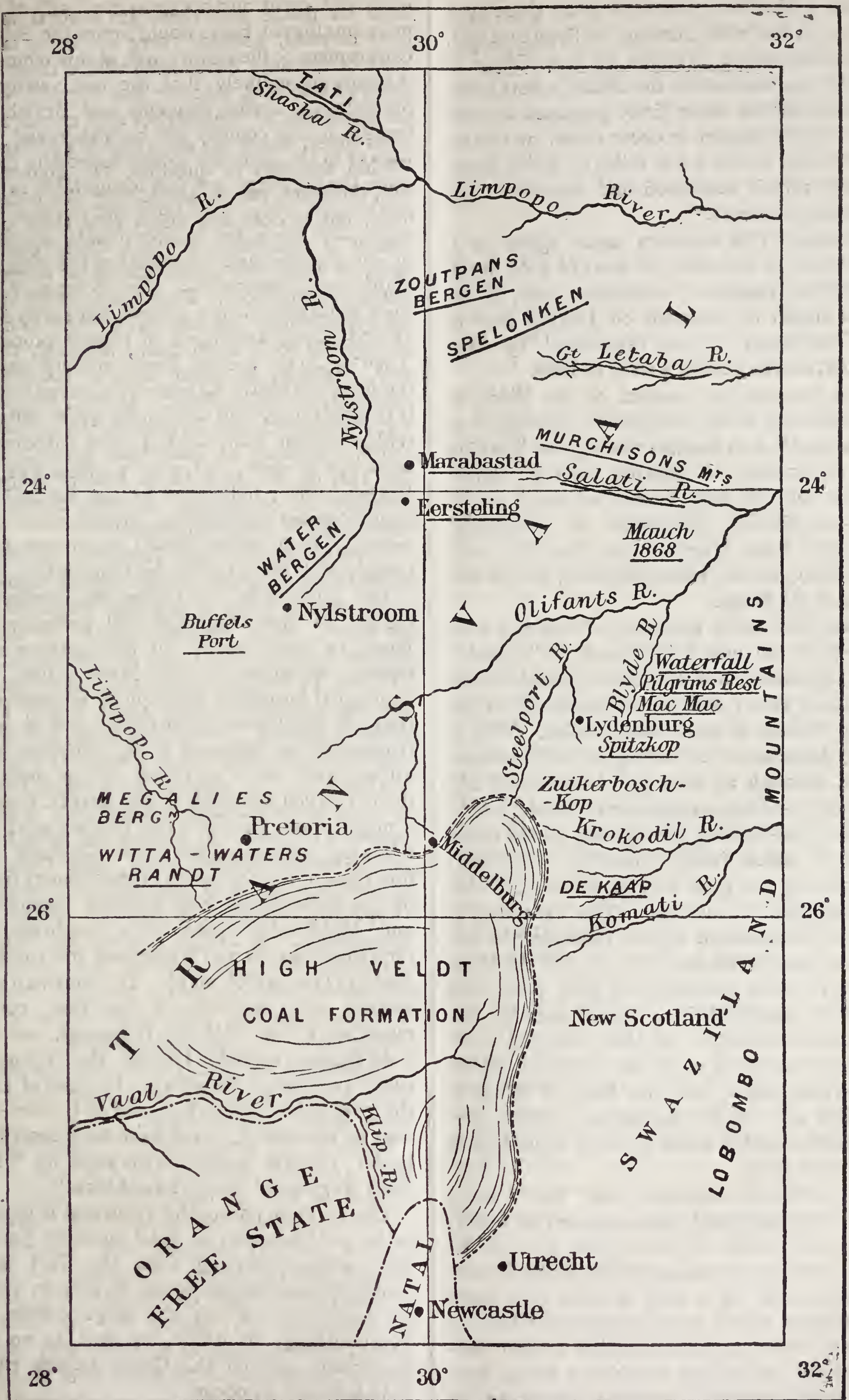
To this end I have not hesitated to avail myself of the published writings of others, or to criticise them freely from my own point of view; in all cases, where possible, giving the names of the writers and the titles of their works, that I may be open to correction if, through inadvertence, I have failed to catch or fairly represent their meaning. In many cases, details are given entirely from my own observations, for which, of course, I alone am responsible. In these, as well as in my deductions from all the facts before me, I am also open to, and will gladly receive, correction. Firmly believing that the true state of the case has only to be known, to render these the busiest gold-fields, as they are naturally the richest yet known in the world, I have exaggerated nothing. On the other hand, although well aware of the difficulties of political situation, of laws (or the want of them), and of the antipathy of the Boers to the Englishman, I have "set down nought in malice."

In a paper of this kind, I would keep clear of all political discussion, but cannot refrain from drawing attention to two significant facts:—A great number (possibly half) of the more intelligent Boers would prefer the British Government to their own; and, at this moment, it seems not unlikely, that the last vestige of protection to British residents and British interests in the country will be withdrawn. In regard to the first, the Boers, especially those upon the diggings, are fast losing faith in the justice and integrity of their own government, especially since the indiscriminate granting of concessions, and the denial of the digger's claims to compensation. The Boers may sell their birthright if they choose, but surely they should respect the rights of private property. Then, as to the second, the suzerainty may be the most shallow of all pretences, nevertheless, it is something, and something upon which a reality may be built; but if once withdrawn, what can be done, and what position will the British subject hold here in the future? It may be added that, before any alteration can be made, both parties should, up to date, fully comply with the terms of the Convention.

The gold-fields, or rather the auriferous region, of the Transvaal will probably be found to cover nearly all the northern and eastern districts of the State. For the geological formation throughout is similar to that of the known gold-fields, and it may reasonably be expected to be auriferous over all the area north and east of an elevated district called the High Veldt; that is, beyond a more or less irregular line passing near the following points:—From New Scotland the line runs across the heads of the Komati river, by the Zuikerbosch Kop between Lydenburg and Middelburg, then in a south-western direction towards and far beyoud the south of Pretoria (see sketch map). The northern and eastern area, bounded by this line, covers much more than half the Transvaal, and the gold-region extends beyond the Limpopo river, its northern boundary. In proof of this, the gold-fields at the Tati and at Hartley-hill may be mentioned, which have been described by Mr. Thomas Baines in his work on "The Gold Regions of South-East Africa."

The northern part of the Transvaal is proved to be gold-bearing, at least in some parts; for instance, coming from the Tati in a southerly direction along the Nylstroom river, we have on our left the large district of Zoutpansberg, in which, as well as on the Spelonken, and on the Great Letaba river, gold is known to occur.

Passing by Marabastadt, also a gold district, we come to Eersteling, where there are some



SKETCH MAP OF PART OF THE TRANSVAAL.

The names underlined represent the gold localities.

mines, worked for gold a few years since by a company, but which, during the Sekukuni war, were abandoned. Thence by the village of Nylstroom, near which the Buffel's Port Company, about the same time, proposed to mine for the gold known to occur there, and so on to Pretoria, within a few miles of which town, I have myself examined and reported upon payable gold-reefs.*

Crossing this northern area again in a north-eastern direction, we hear of gold in the Murchison range of mountains, and, a few miles south, as recorded on Jeppe's map of the Transvaal, it was discovered by Carl Mauch, on the Olifant's river in 1868.

The intermediate district of the Salati is also asserted to be auriferous. Turning now to the south, and leaving the regions in which the occurrence of payable gold is almost certain, but not fully known, we come to the well-established gold-fields at Waterfall, Pilgrim's Rest, MacMac, and Spitzkop, and, continuing in the same direction, to the new fields at De Kaap.

Some few miles westward of this last line, gold-reefs are now being found, for instance, near Lydenburg and towards the heads of the Krokrodil river; and to the eastward, in the Kaap Valley, at least twenty miles. This is a very large area—extending, in the Transvaal alone, through at least $3\frac{1}{2}^{\circ}$ latitude and $2\frac{1}{2}^{\circ}$ longitude—which, as a matter of course, would not be gold-bearing throughout, but in many parts of which (with a possible exception) prospecting for gold may be carried on with fair chances of success. The exception is that in the northern region there may be one or more coal-fields similar to that of the High Veldt, to which reference has been made, and recently described in a paper sent to the Geological Society. In that case the coal-bearing formation would mask that in which gold-veins occur; but the beds of which it consists are chiefly sandstone, readily distinguished, and in which it would be useless to search for gold.

It will thus be seen that the "belt" along which only reef-gold was supposed to occur, and about which we were wont to hear so much, has so great an extent as really to form no belt at all. It is only a short time since speculators would not entertain the idea of buying farms anywhere outside of the supposed belt which was considered to run from the older gold-fields towards the Kaap. I have no doubt that there are several main lines of reefs, because there are many main lines of volcanic dykes with which these are always associated, more or less parallel, with the exception of cross-dykes and consequent cross-lodes, which are often highly auriferous. Within the area in question, the gold-reefs will, therefore, run in something like definite lines, but it does not follow that their continuity is unbroken, or that where quartz-reefs, or veins, are found, they must be gold-bearing throughout. Farms absolutely upon the hypothetical belt are quite likely to have no payable reefs upon them, although there may, perhaps, be good ones in immediate contiguity on either hand. In fact, the gold-belt embraces the whole gold-region indicated above, extending at least from Pretoria and the Tati on the west to its eastern margin, probably at, or possibly beyond, Bondine's randt and the Lobombo mountains.

In many parts of the Transvaal, as elsewhere in South Africa, the traveller or explorer comes across holes of peculiar character in the earth, which present features of some interest, although their real nature cannot, at all times, be readily ascertained. These holes may be classified under three heads, and briefly described, as they have some, although very little, practical bearing upon the question before us. 1. More or less circular holes, in some cases partially refilled with a subterranean channel. 2. Similar but more irregularly-formed cavities, and open trenches with artificial heaps of *debris* upon the margin without any apparent attempt at system or arrangement. 3. Pits, or quarries, sometimes of considerable depth, shafts, open trenches and tunnels, with the refuse material stacked in heaps, or built up to form platforms or retaining walls, in a systematic manner.

Those of the first kind (1) are natural swallow-holes, formed, generally, in or near limestone rocks, by the action of water.

Those of the second kind (2) frequently so much resemble those of the first, that it is difficult to say, at once, whether they are natural or artificial, the heaps of *debris* having become partially levelled, and completely covered with vegetation. They are, however, undoubtedly the work of the natives, perhaps some centuries ago; and as they are found in several different kinds of material, they afford but small indication of the presence of precious metals. These old workings may be in beds, or veins, of the ores of iron or copper; in beds of ochre used by the natives as a pigment; in

* See also "Transvaal," Silver and Co., 1878, p. 20, and Jeppe's "Transvaal Book Almanac," 1881, p. 107.

veins of specular iron, which they use with grease as an ornament for the hair; or even in beds of pot-clay. Mr. Thomas Baines, in his work on "South-East Africa" (p. 26), refers to some of these pits made by the natives, "from which their forefathers used to dig a kind of metal, of which they professed ignorance." He continues (p. 28), speaking of some gold-reefs in the same district, "The reefs seem to be the greater part of a mile in length, but were so covered with refuse, thrown from the old surface workings, that their exact limit could not be easily determined; the holes were three or four feet wide, and sometimes ten or twelve feet deep. Here and there a group of holes had been worked into one, forming a large pit, and, in many of these, mimosa and other trees, from three to ten inches thick, were growing; proving that many years must have elapsed since they were worked, but not establishing for them a high antiquity." He also speaks (p. 42) of a present that he received of "a few grains of gold in a quill," as "invaluable, not that it showed me more than I knew in 1859, but as the means of proving the existence of a gold-field, worked by the natives, to our company at home."

The pits of the third class (3) are, doubtless, the work of white men, probably of the Portuguese, who are known to have mined for gold in this country several centuries ago. The supposition is strengthened by their similarity to the ancient workings, known to be Portuguese, in Brazil, and elsewhere in South America. But the nationality of these early miners is comparatively unimportant; their work proves that gold is sufficiently plentiful in this region to have been discovered ages ago, by those who were ignorant of scientific methods of research, and worked to advantage even by primitive methods and appliances. The old workings are very numerous in some parts of the gold-fields, and, indeed, in many parts also where the existence of gold veins is unknown; it is probable, therefore, that the old miners worked for other metals, as well as for gold.

Like other gold-fields, those of the Transvaal have had a rapid growth, with intervening periods of stagnation, sometimes even almost of abandonment. In 1868, Carl Manch, as before observed, discovered gold on the Olifant's River, and in the following year it was found at Lydenburg and at Marabastadt. In 1870, auriferous veins were reported in the Murchison range, and in 1871 at Spitzkop, which was, however, afterwards abandoned. Then Mac-Mac was opened, but after a time many left for the rich creek at Pilgrim's Rest, which was discovered in 1873, and which has yielded many nuggets of exceptional size. Then followed Waterfall in 1874, Rotunda Creek, and several other "new rushes." But the war with Sekukuni stopped further prospecting, and indeed nearly all kind of work at the gold-fields, for a considerable time. Although gold had been discovered in the valley of the Kaap in 1875, nothing was done there until the rush took place, early in 1882, to the high land overlooking this valley, where nuggets were being found literally on the surface.*

During the last year and half there has been, instead of the earlier spasmodic efforts, a steady development of the Transvaal gold-fields, owing, mainly, to the attention attracted to them by the discoveries at the Kaap. These took place during the recent crisis—almost panic—at the Diamond-fields, where so many hundreds of men were thrown out of work, and thus set free to try their fortune at the gold-fields. A great number from all districts flocked to the new fields, and for the most part met with great loss and disappointment. This was to be expected, as the great majority of them were new to the work, and as water was scarce, without which profitable gold digging was impossible. But they partially opened up many creeks and terraces, which eventually proved auriferous, and although at a loss to themselves, they paved the way for future discoveries. On the other hand, the depression at the Diamond-fields acted prejudicially, because, in consequence of the large withdrawal of capital from the country (to which, and over-speculation, the depression was due), it left but little cash available for Transvaal investments. But, after a time, speculators began to turn their attention in the direction of the gold-fields, which would then have received a great impetus had sufficient capital been forthcoming. Farms were taken under offer by them, and by many others also, with the option of purchase within a given time, and in the hope of re-selling in the meantime. This appeared so easy a method of realising a fortune that the natural result followed. In every direction men were getting farms under offer, and the prices rose enormously in consequence. Farms which were, as farms, worth a few hundred pounds, would be given, under such

* For fuller details of this history, see the "Guide to the Gold-Fields," published in Pretoria, in 1883.

conditions, only for as many thousands; and if they happened to be within the so-called "gold-belt," a very much larger sum was demanded. But the re-sale of unproved farms was found to be not so easy as anticipated. In many cases the stipulated time elapsed without a purchase being effected, and in consequence of this, more reasonable prices now prevail. But, even yet, very high figures are demanded for farms given under offer, which could be purchased for cash at a reasonable sum. Two thousand pounds down would buy farms in promising situations for gold, which would not be given for a time, with option of purchase, for less than six or eight thousand.

The state of things described necessitated a more definite search for gold. If a man had a farm under offer, he would endeavour to test its value before the time of that offer should expire. Consequently much prospecting has been done during the last twelve months, by men competent and incompetent, and with varied results. Certainly, gold has been found in places where its occurrence was before not even suspected. Moreover, almost every Boer now thinks his farm has gold upon it, and sets his "boys" to dig in all sorts of likely and unlikely places; whilst it is rare to meet one who has not a sample of quartz in his pocket, from a reef on his own property.

In the present stage of these fields, systematic search by competent men is greatly to be desired, and could not fail to yield valuable results. This may be accomplished by any or all of three separate methods: 1. By official survey, commencing at the known gold regions, and working towards the unknown; but this, in the present condition of the country, is scarcely to be expected.* 2. By the offer, on the part of the Government, of rewards for the discovery of gold-reefs and of alluvial fields. Such terms should be liberal, and immediate payment thereof guaranteed upon proof of success. The conditions and terms should be well defined—so much for reefs, so much for alluvial—and, on the other hand, the yield of gold that shall entitle prospectors to the reward must be equally definite. One ounce per ton average yield from reefs, two ounces from thin leaders, and one ounce from thirty cubic yards of alluvial ground, in a new field of given minimum area, would offer good chances to prospectors, and amply repay the Government. 3. By private prospecting by parties of men, under competent supervision, on behalf of speculators or companies, such men to be paid in wages, fully-equipped, directed to the more likely localities, judging from scientific observations, and to have their interest and co-operation secured by a small share in the results, in the event of success. The last plan is the one that seems at present most feasible in the Transvaal, having regard to its financial position, and it offers the greatest promise to those who are seeking good investments.

* See "Guide to Gold-fields," p. 73.

But in this many points have to be taken into consideration. The probabilities of good ground being discovered; the existence and the possibilities of ample supplies of water; the difficulties and facilities of travel; and last, but not least, that which has an important bearing upon the others, and upon the chances of success, a knowledge of the geological, physical, and climatal features of the Transvaal.

If a country be rich in mineral resources, it is beyond question to the interest of that country to develope and to utilise such native wealth. But development can only be stimulated by liberal laws, which shall provide not only for the encouragement of prospecting, in other words, of discovery, but also for security of tenure; for freedom from over-burden of taxation; and for facilities of working or sale. Until recently, it could not be said that laws of such a character existed in the Transvaal, nor is the new Gold Law, adopted in the recent Session of the Volksraad, all that could be desired. It is, however, a step in the right dlrection, its main features being briefly sketched as follows:—

Articles 2 and 3.—The Government reserves the right to all minerals, and can proclaim Government ground an open gold-field.

In regard to Government lands, such right is, of course, indisputable; but where private property is concerned, the case is decidedly different, as suggested in the following extract from the "Guide to the Gold-fields," p. 5. "It is hardly necessary to point out that the principle laid down is not maintained upon Australian and Californian gold-fields, where the rights to mine for gold are vested in the owner of the soil; nor, to quote an instance nearer home, does the Government of the Cape Colony assert a right to lease or concede privileges to mine for diamonds on private property." But the wrong to the owner is partially redressed, upon payment of royalty, in the succeeding article:—

Article 4.—The owner can claim a concession (if gold be found on his property) within six months of its published discovery. If he fail to do so, the Government can buy compulsorily and register it as Government ground.

This is somewhat arbitrary, as the proprietor may not, in all cases, however he may wish to do so, be able to pay the fees for getting the ground surveyed, and the first year's royalty, without which no concession is granted. He may, because his farm happens to be rich in gold, be turned out of his house and home, receiving only the amount, whatever it may be, awarded him by arbitration. But this clause, however hardly it may press on individuals, will, doubtless, tend to the opening of the gold-fields.

Article 5.—The Government can grant concessions upon any Government ground (originally so, or whether purchased under Article 4) not proclaimed as a public gold-field.

Articles 10 and 11.—The Gold Commissioner may grant prospecting-licences within twenty-five miles of proclaimed gold-fields, and a Landdrost within his district, but not on private property without the consent of the owner.

Articles 12 and 15.—A Diggers' Committee to be formed for the purpose of making local regulations, the members to be chosen by licence-holders in public election.

Article 22.—Licences will be issued, at a charge of 10s. per month, to prospect or dig on Government ground; also on private property under permit from the owner, who shall receive 7s. 6d. out of every such 10s.

Articles 23 and 24.—Any person shall have the right to one claim 150 by 150 feet only, but he may buy any number.

The law does not state, but it may reasonably be assumed, that after such claim is worked out (whether sold or not), the claim-holder will then be at liberty to take out another.

Article 31.—The prospector is entitled to 5 per cent. of the revenue derived by Government from the gold-field, in addition to his prospecting area.

Article 32.—Claims are protected for six months, upon which £500 has been expended for improvements or machinery, or which have been purchased for £300.

Article 33.—The Government to receive 2½ per cent. upon all finds.

These provisions are fair, although the collection of a per-centage upon finds from private diggers is open to several objections—not the least being the temptation to concealment. This, however, is met by the next clause, which was (amongst others) inserted at my suggestion, and which offers an inducement to diggers to declare the full value of gold discovered.

Articles 34 and 35.—Claims on a proclaimed gold-field can be resumed by Government on payment of compensation, the amount being fixed by an appointed commissioner, and based upon the percentage paid by the claim-holder. But if so resumed for the purpose of granting a concession thereon, the claim-holders shall have the preference if applying for such concession.

The principle here enunciated is just, and had it been adopted earlier, much trouble would have been saved, and much more gold extracted. But diggers have hitherto been in a state of uncertainty, especially at the Kaap, where a proclamation was actually made that the government reserved the right to refuse the renewal of licenses without being liable to claims for compensation.

A few words may be said here upon the concessions which it has recently been the policy of the Transvaal Government to grant, greatly to the future detriment of the country. It may be reasonably argued that these concessions, or some of them, have opened up lines of industry which otherwise would have remained in abeyance. But still they are monopolies, and this for the manufacture or production of those things most in demand by the population. Some of these are, iron, woollen and leather goods, hats, gunpowder, spirits, and so on, the prices of which will be unduly high in the absence of unfettered competition. These remarks do not, of course, apply to the concessions of gold-bearing properties, but in them also the plan pursued is much less to the advantage of the country than to that of speculators. Each mining-concession, except those on odd pieces of government ground, covers 500 morgen, that is, 1,000 acres, an extent quite unnecessary for gold-mining purposes. It is possible for there to be several reefs crossing such an area, and of these but one probably would be worked by the concessionaire or company. Had the ground been given out in small concessions on the reefs, say five to twenty claims, it would have been ample for all purposes, many men would have made fortunes, and the country would have derived immense direct revenues from the royalties payable upon extraction of the gold, and indirect from the increase of population.

Brief descriptions of the geological and physical features of the South African gold-fields have been given in the "Guide," to which previous reference has been made, and they need not be repeated here, as this paper is intended to regard them mainly from the point of view of the political economist. But to this end, and to prove the richness of the fields, a few descriptions are necessary, based upon published and authenticated reports, and upon my own observations; and to indicate the extent of the rich area, the points thus described and remarked upon will be selected from localities separated by wide distances.

(*a*) Commencing on the south, there is said to be much gold in Swaziland, but of this I have no authentic information, beyond that a *bonâ-fide* offer was made of several thousand pounds for a concession over a certain area granted by the King Mbondine.*

(*b*.) Some way north of this, in the Kaap Valley, coarse scaly gold is found in the alluvial deposits. I have seen some rich patches near the junction of the two main branches of the Kaap River, also towards the sources of the more northern stream. There are reefs also in this valley, a sample from one of which, sent to me for assay, yielded gold at the rate of 103·0 dwt. 20 grs. to the ton of 2,000 lbs.

(*c*.) Upon the Godwaan plateau (De Kaap) two rich reefs have been known for more than twelve months; but owing to difficulties about the boundaries of the farm "Berlin," on which they occur, and the claims of the diggers, they have been worked but very little. These are the "Homeward Bound" reef, containing much fine gold, and "Rautenbach's," a so-called "rotten reef," which, in parts, is wonderfully rich in very fine "flour-gold." Another quartz reef (or it may be a continuation of one of the above) has recently been opened, about two miles north, from 4 oz. of which, taken at hazard, I washed out two large specks of gold; and about two miles below the crest of the mountain, on the east of those just referred to, a quartz reef has recently been discovered. I washed a few ounces of this, and found one very large speck of gold, with two or three colours.

(*d*) At the "Devil's Kantoor," the head-quarters of the Kaap gold-fields, also at "Barrett's Rush," and elsewhere, many nuggets have been found on and just beneath the surface of the ground. Of course the majority of these are small, but those of large size are numerous. I have myself seen many taken out from 1 oz. up to 13 oz. in weight, and one has recently been reported of about 60 oz. from the Kaap Valley.

(*e*) Thirty miles or so, as the crow flies, north of the Kaap, is the district of "Spitzkop," in which many valuable auriferous deposits have been opened, and partially worked. Here is "Ross Hill," for the purchase of the mineral rights on which, and for machinery and working, a company was formed, with a capital of £75,000. Three diggers who held claims on this hill were bought out for £2,000 each, and they took away with them, as the result of two or three years' labour, gold worth £15,000.

(*f.*) Some claims upon the farm "Spitzkop" were examined by myself during the current year, and the following are extracts from my report, which was based upon assays and careful investigations:—

"Average samples were taken from this 'rich layer.' The relative proportions, by weight, were as 2¼ of the so-called 'rotten-reef' to 1 of quartz—the rotten-reef representing the 'pay-dirt,' from which gold is at present derived by sluicing, the stone being thrown away, in the absence of machinery for crushing.

"Upon assay the average sample of the rotten-reef was found to yield 16 dwt. 5 grs. of gold to the ton (2,000 lbs.)

"Some ferruginous quartz from a rich leader was crushed and washed on the ground, and yielded fine gold, estimated at 17½ oz. to the ton.

"Some samples were previously assayed by me, with results, as under:—

No. 1.	2 oz.	12 dwt.	11 grs.	to the ton.
,, 2.	4 ,,	10 ,,	21 ,,	,, ,,

"*Shaft No.* 1 *and Drive.*—This shaft is 25 ft. deep, down to the dyke, along the top of which a drive has been made 35 ft. to the N.N.W., following the downward dip to the 'rich layer,' that here consists 3 ft. of rotten-reef, with 1 to 2 ft. of poorer wash between it and the dyke. The shaft is sunk through contorted and partially decomposed shales, with quartz-leaders that are auriferous. This section proves the continuation of the gold-bearing veins and of the rich layer, without any diminution in thickness, as far as the boundary line between the two claims.

"Assays of quartz, with oxide of iron and manganese, from these leaders:—

No. 1.	1 oz.	10 dwt.	11 grs.	to the ton.
,, 2.	3 ,,	6 ,,	16 ,,	,, ,,
,, 3.	0 ,,	9 ,,	2 ,,	,, ,,

* Reported, since this paper was written, to have been sold for £60,000.

"*Shaft No.* 4 *and Cutting.*—Samples were taken, as before, from top to bottom of this section—the proportion of wash to stone is found to be as 3 to 1. The 'rotten-reef,' on assay, yields 1 oz. 13 dwt. 8 grs. to the ton. From this it is found that each ton of the strata passed through comprises 500 lbs. of stone and 1,500 lbs. of 'rotten-reef,' which contains throughout the mass 1 oz. 5 dwt. 1 gr. of gold.

"The 'rich layer' extends over all the unworked area of claims (each 400 by 300 ft.), and may be taken as having an average thickness of 3 ft.

"The quality of gold found is good, it occurs chiefly as very fine 'flour-gold,' about 20 per cent. only being of coarser grain."

As showing the value of this ground for sluicing by hydraulic appliances, for which there is ample water during a greater part of the year, the following example may be given:—One paddock, 35 ft. square and 12 ft. deep, was removed, and the gold obtained by sluicing, without crushing any of the quartz, weighed 107 ounces; equal to 4 dwts. to the ton of rotten-reef, leaders, and the shale in which they occur—the latter not being auriferous in itself, but the whole mass is so decomposed and mixed up in this case as to prevent separation.

I am able to vouch for the accuracy of the foregoing results, as they are based entirely upon my own work on the ground and in the laboratory.

(g.) The diggings at Mac Mac, a few miles north of Spitzkop, are well-known as having yielded much alluvial gold; and the "rotten-reefs" at and near Pilgrim's Rest, still farther north, have recently attracted mueh attention. The immediate future of the fields will depend greatly upon the results obtained by the machinery now being erected here, by the "Transvaal Gold-land and Exploration Company," which purchased the concessions granted to Mr. David Benjamin. The results can scarcely fail to be satisfactory, if the large amounts paid to diggers, as compensation for the loss of their claims, be any criterion. The total amount paid for a few of the best claims, could not have fallen far, if any, short of £50,000.

(h.) A few miles beyond Pilgrim's Rest, is the property called "Waterfall," consisting of two farms purchased by Mr. H. Gwynne Owen, and which has been fully investigated, with a view to the formation of a company, by the South African Syndicate. "Save me from my friends," might well be adopted as the motto of those interested in this undoubtedly valuable property, the failure of whose efforts to secure the confidence of the public, I believe to be due to too glowing representation. Some of the accounts to which publication was given are almost fabulous, and anyone who impartially examines the ground must fail to see whence they can have arisen. Still the veins are rich beyond question, and the existence of much water at a high level (so essential to successful gold-mining), renders Waterfall one of the most desirable properties in this or in any other country. A few brief extracts from reports, and other published documents, with remarks thereon, should be sufficient for the formation of an unbiassed opinion.

In a pamphlet entitled "The Transvaal Gold-fields," Mr. Owen states (p. 3) as to the farm Waterfall or Lisbon,* that "the extent of ground known to contain gold on this side hill, is not less than 5,000 acres, The average depth of the gravel on the side hill containing gold is about 20 ft. Experienced miners who have visited this ground, estimate the yield per ton of earth removed and washed will be 1 oz. per ton. The owner took many shovelsful from various parts of the ground (which he knows to be fair), assayed by Johnson, Matthey and Co., at 1½ oz. per ton." (£5 5s. per ton!)

Now, Mr. J. M. Stuart, in his "Report on the farm Lisbon" (p. 13), says, "the alluvial will average 15 feet in depth, and I estimate that there is not less than 300 acres of this gold-bearing ground. Careful tests on my part, by panning, lead me to the conclusion that the mass will pay from 1s. to 7s. the cubic yard."†

In my own notes upon Waterfall, I find that one man, with three or four Kaffirs, has been able to take out, from some of the best claims, an ounce of gold per day. Assuming them to have moved twenty cubic yards, this gives a value of 3s. 6d. per yard, or 2s. 4d. per ton, thus fairly agreeing with Mr. Stuart's observations. And I consider his estimate of the extent of alluvial ground to be low, as it cannot be much, if any, less than 500 acres; but, on the other hand, the average depth is not more than ten feet, the resulting quantity of available ground thus being about the same.

But I differ widely from Mr. Stuart in much more important particulars:—

* "Waterfall" includes the two farms "Berlin" and "Lisbon."

† Note in the pamphlet referred to:—"A cubic yard of gravel is equivalent to 1½ tons." Therefore Mr. Stuart's estimate of the yield of this material is 8d to 4s. 8d. per ton.

1. In his estimate of the yield of the leaders.
2. In his estimate of the yield of the shales.
3. In his interpretation of the geology of the district.

1. Mr. Stuart "made hundreds of tests on the ground, and the lowest tests showed over 10 ozs., and the highest about 1,000 ozs. per ton. . . . . I took samples from the eleven veins . . . . . being most careful that they should be a fair average. . . . . They were opened by Messrs. Johnson, Matthey & Co., who made assays of them:—average of 11 bags and 27 samples, produce of gold 48·5 ozs. per ton of 20 cwt. of ore.

The following are extracts from my own report upon Waterfall, dated May, 1883:—"In the following cases, where samples were assayed . . . . collected from all parts of the leaders and carefully averaged, all stone in which pieces of gold were visible was rejected.

No. 1.	2 oz.	1 dwt.	16 grs.	Mean 3 oz. 11 dwt. 14 grs. to the ton of 2,000 lbs.
,, 2.	6 ,,	8 ,,	12 ,,	
,, 3.	2 ,,	4 ,,	15 ,,	

To this mean yield may safely be added the odd 8 dwt. 10 grs. for nuggets and visible gold (rejected in the samples) . . . . and an average is thus obtained of 4 oz. per ton."

The proportion of slate to leaders being as 80 to 1, this would give a yield of 1 dwt. to the ton for the whole mass, which would yield enormous returns for sluicing by hydraulic machinery, although not nearly so rich as in the Spitzkop example (see p. 22) quoted, where the mass runs 4 dwt. to the ton. But in that case the ground consists of rotten-reef in much greater proportion; on the other hand, there is a much larger supply of high-level water here, all the year round.

2. Mr. Stuart estimates the proportion of the slate to leader as $13\frac{1}{3}$ to 1—I make it 80 to 1—thus:—" In Howse's claims the average distance apart of the eight leaders is 22 ft., and rather less in the other claims; 20 ft. may be considered a fair average, and 3 in. . . . . as the average width of the leaders."

I am thus compelled to reduce Mr. Stuart's estimates to one-fifteenth of their original dimensions; that is to $\frac{1}{6}$ in quantity of auriferous material $\left(\frac{13\frac{1}{3}}{80} = \frac{1}{6}\right)$, and to $\frac{2}{5}\left(\frac{403}{1003} = \frac{2}{5}\right)$ of the asserted yield of that material ($\frac{1}{6}$ of $\frac{2}{5} = \frac{1}{15}$). Even thus, the veins which, "with their slate interlaminations, constitute practically one vein 80 feet wide, one mile long, and on an average 325 feet deep" (Stuart, p. 9) contain gold to the value of £1,693,125 (£25,396,875 ÷ 15). The cost of extraction, that is, excavating the ground, crushing the quartz, &c. (as per my report), would not exceed £6 per 80 tons, or 1s. 6d. per ton, leaving a net profit of £705,468. But this only on a strip of ground 80 feet wide, whereas the veins are proved by the present workings to extend over a much larger area, and they, doubtless, occur also in the ground still unopened. Therefore, taking into consideration the probable lateral extension of the veins, and their almost certain occurrence to an indefinite depth, and not merely to 325 feet as calculated, I (in the words of my report) "have no hesitation in declaring that Waterfall is an extremely valuable gold mining property."

Mr. Stuart says:—"As to the slate, the softer portion should yield $\frac{1}{2}$ oz., and the harder portion $\frac{1}{4}$ oz. to the ton; but I think it safer not to attach any value to the slate." In this opinion he is quite right, as beyond traces of fine gold in the immediate contiguity of the veins, it is, to my mind, impossible for gold to have traversed the pre-existing rock, in the fissures of which the veins themselves are formed. Even if it were possible, it is difficult to see why, in a homogenous stratified rock, there should be different quantities of gold in its harder and softer portions.

3. I venture to differ entirely from Mr. Stuart in his interpretation of the geology of this district. He says:—"The underlying formation of the hills is composed of igneous rocks." Of this there is no evidence whatever, and the strata are exposed, in the deep valleys, many hundreds of feet; nor does the statement agree with more than one of the six sections (Fig. 6 in Exhibit No. 1) on the twenty-fourth page of his Report. Nor is it possible that "these strata are in many places broken through by dolomite," although they are traversed in many directions by "basaltic rocks."

"*Exhibit I.*—This plate shows the general geological sections of the several farms of Lisbon and neighbourhood. It shows the the different positions in which the gold veins occur, they being marked by a tint of yellow."

Fig. 1. Gold veins, or rather beds, interstratified with decomposed slates, tilted and contorted.

Fig. 2. Gold veins interstratified between diorite and decomposed slates, horizontal.

Fig. 3. Gold veins tilted, and in diorite.

Fig. 4. Gold veins between diorite and slates, tilted also between a diorite dyke and the edges of the slates it breaks through.

This last I consider the only representation in accordance with the facts, or even with the possibilities, unless, like the "deep leads" of Ballarat and elsewhere in Australia, these gold-veins are old alluvial deposits. But the sharp unworn character of the gold, and its occurrence in thin transverse quartz leaders, entirely set aside this supposition.

Fig. 5. Gold veins between diorite and slates.

Fig. 6. Gold veins between slates and between diorite and slates, curved; also between decomposed slates and between diorite and decomposed slates, tilted; one vein is shown in a diorite dyke.

In this latter position, that is in a trap dyke, quartz-reefs and leaders occur, but they are seldom gold-bearing in or near the dyke. The same lodes traced away from the dyke into the slates or sandstones, as the case may be, frequently proved auriferous.

As stated in my Report, "there is an intimate connection between these diorite dykes and the gold-bearing lodes of this region—the main lodes are parallel to the dykes, either in immediate contact or at no great distance, and both have, generally, a north and south direction. . . . In some cases no main lode can be detected, but there are many transverse quartz leaders, or cross-courses, which were originally cracks in the strata, caused by the intrusion of the volcanic mass from below, which naturally terminate at the dyke, although they run through it in some instances."

(*i.*) A few miles farther down the Blyde river, I have traced a reef of qaartz in regular crystals, cemented by oxide of iron, more than 3 ft. wide, and any portion of which will yield gold in the proportion of at least 2 oz. to the ton, one assay having produced 18 oz. to the ton.

(*j.*) Passing now to the westward, gold has been found in reefs, and in payable quantity along the valley of the Orighstad river.

(*k.*) In the Speckboom valley, still farther westward, thin leaders containing gold have recently been opened, and alluvial gold has been found on the banks of the river.

(*l.*) In the vicinity of Pretoria, alluvial gold has been found, although not in large quantity hitherto, and one reef over 2 ft. wide has been opened, a specimen of which, sent to me for assay (that must have been exceptionally rich), yielded gold at the rate of more than 30 oz. to the ton.

(*m.*) A few miles off the road between Pretoria and Potchefstroom there are quartz-reefs, from which 100 lbs. weight were sent to me for examination, and this quartz produced an ounce of gold to the ton.

These instances, although they do not prove, yet go a long way towards substantiating the proposition advanced, that "the gold-fields will probably be found to cover nearly all the northern and eastern districts of the State." By brief comparison with some of the Australian fields, I believe it may be shown, but also not proved, that they are "the richest yet known in the world."

To quote from the *Cape Argus* of October 31st, 1883:—

"The total yield of gold (reef and alluvial) in Victoria, in 1882, was 864,000 ozs. . . . The estimated quantity of quartz raised was 1,027,826 tons, which yielded an average of 6 dwts. per ton. In Sandhurst, the average yield from quartz was $13\frac{1}{4}$ dwts. per ton; in Gipp's-hand, 1 oz. 4 dwts. 6 grs.; at Beechworth, 12 dwts. 16 grs.; at Maryborough, 8 dwt. 7 grs.; at Ballarat, 6 dwts. $14\frac{1}{2}$ grs.; at Castlemaine, 5 dwts. 20 grs.

The mean yield of these reefs is, therefore, just under 11 dwts. per ton.

Again, the *Melbourne Argus*, of August 13th, 1883, in its "Mining Notes" upon about 200 mines, gives its usual weekly statement of returns. In connection with some of these, the number of tons of quartz crushed is also published, so that the yield per ton can be calculated. The average yield of the forty mines which can be thus treated is 10 dwt. 7 grs., thus closely agreeing with the quotation from the *Cape Argus*, and may, I think, be considered as approximately correct for all the mines of Australia; in round numbers, say 10 dwts., or half an ounce to the ton.

Now, taking the South African examples, quoted above, in which results have been obtained, we arrive at the following results:—

	oz.	dwt.	grs.	
b..	1	0	20	(Kaap Valley).
f..	1	9	12	(Spitzkop).
Mean of *h*..	4	0	0	(Waterfall).
i..	2	0	0	(Blyde River).
Assumed average of *l* and *m*....	1	0	0	(Pretoria).
	9	10	8	
Mean yield per ton	1	18	1	

This mean yield is more than three times that of the Australian mines, and is arrived at after rejection of rich samples from Spitzkop, also of Mr. Stuart's fabulous estimates of Waterfall. In the above calculation, only actual assays are taken, many known rich reefs, as *c*, *e*, being omitted in the absence of such assays;

but their yield would probably be over rather than under the above average. I am convinced that the mean yield of the reefs, rotten reefs, and leaders which are at present known, and likely to be worked on an extensive scale, will be at least 1½ ozs. to 2 ozs. to the ton.

It has, however, been shown in section *h*, that where the gold occurs in thin leaders, much ground will have to be removed that is not auriferous. Taking Waterfall (*h*) as a fair example of this, the whole mass of barren slate and quartz leaders will yield 1 dwt. to the ton, value 3s. 6d., against a cost of 1s. 6d. for mining and extraction. This leaves a profit of 2s. per ton on the whole mass, which can be enormously increased where plenty of water is available at a high elevation. Mr. Stuart estimates the cost of working upon the hydraulic system at 6d. (p. 14). Where the gold occurs in "rotten reef," the yield of the mass, as in section *f*, is found to vary from 4 dwts. to 1 oz. 5 dwts. per ton, independent of the exceptionally rich leaders here and there, some of which have been proved by myself up to 17½ oz. per ton.

Looking at all the facts before us, and rejecting all fancy estimates and favourable probabilities, we can scarcely fail to admit that these fields are amongst the richest, if not absolutely the richest, yet known in the world. It is otherwise as regards alluvial gold, and this is the cause that, in South Africa, has so frequently led to failure and disappointment.

In the "Guide to the Gold-Fields," the following passages occur:—"It must be borne in mind that Australian and Californian diggers, although, many of them, men of great experience, came to this country with preconceived notions. Most of them sought for alluvial gold on the water-worn creek gravels, and the lower contiguous terraces. Little attention could have been paid to the general character of this country, which presents evidences of denudation upon a very extensive scale, or their efforts would have been directed as well to the upper terraces and old river-beds at a higher level. Where no signs of what is called 'made ground,' existed, scarcely a pick was put in or a sod turned. Wherever attention was drawn to the rich deposits of doubtful origin, but now locally known as 'rotten reef,' it was declared that the reef was 'calcined' and the gold 'burnt out.' Sufficient evidence of the fact that the experience of other gold-fields has been at fault here is shown by the number of shafts that have been sunk, and afterwards abandoned, through soils that are now proved of the richest quality. Instances of this may be seen where shafts have passed through large masses of soil rich in fine gold, more especially on the highest point of the mountain above Pilgrim's Rest, which afterwards became known as the 'Company's Reef' and is now worked for fine gold upon the same spots that were successively abandoned as worthless." (pp. 11 and 12). "As the creeks at the lower levels are the result of recent denudation, and contain but little gold—as the higher patches of alluvium are more ancient, and contain a greater proportion of gold—the same condition of things will hold good elsewhere. If so, payable alluvial fields will be discovered, not exactly along the course of the existing streams (although fine gold may be found here and there in such situations) but at a greater or less distance from them, on the hills and terraces where alluvial deposits now represent the lines of an ancient denudation" (p. 57). But it is doubtful, for those very reasons, if an extensive as well as a payable alluvial gold-field will ever be found in this part of Africa."

If this be so, then the future of the fields depends not upon the advent of a large population, but upon the influx of capital. This is essential to the working of the large concessions taken out under the existing laws. Had small concessions been granted on reefs, as previously suggested, a few diggers could have combined and worked their ground as amalgamated claims; but there appears no chance of this being conceded by the Government. Therefore the reefs will be worked only by companies or capitalists, and herein lies the germ of temporary failure, as well as of ultimate success. Ground, rich beyond dispute, is purchased, tested by experts, and the promoters of the proposed company, not content with stating facts in themselves good enough to command public confidence, issue glowing descriptions and estimates of profit which would be marvellous if they were not ridiculous. The public are not to be caught by such shallow methods, but, unfortunately, rush to the other conclusion, that there is no gold in the Transvaal, and that the whole thing is a swindle. Had facts been stated in the first place, and reasonable sums invited, we should have seen by this time many companies at work, producing large quantities of gold, and paying high dividends. Instead of that, we have an exactly analogous case of over-greed and consequent collapse to that of the Diamond-fields.

But these things will rectify themselves. The gold is here, and, sooner or later, will be extracted, and, after all, the lesson of the last few months will not have been lost if it lead to a more careful and healthy tone of speculation. It should lead also to a thorough detailed investigation of the opened mines, that a reliable report upon them may be issued by the authority of the Government. This, and this only, will hasten a return of that confidence which must, at no distant date, be restored in gold-fields of the Transvaal. Surely our own Government should take an interest, not to say an active part, in furthering an inquiry into the truth or falsity of the statements published regarding the wealth of this country. If the gold-fields are unworthy of confidence, let the fact be made known, so as to prevent a recurrence of the Indian experience; if worthy, let this fact be also known—wide and authoritatively known—as the fields will provide an outlet, not only for British capital but for emigration. At the present period of our history this surely is an important consideration—the point towards which, with advantage to them and to ourselves, we shall direct our surplus population. And now is the time, if these fields be good, to encourage a movement in this direction; now the Boers will gladly see an influx of diggers and companies, for then they will have a market for their produce which they have not had since the retrocession of the country.

The argument may be summed up in a few words:—That the Transvaal gold-fields were known in the past, is proved by the existence of old workings by the natives, and probably by the Portuguese; the earlier efforts having been suddenly terminated, as have those of more recent times, by wars between the white and black races. As regards the present, the wealth of the fields is known to a few, although doubted by many, but the doubt is evidently qualified by a suspicion that, after all, there may be in them something worthy of investment. The Transvaal always attracts attention if not capital, and if the former were to be properly directed, the latter would speedily follow. Hitherto this has not been the case, for wrong ideas prevailed regarding the gold-belt, and this limited the earlier prospecting; then the promised recent development was retarded by uncertain laws, by the granting of concessions, and by false speculation. The future may be easily foreseen, for that very attention will ensure at an early date, if not capital, at least funds for investigation. Then the extent and richness of the Transvaal gold-fields will be not only asserted but proved, and the comparison, briefly instituted above, between them and others will be substantiated. Peace between the whites and the blacks seems now to be assured for some years to come; the Government must soon see the necessity of increasing the revenues of the country, and better gold laws will be framed to that end. Then a tide of population and capital will set in, and the the gold now lying unutilised will be extracted from the ground. By this, not only will investors be benefited, but it will provide an outlet for the other resources of this country, as well as for the surplus population of our own. It will tend also to promote friendship between the European and the Africander, by the creation of mutual interests and of joint prosperity.

DISCUSSION.

Sir JOHN SWINBURNE, Bart., said that in 1869 he went up into the interior through the Orange Free State, across the Vaal River, and thence over the centre and western portion of the Transvaal Republic. He was accompanied by Mr. Auguste Greite, an Australian miner of great practical experience. Between Rustenberg and Potchefstroom, some twenty or thirty miles north of Wonder Fontein, they were struck with the appearance of some quartz reefs which cropped out on the surface, and Mr. Greite expressed a firm conviction that there was gold there. He now heard that this opinion had been verified. He could not say much as to the gold-fields of Pilgrim's Rest and the eastern portion of the Transvaal, as he had never visited that side of the Transvaal; but some nine or ten years ago, an old friend informed him that his son had worked for less than twelve months at those gold-fields, and had returned to England with a competency. He had also heard of parties returning to Australia with as much as £40,000 to £60,000, which they had earned in a space of two or three years. Many of the Europeans who went to the Transvaal were unable to keep their temper with the Kaffirs, who, no doubt, were frequently very trying to men accustomed to employ only white men, and the Kaffirs will not remain with any one who is hard towards them. His own manager had reported to him that the Zulus and other natives north of the Transvaal made splendid miners after a few weeks' training, but after twelve months' work they earned sufficient to purchase a gun, when they considered themselves gentlemen, and consequently declined to work any longer; but they generally induced some friend or relative to take their place before leaving. In the Transvaal you had a healthy climate, cheap provisions, and cheap labour; while in most places there was plenty of water power at command for working stamp mills and the usual mining machinery. After a few years occupied in the steady development of this country, he could not see why the South African Republic should not be equal, as a gold-producing country, to any portion of Australia or South America.

Captain MILLS, C.M.G., as representing the Cape Colony in this country, said he could not but be deeply interested in the paper which had just been read. There were many points in it which he could fully corroborate, such for instance as the knowledge of the existence of gold-fields for ages past in the Transvaal. He had himself seen a map executed in the year 1642, on which the gold-fields of the Transvaal were plainly laid down. That map was now in the possession of the Royal Geographical Society. One point which struck him as deserving of notice, was the suggestion that the Transvaal Government should offer prizes for the discovery of gold, in fact for the discovery of any mineral wealth; but he was totally opposed to prizes being given by the Government for such discoveries, as he considered it was the business of private enterprise to develop resources of that kind. As to the comparison between the finds in Australia and in the Transvaal, it struck him (without wishing for a moment to disparage the estimate of the finds in the Transvaal) that the Australian average was taken from the total amounts derived of the workings from all the mines, whereas the average in the Transvaal was taken from samples, which made an immense difference. He should like to know from Dr. Mann whether the estimate had been taken from sample, or from the total produce. Mention was made in the paper as to the gold-fields being visited by Europeans as well as Africanders. He himself did not like to see such distinctions drawn. He deprecated any national distinction. With the knowledge that they had such a rich gold-field in the Transvaal, surrounded as it is by British colonies, we ought to make up our minds that all nationalities should go hand in hand and help each other in developing the wealth and resources of the country. In California and other parts of the world the Chinese worked side by side with Europeans, and that being so, the English ought not to draw distinctions between themselves and the Dutch and the Africanders, or any one else.

The Hon. Major ERSKINE said that, being connected with the Lisbon mines, he had not intended to take any part in the discussion, but as allusion had been made to former mining operations in this part of South Africa, and he had studied that question very carefully lately, he felt that he might mention some results which he had arrived at. The English description of the old mines was to be found in "Miller's Geography," 100 years old, and the return given from the Portugese mines was fallacious, it being stated at three and a half millions per annum. Such a statement as that was enough to ruin belief in the whole matter. He was convinced that nothing of the kind had ever taken place, because if it had, the Portuguese would never have abandoned the territory. Nevertheless, enormous results were produced, considering that machinery was scarcely used, and in some cases, from the labour of Kaffir women alone, £40,000 worth of gold had been exported in one year from one mine. He had not been able to get any return of the whole amount which had been exported, although the Government had promised to supply this information. The most auriferous district was "Monica," extending to 27°, and the Lydenburg gold-fields were situate in 25½°. For 1,000 miles along that coast gold-fields had existed for centuries, and if £40,000 worth of gold could be produced from Kaffir labour alone from one mine annually, there was no reason why, if proper machinery was employed, £400,000 worth should not be produced from the "Lisbon and Berlyn" mines. He had lately received a letter from his son, who was at present at the gold-fields, stating that "Lisbon and Berlyn" was full of gold.

Mr. HYDE CLARKE said he had long taken a deep interest in South Africa, though he could not say that he had any practical experience of the Transvaal. He thought it important that prospecting should be encouraged in every way, but, at the same time, it was exceedingly desirable that persons should not expect too much in the early stages of work, and the writer of the paper had given some very good cautions upon that subject. As reference had been made in the paper to the subject of Indian gold, he might, perhaps, be permitted to say that the Indian gold mines could teach them a very good lesson. When the subject was previously discussed in that room, there was, upon the one hand, a strong disposition to represent that there was no gold in India at all; and, upon the other hand, there was a disposition to raise exaggerated expectations, and he then took the liberty of suggesting that the subject should be dealt with in a practical way. However, that had not been done, and gold-mining in India had been carried on from a Stock Exchange point of view, with what result every one knew. When the mines were taken over, too great a price was given for the land, and machinery was sent out before the grounds were developed, merely for the purpose of raising expectations amongst speculators. In Africa, as well as in India, they had examples of ancient workings, and it was absolutely necessary in all gold-mining operations that the work should be taken up in a practical spirit. He quite agreed with the remarks made by a previous speaker as to the necessity of Europeans working amicably with the Africanders. It is well known that the Transvaal delegates had not been received in some quarters with the attention which many desired should be shown to them, though, fortunately, her Majesty's Government had shown a great degree of attention, and the delegates entertained a very good feeling as to the reception which had been accorded them.

Mr. BARRETT said he had just arrived from the Transvaal, and had brought a few nuggets back with him, which he should be glad to exhibit. The nuggets had been found on the surface of the Berlin and De Kaap farms. One of the nuggets now exhibited weighed as much as 32 oz., another 14 oz. 14 dwt., and another 11 oz. 16 dwt. They were found during February and March, and in six weeks one man secured 105 oz. of gold, with the aid of one Kaffir and his son. He had also himself brought back to this country six tons of quartz which had been taken from the reefs "Homeward Bound," "Rautenbach," and "Collins," on the farms Berlin and De Kaap.

Dr. HUGH EXTON thought nothing could give greater weight to the paper which had been read than the specimens of gold which had just been produced by Mr. Barrett. He was himself one of those who had preceded Sir John Swinburne in a visit to the Tati fields, and he had listened with great interest to the paper, as well as to the remarks of Captain Mills with regard to the ancient map describing the gold-fields 200 years ago. Gold was first discovered at Tati by a hunter named Hartley, and upon an investigation, it was found that excavations had been made at this place many hundreds of years previously. In Tati the gold existed in extremely minute particles, though a small quantity had been obtained by means of crushing apparatus. In the Transvaal gold was also discovered in extremely small particles in the first instance, but as time had gone on, the yield had not only become larger, but the size of the nuggets found had also increased, and there was now no question, from the evidence which had been published, and the gold which had found its way into Natal, that a large quantity was being obtained. If prospectors had some security that they would reap the benefit of their finds, there was no doubt that a great stimulus to prospecting would take place.

Dr. MANN said, with regard to the question as to the estimate which had been made, the paper itself would show that Mr. Penning had exercised great care, having taken samples from many different places. No doubt some margin should be allowed with estimates of this class. His own impression, however, was, that Mr. Penning had taken care to have fair ground for the statements he had made. Captain Mills was no doubt right that the Australian returns were taken from the results of actual work.

Captain MILLS said he did not wish to throw any doubt upon Mr. Penning's statement. He only desired to guard against over sanguine statements which might lead to a mischievous reaction. He begged to propose a vote of thanks to Mr. Penning for the paper, and to Dr. Mann for reading it.

The Hon. Major ERSKINE seconded the resolution.

The CHAIRMAN said the paper was one of much value, its author being a trained scientific observer. Notwithstanding some observations which had been made upon it, Mr. Penning's view seemed, on the whole, moderate. It unfortunately happened, as Mr. Penning pointed out, that occasionally people who were naturally interested in the development of gold-fields in the colonies allowed their imagination too much scope; but, upon the other hand, there were people who, having been bitten before, were exceedingly shy in entering upon gold speculations. The author of the paper had taken a mean course, and had warned them against too brilliantly coloured reports, though he pointed out that the gold-producing rocks of the Transvaal were distributed over a very wide area. Any scepticism was disposed of by the wonderful specimens which had been exhibited that night. He had hoped that the paper would have dealt with the geological description of the gold-bearing area in the Transvaal; but no doubt this subject would be taken up on a future occasion. The relation between the auriferous reefs and the dykes of diorite was interesting in connexion with certain views held by the late Mr. David Forbes. Before concluding, he might refer to a globe which had been exhibited by Mr. J. Baddeley at the Geological Society, around which was marked a red line, cutting the equator obliquely in long. 10° E., and 170° W., and with its northern and southern intersections in lat. 45°. The circle corresponded nearly in position to some of the principal gold-producing mines in the world; in Australia, in several parts of North America (from California to Nova Scotia), in West Africa, and in the Transvaal. At the same time he was careful to explain that he regarded this as nothing more than a "curious coincidence.

The resolution was passed unanimously.

Dr. MANN said he would take care to convey to Mr. Penning, who was at present in the Transvaal, the vote of thanks which had just been passed by that meeting.

TWENTIETH ORDINARY MEETING.

Wednesday, May 7, 1884; B. W. RICHARDSON, M.A., M.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Flew, John Pearce, Fulham-park-gardens, S.W.
Habershon, Matthew Henry, Eversley, Richmond-road, New Barnet.

Harris, David, Caroline-park, Edinburgh.
Hope, R. C., F.S.A., Albion-crescent, Scarborough.
King, G. Swinburn, 1, Devonshire-terrace, Hyde-park, W.
Phillips, John Orwell, Gas Light and Coke Company, Horseferry-road, S.W.
Pocknell, George, Lonsdale, Exeter.
Shuter, James Legasick, 9, Steele's-road, Haverstock-hill, N.W.
Watson, Thomas Donald, 23, Cross-street, Finsbury, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Beilby, George T., Midcalder, N.B.
Bridgford, Major Sidney Thomas, R.M.A., Army and Navy Club, Pall-mall, S.W.
Butler, Henry, 50, Lee-terrace, Blackheath, S.E.
Clarke, Caspar Purdon, C.I.E., 3, Sheffield-terrace, Campden-hill, W.
Gibbs, Surgeon-Major J. G., Riggindale-road, Streatham, S.W.
Morgan, William, Waverley, Albemarle-road, Beckenham.
Parlane, James, Appleby-lodge, Rusholme, Manchester.
Pearcy, Joseph, 127, Englefield-road, Islington, N.
Peel, Captain Francis, Boxted-house, Colchester.
Pleydell, Thomas George, Commercial Bank of South Australia, 24. Lombard-street, E.C.
Ross, Rev. Henry, M.A., Dallas-house, Lancaster.
Samuel, Sir Saul, K.C.M.G., 15, Courtfield-gardens, S.W., and 5, Westminster-chambers, S.W.
Turpie, William, Bank-house, Derby.
Wight, Laurence Hill, M.A., 41, Chambers-street, Edinburgh.
Wilkin, Miss, Cossey-cottage, Hampstead, N.W.

The paper read was—

BICYCLES AND TRICYCLES.

By C. V. Boys.

The subject of this paper is one of such wide interest, and of such great importance, that it is quite unnecessary for me to make any apology for bringing it before your notice. Exactly two months ago, I had the honour of dealing with the same subject at the Royal Institution. On that occasion I considered main principles only, and avoided anything in which none but riders were likely to take an interest, or which was in any way a matter of dispute. As it may be assumed that the audience here consists largely of riders, and of those who are following those matters of detail, the elaboration, simplification, and perfection of which have brought the art of constructing cycles to its present state of perfection, I purpose treating the subject from a totally different point of view. I do not intend, in general, to describe anything, assuming that the audience is familiar with the construction of the leading types of machines, but rather to consider the pros and cons of the various methods by which manufacturers have striven to attain perfection. As a discussion on the subject of this paper will doubtless follow—and I hope makers or riders of every class of machine will freely express their opinion, for by so doing they will lend an interest which I alone could not hope to awaken—I shall not consider it necessary to assume an absolutely neutral position, which might be expected of me if there were no discussion, but shall explain my own views without reserve.

The great variety of 'cycles may be grouped under the following heads :—

1. The Bicycle unmodified.
2. The Safety bicycle, a modification of 1.
3. The Centre-cycle
4. The Tricycle, which includes five general types.—
(a.) Rear steerer of any sort.
(b.) Coventry rotary.
(c.) Front steerer of any sort (except e).
(d.) Humber pattern.
(e.) The Oarsman.
5. Double machines: sociables and tandems.
6. The Otto.

It is perfectly obvious that not one machine is superior to all others in every respect, for if that were the case, the rest would rapidly become extinct. Not one shows any signs of becoming extinct, and, therefore, it may be assumed that each one possesses some points in which it is superior to others, the value of which is considered by its riders to far outweigh any points in which it may be inferior. The widely varying conditions under which, and purposes for which, machines are used, and the very different degrees of importance which differently constituted minds attach to the peculiarities of various machines will, probably, prevent any from becoming extinct. Nevertheless, the very great advantages which some of these possess over others will, no doubt, in time become evident by the preponderance of the better class of machines.

The bicycle, which surpasses all other machines in simplicity, lightness, and speed, will probably, for these reasons, always remain a favourite with a large class. The fact that it requires only one track places it at a great advantage with respect to other machines, for it is common for a road which is unpleasant from mud or stones to have a hard smooth edge, a kind of path, where the bicyclist can travel in peace, but which is of little advantage to other machines. Again, the bicycle can be wheeled through narrow gates or doorways, and so kept in places which are inaccessible to tricycles. One peculiarity of the bicycle, and to a certain extent of the centre-cycle, is that the plane of the machine always lies in the direction of the resultant force, that the machine leans over to an amount depending on the velocity and the sharpness of the curve described. For this reason all lateral strain on the parts is abolished, and if we except the slipping away of the wheel from under the rider, which can hardly occur on a country road, an upset from taking a curve too quickly is impossible. This leaning to either side by the machine and rider gives rise to that delightful gliding which none but the bicyclist or the skater can experience. In this respect the bicycle has an enormous advantage over any machine, tricycle or Otto, which must at all times remain upright, and which must, therefore, at a high speed, be taken round a curve with discretion.

The perfect and instantaneous steering of the bicycle, combined with its narrowness, counteract, to a great extent, the advantage which the tricyclist has of being able to stop so much more quickly, for the bicyclist can "dodge" past a thing for which the rider of the three-wheeler must pull up. In one other respect the bicyclist has an advantage, which, though of no real importance, has great weight with many people. The bicycle well ridden presents a picture of such perfect elegance that no one on anything else need expect to appear to advantage in comparison.

The chief disadvantage of the bicycle is the fact that a rider cannot stop for any purpose, or go back a little, without dismounting. For town riding, where a stoppage is frequently necessitated by the traffic, this perpetual mounting and dismounting is not only tiresome but wearying, so much so, that few bicyclists care to ride daily in town.

The position of the rider on a bicycle with respect to the treadles is by no means good, for if he is placed sufficiently far forward to be able to employ his weight to advantage without bending himself double, he will be in so critical a position that a mere touch will send him over the handles. He has, therefore, to balance stability and safety against comfort and power; the more forward he is, the more furiously he can drive his machine, and the less does he suffer from friction and the shaking of the little wheel; the more backward he is, the less is he likely to come to grief riding down hill, or over unseen stones. The bicyclist is no better off than the rider of any other machine with a little wheel, the vibration from which may weary him nearly as much as the work he does. The little wheel as a mud-throwing engine is still more effective on the bicycle than it is on any tricycle, for in general it is run at a higher speed.

I now come to the usual complaint about the bicycle. There is a fashion just now to call it dangerous, and the tricycle safe. But the difference in safety has been much exaggerated. The bicyclist is more likely to suffer from striking a stone than his friend on three wheels, but then he should not strike one where the tricyclist would strike a dozen. Properly ridden, neither class of machine can be considered dangerous; an accident should never happen except it be due to the action of others. People, carts, cattle, and dogs on the road are liable to such unexpected movements, that the real danger of the cyclist comes from the outside; to danger from absolute collapse due to a hidden flaw in the materials employed, every one is liable, but the bicyclist more remotely than the tricyclist, owing to the greater simplicity of his machine. The bicyclist, though he has further to fall in case of an accident from any of these causes, is in a better position than the tricyclist, for he is outside instead of inside his machine; he can in an instant get clear. It would appear that many tricyclists consider accidents of the kind next to impossible, for in several machines the rider is so involved, that an instantaneous dismount without a moment's notice, at any speed, is absolutely impossible. There remains one objection, which, however, should be of next to no importance—the difficulty of learning the bicycle prevents many from taking to the light and fast machine, because they are afraid of a little preliminary trouble.

The chief objections to the bicycle, then, are the liability of the rider to go over the handles, the impossibility of stopping very quickly, and the inability to remain at rest or go backwards, and the difficulty of learning.

The first two of these are, to a large extent, overcome in the safety bicycles, but not without the introduction of what is in comparison a certain degree of complication, or without the loss of the whole of the grace or elegance of the bicycle. On almost all these safety bicycles the rider is better placed than on the unmodified bicycle, but though safer I do not think bicyclists find them compete in speed, though, no doubt, they are superior in that respect to the tricycle. Though they do not allow the rider to stop without dismounting, the fatigue resulting from this cause is less than it is with a bicycle, owing to the fact that with the small machines the rider has so small a distance to climb. Of these machines, the "Extraordinary" leaves the rider high up in the air on a full-sized wheel, but places him further back and more over the pedals. The motion of these is peculiar, being not circular but oval, a form which has certain advantages.

In the Sun and Planet and Kangaroo bicycles, a small wheel is "geared up," that is, is made to turn faster than the pedals, so as to avoid the very rapid pedaling which is necessary to obtain an ordinary amount of speed out of a small wheel. In each of these the pedals move in a circular path, and their appearance is in consequence less peculiar than that of the Facile, which, in this respect, does not compare favourably with any good machine. The pedal motion on the Facile is merely reciprocating. Riders of machines where circular motion is employed, among them myself, do not believe that this reciprocating motion can be so good as circular, but I understand this view is not held by those who are used to it. Of course, the harmonic motion of the Facile pedal is superior to the equable reciprocating motion employed in some machines where speed is an object, especially with small wheels.

If I have overlooked anything typical in the modified bicycle class, I hope someone will afterwards supply the omission, and point out any peculiarities or advantages.

That very peculiar machine, the Centrecycle seems to combine many of the advantages of the bicycle and tricycle. On it the rider can remain at rest, or can move backwards; he can travel at any speed round curves without an upset being possible; he can ride over brickbats, or obstructions, not only without being upset, but if going slowly, without even touching them. As this machine is very little known, a few words of explanation may be interesting.

In the first place, the rider is placed over the main wheel, as in the bicycle, but much further forward. There are around him, on or near the ground, four little wheels, two before and two behind, supported in a manner the ingenuity of which calls for the utmost admiration. Turning the steering handle not only causes the front and rear pairs to turn opposite ways, but owing to their swivelling about an inward pointing axis, the machine is compelled to lean over towards the inside of the curve; not only is this the case, but each pair rises and falls with every inequality of the road, if the rider chooses that they run on the ground; but he can, if he pleases, arrange that in general they ride in the air, any one touching at such times as are necessary to keep him on the top of the one wheel on which alone he is practically riding. He can, if he likes, at any time, lift the main-wheel off the ground, and run along on the others only. The very few machines of the kind which I have seen have been provided with foot straps, to enable the rider to pull as well as push, which is a great advantage when climbing a hill, but this is on every machine except the Otto, of which I shall speak later, considered a dangerous practice.

Some of the objections to the bicycle to which I have referred were sufficient to prevent many, especially elderly men, from dreaming of becoming cyclists. So long as the tricycle was a crude and clumsy machine, there was no chance of cycling becoming a part, as it almost is, and certainly soon will be, of our national life. The tricycle has been brought to such a state of perfection, that it is difficult to imagine where further progress can be made.

Perhaps it will be well to mention what is necessary, in order that a three-wheeled machine may be made to roll freely in a straight line, and also round curves. At all times each wheel must be able to travel in its own plane in spite of the united action of the other two. To run straight, the axes of all the wheels must obviously be parallel. To run round a curve, the axis of each must, if continued, pass through the centre of curvature of the curve. If two wheels have a common axis, the intersection of the two lines forming the axes can only meet in one point. To steer such a combination, therefore, the plane of the third wheel only need be turned. If the axes of no two are common, then the planes of two of the wheels must be turned in order that the three axes may meet in a point.

Not only does free rolling depend on the suitable direction of the planes of the wheels, each wheel must be able to run at a speed proportional to its distance from the point of intersection of the three axes, *i.e.*, from the ever-shifting centre of curvature.

The most obvious way, then, of contriving a three-wheeler is to drive one wheel, steer with another, and leave the third, which must be opposite the driver, idle. The next in simplicity is to drive with one wheel, and steer with the other two, having one in front, and the other behind. So far then, the single driving rear-steerer and the Coventry rotary pattern, are easily understood. The evils of single driving, minimised, it is true, to a large extent, in the Coventry rotary, have led to the contrivance of means by which a wheel on each side may be driven without interfering with their differential motion in turning a corner. Three methods are commonly used, but as only two are employed on tricycles, I shall leave the third till I come to the special machine for which it is necessary. The most easy to understand is the clutch, a model of which I have on the table. If each main wheel is driven by means of one of these, though compelled to go forward by the crankshaft, it is yet free to go faster without restraint. By this means "double driving" is effected in several forms of tricycle. Differential gear, which is well understood, and of which there are several mechanically-equivalent forms, divides the applied driving power, whether forwards or backwards, between the main wheels, equally if the gear is perfect, unequally if imperfect. To understand the effect of the two systems of driving, and of single driving, let us place on grooves a block which offers resistance to a moving force. If we wish to move it, and apply our force at the end of one side, it will tend to turn round as well as move forward, and much friction will be spent on the guides by their keeping it straight. This is the single driver. If, instead of applying force at one side, we push the block bodily forward by a beam moving parallel to itself, then so long as the guides are straight no strain will be put upon them, even though one side of the block is resisted more than the other; if, however, the guides compelled the block to travel round a curve, then the power, instead of being divided between the two sides in such proportion as is necessary to relieve the guides of all strain, is suddenly applied only to the inside, and the effect is that of a single driver only. This is the clutch. Lastly, if the last-mentioned beam, instead of being pushed along parallel to itself, were pivoted in the middle, and that pivot only pushed, the same power would be applied to each side of the block, and no strain would be thrown on the guides, whether straight or curved, so long as the resistance opposed to the block on the two sides were equal; if, however, one side met with more resistance than the other, then the guides would have to keep the block straight. This is the differential gear. I have assumed that in the last case the force was applied to the middle of the beam; this corresponds to every evenly-balanced gear. In the gear employed by Singer, which is not evenly balanced, but which derives its good qualities from its simplicity, the same effect is produced as if the beam were pivoted on one side of the centre, instead of on the centre. Thus, though both sides are driven, one is driven more than the other. On the whole, there is no doubt that the balanced gear gives a superior action to the clutch, for except when the two sides of the machine meet with very different resistance, and then only when running straight, the clutch will not compare with the other. The clutch also gives rise to what is considered by most riders a grave defect, the inability to back treadle, while the free pedal, which is an immediate consequence, is considered by others a luxury. On the other hand, this same free pedal can be obtained on differentially-driven machines to which speed and power gear have been applied.

Of the relative merits of different forms of differential gear there is little to be said. Perhaps it will not be thought I am unduly thrusting myself forward, if I refer to a scheme of my own, in which no toothed wheels are employed, but in which two conical surfaces are driven by a series of balls lying in the groove between them, and jambed against them by a recessed ring. I have here a large wooden diagrammatic model, and a small working model in steel, which shows that the new principle employed is correct, namely, that a ball while jambed is free to turn, or if turning is able to jamb. All Humbers, and most front steerers, employ differential gearing; in some front steerers the clutch of necessity is used.

Neglecting for the present the different modes of transmitting power from the pedals to the main wheels, it is possible now to consider the four typical builds of tricycle. The only advantage that a rider can find in a rear-steerer is the open front, so that in case of accident he can more easily clear himself of his machine; as I have already remarked this power of instantly escaping seems to be considered by many as of no importance. In a rear-steerer which has not an open front, whether driven by a clutch or by differential gear, I fail to discover any good quality. The steering of a rear-steerer is so very uncertain, that such machines cannot safely be driven at any thing like a high speed, because any wheel meeting with an obstruction will, by checking the machine, diminish the weight on the steering wheel just at the time when a greater weight than usual should be applied. It is for the corresponding reason that the steering of a front-steerer is so excellent; the more the machine is checked by obstruction, by back treading or by the brake, the greater is the weight on the front wheel. For shooting hills, or for pulling up suddenly, no machine of any kind will compare with a good front-steerer. In all respects it is superior to the rear steerer if we except the open front, but against this may be set the fact that on many the rider can mount from behind, or can dismount in the same manner while the machine is in motion. Experience shows that the front-steerer is for general excellence, safety, easy management, and light running, the best all-round tricycle that is to be had.

The Humber build, which departs less from the ordinary bicycle than any other, is far superior to all others for speed; it is, however, somewhat difficult to manage, for the steering is not only delicate, but critical, requiring constant care lest a stone or other obstruction should take the rider unawares, and steer the machine for him. The control which a skilful rider of the Humber has over his machine is wonderful; the elegance of the machine among tricycles is unequalled. So great a favourite is this form, especially among the better class of riders, that almost every firm have brought out their own Humber, each with a distinguishing name. The only improvement or change, whichever it may be, that has been made by others with which I am acquainted, is the triple steering, in which the hind wheel moves the opposite way to the others. The corresponding change in the bicycle was soon discarded; I do not know what advantage can result from the increased delicacy of steering here, I should have thought it delicate enough already.

One noticeable change in the front-steering tricycle, which has been largely made, lately, is the substitution of central for side-gearing, in consequence of which, bicycle cranks can be employed, instead of the cranked axle, with its fixed throw. This gives an appearance of lightness which the older types of machine do not possess.

I now come to that very difficult and all-important subject, the method of transmitting power from the body of the rider to the main axle. Next to the structural arrangement, this is most important in distinguishing one type of machine from another.

The first to which I shall refer, is the direct action employed on the "National" and the "Monarch" tricycles. It is obvious that by having no separate crank shaft, much greater simplicity and cheapness, and less friction are attained, than can be possible when the extra bearings and gear generally used are employed. In this respect the direct action machines undoubtedly have an advantage, but an advantage of any kind may be too dearly bought, as it certainly is here. In the first place, the direct action can only be applied to a rear-steering, clutch-driven machine, or single driver, for if the wheels were not free to run ahead, it would be impossible to go round a curve. In the second place, the rider must be placed at such a height for his feet to work on the axle, that the machine of necessity is very unstable, and is likely to upset if ridden without great caution round a curve. Thirdly, to diminish as far as possible this last objection, miserable little wheels must be employed, which cannot be geared up, that is, made to travel faster than the treadles, and so be equivalent to larger wheels. Therefore, though it is likely that at such low speeds only as it is safe to run such a machine, it may move more easily than a machine of a recognised type, and though direct action would undoubtedly be advantageous if it did not entail defects of a most serious order of magnitude, we may dismiss this at once from our consideration. It is true that in the "Monarch" a few inches of height are gained by the hanging pedals, but I question very much whether one machine is much better than the other.

The chain which is used on almost every make of machine cannot be considered perfect; it is, on the whole, a dirty and noisy contrivance, giving rise to friction where the links take and leave the teeth of the pullies; stretching, or rather lengthening, by wear, and, finally, allowing back lash, which is most unpleasant. In spite of all this it affords a convenient and reliable means of transmitting power, which is applicable to every type of tricycle, except one.

Instead of a chain, an intermediate or idle wheel has been tried, but this has not been found advantageous. The intermediate wheel has been removed, and the crank and wheel pulley allowed to gear directly together, making reverse motion of the feet necessary, and possibly reduciug friction.

The crank and connecting rod are employed in some machines. If there are two only, they must not be placed in opposite positions, but be fixed at an angle, so that there are times when each rod is under compression, a strain which delicate rods cannot stand. In the three-throw crank, employed in the Matchless tricycle, this objection is obviated, for one, at least, is at all times in such a position as to be in tension. The objection to the crank is the fact that it weakens the shaft, and that it can only be used with a clutch, not with a differential gear.

The most silent, neatest, and cleanest driver, the one of which the working friction is least, is the endless steel band, so well known in connection with the Otto bicycle. This is not, as far as I am aware, employed on any tricycle, makers probably fearing lest it should slip. The Otto shows that it can safely be employed.

I have devised a scheme, of which I now show a model, which seems to me to be free from the objections which may be urged against other methods; but I, of course, cannot be considered in this respect a judge. Eccentrics are well known as equivalent to cranks, but if used in the same way, with a connecting rod, either fatal friction or enormous ball-bearings would be necessary. Instead of these, I connect two pair of equal eccentrics by an endless band embracing each, so that the band acts like a connecting rod without friction, and, at the same time, acts by its turning power as on the Otto, thus making two eccentrics sufficient instead of three, and carrying them over the dead points.

There is one more system of transmitting power employed on a few machines. In these, a band or line passes over the circumference of a sector or wheel, and the power is directly applied to it. The motion of the feet in the Omnicycle, and of the hands and body in the Oarsman, is therefore uniform. There would be no harm in this if it were not for the starting and the stopping, which cannot be gradual and at the same time effective in machines of this type. For this reason, a high speed cannot be obtained; nevertheless, these machines are better able to climb hills than are tricycles with the usual rotary motion, for, at all parts of the stroke—which may be of any length that the rider chooses—his driving power on the wheels is equal. The ingenious expanding drums on the Omnicycle makes this machine exceptionally good in this respect, for increased leverage is effected without increased friction, which is the result of "putting on the power" in some of the two speed contrivances.

Having spoken of the Oarsman tricycle, I must express regret that I have not been able to find an opportunity to ride on or with the machine, so that I cannot from observation form an opinion of its going qualities. There can be no doubt that the enormous amount of work that can be got from the body in each stroke on a sliding seat in a boat must, applied in the same manner on the Oarsman tricycle, make it shoot away in a surprising manner; whether such motion, when continued for hours, is more tiring than the ordinary leg motion only, I cannot say for certain, but I should imagine that it would be. The method by which the steering is effected by the feet, and can with one foot be locked to a rigidly straight course, is especially to be admired.

There is much difference of opinion with respect to the most suitable size for the wheels of machines. Except with certain machines, this has nothing to do with the speed at which the machine will travel at a given rate of pedalling, for the wheels may be geared up or down to any extent that is made to turn more quickly or slowly than the cranks. This the most suitable speeding is a separate question, and must be treated by itself.

Large wheels are far superior to small wheels in allowing comfortable easy motion, a matter of considerable importance in a long journey. They are also far better than small for running over loose or muddy ground, for, with a given weight upon them, they sink in less, from the longer bearing they present, and this, combined with their less curvature, makes the everlasting ascent which the mud presents to them far less than with a smaller wheel. On the other hand, the large wheel is heavier, and suffers more from air resistance than the small wheel. For racing purposes a little wheel, geared up of course, is certainly better than a high wheel; for comfortable travelling, and in general, the high wheel is preferable. Though this is certainly the case, it does not follow that large wheels are worth having on a machine when there is already one little wheel. If the rider is to be worried with the evils of a little wheel at all, it is possible that any advantage which large wheels would give him would be swamped by the vibration and mud-sticking properties of the small steering wheel. One firm, in their endeavours to minimise these evils, have designed machines without any very small wheels; all three wheels are large, and a steadier and more comfortable motion no doubt results.

High and low gearing are the natural sequel to high and low wheels. Of course the lower the gearing the greater is the mechanical advantage in favour of the rider when meeting with much resistance, whether from wind, mud, or steepness of slope. In spite of this, for some reason which I cannot divine, the machines with excessively low gear do not seem to obtain so great an advantage in climbing hills as might be expected. To make such a machine travel at a moderate speed only, excessively rapid pedalling is necessary, and the rider is made tired more by the motion of his legs than by any work he is doing. The slow, steady stroke by which a rider propels a high-geared machine is far more graceful and less wearying than the furious motion which is necessary on a low-geared machine. The height up to which the driving-wheels are usually geared may be taken as an indication of the ease with which any class of machines runs. A rider on a low-geared machine can start his machine much more quickly than an equal man on one that has high gearing, and therefore in a race he has an advantage at first, which he speedily loses as his rapid pedalling begins to tell. For ordinary riding the slight loss of time at starting is a matter of no importance whatever.

There are several devices which enable us to obtain the advantages of high and low gearing on the same machine, which at the same time give the rider the benefit of a free pedal whenever he wishes. On some single driving rear-steering tricycles the connection on one side is for speed, and that on the other for power, either being in action at the wish of the rider, or both speed and power combinations are applied on the same side. To drive with a power gear a single wheel only seems to me to be the height of folly; in my opinion no arrangement of this type is worthy of serious attention. Among the better class of machines there are three methods by which this change is effected—First, that employed on the Omnicycle, to which I have already referred; secondly, an epicyclic combination of wheelwork which moves as one piece when set for speed, thus adding nothing to the working friction except by its weight, but which works internally when set for power, thus reducing to a small extent, by the additional friction, the gain of power which the rider desires; thirdly, a double set of chains and pulleys, each set always in movement, so that whether set for speed or power, there is rather more friction than there would be if there were no additional chains, but these are free from that increased friction due to toothed wheel gearing, from which the epicyclic contrivances suffer only when set for power. There is much difference of opinion whether any of these arrangements are worth carrying, for perhaps nine miles, for the sake of any advantage that may be obtained in the tenth. It is on this account that the drums on the Omnicycle are so excellent; whether expanded or not, there is, on their account, no loss of work whatever, for there is no additional friction. The subject of these two speed gears will, I hope, be discussed; it is one which, though not new, is coming more to the front, and about which much may be said.

Having now dealt with the means by which tricycles are made to climb hills more easily, I wish to leave the subject of bicycles and tricycles altogether for a few minutes, to say a few words which may specially interest those who are fond of trying their power in riding up our best known hills. The difficulty of getting up depends to a large extent on the surface and on the wind, but chiefly on the steepness. The vague manner in which one hill is compared with another, and the wild ideas that many hold who have not made any measurements, induces me to describe a method which I have found specially applicable for the measurement of the steepness of any hill on which a cyclist may find himself, and also a scheme for the complete representation of the steepness and elevation of every part of a hill on a map so as to be taken in at a glance. The force required to move the thing up a slope is directly proportional not to the angle but to the trigonometrical sine of that angle. To measure this, place the tricycle, or Otto—a bicycle will not stand square to the road, and therefore cannot be used—pointing in direction at right angles to the slope of the hill, so that it will not tend to move. Clip on the top of the wheel a level, and mark that part of the road which is in the line of sight. Take a string made up of pieces alternately black and white, each exactly as long as the wheel is high, and stretch it between the mark and the top of the wheel. If there are n pieces of string included, the slope is 1 in n, for by similar triangles the diameter of the wheel is to the length of the string as the vertical rise is to the distance on the road. This gives the average steepness of a piece sufficiently long to be worth testing, because an incline, only a few feet in length, of almost any steepness can be mounted by the aid of momentum.

There is only one process, with which I am acquainted, which supplies a method of representing on a map the steepness of a road at every part. Contours, of course, show how far one has to go to rise 50 or 100 feet, but as to whether the ascent is made uniformly or in an irregular manner with steep and level places, they tell us nothing. Let the course of a road be indicated by a single line where it is level, and by a pair of lines where inclined. Let the distance between the lines be everywhere proportional to the steepness, then the greatest width will show the steepest part, and an intermediate width will show places of intermediate steepness, the crossing of the lines, which must be distinguishable from one another, will show where the direction of the slope changes. Further, the size of the figure bounded by the two lines will show the total rise; a great height being reached only by great steepness or by great length, a large figure being formed only by great width or by great length. Those who are mathematically inclined, will recognise here that I have differentiated the curve representing the slope of the hill, and laid the differential curve down in plan.

Having wandered off my subject, I must return to more mechanical things, and give the results of some experiments which I have made on the balls of ball bearings. There is no necessity to argue the case of ball *v.* plain bearings, the balls have so clearly won their case, that it would be waste of time to show why. Of the wear of the twelve balls forming one set belonging to the bearings of the wheels of my Otto, I have on a previous occasion spoken; I may, however, repeat that in running 1,000 miles, the twelve balls lost in weight only $\frac{1}{20.8}$ grain, or each ball lost only $\frac{1}{250}$ grain. The wear of the surface amounted to only $\frac{1}{158000}$ inch; at the same rate of wear, the loss in travelling from here to the moon would amount to only $\frac{1}{54.3}$ of their weight. I examined each ball every 200 miles, and was surprised to find that on the whole the wear of each, during each journey, varied very little. The balls experimented on were a new set obtained from Mr. Bown. I also had from him one ball of each of the following sizes 3, 4, 5, 6, and 7-16ths of an inch in diameter, as I was curious to know what weight they would support without crushing. As a preliminary experiment, I placed a spare $\frac{7}{16}$ ball between the crushing faces of the new testing machine at South Kensington, and applied a gradually increasing force up to 7 tons $9\frac{1}{2}$ cwt., at which it showed no signs of distress. On removing it I found that it had buried itself over an angle of about 60° in the hard steel faces, faces so hard that a file would not touch them. Those marks will be a permanent record of the stuff of which the ball was made. The ball itself is sealed in a tube, so that any one who is curious to see it can do so. Finding that the crushing faces were not sufficiently hard, I made two anvils of the best tool steel, and very carefully hardened them. These, though they were impressed slightly, were sufficiently good for the purpose. In the following Table are the results of the crushing experiments:—

$\frac{3}{16}$ ball at 2 tons 13 cwt. did not break, but crushed on removing part of the weight.

$\frac{1}{4}$ ball at 3 tons 15 cwt. did not break, but crushed on removing part of the weight.

$\frac{5}{16}$ ball at 4 tons 9 cwt. broke.

$\frac{3}{8}$ ball at 8 tons 6 cwt. did not break, crushed under another 120 lbs.

$\frac{7}{16}$ ball crushed before 3 tons, with which I was starting, had been applied. Examination showed that the steel bar of which it was made had been laminated.

These experiments do not tell much of importance; they are curious, and, perhaps, of sufficient interest to bring before your notice. The fragments are all preserved in tubes, and labelled so that anyone who likes to see them can do so.

Of the advantage which a machine which will collapse or fold up when desired, but retain its form on the road, offers in convenience, it is unnecessary for me to speak.

Of double machines, the Rucker tandem bicycle seems to me to be in every respect the best, but I should add that I speak only from imagination and not from experience. The independent steering, the impossibility of capsizing forwards or sideways, the position of the rider over his work, the absence of any little wheel with its mud throwing and vibrating tendencies, combine to make a machine which ought to be superior in almost every desirable quality to any other; what it may be in practice I hope to hear in the discussion.

Of double tricycles, the Sociable has been tried by many, and is practically a failure in so far as travelling quickly and easily is concerned. The Tandem, though it presents so objectionable an appearance, seems likely to become a favourite, for it surpasses any single tricycle, and rivals the bicycle in speed. How it may compare in comfort or in safety with the single machine, perhaps those few who are well acquainted with them will say; at any rate, in the case of the Humber, greater stability is given to the steering owing to the weight of the front rider.

Time will not allow me to say more of these machines, or to attack the subject of steam, electric, or magic tricycles, which I had hoped to do. With steam and electricity we are well acquainted; by magic tricycles, I mean those driven by a motor which, without any expense, will drive one twenty miles an hour, up or down hill, with perfect safety. Highway regulations, and certain reasons not well understood, have at present prevented these contrivances from making a revolution.

There remains one machine which must be considered separately, for it cannot be classed with any other. This is the Otto bicycle. My opinion of this machine is so pronounced that I do not care to state it fully. I shall merely give the reasons why I prefer it to anything else, and in so doing I shall be taking the first step in the discussion, in which it will be interesting to hear from riders of other machines the reasons for their preference.

In the first place, the evils of a third or little wheel, the cause of trouble in all tricycles, are avoided. There is none of the vibration which makes all other machines almost unbearable to Ottoists, vibration which tricyclists have learnt to consider a necessary accompaniment of cycling, but which has, no doubt, been diminished by the use of the spring support of the front-steering Humber. It would be presumptuous in me to make any remarks on the effect of this vibration on the human system; we shall all be anxious to hear what our Chairman has to say on this point. By having only two wheels, we have only two tracks, so that we can travel at a fair speed along those places in the country called roads, which consist of alternate lines of ruts and stones, where a three-track machine could not be driven, and where, from the quantity of loose limestone in the ruts, a little wheel of a two-track tricycle would be likely to suffer. By having no little wheel, we can ride in dirty weather without having the rest of our machine pelted with mud, so that cleaning takes less time than it does with anything else. As I have already remarked, the small wheel is the culprit which makes the bicycle and tricycle drive so heavily on a soft road. The ease with which the Otto can therefore be run through the mud, astonishes everyone. Having no little wheel, we can obtain the full advantage of the high 56-inch wheel, which almost everyone prefers. As I have ridden all combinations, from a 50-inch geared up to 60-inch, to a 60-inch geared level, I can speak from experience of the increased comfort to be derived from these large wheels, though for speed only they do not compare with the smaller and lighter wheels geared up. A further point gained by the use of two wheels only is the fact that the whole weight of machine and rider is on the driving-wheel, as it is also on the steering-wheels, so that by no possibility can the wheels be made to slip in the driving, or to fail in steering from want of pressure upon them.

The most important consequence, however, is the absence of any fixed frame. In all machines, bicycles and tricycles, with the usual fixed frame, a position is found for the saddle, which is, on the whole, most suitable. For some particular gradient it will be perfect, on a steeper gradient the treadles will be further in advance, but with a steeper gradient the rider should be more over the front of the treadles. To get his weight further to the front, he has to double up in the middle, and assume a position in which he cannot possibly work to advantage. The swinging frame of the Otto carries the treadles, of necessity, further back, so that the Ottoist, when working at his hardest, is still upright, with his hands in the line between his shoulders, and his feet and his arms straight, so that he can hold himself down, and employ his strength in a perfectly natural position. On going down a slope, the fixed frame of a bicycle or tricycle leans forward, and places the rider in such a position that extra weight is thrown on his arms and shoulders, whereas the swing frame of the Otto goes back, and the rider of necessity assumes that position in which his arms are relieved of all strain. In so far as the general position taken by the automatic Otto frame is concerned, nearly the same effect can be obtained by using the swing frame of the Devon tricycle, which can be shifted and locked in any position which the rider wishes, or by the sliding saddle which can be slid backwards or forwards and locked so as to place the rider in one of three positions. Though the rider can by these devices assume nearly that position with respect to the treadles which is most advantageous, he cannot obtain that curious fore and aft oscillation made use of by the Ottoist in climbing hills, which, as the model on the table shows, enables him to get past the dead points without even moving, and which, therefore, makes the Otto by far the best hill-climbing machine there is, if account is taken of the high speeding with which all Ottoists ride. This is a proposition which none who knows the machine will question for one moment.

The freedom of motion resulting from the swing of the frame of the Otto gives a pleasurable sensation, which those who have only experienced the constrained motion of a three-wheeler cannot even understand.

The very peculiar method of driving and steering which seems so puzzling to the novice, especially if he is a good rider of other machines —for in that case he is far worse off than one who has never ridden anything—give the rider, when he is familiar with them, a control over the machine which is still surprising to me. In the first place, the machine will run along straight, backwards or forwards, so long as the handles are let alone. This automatic straight running is a luxury, for till a deviation has to be made, the steering handles need not he touched, and the rider may, if sufficiently confident, travel with his arms folded or his hands in his pockets. The rigid connection between the cranks and the wheels does away with all the back-lash, which is so unpleasant with chain or toothed-wheel gearing. There is no differential gear or clutch, but the machine possesses the advantage of the clutch over the differential gear when meeting with unequal resistance on a straight course, for each wheel must travel at the same speed; but, in turning a corner, instead of driving the inner wheel only, which is done by the clutch or both wheels equally, which is the case with differential gear, each wheel is driven, but the outer one more than the inner. At high speeds, the steering of the Otto has this advantage, that whereas, with a given action on a tricycle, the same deviation will be effected in the same *space* at high as at low speeds, the same action on the Otto will, at high speeds, produce the same deviation in the same *time* as it does at low speeds; and so instead of becoming more sensitive at high speeds, as is the case with the tricycle, the steering of the Otto remains the same. This is because the steering of the tricycle depends on a kinematical, that of the Otto on a dynamical principle.

In another respect, no machine can approach the Otto; at almost any speed the rider can, if there is reason, instantly dismount, by which action he puts on the brakes, and the machine will save him from falling, stopping with him almost instantly. As is well known, we can move backwards and forwards, we can twist round and round in our own width, or can ride over bricks with impunity.

One objection to the machine is the difficulty of learning, which is considerable, but which presents no danger. This difficulty has been much exaggerated, for before the present powerful brake was applied, it did require considerable skill to ride it down a steep hill. The way to do this must still be learnt, but it is now comparatively easy. For going down steep hills, the front-steering tricycle is without a rival; I do not know what other machine will do this better than the Otto. Lastly, the foot straps, which would be a great advantage on any machine, if only they were safe, are not—though none but riders will believe it—in any way a source of danger on the Otto. Having ridden this machine for close upon 10,000 miles, I can speak with more authority on this point than can those who are not able to sit upon it for a moment.

The only disadvantage which the machine presents is the fact that it is impossible to remove the feet from the pedals while running without dismounting; but though they must at all times follow the pedals, the Ottoist is not, as is generally thought, working when descending a hill.

The enthusiastic terms in which every one who has mastered the peculiarities of the Otto speaks of it would be considered as evidence in its favour, if we were not all considered by other cyclists to be in various stages of lunacy.

A number of representative machines, kindly lent by the following firms, were exhibited at the meeting:—

T. H. Brooke-Hitching, Ludgate-hill, E.C., Monarch tricycle.

Brixton Cycle Company, Limited, Brixton-rise, S.W., Brixton Improved Merlin tricycle.

E. Burstow, Grove-cottage, East-parade, Horsham, Centre-cycle.

Crypto Cycle Company, 73A, Chiswell-street, E.C., Humber, National, and Premier tricycles, fitted with crypto-dynamic two-speed gearing.

Ellis and Company, 165, Fleet-street, E.C., the Facile Safety bicycle.

Exeter Bicycle and Tricycle Company, Exeter,e Special Devon tricycle, with swing frame.

H. Goy, 21, Leadenhall-street, E.C., the Nonpariel

Telescope tricycle; an original Bone Shaker, built by the celebrated Beck.

Hillman, Herbert and Cooper, 14, Holborn-viaduct, E.C., Sparbrook Two-gear tricycle, Premier and Cruiser tricycles.

Lloyd Bros., Harborne, Birmingham, Quadrant tricycle No. 1 (rear-steerer).

Otto Company, Newgate-street, E.C., Otto cycle, Bicycle, with corrugated spokes.

M. D. Rucker and Company, Litchfield-buildings, Bethnal-green-junction, E., Rucker's Tandem bicycle.

Safety Cycle Company, St. Paul-square, Bedford, Sun and Planet bicycle.

Singer and Company, 17, Holborn-viaduct, E.C., Xtraordinary Challenge bicycle, Traveller tricycle.

Taylor and Weatherhead, Seer-green Vicarage, Beaconsfield, the Oarsman tricycle.

DISCUSSION.

The CHAIRMAN said there were two remarkable features about the paper, one the thorough mastery of the subject which it displayed; and the other the writer's entire independence of thought in expressing his opinions. He hoped the same independence would be shown in the discussion, but that speakers would endeavour, as far as possible, to keep to general principles, and avoid going too much into detail. He agreed with Mr. Boys in almost every point he had advanced, particularly with regard to the rear-steerer, that it possessed no particular advantage, but had elements of danger connected with it, whilst the front-steerer was safe, particularly in going down hill. He did not think anything could be more graceful than the Humber, and he had often felt envious of those he had seen riding it. He had tried one himself, but not successfully. He was enjoying himself on it very much, in company with two friends, when coming down the Alpha-road, St. John's-wood, he suddenly, for no intelligible reason that he had been able to discover, found himself in the middle of the road. This was probably caused by something connected with his own bad steering, very likely from a difference of power in the two hands, for he had found by trial with a dynamometer that he was much stronger on the right side than the left. It had occurred to him that there might be a guide placed on the steering part, in the shape of a needle on a dial, which should indicate when the rider was not keeping an even course. He agreed with Mr. Boys that the band was a great improvement on the chain, and hoped at the next Exhibition to see a great many tricycles thus fitted. He was not surprised at the high terms in which the Omnicycle had been spoken of, for it was a very good machine, and, if it could only be made lighter, would for many persons be the best. He liked the propelling motion of the Omnicycle, it was not at all a tiring motion, and for hill climbing it was very good indeed. It seemed to him, however, that when the leverage was increased, the motion seemed to be loose, and he had heard other riders make the same observation. Again, the noise connected with it was not pleasant, but altogether it was a very good machine. He was not, however, quite sure whether it was of much advantage to change the power for ascents, and thought perhaps all riders would by-and-bye learn to climb hills without any change at all, and that it was, after all, more a matter of practice than anything else. He found, after riding a few days he did not care for change, and that when the machine was geared level it answered very well. He could not see much difference between a high wheel, and a small wheel geared up, and was rather surprised that high wheels had so much gone out; in fact he should not be surprised to see them come in again. The disadvantage lay in connecting a small wheel with the large wheels, the bad effect of which reduced the advantage obtained from the large wheels. There was one machine made with the wheels all the same size, and those who had tried it told him it had many advantages. The Oarsman would, no doubt, have a very powerful motion, but it certainly would not be so healthy in use. The great advantage in the bicycle and tricycle lay in this, that the body was moved by the legs, whilst, at the same time, the weight of the body was supported by the machine, and the upper part of the body was saved the work which would throw a back stroke on the heart. That was the reason why persons advanced in life could travel so much farther on a tricycle than in walking. [He then, by means of a diagram on the blackboard, explained the action on the valves of the heart of any violent exertion, by the upper part of the body especially.] He quite agreed with Mr. Boys that rapid pedalling was more exhausting than a slow, firm action. The single driver seemed altogether out of the field, and he need not allude further to it. There was nothing to lament in what had been said about motor power in the management of these machines; they did not want any other motor power than belonged to the bodies of the men and women who propelled them, and who improved their health at the same time that they enjoyed the exercise. If motor power were introduced, idle people would get on their machines and ride about where they pleased, but all the advantages of the exercise would be gone; the machines would be mere toys. If the Otto saved vibration it certainly stood pre-eminent, for vibration was a very exhausting process, and those machines which vibrated a great deal were not only very difficult, but very tiring, to ride. Every act of vibration was so much waste, and they could not be too grateful to those makers who managed to avoid this drawback.

Mr. ROUND wished to emphasise what had been said as to the advantage of the bicycle over the tricycle. The real difficulty of the bicycle was in learning, and no doubt it took some time and attention in the first place, but many failed because they did not pay sufficient attention to details. After seven years' experience, he could say that if there were any choice between the two on the score of safety, it lay with the bicycle, for he had known of fewer serious accidents with it than with the tricycle. One reason no doubt was, that people thought the tricycle did not require learning, and they were less cautious in going down hill, and so on, than they ought to be. The Tandem Rucker was a remarkable form of machine, not unlikely to come largely into use. He had ridden a short distance on the front wheel of one having two wheels behind. It was very rigid, with no possibility of falling backwards or forwards. but there seemed a little difficulty in steering. He thought no one, however advanced in years, if they were tolerably active, need be afraid of learning the bicycle, the Otto included.

Mr. KIRBY confirmed the observation of the previous speaker with regard to there being more accidents with tricycles than bicycles, and thought the difficulties of learning to ride were much exaggerated. He did not think the small back wheel was entitled to so much opprobrium as had been thrown upon it. It did not throw up mud because it travelled faster than the large wheel, but as the mud only adhered for a certain time, it was thrown off in a different direction. The same idea had occurred to him with regard to differential gearing, which Mr. Boys had described, only he had carried it out in rather a different way. There was another way in which it might be obtained, by employing india-rubber balls or rollers, in place of the steel balls, but the great drawback was that the india-rubber got set, and did not act perfectly. Mr. Boys had spoken of the impossibility of making machines of the National type double driving, but he had contrived a means of doing so, the gear being applied to the cranks. It had never been carried out practically—only as a scientific experiment. There were certain mechanical reasons why a small wheel had an advantage in going up hill which it would be difficult to explain without a diagram. The figures which had been given, with regard to the resistance of balls to crushing, were very valuable, especially to manufacturers.

Major KNOX HOLMES said he had no scientific knowledge on this matter, only practical experience, the result of which he would state. He found that with a Roadster 42 in., geared up to 56, he could ascend hills with more ease than when geared level, the reason for which he could not tell, except that the action was much slower and less fatiguing. There was also a common-sense explanation of the fact that a small wheel would be more effective in going up hill than a large one, viz., that at each revolution the weight was carried a less distance, and consequently was not lifted through so great an elevation. The advantages of wheels geared up were very great in descending and on the level, and in practice he had found no difficulty in climbing. He could travel on fair roads, eight, nine, or ten miles an hour without the slightest fatigue, and for a man of his age he thought that was enough. He had found the exercise very beneficial to his health, and it had removed a stiffness in his knees from which he had previously suffered. He lately went to Brighton and back in $12\frac{1}{2}$ hours, and the next day was able to walk five miles an hour, which he could not have done a short time ago.

Mr. W. T. SHAW said there was very little in the paper which was open to controversy, and he thought there was not one point on which he was not in entire accordance with Mr. Boys. He would rather leave the discussion of gear to others, but the point he had aimed at was the combination of a high and low gearing in one machine; not an immoderately high gearing, but one well within the powers of the rider. The height to which wheels could be geared, must depend first on the powers of the rider; that being determined, as the conditions of the road often differed very materially within the space of a few miles, the question arose whether some provision should not be made for contingencies beyond the control of the rider, such as the condition of the road, steepness of the hills, &c. He was not able to follow the gallant Major in asserting that a 56-inch wheel could be driven more easily than a 42-inch; though, of course, provided the rider could drive it comfortably, the higher the wheel was geared the better.

The CHAIRMAN suggested that perhaps the difference might be explained by differences of age. He could imagine that to young riders who could move their limbs with great rapidity, a change of gear might be an advantage, while to those who could only move more slowly, but with considerable force, a change would not be so important. But he saw no reason why the rider should not have the opportunity of changing the gear if he desired, and he thought the crypto-dynamic apparatus very beautiful and ingenious.

Mr. BOLT suggested that some of the difficulties referred to would be got over by the use of adjustable cranks, and was surprised to find they were not employed. He had known them used, and had used them himself on a bicycle fourteen years ago with great advantage. They could be adapted to bicycles, and to any tricycle with outside cranks. You had simply to turn the toes in or out, as the pedal was going up or down, to lengthen or shorten the stroke, and it might be reduced or lengthened by as much as three inches, or even more. There was no difficulty with friction, and the expense was not worth mentioning. He had often heard that the Coventry rotary was a difficult machine to drive, but on the other hand it was convenient in many ways. The Otto was a very pretty machine, but you could not take it through a narrow doorway. He should like to know which tricycle Mr. Boys recommended.

Mr. MORTON said the luggage-carrying power of the various tricycles had not been referred to, but it seemed to him a very important point, especially to those who might wish to make long journeys, who though they might adopt a costume suitable for riding, would prefer to appear in ordinary garb when they reached their destination.

Mr. WARNER JONES agreed that the Otto was the best machine in principle, but it did not seem to be so in practice, judging by the number of other machines in use. Everyone seemed to be inquiring what machine he should ride, and he thought the answer would be—the one that suited him best; but they did not seem always to pay so much attention to the question how they should ride it. A great deal of force was wasted from ignorance. As had been explained, the Otto had great advantages in regard to the power gained by leaning forward; but unfortunately, when riding on a rough road, you were sometimes bobbed forward when you did not require it, and had to recover yourself; and that was where the large wheels were so useful, as they gave you time to do so. The size of the wheels depended more on the road than anything else, and on the condition of the roads more than the gradient.

Mr. STARR said he had heard that the Otto was liable to land the rider on his face in the road, which would no doubt account for the prejudice against it, but the question was whether it could not be made safe in that respect. He should also wish to ask, the comparative merits of a front-steering tricycle and the Coventry Rotary, and other things being equal, which took the most muscular power to propel.

Mr. BOYS, in reply, said, that when he referred to the small wheel of a bicycle throwing more mud because it went faster, he was comparing it with the small wheel of a tricycle, not with the large wheel of the same machine. The linear velocity was the same, but the tendency of the mud to fly off was inversely as the size of the wheels. A wheel of 56 in. would have just half the tendency of one of 28 in. if going at the same speed. With regard to differential gear, he did not know if an india-rubber ball, apart from the difficulty of india-rubber versus grease, could be made sufficiently strong to resist the strain. One reason which induced him to make those crushing tests was the desire to find out whether balls could be relied on to withstand a pressure of cwts. or tons, because in the gear that he had devised that pressure was acting on a very short arm or a lever, and would be, therefore, very considerable. He was glad Major Holmes, from his great experience, had confirmed his opinion as to the advantages of high speeding; in fact, Major Holmes had gone farther than he had, and said he could climb hills better when the wheels were speeded than when they were level, which was certainly more than he had expected. He did not think the adjustable cranks Mr. Bolt had recommended would be altogether advisable for this reason. Before he had his present Otto he had one with 5 in. cranks, and was rather doubtful about changing to 6 in., though that was the usual length; he therefore went out several times with a friend who had a 6 in. crank machine, and they kept changing from time to time; each time he made the changes the machine felt at first as if it would not go, and he had to ride some distance before he could put out his full power. The change seemed more uncomfortable from 6 in. to 5 in. than from 5 in. to 6 in., so that determined him to have a 6 in. crank; but he thought that showed that a crank the length of which was being often changed would not be of any practical advantage, as the rider would not be able to exert his whole power for some distance after each change. He never recommended one machine more than another. He had given reasons why he preferred the Otto. Some people found it difficult, and they had better adopt some other, but those with ordinary perseverance and skill he would recommend to try it. Luggage-carrying was not a matter on which he cared to say much; he had managed to carry a bundle of clothes, and a large bag, from the north-west of London to Liverpool-street, where he sent the bag on by train, and that was the course he preferred to adopt. It was not worth carrying 10 or 12 lbs. of luggage all day for the sake of saving ninepence. He did not agree with Mr. Jones that the Otto, though excellent in principle, was not so in practice; nor did he find himself bobbed forward in riding on a rough road, and he had on occasions gone right over a brick. Mr. Starr suggested that it was possible to come out on your face, and perhaps it was, but there was not the slightest necessity for it. He had ridden the machine at all speeds, and had jumped out and stopped in about a yard and a-half. Over and over again, when riding in the dark, he had struck against something in the road, and come out suddenly, without the slightest warning, but he did not come on his face. With regard to the front-steerer, and the Coventry rotary, the latter possessed in many respects the advantages of the front and rear-steerer; you had an open front and very excellent steering, but then it was a single driver; and though there was great length, so as to resist the swaying tendency, he did not think the single driver would live. The narrowness of the machine was a great convenience, but there was a corresponding want of stability, which necessitated great care in going round curves.

The CHAIRMAN then proposed a vote of thanks to Mr. Boys for his able paper, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

SEWAGE IN THE THAMES.

The Royal Commission on the discharge of sewage into the Thames, recently issued their first report, of which the following is a summary:—

The history goes back as far as to legislation in the reign of Henry III., at which time such sewers as existed were intended only to cover over or supply the place of natural streams and ditches, and so to carry away the rainfall from the fields, roads, and roofs of houses. From the time of Henry III. to Henry VIII. all enactments affecting drainage were of a local nature, but in the 23rd year of the reign of Henry VIII. (1531 A.D), the general "Bill of Sewers" was passed, which appears to have laid the foundation of modern legislation for all works of this kind. Many other Acts followed to amend and explain this celebrated Act, most of them applicable to the country in general. The rapid growth of London rendered necessary more frequent special enactments for making, enlarging, amending, and cleansing its "vaults, drains, and sewers." The formation of many new "districts," successively built upon, each with its own local governing body, led to a subdivision of the management of underground drainage; but throughout all the changes, sewers were regarded as the legitimate channels for surface waters only. All offensive house refuse was collected into cesspools, and carted into the country as manure; and at the commencement of the present century, it was penal to discharge what is now called "sewage," or other offensive matter into the sewers.

Such was the method of sewage and drainage till the invention of the water-closet, which completely revolutionised systems that had been followed for centuries. It was first introduced about 1810, and after 1830, its adoption rapidly became general. The cesspools were used as the receptacles of water-closet discharges, and the addition caused to their contents in this way rendered it necessary to introduce overflow drains from them into the street sewers, the effect of which was, of course, to pollute the sewers.

Here was the commencement of those sewer and Thames pollution troubles which have grown to such magnitude.

As the water supply of London was then largely drawn from the river in the neighbourhood of sewer outlets, it was early recognised that the purity of this supply was endangered. In 1834, John Martin, the artist, designed a plan to embank both sides of the Thames, and to construct an intercepting sewer in each embankment, for the purpose of collecting the sewage and conveying it to points in the river below the most populous parts of London.* The scheme, however, was in advance of the times, though its important features have been followed in the works which have been ultimately adopted. In 1845, the scheme was again suggested by Mr. Thomas Wicksteed, who proposed Barking Creek and Greenwich-marshes as the points of outlet, but it met with no better success than before.

At this time the drainage of the metropolis was under no less than eight local "Commissions of Sewers," each having its own regulations as to size of drains, shape, angle of inclination, &c. The evils of the consequent confusion were so manifest, that a consolidated Commission of Sewers was constituted by an Act of Parliament in 1848, and the same Act provided that every house should have a proper water-closet, and be drained into the main sewers. This completely reversed the legislation on this point as it existed at the beginning of the century. The Commission zealously began the improvement of house drainage, the abolition of cesspools, and the introduction of pipe-sewer communications between the houses and the main drains. In 1849, however, they were superseded by a fresh Commission, and this new body held that sewage should be kept out of the Thames altogether. They advertised for competitive plans, received 116, discussed them, came to no conclusion, and resigned. A third Commission examined the plans, decided none would do, and appointed Mr. Frank Foster to prepare a scheme. He adopted the fundamental principle of intercepting sewers, planning the outlets at Galleons Reach and at Woolwich-marshes. The Commission, however, decided nothing, nor did a fourth, nor a fifth, nor a sixth, appointed in 1854. Meanwhile the state of the Thames was becoming alarming, and in 1855 the Government, by an Act which received Royal assent on August 16th, created a new representative body, the Metropolitan Board of Works. Their most important office was to take charge of the main sewers of the metropolis, and in particular to construct works of a comprehensive system of main drainage. A very important section of the Act (18 and 19 Vic., cap 120), became a source of much controversy, and for three years proved a block to work. Section 135 provided, "and such Board shall make such sewers and works as they may think necessary for preventing all or any part of the sewage within the metropolis from flowing or passing into the River Thames, *in or near the metropolis*, ... and the said Board shall cause the sewers vested in them to be constructed, covered, and kept so as not to be a nuisance or injurious to health."

* A report on this was published April 23, 1836.

One of the first steps taken by the Board was to instruct its chief engineer, Mr. (now Sir Joseph) Bazalgette, to report on the works necessary. He took the old proposals of Mr. Foster, which were in essential points similar to those of Martin, as his basis, and prepared a plan which gave the north outfall at Barking, and the south at Plumstead. The plan was laid in accordance with the requirements of the Act, before the First Commissioner. This was in June, 1856. The First Commissioner applied to the Admiralty for information as to the extent of tidal action in the Thames, and Captain Burstal, R.N., was appointed by them to report. On receipt of his report, the First Commissioner wrote to the Board that the plan they had sent "actually provides that the sewage shall flow into the Thames," and that before any such scheme could be carried out, it would be necessary to ask Parliament to repeal such parts of the Act as Section 135 (quoted above), and he returned the plans. From this point in the history the question of the outfalls holds a prominent place.

In November, 1856, the Board submitted another plan with outfalls two or three miles lower down, and also reported that they had considered a scheme for discharging below Gravesend. Other plans were prepared, and eventually the whole question was referred to three Government referees, Captain Douglas Galton, Mr. James Simpson, and Mr. Thomas Blackwell. They sent in a report, which was published as a Parliamentary Paper, August 3, 1857. This report went into many matters in much detail, and on the subject of the outfalls recommended for the north a place near Mucking Lighthouse, in Sea Reach; and for the south, Higham Creek, in the Lower Hope. The Board, on receiving the report, objected, and much correspondence followed.

The Board then appointed Mr. Thomas Hawksley and Mr. G. P. Bidder to be associated with Mr. Bazalgette in drawing up a report on the whole question, and this was sent in on April 6th, 1858. A correspondence between these gentlemen and the Government referees continued for several months. During these deliberations, the state of the Thames was becoming worse, "and was exciting great alarm and indignation. The subject was repeatedly noticed in Parliament, and strong language was used in both Houses."

In February there had been a change of Government, and the new administration took the view that the metropolis, through its representative Board of Works, might carry out its drainage and sewerage without obtaining Government sanction. "As the metropolis paid for the work, they had a right to construct it in any way they pleased." After debates at every stage of progress, an Amendment Bill was passed, and became law August 2, 1858.

The clause which gave the Board power to carry out sewers and works, "according to such plan as to them may seem proper," also added, "and for preventing, *as far as may be practicable,* the sewage of the metropolis from passing into the River Thames, *within* the metropolis."

In commenting on this, the Commissioners, in Sec. 54 of the Report, say:—"It certainly appears remarkable that the Legislature should have withdrawn all control over the construction of gigantic works of this kind, which were certain to have influence of a wide national character. But if the debates which occurred at the time are carefully studied, it is not difficult to trace out the reasons which mainly influenced the decision." They point out (1) that the state of the river required immediate action. (2.) That all contending parties were agreed that intercepting the sewage by main drains running eastward was the correct principle. (3.) It was felt this might be commenced at once, leaving the ultimate mode of disposal of the sewage for later decision. It was considered that the plans of the Board were not necessarily final, but might be extended and amended at a future time. (4.) There was a confident expectation that the sewage would be treated by some process of deodorisation before entering the Thames. (Extracts from the debates are given.)

Immediately after the passing of the Act, the Board took the matter earnestly in hand, and by 1864 both the northern and southern outfalls were in use, and in 1875 they were pronounced complete.

The Thames Embankment, to limit the areas left dry at low water, was also completed about the same time.

Complaints, however, followed soon after the drainage works came into operation, and then ensued the two well-known inquiries, the Barking inquiry, 1868, and the Mud Bank inquiries, 1867 to 1880.

Part 2 of the Report describes the whole system of the metropolitan main drainage. In the "Remarks" which the Commissioners append, it is mentioned that the weak points are (1) the necessity for a large provision of storm outlets, and (2) the discharge of the sewage in its natural crude state.

1. There are hundreds of miles of sewers now in the metropolis, in which the sewage does not flow at the velocity necessary to prevent the sewer matters from depositing. When sudden heavy rains occur, great masses of deposited filthy material are washed out, and find their way directly into the urban reaches of the river.

As regards (2) the discharge in a crude state, it is pointed out that this is not a defect inherent in the system, and at the time of the passing of the Act it was distinctly understood that the construction of the works, and the management of the sewage, were separate considerations (see above). How far remedies can be applied will be the subject of future inquiry. Meanwhile facts have been ascertained with regard to the distribution of sewage by tidal influence.

The discharged sewage undergoes a daily oscillating movement due to the tide, and also a gradual displacement of these oscillations down the river, depending on the quantity of fresh water entering the river.

The oscillations have been studied by observing the movement of floats put in at various periods of the tide. This had been done in several previous inquiries, and a further large series of experiments were made for the purposes of this Commission. The floats were put into the river opposite the Barking (northern) outfall, at various periods of the tide. Each was watched, and its position and motion recorded during thirty and, in some cases, forty-five days. The chief results were—

1. The extent of tidal oscillation varied considerably, some parts of the river moving much more rapidly than others.

2. The maximum range of oscillation recorded was, at spring tides, eighteen miles; at neap, a little under seven.

3. A float, started at high water, ascended up to Greenwich, a distance of eight miles; another, started three hours after high water, ascended to between Putney and Hammersmith, twenty miles; a third, started at low water, ascended twenty-two miles.

These were the points reached with subsequent flowing tides, and the Commissioners consider that these experiments add important and novel information as to the distance which tidal currents may travel.

The practical inference drawn is that where the floats went, sewage discharged at the same times of the tide may also go; but it is mentioned (Section 83) that Sir J. Bazalgette "does not consider that the motion of a float is analogous to what would take place with the particles of sewage."

The rate of displacement, *i.e.*, progress downwards of the sewage, is a different question, and various calculations give it at a quarter, a third and a-half mile a day. A rough estimate is that sewage would take 150 days to travel from the outfalls to the sea, if its progress depended on the influx of upland water.

It is, however, necessary to take into consideration the mixing action which has such a remarkable influence on the distribution of sewage.

Taking the amount of chlorine in water as a test, it is seen that sea water so mingles with the river water, it has been traced as high as the tidal limit at Teddington. It is argued that since a mixing action is known to go on between the sea water and the fresh, there is every reason to believe that the same kind of action will go on between each of these and the sewage.

The data for the statements laid before the Commission, are derived from the determinations of the amounts of chlorine contained in certain samples of water, taken on certain days, at various points of the Thames from Teddington to Southend. To these are added the known quantities of land water and of sewage entering the river on each of the days in question.

The problem of the proportion of sewage present has been worked out by several independant methods with very concordant results. "Nobody has hitherto anticipated that liquid discharged into the river at Barking could be transported by any natural causes, many miles up the river, directly in the face of the powerful descending stream of land water; but that this effect is produced can no longer be doubted."

The Metropolitan Board of Works put forward that the sewage, during its oscillation, travel, and mixing, becomes so quickly oxidised and purified, as to lose almost immediately all its offensive qualities, and to become as innocuous as the natural water in the river. This argument receives consideration in the 3rd part.

Part 3 deals with the question whether any evils result from the system under which sewage is discharged into the Thames.

After noticing the voluminous evidence of various kinds given, the Commissioners state the summary of their conclusions in a series of concise paragraphs, twenty in number. Though the river is "not as it should be," no evil has yet been done to navigation. Fish, however, have disappeared below and above the outfalls. There is a partial purification of sewage by oxidation, and this purification is carried further by the action of animal and vegetable organisms. Between Greenwich and Greenhithe the effects of sewage discharge are apparent at all times, but above Greenwich there is not ground for serious complaint. It is, however, added, "that the evils and dangers are likely to increase with the increase of the population."

The question of remedies is reserved for further consideration.

ECONOMIC PLANTS IN TRINIDAD.

The report of Mr. Prestoe, the Government botanist in Trinidad, on the Botanic Gardens of that island for 1882, has lately been received. A large portion of this voluminous report is devoted to the consideration of economic plants.

Nutmegs.

Mr. Prestoe gives some notes on the cultivation of the nutmeg, from which the following facts are gathered. Regarding the effects of manure, he says that the whole of the trees have been treated with cattle-pen manure, so arranged on the slope to have its fertilising properties conveyed directly to the roots by the rain. The good effect was most marked, especially to the young trees, which at once produced leaves twice the size of those which preceded them on the branches, Mr. Prestoe says he cannot too strongly recommend the use of cattle-pen manure for pushing on young nutmeg trees. "The planting out," he says, "of successional nutmeg trees, during the last few years, has enabled me to determine the sexes in seedling plants under a foot high by characters presented in the leaf form, and with sufficient accuracy for all practical purposes; as also the proportion of male trees and female usually raised from seeds. These points having been determined by direct experiment with two sets of nine and eleven pairs of young nutmeg trees, respectively kept under observation in the one case for nine, and the other for five years, from the seeds.

"Male trees occur more numerously than females to the extent often to fifteen per cent. At the same time a walk or plantation of nutmeg trees would be effectively fertilised by male trees, standing at the rate of one to every eight or ten female trees. It is not to be recommended, however, that the definition of the sexes in the young trees be exercised for planting the male and female trees merely in this proportion, but for setting the trees in pairs of male and female as regularly as practicable.

"These pairs—the plants being 3 feet apart—should be planted at intervals where they are to be permanent, of about 25 feet or 30 feet, and when they have grown up to produce flowers—fourth or fifth year to show the sexes with certainty—the excess males (over 10 or 12 per cent.) can be removed. That is, one of each pair will be removed in a manner to leave one male to eight or ten females. In doing this, four or five feet lengths of the stem of the cut away, should be left to keep alive and serve as a support to the standing tree, as also to prevent the development of fungoid growths that would be likely to occur by sudden decay of the tree stumps.

"In order then to have the young nutmeg tree in pairs as regularly as possible, male and female, the form of the leaf and direction of the veins must be observed, the female leaf being the most perfectly elliptical with the straighter primary veins; the male leaf is broader towards the point than at the middle; that is of obovate shape, and furnished with a point much longer than that of the female; the veins are curved in towards the point much more roundly than n the female."

A large stock of nutmeg trees, it seems, is always in stock at the Trinidad gardens, and they are disposed of at a low rate, so that the system of double planting to ensure proper fertilisation is always practicable.

Mango.

Referring to the growth of the mango (*Mangifera indica*), Mr. Prestoe points out differences in the constitution of the tree which furnish the different varieties of fruit. The sap is, it is stated, at all times watery in the mild form; in some varieties it is watery at one season, and milky at another; in other varieties it is always milk like, and on exposure assumes the consistence of tough gum. As with European fruit trees, the better qualities of mangoes are propagated by grafting their stems or stocks raised from seed. Grafted mangoes thrive well in Trinidad, and some of the very largest trees in the gardens, as well as those distributed about the island, are grafted trees introduced from Martinique, Cayenne, and East India. Of the value of the fruit, Mr. Prestoe says that there can be no question that in the four varieties cultivated in Trinidad they have the finest fruit of the Western tropics, except the pine apple; nevertheless these few varieties are but little known, consequently mangoes on the whole are regarded with disfavour by those capable of judging, and whose appreciation would promote interest in the really good kinds.

"In the hands of an English gardener accustomed to grow peaches or pears, a number of the varieties of mango would be produced with the lusciousness and rich colouring scarcely to be matched in the peach and nectarine, or hot-house melon, as indeed, sometimes now occurs under anything but high culture. There are varieties where the melon and pine flavours are combined, the ribston pippin flavour with the mangoes' own; in another the consistence of apricot and flavour of rich strawberry are blended with delicate mango flavour."

Cocoa.

A large space of this report is devoted to the consideration of the cacao tree (*Theobroma cacao*), application for seeds of the best kinds of which are continually being received, which requests Mr. Prestoe points out cannot be entertained.

Caoutchouc.

As in most of our Colonies at the present time, the several sources of rubber or caoutchouc appear to be receiving much attention in Trinidad. The well-known Para-rubber (*Hevia brasiliensis*), as well as other species of this genus, are growing in perfection. It is said to answer well as a shade tree for cacao plantations, "a point on which it will be soon possible to speak with certainty. From the experience here, the tree might be regarded as of promise to figure as a valuable subject in the future agriculture of the island. As a rubber-yielding tree alone—considering the length of time it takes to mature, and its comparatively small yield of rubber, as described by travellers—it is not a tree to be recommended except for plots designed to be left to develop forest growth, soil and other conditions being sufficiently favourable."

Of the Demerara rubber (*Hevia spruceana*), the milk is said to turn yellow or brown immediately on exposure to the air; it forms a rubber of very good quality.

Ceara - rubber continues to thrive under conditions of soil which are most common on the hills about the north - west of the island. Mr. Prestoe regards it as a plant of much promise for cultivation about the hill slopes, where the soil is too poor or dry for cacao, coffee, or other hillside cultures. "The roots are of a fleshy character, and, as compared with the size of the tree, are of enormous development, and penetrating directly downwards; hence, its impatience of a stiff, or saturated condition of soil, the extraordinary root development being really a provision of nature to sustain the plant under conditions of prolonged drought in stony soils, and to which it appears subject in its native habitat."

With regard to the yield of rubber from these trees, the experimental tapping was limited to testing the conditions of the milk sap at intervals, the results showing that it varies in density very considerably in different trees under the same conditions, most dense and apparently to be obtained in largest quantity with the least harm to the tree on the maturation of new growths of leaf and branch, that is, during autumn to the middle of the dry season. Mr. Prestoe gives details as to the habit of the tree and the effects of tapping, amongst which he says:—"These considerations seem to imply that the method of tapping the tree at the trunk, or any point between the root and the leaf-bearing branches, is more or less objectionable according to the nature of the subject dealt with. And although the method of tapping the stem or trunk is generally practised by native rubber collectors, dealing with this growing in a state of nature, I do not think it should be accepted as the correct one for obtaining the largest supply of milk sap, with the least injury to the tree."

The Panama, or Central American rubber tree (*Castilloa elastica*), is reported as thriving well in Trinidad, as also the African rubbers—species of *Landolphia*. These latter, being climbing plants, and consequently requiring support, Mr. Prestoe does not think likely to be of much promise for the island, or indeed, for the West Indies generally. On this point he says:—"In the present state of the labour market, and the manner of life of the present proprietors and labourers, particularly about the outlying districts, I am afraid rubber at its present price could not be collected from vines growing promiscuously for the value it would realise, even if it were certain that the people would take to such work as rubber collecting, or being got, they could ever be induced to follow a method of tapping that would not be destructive to the source." Many other plants of more or less economic value are treated of in this paper, which is, perhaps, one of the fullest and most detailed that has been issued from a botanic garden.

General Notes.

Stuttgart Polytechnic Institution.—A laboratory has lately been organised in which tests of extension, pressure, &c., can be carried out upon cement, building-stones, wood, driving bands, ropes, metal bars, &c. This branch of the Institution is provided with machinery capable of exercising a strain of 60 tons. This addition to the utility of this establishment has been rendered possible by the surplus funds arising from the recent Industrial Exhibition.

Pasturage of the World.—Australia stands at the head of all the sheep-producing countries, New South Wales furnishing by far the greater proportion of colonial pastoral wealth. At the close of 1882, the number of sheep in Australia was 76,493,105, as against 76,230,000 on the River Plate; 49,237,000 in the United States; 48,820,000 in Russia; 27,237,000 in the United Kingdom; 25,420,000 in Spain and Portugal; 25,200,000 in Germany; 23,370,000 in France; 21,418,000 in Austria; and 11,280,000 in Cape Colony. New South Wales alone possesses as many sheep as the whole of the United Kingdom, Germany, and Cape Colony.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, eight o'clock:—

May 14.—"Telpherage." By Professor Fleeming Jenkin, F.R.S. Sir Frederick Abel, C.B., F.R.S., Chairman of the Council, will preside.

May 21.—"Telegraph Tariffs." By Lieut.-Col. Webber, R.E. Dr. Cameron, M.P., will preside.

May 28.—"Primary Batteries for Electric Lighting." By I. Probert. W. H. Preece, F.R.S., will preside.

Applied Chemistry and Physics Section.

Thursday evenings:—

May 22.—"Economic Applications of Seaweed." By Edward C. Stanford, F.C.S.

May 29.—"Some Economical Processes connected with the Woollen Industry." By Dr. William Ramsay.

Indian Section.

Friday evenings:—

May 9.—"Indigenous Education in India." By Dr. Leitner. Sir Lepel Griffin, K.C.S.I., will preside.

May 30.—"Street Architecture in India." By C. Purdon Clarke, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Sixth Course will be on "Fermentation and Distillation." By W. N. Hartley, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin.

Lecture I.—May 12th.

The production of alcohol and alcoholic products. The uses of alcohol in manufactures. The sources of alcohol. Technical processes. Grain and potato spirit. Grinding and washing grain. The action of water upon starch. The gelatinisation of starch. The addition of malt. The preparation of mash from potatoes. The estimation of starch in potatoes. The saccharification of potato mash (*a*) by malt, (*b*) by sulphuric acid. The chemistry of the mashing process. The properties of starch. The change of starch into sugar and dextrine. The most suitable temperature for mashing. Of diastase and other soluble ferments. The general action of soluble ferments. Their chemical action on glucoside and polysaccharides.

Lecture II.—May 19th.

Fermentation proper. The cause of fermentation. The nature of the yeast cell. Its mode of growth. The chemical action of fermentation. Rapidity of growth of yeast. Charasteristic appearances of exhausted and revived yeast. Of "high" and "low" fermentations. Conditions of a good fermentation. Healthy and foul yeast. Explanation of the custom of a "change of yeast." Methods devised for purifying yeast. Exhausted yeast not necessarily foul. Mineral food necessary for yeast. Explanation of the reason for fermenting with mixed yeast. Influence of temperature on fermentation. Heat evolved during fermentation. Methods of warming and cooling mash. The products of alcoholic fermentation.

Lecture III.—May 26th.

Alcohol produced by mould. Its existence in rain, river, and sea water. Its presence in the soil. The process whereby alcohol is separated from water. The simplest form of distillation by a still and worm. The boiling points of water and alcohol. Boiling of mixtures with low boiling points by means of vapours with high boiling points. Pot stills and patent stills. Langier's still. The principle of Coffey's still. Its mode of action described. Improved forms of still. Alcoholic beverages and other products.

Health Exhibition Season Tickets.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 12...SOCIETY OF ARTS, John-street, 8 p.m. (Cantor Lectures.) Professor W. N. Hartley, "Fermentation and Distillation." (Lecture I.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Robert Michell, "The Region of the Upper Oxus."

Tuesday, May 13...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gamgee, "The Physiology of Nerve and Muscle." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Adjourned Discussion on Mr. S. B. Boulton's paper, "The Antiseptic Treatment of Timber." 2. Mr. R. W. Peregrine Birch, "The Progesss of Upland Water through a Tidal Estuary."

Anthropological, 3, Hanover-square, W., 8 p.m. 1. Mr. E. H. Man, "The Ethnology of the Andaman Islands." 2. Professor Flower, "Additional Observations on the Osteology of the Natives of the Andaman Islands."

Colonial Inst., St. James's Banqueting-hall, Regent-street, W., 8 p.m. Mr. R. Mosse, "Irrigation in Ceylon—Ancient and Modern."

Wednesday, May 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Fleeming Jenkin, "Telpherage."

Geological, Burlington-house, W., 8 p.m. 1. Dr. Henry Hicks, "The Pre-Cambrian Rocks of Pembrokeshire, with especial reference to the St. David's District." With an Appendix by Mr. Thomas Davies. 2. Mr. Herbert Green Spearing, "The Recent Encroachment of the Sea at Westward Ho, North Devon."

Microscopical, King's College, W.C., 8 p.m. Mr. P. Herbert Carpenter, "The Minute Organisation of the Nervous System of Crinoids."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Thursday, May 15...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. "Dr. J. H. Gladstone, "The Indices of Refraction of Organic Substances." 2. A. B. Griffiths, "Some Minor Researches on the Action of Ferrous Sulphate on Plant Life."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. G. A. Storey, "Mysteries of Colour."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture IV.)

Historical, 11, Chandos-street, W., 8 p.m.

Clerks of Works Association, St. James's (small) Hall, Regent-street, W., 8 p m. Mr. A. Reckenzaun, "Electricity: Its Application to Public Works and Buildings, Motive Power, &c., with Experimental Illustrations."

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Friday, May 16...United Service Inst., Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Weekly Meeting. 9 p.m. Prof. W. Odling, "The Dissolved Oxygen of Water."

Philological, University College, W.C., 8 p.m. Anniversary. President's Annual Address, by Dr. J. A. Murray.

Medical Officers of Health, 1, Adam-street, Adelphi, W.C., 7½ p.m.

Saturday, May 17...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Bonney, "The Bearing of Microscopical Research upon some large Geological Problems." (Lecture I.)

Geologists' Association, University College, W.C. Excursion to the New Docks at Tilbury, under direction of Mr. F. V. Holmes.

Erratum.—In Report on Collisions, in the last number (p. 576, col. 2, note 2) *for* "urges" *read* "states."

Journal of the Society of Arts.

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FRIDAY, MAY 16, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the Sixth Course was delivered by Professor W. N. HARTLEY, on Monday evening, 12th inst., the subject being "Fermentation and Distillation." The lecturer dealt with the production of alcohol, and its uses in manufactures, and described the change of starch into sugar and dextrine, and the chemical action which brings about this change.

The lectures will be printed in the *Journal* in the autumn recess.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Mr. W. A. Barrett, Mus.Bac. (Oxon), at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 9th June, 1884.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 8, 1884; Professor W. J. RUSSELL, Ph.D., F.R.S., in the chair.

The paper read was—

CUPRO-AMMONIUM SOLUTIONS AND THEIR USE IN WATERPROOFING PAPER AND VEGETABLE TISSUES.

By C. R. ALDER WRIGHT, D.Sc., F.R.S.

The term "Cupro-ammonium Compound" is usually understood by chemists as indicating a member of the class of substances obtainable by the combination of ammonia with certain copper compounds, so as to give rise to a "metallo-ammonium" derivative containing copper. Salts of copper, *e.g.*, copper sulphate, usually combine with four proportions of ammonia; thus the *Cupro-tetrammonium sulphate* $(Cu.\ 4\ NH_3)\ SO_4, H_2O$, is obtainable in crystals, by simply pouring a concentrated solution of copper sulphate into a solution of ammonia, in such proportions as to obtain a clear deep blue liquid, and then precipitating the crystallised salt by adding a considerable quantity of highly concentrated ammonia solution, or by shaking with alcohol; in a similar fashion numerous other cupro-tetrammonium salts can be obtained. A closely related compound, but possessing somewhat different properties, is *cupro-ammonium hydroxide*, prepared by dissolving cupric hydrate in ammonia solution, or by agitating together metallic copper and ammonia solution in presence of air, when the copper oxidises and dissolves in the ammoniacal liquor, forming a deep blue liquid, sometimes termed "copperised ammonia;" probably the cupro-ammonium compound present is $(Cu.\ 4\ NH_3)\ (OH)_2$, related to the hydrated copper oxide formed as cupro-tetrammonium sulphate is to copper sulphate.

Most of these compounds are very unstable, breaking up under the influence of heat and water alone, or conjointly; thus cupro-tetrammonium sulphate treated with a large bulk of cold water is partly decomposed, forming a basic insoluble copper sulphate, together with free ammonia and ammonium sulphate; cupro-ammonium hydroxide solution is decomposed by simple addition of alcohol to its ammoniacal solution, a blue substance essentially consisting of hydrated copper oxide being precipitated; the same result ensues on boiling, save that anhydrous black copper oxide is then formed, ammonia being driven off. In presence of a large excess of ammonia, the instability is less marked in all cases; the strongly ammoniacal fluids formed by dissolving copper salts or copper hydroxide in a considerable excess of ammonia water are the "cupro-ammonium solutions" referred to in the present paper.

It has long been known that these solutions possess the power of apparently dissolving cellulose and various allied substances; thus paper, cotton wool, and similar materials, when digested with these fluids, disappear, and are apparently truly dissolved. It is held, however, by some chemists (*e.g.*, Erdmann, *Jour. Prakt Chem.* lxxvi., 385), that these are not cases of true solution, but that the substances are simply gelatinised and disseminated through the fluid in a transparent form, as starch is in water. On the other hand, on neutralising the fluid by an acid, or better still, on adding potassium cyanide solution until the blue tint is discharged, the cellulose reappears as a gelatinous precipitate; this result would suggest that the reappearance of the cellulose is brought about by the destruction of the solvent in which it was truly dissolved, viz., the cupro-ammonium compound, by conversion into ammonia and cupro-cyanide (or into ammonic and cupric salts, if an acid be used). On evaporation to dryness of a cupro-ammonium solution in which cellulose has been dissolved, a more or less gummy mass is formed, containing the cellulose intermixed with copper oxide, and with ammonia and copper salts if a cupro-ammonium salt were used, but containing copper oxide and a green copper derivative or compound of cellulose if cupro-ammonium hydroxide were employed. When the cellulose is in excess, *e.g.*, when the solution is evaporated on the surface of paper, calico, &c., just dipped in the solution, black oxide of copper is often not formed at all; but a green varnish-like mass of cellulose conjoined with copper-oxide, or of the copper salt of some feeble acid derived from and closely akin to cellulose, coats the surface of each filament of the fabric used, welding and cementing them together. This cement-like *cupro-cellulose*, as it may be termed, being insoluble in water, communicates water-resisting properties to the material so treated; moreover, the presence of copper renders the dipped and dried substance less prone than before to the attacks of insects and mould, so that animal and vegetable life of a parasitic nature and fungoid growths are rarely, if ever, to be observed in the substances, even when kept under conditions where boring worms, ants, rot, and mould, would be likely to attack them.

To produce the best results in this direction, solution of cupro-ammonium hydroxide is, for many reasons, preferable to solutions containing cupro-ammonium salts; not only is the action on cellulose more energetic for a given amount of copper and ammonia in solution, but various other advantages are gained. For example, if ammoniacal solution of cupro-ammonium sulphate be used, the dried treated fabrics will contain ammonium sulphate, and sometimes copper sulphate, soluble in water, rendering the material porous if exposed to the action of water in sufficient quantity to dissolve out the soluble matters, and causing more or less tendency to unsightly efflorescence under other conditions. Further, during the drying of materials treated with cupro-ammonium hydroxide solution, all the ammonia present is volatilised, and may be recovered by appropriate means; whereas, with cupro-ammonium sulphate solution, a considerable fraction of the ammonia is fixed in the fabric as sulphate, and so lost.

A peculiar property of cupro-ammonium solutions, and one most important from the manufacturing point of view, is that whereas iron is, as is well known, attacked and dissolved by solutions of ordinary copper salts (*e.g.*, the sulphate, "blue vitriol"), an equivalent quantity of copper being precipitated during the operation, no such action is observable with cupro-ammonium hydrate solutions; so that cast and wrought-iron tanks and baths for the reception of the liquor may be used with impunity, as may steel rollers and machinery of all kinds when employed in contact with the liquor, or with fabrics moistened therewith. On the other hand, copper and brass must be studiously avoided in the construction of such appliances, otherwise corrosion and injury is speedily brought about. This peculiarity, as regards the non-action of iron and steel, is the more remarkable in that it is not observed with zinc; this latter metal precipitating copper (and being itself dissolved) with about equal facility, whether the copper be in the form of an ordinary copper salt, or in that of a cupro-ammonium solution.

For certain purposes, a bath containing a mixture of cupro-ammonium and the analogous zinc-ammonium hydroxide solutions may be used with advantage; the zinc compound does not of itself sufficiently pectise cellulose to give good results, but when used in conjunction with cupro-ammonium hydroxide, pectising is brought about by the copper solution, whilst certain advantages are gained by the simultaneous presence of zinco-cellulose and cupro-cellulose in the finished goods. The subject of the manufacture of both cupro-ammonium and zinc-ammonium solutions having been already dealt with in a paper read before the Society of Chemical Industry (published in a recent number of the journal of that Society), it will suffice, on the present occasion, to state that the fluids are obtained by the simultaneous action of air and ammonia water on metallic copper (or brass, if a mixture of cupro- and zinco-ammonium hydroxides is required), due attention being paid to the recovery of the large amount of ammonia necessarily carried away by the "spent" air during the operation.

The manufacture of fabrics, notably paper and canvas, treated with cupro-ammonium solutions so as to waterproof them and render them rot-proof, and practically free from the attacks of insects and mould, has been recently commenced on the large scale, at Willesden, by the Patent Waterproof Paper and Canvas Company, Limited, after a laborious series of trials and experiments on the matter, lasting over several years. The earliest patent relating to the production of these substances; was taken out as far back as 1868, by the late Dr. John Scoffern, whilst laboratory-made specimens, and models, &c., were exhibited in the Exhibition at South Kensington, 1872 (Scientific Inventions Department). Owing to the promising nature of the results obtained at this time, Mr. A. E. Healey, the present managing director of the company, selected a site at Willesden, and started the process in an experimental way in 1873; but numerous practical difficulties were encountered, and many modifications of the first machines employed were tried before the present arrangements were arrived at, enabling layers of material to be rolled 4 feet 6 inches wide, and of any required continuous length, without ruckle, flaw, or inequality. After the expenditure of much labour and patience, during some five years, a considerable measure of success in this direction was attained, so that in the Paris Exhibition of 1878 some fairly well-made rolls were shown with other specimens, for which three prizes were awarded; and since this date, numerous further improvements have been made, both in the nature of the plant and machinery requisite for the carrying on the manufacture, and in the preparation of the cupro-ammonium solution forming the starting point of the process;* so that it is only within a very recent period that the manufacture has actually attained to such a condition of completeness and perfection as to enable the products to be put in the market on any considerable scale, and that it has been practicable to produce in almost any required quantity such well made and useful products as those of which I am enabled to-night to show you specimens, through the kindness of the Directors of the Willesden Company.

In the trade, these products are now known as "Willesden" goods, and are divisible into two classes, viz., (*a*) the round or made-up goods, such as Willesden rope and cordage, Willesden netting, &c., and (*b*) the rolled or flat goods turned out in roll at the Willesden Mills.

Goods of the first class (*a*) are prepared by simply dipping the made-up materials to be treated into a bath of cupro-ammonium solution, using certain precautions as to the mode of immersion and its duration, and the strength of the solution. On subsequently drying the dipped fabrics, they are obtained coated and impregnated with cupro-cellulose, which thus not merely forms a kind of varnish-like surface dressing, but further adds strength to the fibres by more or less intimately cementing them together. The freedom from liability to mildew and rot of these products is remarkable, whilst they possess many advantages as compared with similar goods protected by tarring, or dipping in the bark vat, or treatment with other preservative compositions.

Goods of the second class (*b*) constitute a much more important group, to which at present the Willesden Company more especially devotes its attention. These fabrics are essentially of three kinds, viz., Willesden Canvas, Willesden Scrim, and Willesden Paper. The former two of these classes possess many features in common with the round or made-up goods just described, being prepared in much the same way, saving that the fabric to be treated is usually unwound from one roller and re-wound upon another, after passing successively through the bath and a succession of drying rolls somewhat analogous to those of a paper mill. Like Willesden cordage and netting, they exhibit remarkable freedom from moulding and mildewing influences. This point is well exemplified by the illustrations exhibited.

[Specimens were here shown of strips of canvas and scrim of various kinds, kept partly immersed in water in loosely covered jars for periods varying from a few weeks to

* Of the various patents possessed by the Willesden Company, for successive improvements and modifications, the latest is that of Dr. Alder Wright, for improvements in the production of cupro-ammonium and other analogous metallic solutions, by means of which the manufacture of this essential fluid is greatly cheapened and facilitated.

about four months; in each case a strip of original untreated fabric and one of the same substance after "Willesdenising" being side by side. The untreated specimens were copiously mildewed to extents varying with their age from just perceptibly incipient growth to completely developed large fungoid masses. The "Willesdenised" samples were just as perfect and free from mildew as when first put in.]

Willesden Paper.—This manufacture may be subdivided into two departments, viz., (1) Willesden unwelded, (2) Willesden welded (rolled goods), the first class being a single web or ply of paper of indefinite length passed through the bath, and rolled and dried in much the same way as canvas and scrim; the second class consisting of more than one ply or layer of primary material, incorporated into one solid insoluble sheet or homogenous panel of indefinite continuous length.

1. Unwelded or "one-ply" paper exhibits much the same general resistance to mildewing and moulding influences as Willesden canvas and cordage, &c. According to the nature of the paper originally treated, different kinds of Willesden 1-ply (W.P.G. 1) result. Certain coarse varieties furnish a waterproof material excellently adapted for lining packages, and wrapping parcels, &c., liable to be exposed to damp during transit, and of special value as a first coat of paper to be applied to damp walls. Finer qualities furnish envelopes and stationery possessing the valuable property of not being affected by water. Letters written with such stationery would be as legible as ever (provided the ink were not washed away or bleached) even if the mail-bags containing them were sunk in the ocean or washed overboard, and not recovered until after long periods of immersion. In connection with this may be noticed a mode of fastening envelopes, affording security against opening and tampering with contents, impossible with ordinary gummed envelopes, or with those secured by sealing-wax, either of which, as is well known, can be readily opened by a skilled person, and re-closed without noticeable alteration (an impression of the seal being of course taken in the case of sealed letters, and subsequently used to re-seal them). This method consists in using as fastening material a concentrated cupro-ammonium solution; the edges of the envelope are moistened therewith, whereby the paper is gelatinised; the envelope is then closed and ironed with a warm flat iron, when the gelatinised cellulose is converted into an insoluble cupro-cellulose, and the cover is fastened down so securely that the only possible mode of opening is to tear the paper. No amount of steaming or treatment with water will undo the cement, as it would with a gummed envelope. Another application of this same principle consists in the use of a wafer of "Willesdenised" paper, moistened with cupro-ammonium solution before use. Obviously, the same principle may be applied in the direction of cementing together the edges of sheets of paper so as to form larger sheets, fixing firmly together paper, pasteboard, wood, and analogous surfaces, bookbinding, and in numerous other ways; troughs and dishes, watertight boxes and packing-case linings, &c., are readily prepared thus.

[Samples of the same kinds of paper before and after treatment, immersed in water for various periods, side by side, were here exhibited, the former being more or less completely softened and pulped, whilst the latter indicated no change whatever; practical illustrations of the effect of a few minutes' boiling in water on the different specimens were also given, the treated specimens being unaffected, whilst the untreated ones were more or less completely softened and disintegrated.]

2. Welded Willesden goods have undoubtedly the merit of being the most remarkable and interesting of all, on account of their novelty and important applications; they are all prepared in substantially the same way, viz., by simultaneously dipping more than one ply, and pressing into one compact homogeneous sheet the various layers, whilst still gelatinised or pectised by the action of the cupro-ammonium solution. According to the nature and thickness of the finished material, various sub-divisions of this class may be tabulated, *e.g.*:—

W.P.G. 8. Willesden 8-ply; panel board.

W.P.G. 4. Willesden 4-ply; for roofing, building, panelling, decorating, &c.

W.P.G. 2. Willesden 2-ply; for underlining, interior decoration, floors, damp walls, packing, leaky roofs, &c.

W.P.G. 1. Willesden 1-ply; described above as unwelded Willesden goods.

Besides these, various kinds of combination fabrics may be noticed, such as those obtainable by simultaneously treating paper and calico, and welding the two together so as to form an article resembling ordinary mounted drawing paper, but differing therefrom in the important character that long continued immersion and even long boiling in water causes not the least disintegration or separation of the two diverse fabrics thus combined; so that military and submarine engineers' and surveyors' plans, and the like, drawn on such paper would be uninjured by being exposed to wet and rain, if the colours or ink were of suitable kinds, so as to resist the action of the water.

Willesden 8-Ply.—This material is adapted for panel work and use where great strength is required, and is valuable owing to its being made (to special order) 54 or even 60 inches wide, and in continuous lengths; from the nature of this material there is no fear of its cracking or splitting like ordinary panel board. For boat-building and naval construction generally it is well adapted. [Specimen shown of 8-ply panel boiled under 60 lbs. pressure for eight consecutive weeks in one of the steam boilers at the Willesden factory, without undergoing any disintegration, or serious change of any kind beyond a slight cockling.]

Willesden 4-Ply.—Next to slates and tiles, this material stands pre-eminent as a durable roofing material, unassailable by weather of all kinds; whilst its strength, combined with lightness and flexibility, combine to render it a most valuable and unique article for practical use and service; more especially are these advantages manifest in connection with up-country and foreign employments. Mr. Healey furnishes me with the following statement, comparing the relative weights and covering powers of W.P.G. 4, and good galvanised iron:—

WEIGHT OF ONE SQUARE (100 SQUARE FEET) IN POUNDS.

W.P.G. 4.	Galvanised Iron.
15 to 18.	103 to 280.

AREA COVERED BY ONE TON.

800 to 2,170 square feet, or 8 to 22 squares.	12,500 to 15,000 square feet, or 125 to 150 squares.

It is hence abundantly manifest that Willesden 4-ply would come far cheaper than galvanised iron, in any district where the cost of transit is heavy, more especially in new districts where the means of communication with the seaboard are but imperfectly opened up. Again, being put up in compact rolls (ordinarily of 2 cwt. each), no space is wasted in packing. Another special advantage is, that being comparatively non-conducting, the heat of a tropical sun is less felt under a roof of this kind than under a metallic one; whilst, on the other hand, the condensation of moisture from warm air inside a hut thus roofed or walled is all but imperceptible, even on a cold night; whereas an iron building, under similar conditions, frequently gives an inconvenient drip of condensed water from the roof, and small streams running down the walls.

For building purposes generally, and interior use, W.P.G. 4 offers many advantages. Where the buildings are temporary and intended for subsequent removal elsewhere (*e.g.*, workmen's huts when engaged in railroad construction, &c.), the lightness of this material renders it eminently adapted for construction in removable sections; and for more permanent structures it is equally advantageous for numerous reasons. It does not harbour moths or other vermin; in the hottest weather, under a broiling tropical sun, it remains unchanged, and emits no unpleasant odour; it requires no painting, and exempts from the necessity of using pot and brush year after year to prevent corrosion, or to make a neat surface, or render water-tight, being weather-proof in itself. If required for internal decoration, however, it will take paint readily, and, indeed, forms an admirable foundation for the painter and decorator to work upon, in this respect having marked advantages over felt, with which material it has nothing in common, although the two can, if desired, be used in conjunction. In case of fire, although not absolutely indestructible, yet "Willesden" will not readily feed the flames, the copperising and compacting process by which it is made rendering it far less inflammable than such substances as painted or tarred felt, or wooden shingling; its lightness moreover renders much less massive timbering requisite for the support of roofs, thus again diminishing the risk of damage by conflagration, there being actually less combustible matter about a building erected with this material than is necessary when the weight of a slated or tiled roof has to be supported. It is to be noticed that a special method of fixing walls and roofs of Willesden paper is recommended, illustrations of which are exhibited. Many such roofs are now standing in perfectly good condition, after upwards of eight years' exposure to weather of all sorts: similarly, pipes conveying both water and steam, such as those exhibited, have been in use upwards of three years below ground at the Willesden Works, without any visible deterioration. [A number of experiments were here shown, and others described, illustrating the comparative effect of dry heat and of boiling water on W.P.G. 4, and on mackintosh, pitch papers, felt, tarpaulin, asphalte, Manchester packing, &c.; the former being unaffected, and the others rendered more or less unserviceable, and, in many instances, utterly spoiled.]

Willesden 2-Ply.—This material is susceptible of being used for many purposes for which 4-ply is applicable, more especially when a less degree of body and substance will suffice. One special purpose to which it is excellently well adapted, is for laying upon or under floorboards, upon joists, &c., to avoid damp and draughts. Used as a floor-cloth for stairs, offices, &c., it wears well and is most effective, the cost being only a fraction of that of linoleum, kamptulicon, and similar articles.

In conclusion, I am enabled, by the kindness of the Directors, to exhibit not merely the numerous examples of Willesden goods, and their applications surrounding us, but also a series of lime light enlargements of photographs of buildings and other structures of magnitude, erected of Willesden paper.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said the subject was one of great interest to all parties, and the number of applications to which the manufacture might be applied, was certainly very numerous.

Dr. HATCHELEY said that, apart from the scientific value of the paper, he was much interested in the subject of cupro-ammonium, as he had had the privilege of a long and intimate acquaintance with Dr. John Scoffern, the original discoverer of the commercial value of this compound; and many were the interesting conversations which they had, in the infancy of the discovery, as to the probability of its great future, and the different purposes to which it might be applied. Dr. Scoffern was no visionary, but a man of great foresight, for he had rightly predicted the applications which cupro-ammonium would have, and it was much to be deplored that he had not lived to see his predictions verified.

Mr. J. M. THOMSON said, that having listened with very great interest to the paper, it struck him that Willesden paper might be used for the manufacture of light boats, which could be carried with ease; and, in the next place, in the manufacture of dishes for photographers. He should like to know whether a boat built of this paper would stand the action of sea water, and dishes the action of chemicals. It was well known that porcelain dishes were exceedingly heavy and unwieldly, and if dishes could be made of this paper, it would be a great advantage.

In reply to a question,

Dr. C. R. ALDER WRIGHT stated that there would be great difficulty in removing the whole of the copper from the paper by means of solvents such as acids.

The CHAIRMAN observed that the specimens of rope which had been exhibited had only been acted upon superficially by the coppery material, and he wished to know whether it was not possible to act upon the inner strands.

Mr. HALL said that Captain Abney, who had experimented upon this compound, found that the various developing solutions used in the fixing of photographs were not effected by Willesden paper, though in all cases he took the precaution to give the paper dishes a rinse out before putting in a fresh solution. He had also been informed by Mr. Whaite, the well known photographer, that he used dishes made of the paper.

Mr. A. E. HEALEY mentioned that a paper upon this subject had lately been read at the Photographic Society, when the whole subject was discussed, pans and dishes made of the paper being then exhibited.

The CHAIRMAN asked whether the paper dishes were cheaper than porcelain?

Mr. HEALEY said they were much cheaper.

Mr. J. O. CHADWICK suggested that the paper might be used by painters for works of art. Many of the works of the old masters had been preserved solely owing to the quality of the canvas used, and if this new material could be used, pictures would be almost undestructible. For the use of emigrants and colonials, it offered a field of unlimited extent, owing to its portability. Another remarkable property of the paper was its power of retaining the legibility of writing after being submerged in water for a lengthened period, which would be found of great service in the event of mail bags being recovered after a wreck. If the paper could be used for constructing the cells of galvanic batteries cheaply, and on a large scale, a great future was before it, as vulcanite, which was now used for this purpose, was very brittle and expensive.

Mr. E. W. BECKINGSALE inquired whether the material was capable of being moulded; if so, it might be used for cells. Perhaps Dr. Wright would tell them whether it was di-electric, and capable of withstanding the action of sulphuric acid.

Mr. LANT CARPENTER said that having had a summer-house roofed with this paper last year, he was able to speak in its favour, for it was as sound now as when put up. As far as he understood the manufacture of the paper, it was almost a case of superficial coating of the fabric treated, and therefore he should be glad to know whether any experiments had been made in the direction of incorporating the cupro-cellulose solution with paper pulp.

A MEMBER asked whether the copper was an essential part of the operation, because, if so, its presence might, in many cases, prevent the use of the paper. He rather thought that the cellulose was entirely changed, and that the copper became a sort of impurity. The paper might usefully be employed in South Africa and other places for the construction of light buildings, especially in places where they were troubled with white ants.

Dr. HATCHELY remarked that white ants would eat nearly everything but iron and stone; but from experiments made by a friend of his in a place infested with these insects, it was proved that they would not touch this paper.

A MEMBER asked if a paper prepared in this manner was the same as paper prepared with sulphuric acid, for vegetable parchment?

A MEMBER inquired whether the paper, when used for decorative purposes, had any effect upon pigments. As he had lately superintended the putting up of a decorative frieze in Westminster Hospital, he wished to know, as the medical staff had insisted upon the decoration being washable, whether his work was doomed in any way to suffer in the far future.

Dr. ALDER WRIGHT, in reply, said he had heard from various sources that white ants and other vermin would not touch the Willesden material, owing to the presence of the copper, so that, if the copper could be removed, as one speaker had suggested, the safety of the material in this respect would be gone. Boats had been made of the paper, and they answered very well in fresh water, but he could not say whether they had been tested in salt water. One advantage in making boats of the paper was that they were lighter than those made of wood, and, in the next place, they were very easily repaired. Photographic dishes could easily be made by taking a sheet and pinching up the corner, bulging being prevented by running a thread through the corners. These dishes could be used for chemicals, though it was not advisable to put in a second chemical if the first had remained in the dish for some time. As to the action of acids upon the card, that depended upon the concentration as well as the nature of the acid and the temperature. If the card were boiled in a beaker, with weak sulphuric or hydrochloric acid, beyond doubt copper in solution would be found, and, no doubt, there would be less copper in the card than there was before; but, in the cold, very little copper was dissolved out. He did not think that the solution of copper in this way would affect the stability of the material for such purposes as had been alluded to, more particularly in the use of galvanic cells. As to whether this material could be used for vats for bleaching purposes, that was a matter which experience alone could decide, though there was nothing in the character of the material which would unfit it for the purpose. At the same time, he was not prepared to assert that oil of vitriol could be kept in a vessel made of Willesden paper. With regard to the ropes being only superficially tinged with the coppery material, that partly arose from the circumstance that the rope had purposely not been immersed sufficiently long to enable the fluid to penetrate deeply. As the action of the solution was to dissolve and disintegrate fibres, if thin ropes were saturated all through, they were apt to lose a certain amount of strength. It was not necessary that a rope should be saturated throughout. As to the paper treated at Willesden, complete penetration of the fluid into each ply of paper was a necessity, in in order to obtain a proper product. The principal difficulty in carrying out the process consisted in exactly regulating the strength of the solution as regarded the amount of copper and ammonia, the nature of the paper and the length of time during which it had to pass through the vat, in order that the solution should pass into the interior of the paper to the proper extent and no more; for if the action of solution was overdone, the material became too soft and tender to be dealt with by the machine. As to the paper being used as a medium for painting, he might say, that both the canvas and paper were susceptible of use in this direction, though he was unable to speak with certainty as to canvas, owing to it not having been long in use; but there was every reason to believe that works of arts on canvas treated by this process would be less subject to deterioration through injury to the foundation. He was not aware that the paper would have any effect upon any mineral colour employed for decorative purposes. The action of copper upon certain organic dyes was well known, but these substances were rarely used for painting. The paper could be moulded into any shape, though this particular branch of the business had not yet been pushed, as the manufacture of the rolls appeared more promising. The production of thick plates for backing of armour plating was contemplated, and could be carried out by the action of the cupro-ammonium, either from paper pulp or cutting upon a mass which could be moulded into shape. As to the analogy between this paper and paper parchmentised with sulphuric acid, he might say the two processes were dissimilar, though chemically the change produced on the paper fibre was of much the same character. There was a certain amount of analogy between the processes; if, for example, a sheet of writing paper were impregnated with cupro-ammonium to a certain extent, it had much the same texture when finished as parchmentised paper, and microscopically there was the same kind of structure. The quantity of copper left in the paper after treatment would vary very much according to the length of time the paper was allowed to remain in the solution, and the quantity taken up. but in round figures, an analysis of 4 ply paper showed that it contained about 4 per cent. of metal. Among other uses to which the paper might be put, was for covering bricks in the brickfield, and for making shelters for vineries. Upon the question of whether Willesden paper was a non-conductor for electricity or not, he thought, if the material was rolled up into a pipe and used for telegraph cables, it would serve very efficiently, though he doubted whether it would be used with advantage as a substitute for gutta-percha. It certainly did not conduct electricity readily; but as it contained copper, if there happened to be a leaky wire, reduction of metallic copper might be caused, whereby metallic communication would be set up from the wire to the earth, and, therefore, he doubted whether the substance could serve for the purpose of insulation. For chemical laboratories, and household matters, there were a considerable number of applications where the material would come in most handily.

On the motion of the CHAIRMAN, a vote of thanks was passed to Dr. Wright for his interesting paper.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 14, 1884; Sir FREDERICK ABEL, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Atkins, Richard Day, 3, Sidney-place, Cork.
Chapman, Spencer, 84, Eccleston-square, S.W.
Clarke, Stewart, M.P., Bailey's Hotel, South Kensington, S.W.
Kendrew, John Anthony, The Ollands, Reepham, Norfolk.
Paget, Sir James, Bart., F.R.S., 1, Harewood-place, Hanover-square, W.
Pearson, Rev. H. D., M.A., St. James's Vicarage, Clapton, N.
Phillips, Henry Dominie, J.P., The Maples, Hampton-wick.
Stotherd, Colonel Richard Hugh, Ordnance-house. Southampton.

The following candidates were balloted for and duly elected members of the Society:—

Barclay, Robert, 17, Major-street, Manchester.
Bishop, Frederic Sillery, M.A., Welwyn-lodge, Swansea.
Ellis, Herbert, 62, New-walk, Leicester.
Francis, George Bult, 5, Coleman-street, E.C., and 21, Taviton-street, W.C.
Guttmann, Charles, 16, Brownswood-park, South Hornsey, N.

The paper read was—

TELPHERAGE.

BY PROF. FLEEMING JENKIN, LL.D., F.R.S.

In the first place, it is necessary that I should define what is meant by this word "telpherage," and perhaps that I should defend its formation. The word is intended to designate all modes of transport effected automatically with the aid of electricity. According to strict rules of derivation, the word would be "telephorage;" but in order to avoid confusion with "telephone," and to get rid of the double accent in one word, which is disagreeable to my ear, I have ventured to give the new word such a form as it might have received after a few centuries of usage by English tongues; and to substitute the English sounding "telpher" for "telephore."

In the most general sense, telpher lines include such electric railway lines as were first proposed by my colleagues, Messrs. Ayrton and Perry. The word would also describe lines such as I have seen proposed in the newspapers, for the conveyance of small parcels at extremely rapid rates. But to-night I shall confine myself entirely to the one specific form in which the telpher line first presented itself to my mind, and which it has fallen to my lot to develop. In this form telpher lines are adapted for the conveyance of minerals and other goods at a slow pace, and at a cheap rate.

The problem which occurred to me was this: Was it not really possible to send vehicles, by means of electricity, along a single suspended wire or rod—in fact, to telegraph goods and passengers instead of messages. The idea is familar as a joke, but, on consideration, it appeared that there might be good grounds for supposing both that the idea was practicable and useful. I am now able to show you the realisation of that idea, and the result of experiments on a large and practical scale has, I think, justified the arguments which have induced me to devote much time and labour to tepherage.

[Here the model was shown in action. This model consisted of two concentric octagons of wire, the length of each outer span being 5 ft. On each octagon there was a single locomotive and train, equal in length to that of the span. These trains ran well and steadily in opposite directions round the lines.]

These arguments may be stated as follows:—

We could not with steam employ a vast number of little one-horse engines to pull along a number of small trains or single waggons. There would be waste in the production of power, and great cost in the wages of the men employed at each engine. But an electric current, of, let us say, 50 horse-power, will, as it circulates through a conductor of moderate size, drive thirty small engines each of one horse-power, which require practically no supervision, and can be made nearly as economical in their action as a single electromotor of 30 horse-power could be.

But if the power can be distributed economically along a line, say, ten miles in length, this allows us to employ thirty small trains, corresponding each to a waggon pulled by one horse, instead of a single train such as might require 30 horse-power. If we further distribute the weight by making each train of considerable length, we are able to employ an extremely light form of road, such as a suspended rope or rod of, say, ¾ in. diameter. Later on in the paper I will show the amount of traffic which such a rod can practically convey. Meanwhile, I simply draw your attention to the general principles of the subdivision of power and the subdivision of weights. In distributing the power by means of electricity, it was clear that considerable waste must be incurred, but the amount of that waste is easily calculated, and is by no means prohibitory. Moreover, the power, being obtained from stationary engines, or in certain cases from falls of water, could be produced at a cheap rate in comparison with that obtained from locomotives or traction engines.

When I examined the various forms of possible road by which the distributed power and distributed load could be conveyed, it seemed to me that the single suspended rope or rod offered great advantages. The smallest railway involved embankments, cuttings, and bridges, fencing, and the purchase of land. A single stiff rail, with numerous supports, from which the train might hang, seemed better, and may, in some cases, be employed, but the supports would require to be numerous—say, one post every 10 or 15 feet—and even with these spans, the girder required to carry vehicles weighing 2 cwt. each, would be costly. With a single suspended rod or rope, we may have supports 60 or 70 feet apart. A ¾-inch rod, thus supported, will carry five vehicles, each bearing 2 cwt., without excessive strain. No purchase of land is necessary, no bridges, earthworks, or fencing. The line can be so far removed from the ground that it will not be meddled with, either by men or animals. A single wheel-path gives the minimum of friction, and the rolling stock can be much more easily managed than if we attempted to let vehicles run on double swinging ropes. On all those grounds it seemed well worth while to devise means by which trains could be electrically and automatically driven along the single suspended rod.

Before proceeding further, I had better state how far this idea has been realised. The Telpherage Company, Limited, was formed last year, to test and carry out my patented inventions and those of Professors Ayrton and Perry for electric locomotion. On the estate of Mr. M. R. Pryor, of Weston, two telpher lines, on my plan, have been erected. One of these is a mere straight road, with spans of 60 feet, and various forms of rod and rope. The first full-sized train was run on this line with a locomotive which we call the bicycle-wheel loco (Figs, 8 and 9, p. 653). The line was found inconveniently large and high, and the experiments were continued on a line ⅝-inch diameter, of round steel rods, with 50 feet span. This line is continuous, that is to say, it reenters on itself. It is 700 feet long, and we have run a train of more than one ton at a speed of five miles per hour on this line with complete success. The insulation has given no trouble. It need hardly be said that we see our way to great improvements in details. Thus, we can make the road more uniform, and stronger for its weight; we can lessen the quantity of material used, and greatly diminish the amount of skilled labour required in erection. We can improve the design of the posts. We can improve the trucks and locomotives, so that they will go round sharper angles, and so forth, but the main object has been practically carried out. We have had trains on a scale as large as I am prepared to recommend, running at the highest speed I have contemplated.

I trust it will be clear to you, from this description, that what I have contemplated and realised is not an electric railway destined to compete with steam railways in conveying goods and passengers at high speeds, neither is it a new form of communication destined for small parcels and high speeds; it is simply a cheap means of conveying heavy goods which, like coal or grain, can be carried in buckets or sacks, each containing two or three hundred weight. The speed on a telpher line will be that of a cart, and the object we aim at is to cart goods at a cheaper rate and more conveniently than with horses.

I assume that you all know that an electric motor is a machine which will run so as to exert power whenever an electric current is passed through it. You also know that a machine called a dynamo, driven by a steam-engine or other source of power, will produce an electric current which may be conveyed along a suspended and insulated rod, and used to drive an electric motor.

In describing the details of my system, the first point to be explained is, how the current produced by the dynamo, and conveyed along a single line, is taken from that line and directed round the motor.

In endeavouring to realise this idea, the first thought which occurred to me was that of dividing the line into lengths, equal to the length of the train, so that using the train to bridge over a gap between two sections at different potentials, the current could be conveyed from the leading to the trailing wheels of the train, round the motor. This idea is employed in the model now shown; but, in the first form which suggested itself, the gaps between the sections were opened by a switch worked by the front of the train, and closed by a switch worked by the end of the train. The first model, which may have been seen by some present, working in Fitzroy-street, was made on this plan. Trains driven in that way would all be coupled in series. The present model is differently arranged; there are no working parts or switches. Let the successive sides of the polygon be called the odd and even sides; the odd outer sides are connected with the even inner sides, and the even outer sides with the odd inner sides. We thus have two continuous conductors each going right round the model, but not joined to each other; these are connected to the two poles of a battery. So long as no train bridges a gap no current flows, but whenever the train bridges the gap, a current flows from the positive to the negative pole round the motor. This plan is called the cross-over system; all the trains are joined by it in parallel arc, and the current is reversed each time a train passes a gap. This reversal does not affect the working of the motor. This is the plan which has been carried out on a large scale at Weston. Its simplicity leads me to believe that it will be the plan most usually adopted, but several other methods of driving have been devised. A spark passes between the wheels and the line each time the current is stopped, but this spark occurs between large masses of metal, where it appears to be harmless; it has given no trouble whatever at Weston. Moreover, it has been found very easy to make connection between the line and the train. The ordinary truck wheels answer admirably, so that no complicated brushes are required. There are some absolute advantages in having interruptions at regular intervals, but the discussion of these would lead me too far for my present purpose.

Only one of the two continuous conductors requires to be insulated; this results in alternate insulated and uninsulated sections all along each line. Fig. 1 shows a saddle, as we call

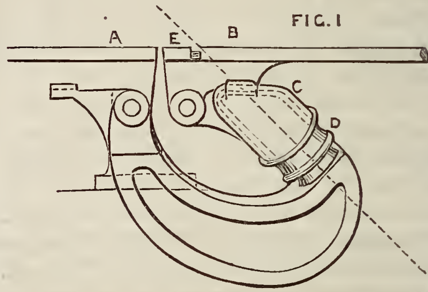


FIG. 1

it, with an insulated attachment, B, at the one end, and an uninsulated attachment, A, at the other, as used for a short sample line which has just been sent to Peru for the Nitrates Railway Company, Limited. The line itself is a three-quarter inch steel rod with forged ends, and Fig. 2 sufficiently shows the

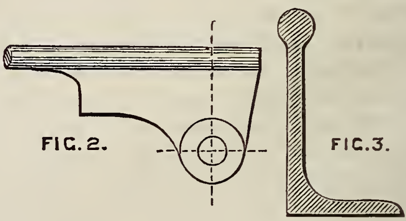
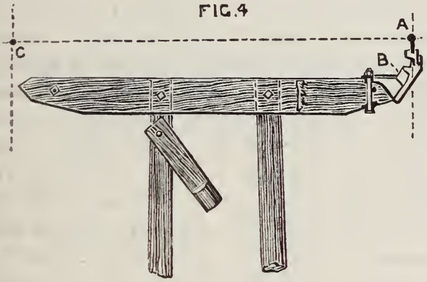


FIG. 2. FIG. 3.

mode of attachment. The insulation is given by a vulcanite bell insulator, D, carrying a cast-iron cap, C. All the parts are designed to stand 2·2 tons strain; the vulcanite is secured between two layers of Siemens's cement. The experiments at Weston have shown that vulcanite answers perfectly, but the material is rather expensive. I have here a smaller porcelain insulator, which has been subjected to 2·2 tons' strain. I believe porcelain will answer well in all respects, but it has not yet been subjected to the test of actual traffic day by day. At Weston the vulcanite was used between layers of Portland cement, the only objection to which is, that it takes some time to set. The simple steel rod has been found preferable in all ways to rope. We find that there is less friction and less jar with the rod, and ample flexibility; it is also much easier to secure. Moreover, a solid rod with welded ends can be made so that the ends, where supported, are, to some extent, undercut, as is shown in the corresponding bulb angle-iron (Fig. 3, p. 650) used for rigid parts of the road, this undercutting allows much greater freedom of rolling than would be compatible with the horizontal gripping wheels, especially when gripping wheels are used which, like those in the model, actually hold on to the line so as to resist being lifted. A short piece, E, slightly insulated, prevents the sections from being short-circuited by the wheels.

Fig. 4 shows the posts and crosshead sup-

FIG. 4

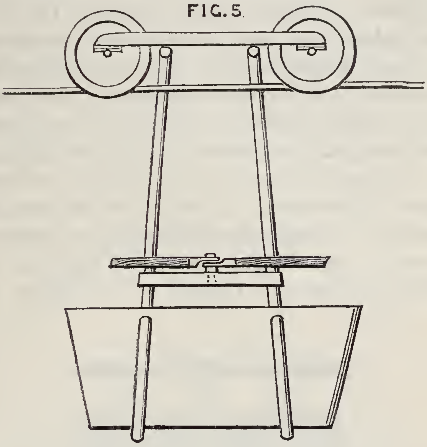


porting the line. In the one-inch example this design was fully carried out, and the posts stood the cross strain due to the overhanging load perfectly. In the five-eighth line an attempt was made to cheapen the construction, but the posts in wet weather work at the foundations; it is well that we are put on our guard against this danger. In the first design a sort of rocking saddle was employed, to allow the strain to be transmitted from one span to the next, but the flexibility of the posts provides amply for this object.

Abutment posts are required at intervals, and these can be made use of to provide compensation for changes of temperature, and to limit the stress on the rods. In straight lines I reckon about four abutment posts per mile.

In the short South American line, curves of 45 degrees at the posts will be employed, as shown in the model. At the stations where goods are to be handled, a rigid road will be more convenient than the flexible rod. A bulb angle-iron like that shown in Fig. 3, supported every ten feet, answers well at Weston, and a siding, leading the trucks off this line, has been satisfactorily carried out. The siding leads back to the line at a point between two flexible spans. In fine, it may be said to-night that the problem of the continuous line, whether straight, curved, rigid, or

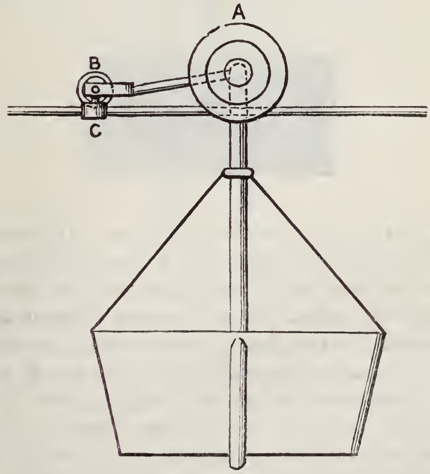
FIG. 5.



flexible, has been completely solved. Drawings and specifications can be put, without further delay or experiment, into the hands of contractors.

Trucks used on ordinary rope lines are

FIG. 6.



designed to be pulled by ropes on a road which is necessarily straight. When trucks of this description, with wheels 8 in. diameter and 22 in. wheel-base (Fig. 5), were tried at Weston, arranged in trains, some new difficulties presented themselves. Any sudden check to the motion was followed by a rearing action, throwing the truck off the line; similar results followed the application of any sudden pull. Moreover, trucks with two rollers on a rigid frame, even with so great a wheel-base as 22 in., require curves of considerable radius if we are to avoid serious binding at the flanges. Notwithstanding these difficulties, the trains at Weston, with a little care, run well and lightly, but the trucks which have gone to South America are on the plan adopted in the model, and run much more safely, and turn much sharper curves. They have two peculiarities—first, each wheel 7 in. diameter (Fig. 7), is pivoted on an axis, B, vertically over the centre of the wheels, A; this allows the truck to run with the freedom of a bicycle round curves; secondly, the weight carried is hung on a swinging arm, D, pivoted to the frame at

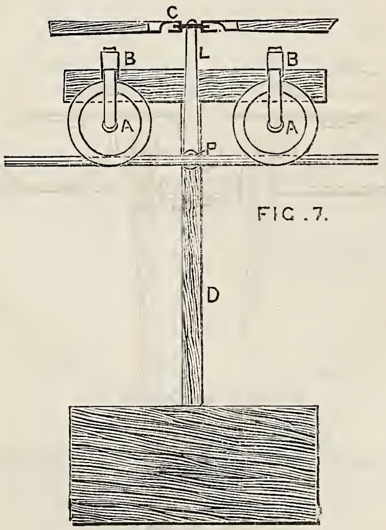


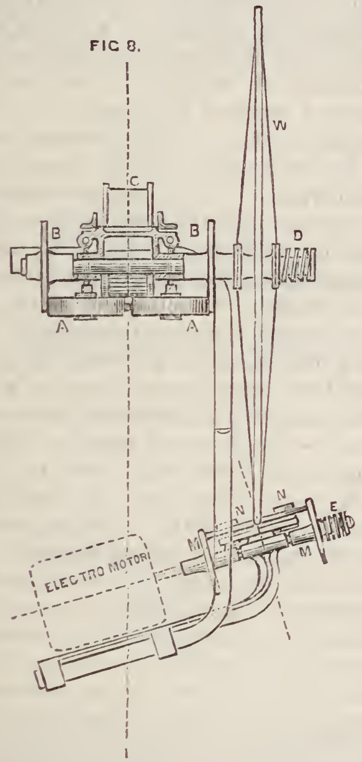
FIG. 7.

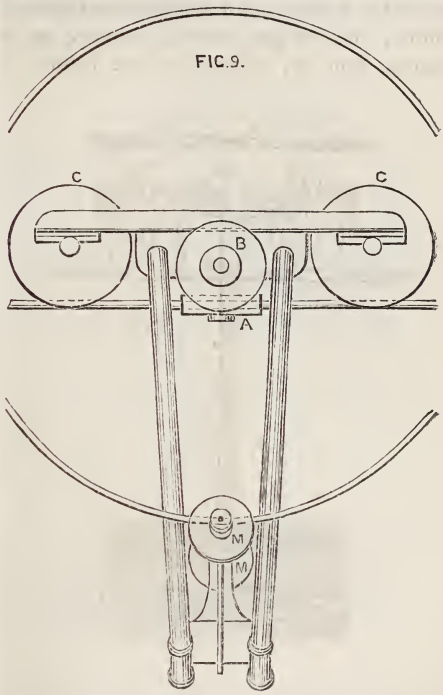
a point, P, on a level with the line. The result is that any force applied in a plane containing the line acts as if applied at the line itself, and will neither lift the wheels in front nor behind. In the model, the coupling, as you see, is on one line attached to the top of the swinging arm, where the coupling rods are well out of the way. In the other line the coupling is below the road. The swinging arm relieves the locomotive from all jerk at stopping or starting.

The truck is completed by a small hook or catch embracing the rod. In case of any accident causing the wheels to leave the line, this hook will prevent the truck from falling. The weight of the two-wheel stiff truck, shown in Fig. 5, with wrought-iron buckets, is 75 lbs. The weght of the two-wheel pivoted trucks, with wooden bucket, is 63 lbs. They are both adapted to carry 2 cwt. Fig. 6 (p. 651) shows a one-wheeled truck tested—the results were not favourable. A special form of bucket must be designed to suit such kind of traffic. Simple iron hooks for sacks will, in many cases, be available, and these hooks can be so contrived that on being struck they will drop the sack.

The first type of locomotive which was tried on a large scale is shown in Figs. 8 and 9 (p. 653). The motor lies horizontally across the line, and is connected by a form of frictional gearing, which I term right angle nest gearing, with the edge of a bicycle wheel, W. The shaft of the bicycle has on it two discs, B B, one of which is fixed on the shaft, while the other can slide longitudually on the shaft. These two discs are pressed together by a spring, D. Their edges bear on the horizontal gripping rollers, A and A, which seize the line. These rollers are supported in such a way as to be free to come together under the pressure of the spring transmitted by the discs, B and B. By tightening the spring, any required grip can be obtained with no injurious friction, either on the cross shaft or on the spindles of the rollers. This grip is a form of right angle nest gearing. The weight of the locomotive was taken by wheels, C C, fore and aft. The following defects were observed:—The frictional surfaces, both in the upper and lower nests, were too small, and the materials too soft, so that rapid wearing resulted with a consequent increase of friction. Moreover, the grip was so powerful, that the rollers, A A, were capable of supporting the weight, and thus a small inclination of their vertical axis was enough to cause the locomotive to rise, and even run off the line; moreover, the vertical curvature in the rope, or at the posts, required the rollers, A A, to be deep, thus limiting the extent to which rocking was admissible; moreover, very broad pulleys, fore and aft, would be required even for moderate horizontal curves. Nevertheless, this locomotive ran sufficiently well on the one-inch line during an exhibition to the shareholders last autumn. The weight for a five-eighth line of a somewhat improved form of this type, to exert one-half horse-power, on the average, is 200 lbs., an extra half hundredweight would give one horse-power. The driving wheels, A A, of this example are $6\frac{1}{2}$ in. diameter. The motor makes 9·23 revolutions for one of the driving wheels. One mile per hour corresponds to 473 revolutions per minute of the motor. 35·21 inch-pounds at the motor spindle are required for a pull of 100 lbs. at the rail.

Figs. 10 and 11 (p. 654) shows a locomotive designed by Mr. A. C. Jameson, when I was personally unable to attend to work. This locomotive, which is called the belt locomotive, shows a great advance on its predecessor. The general arrangement of the upper nest grip is retained, but a most ingenious modification has been introduced by which the discs, C C, run on one path on the rollers, A A, while the rod runs on another. In this way, the dirt from the line is never conveyed to the driving disc surface between A and C. Moreover, these frictional surfaces, which are points in the first form, have become lines in the second. This head answers admirably. The weight is carried by a roller, B, between the gripping discs, an arrangement contained in one of my first small models, and wrongly rejected in the first large locomotive. With this subdivision of weight, the gripping wheels are much less likely to rise, and can be made very shallow. In the actual locomotive, these gripping wheels are of an open inverted Λ shape, which has certainly run very well, although I prefer at present the upright V



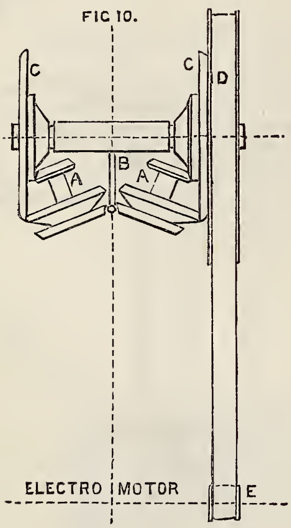


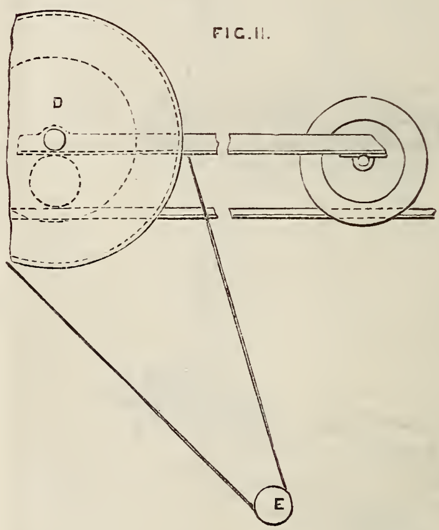
shape, which closes under the rail, as used in the model before you. Both of the gripping rollers drive, as in the first type. The cross shaft is driven by a belt on a 20-in. pulley, D; the other end of the belt runs on a 2-in. pulley, E, on the motor spindle. The friction due to the pull of this belt on the motor spindle is relieved by friction rollers. This locomotive runs extremely safely and steadily on the line; indeed I am not aware that it has ever been thrown off.

The following are particulars of its construction:—Weights with 96 lbs. one horse-power motor 269 lbs.; wheel-base 2 ft. 6in.; diameters of driving rollers 6 in.; 4·94 revolutions of motor per one revolution of driving wheel. A couple of 60·6-inch lbs. on motor is required for 100 lbs. pull at rail. 276 revolutions of motor correspond to one mile per hour on the rail.

The only improvements I have to suggest in this design are:—1st, the addition of gear which will give a higher speed of motor for the normal speed of four miles per hour, which we contemplate; 2nd, the addition of a swivel or bogie arm, such as is used in the model before you; 3rd, improvements in the belt connection. Moreover, the machine requires strengthening in some places. It will, however, be seen that none of these points touch the essential features of the design, which might at once be adopted in practice. Worked with motors of the Gramme type, the additional gear would not be required.

Before the belt locomotive had been completed, it was necessary to design a locomotive for the South American line, which I have several times mentioned. I had, meanwhile, constructed the model which is now before you; and this little locomotive, in which the power is transmitted by ordinary spur wheels, ran so extremely well, that I adopted the general arrangement for the next example on a large scale. This arrangement is shown in Figs. 12 and 13 (p. 655), the grip (C C and B B) is a third variety of the right angle nest, simpler than than that in the belt locomotive. In this form, also, we have line contacts, and two paths for the discs and rod. Where it is desired to drive from both sides, this arrangement is less powerful than that in the belt locomotive. In the South American locomotive, I drive from one side only, leaving the off side roller free to revolve as it pleases; this avoids grinding at rapid curves, and the adhesion given by one wheel will be ample in a dry country, such as that where this locomotive is to work. The arrangement of the gearing, E and F, is obvious; it allows the locomotive to lie fore and aft instead of across the line, and this design has some advantages in the adjustment of the weights. The surfaces of the gripping wheels are arranged





like an upright **V**, so as to hold on under the line. This makes it very difficult for the wheels to leave the line, both because of their absolute hold and because the inclination of the **V** is such as to favour the action of gravitation in overcoming the friction of the grip, instead of opposing it as in the inverted **V**.

Another feature of this machine is the arm pivoted at P, and carrying the leading wheel, which is again pivoted at M in the arm, as in the case of the trucks. This construction allows the locomotive to traverse curves of 6 ft. radius—a very remarkable result.

The full-sized locomotive has only just been completed, and run on three spans at Messrs. Easton and Anderson's. So far as I am able to judge from the trial, it is likely to be a complete success. It will be immediately shipped for its destination, so that its performance cannot be more fully tested in this country. The following particulars will show that it is much more powerful than the belt locomotive, but it is considerably heavier:—Wheel-base, 2 ft. 6 in.; weight, about 3 cwt. 14 lbs.; 15 revolutions of motor per revolution of driving wheels; diameter of driving wheels, 10 in.; 33·3 in. lbs. per 100 lbs. pull at rail; 504 revolutions of motor per minute for one mile per hour.

I am in doubt at this moment whether to adopt the belt locomotive or the spur wheel locomotive for the next example; it is simply a question of cost, weight, and durability. Either will do the work.

In all the arrangements it is essential that the second bearing wheel at M (Fig. 13), should lead, not follow the drivers in regular work. The reverse arrangement lets the rope lead on at an angle with the plane of the roller, causing an injurious grinding action.

Details of couplings have been well worked out, but space fails for their description.

As general features of the train running on the line, I may mention that the deflection of the rod within reasonable limits has very small influence on the resistance. When the deflection on a 50 ft. span was about 2·4 ft., the resistance for a train of trucks, weighing in all 1,260 lbs., was 22 lbs.; and no sensible difference could be detected when the deflection was materially reduced. This resistance was measured by pulling a train along, span after span, by one end of a rope passing over a pulley on the leading truck, and having a weight hanging vertically from the other end of the rope; the weight thus limited the pull. This pull differs extremely little as the train moves along, for when one part of the train is descending the curve the other part is ascending. It should be noted that during this experiment no special care had been taken to oil the bearings, and I have no doubt this pull can be materially reduced.

I have ventured to dwell at some length on the mechanical problems involved in this form of telpherage, because the experiments made

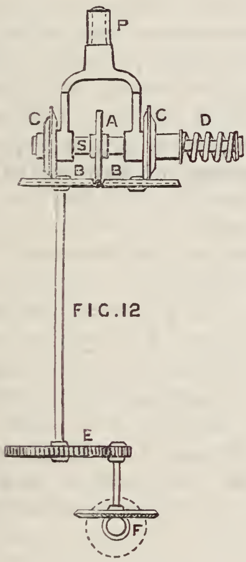


FIG. 12

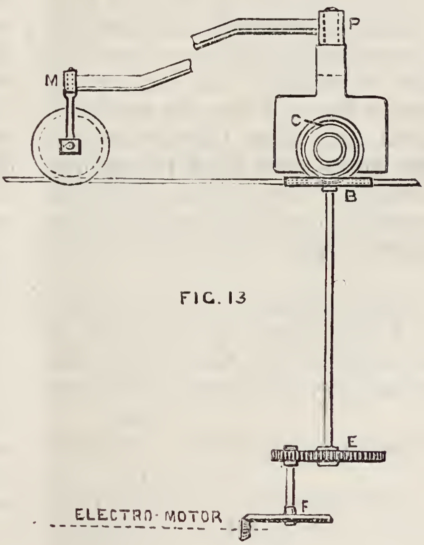


FIG. 13

so far have chiefly borne on questions of mechanics. The makers of dynamos can put at our disposal apparatus which will generate day after day, with perfect certainty and regularity, currents of electricity such as will transmit the horse-power generated by powerful steam-engines. These makers have already solved the chief electrical problems which present themselves in connection with telpher lines. They can give us at will constant current or constant electromotive force, high or low, as we may choose. They are now able to arrange their apparatus so that any number of incandescent lamps may be turned off or on, without disturbing the regularity with which other lamps are supplied, and by the same arrangement we are enabled to start or stop any nnmber of telpher trains without disturbing the running of others. The electrical problems of the telpher line, and those of electric lighting, run in absolutely parallel lines.

The electric motor, although it may be termed a mere inversion of the dynamo, has not as yet been brought to equal perfection, but month by month improved designs, proportions, and materials are being introduced, and the result already attained is sufficient for our purpose. It is all the more encouraging to feel that these results will certainly be surpassed, and far surpassed in the immediate future.

The following short summary of the problem of the transmission of power by means of electricity, may interest those who have not studied the subject. There are three steps in this transmission—1st, we convert mechanical power into electricity by means of a dynamo; in doing so we incur a loss of from 10 to 20 per cent.; 2nd, this electricity, in flowing along a conductor, generates heat, representing a further loss, analogous to that resulting from friction in mechanical gearing. This loss, depending on the distance of transmission, the size of the conductor, and the electromotive force employed, is easily computed. 3rd, We re-convert the electricity into mechanical power by means of an inverted dynamo, which we term an electric motor. With motors in which large weights of iron and copper are employed, the loss in re-conversion need not exceed 20 per cent., but with light motors, weighing from 70 lb. to 100 lbs. per horse-power, such as we must employ in the locomotives, I could not undertake with certainty at this moment to effect the re-conversion without a waste of one-half. The effect of all these sources of loss is, that at the stationary engine I must exert about 3 horse-power for every single horse-power which is employed usefully on the line. I look forward confidently to the time when 2 horse-power at the engine will be sufficient to give 1 horse-power to the motor.

To put these conclusions in a more scientific form, I may assume the efficiency of my dynamo as 80 per cent., that of my small motor as 50 per cent. The waste by heat expressed as horse-power is equal to $\frac{C^2R}{746}$ where C is the current in ampères, and R the resistance in ohms. The horse-power represented by the current is equal to $\frac{E \cdot C}{746}$ where E is the electro-motive force in volts, and C the current in ampères. It follows from the last expression that I may increase the horse-power in three ways, by increasing either E or C, or both. If I increase E, leaving C the same, I do not increase the loss during transmission along the line, no matter what horse-power the given line may transmit. A practical limit is set to the application of this law by the difficulty met with in dealing with electromotive forces above 2,000 volts. Marcel Deprez, taking advantage of this law—first pointed out by Sir William Thomson—has transmitted seven or eight horse-power over seven or eight miles, through an ordinary telegraph wire, and he obtained a useful duty of 63 per cent., taking into account all the three sources of loss which I have enumerated. With small motors I cannot yet promise a result so good as this, and I merely mention it to let you understand that, in speaking of 3 horse-power for one at the locomotive, I am leaving a very ample margin.

Quitting generalities, I will give some details as to the electrical and other conditions necessary, in two examples, for what may be considered as typical telpher lines:—

First Line.—Length, five miles. Length of circuit, out and in, ten miles. Twenty-five trains running at once, spaced one-fifth of a mile apart; speed, four miles per hour. Let each require 1 horse-power on the average; let the motor take on the average two ampères of electric current; let the electromotive force near the stationary engine be 840 volts; the electromotive force at the end of five miles will be about 746 volts. The total current entering the line will be fifty ampères at the near end of the line. Fifty ampères and 840 volts represent 56·5 horse-power; of this, 6·5 horse-power will be wasted in heating the line; the remaining 50 horse-power will do work in the motors equivalent to 25 horse-power. In order to give this current of fifty ampères with 840 volts, the stationary engine will require to exert $\frac{10}{8} \times 56 \cdot 5$ horse-power, or roughly, 70 indicated horse-power, or somewhat less than three times the useful horse-power. Let us now examine the economical results to be obtained from such a line as this. Mr. Dowson, in an interesting comparison between the cost of horse-power obtained from coal and gas, reckoned the cost per horse power for a 100 horse-power engine, at the rate of £3 6s. 9d. per annum, to include wages, coal, oil, and depreciation. Mr. Dowson would naturally be led to put the cost of steam power obtained from coal rather high than low. I will, however, adopt a very much higher figure, and assume that the power may cost as much £6 10s. per horse per annum; this gives £455 as the cost of the 70 horse-power required for my telpher line.

Let the 25 trains each convey a useful load of 15 cwt. In a day of 8 hours the line will have conveyed a traffic which we may express as 600 ton-miles—*i.e.* it will be equivalent to 600 tons conveyed 1 mile, or 60 tons on each line conveyed from end to end daily. If we count 300 working days in the year, the sum of £455 gives £1 10s. 4d. per diem, and the 600th part of this is about 0·604 of a penny, as the cost of the power required to carry a ton one mile.

In Great Britain we ought easily to be able reduce this below a halfpenny per ton per mile, which proves that the apparent great waste, even of two-thirds of the power in transmission, does not involve prohibitory expense. In calculating the whole cost of transport, we must further take into consideration the cost of the installation. Taking the spans at 70 ft., I estimate this cost as follows:—

Line £500 per mile	£2,500
Engine, boiler, and shed, at £20 per indicated horse-power	1,400
Dynamo and fittings	1,000
Twenty-five trains	2,500
Contingencies	600
Total cost	£8,000

Allowing 12½ per cent. for interest and depreciation, this represents an annual cost of £1,000. Allowing £100 as the salary of an electrician or young engineer, and adding £455 the cost of the power, this gives a total annual expenditure of £1,555 for a daily duty of 600 ton-miles. If we continue to assume the year as containing 300 working days, the total cost of conveying one ton one mile will be found equal to 2·07d. If goods are to be transmitted for long distances, the same calculation applies. We should simply have stations ten miles apart, working lines five miles long on each side of them. This, then, is the practical outcome of the general principles stated at the beginning of this paper. We may expect with great confidence that it will pay investors to convey goods for any distance at the rate of 2d. per ton per mile, by the agency of the suspended telpher line.

Matters are somewhat modified when the traffic is smaller. Making similar calculations for a line one mile long instead of five, with only four trains running at once, we might employ an electromotive force as low as 100 volts; the loss by heating would be insignificant; we should require about 12 horse-power; the work done in 8 hours would be 96 ton-miles. I estimate the cost of installation at £1,600, and the annual cost of working £344, without the annual salary of an electrician. This corresponds to 2·875d., or less than 3d. per ton per mile. One very important feature in respect to the cost of telpher lines is the fact that the larger part of that cost is due to plant, such as locomotives, trains, and dynamos. This plant can be increased in proportion to the work required; thus there is a very moderate increase of cost in the rate per ton per mile for a small traffic as compared with a large one, and, on the other hand, a line laid down for a small traffic will accommodate a much larger traffic with no fresh outlay on the line itself.

There are numerous minor electrical problems involved, but time does not permit me to enter into the consideration of these to-night. It will be sufficient for electricians when I say that I see my way to governing, blocking, and breaking the trains, without ever interrupting the current used to work the motor, except between the line and rolling wheels. We already know that the interruption at this point, although accompanied by a spark, does no injury whatever. I have often been asked whether the frequent reversals involved in the cross-over system do not tend either to injure the dynamo or the motor. I made special experiments on this very point lately with a compound wound Crompton dynamo and Mr. Reckenzaun's motor with thirty-six coils. I was unable at the commutator of the motor to detect the smallest change in the motion due to the most rapid reversal. At the dynamo commutator I could just see when the reversal occurred, but there was no change of a character to cause the smallest alarm. At the same time I may state that, when from any cause reversals may be thought undesirable, we are in possession of apparatus which we call "step overs," which, without diminishing the simplicity of the permanent way, enable us to send a continuous and unreversed current. These and similar electrical questions, such as the performance of Messrs. Ayrton and Perry's excellent motors, might possibly have had greater interest for electricians than some of the mechanical details discussed to-night; but I have felt that the main point to establish, in bringing this invention before the public, is that we have in telpher lines a means of conveying goods in an economical manner, by lines, locomotives, trucks, dynamos, and motors, which have undergone their preliminary trials with success, and can be at once applied to the more searching test of performing work for the public. If I have established this fact, I think you will have no difficulty in believing that the subsidiary electrical problems have been, or will be, readily solved. I hope that at a future period these will be brought before you in detail on many occasions by many men.

In conclusion, I will enumerate some of the uses to which telpher lines may be put. They will convey goods, such as grain, coals, and all kinds of minerals, gravel, sand, meat, fish, salt, manure, fruit, vegetables; in fact, all goods which can be divided conveniently into parcels of two or three hundredweight. If it were necessary, I should feel no hesitation in designing lines to carry weights of 5 or 6 cwt. in each truck. The lines will carry even larger weights, when these, like planks or poles, can be carried by suspension from several coupled trucks. The lines admit of steep inclines; they also admit of very sharp curves. Mere way leaves are required for their establishment, since they they do not interfere with the agricultural use of the ground. They could be established instead of piers, leading out to sea, where they would load and unload ships. With special designs, they could even take goods from the hold of a ship and deliver them into any floor of a warehouse miles away. When established in countries where no road exists, the line could bring up its own materials, as a railway does. Moreover, wherever these lines are established, they will be so many sources of power, which can be tapped at any point, for the execution of work by the wayside. Circular saws, or agricultural implements, could be driven by wires connected with the line, and this without stopping the traffic on the line itself. In fine, while I do not believe that the suspended telpher lines will ever compete successfully with railways, where the traffic is sufficient to pay a dividend on a large capital, I do believe that telpher lines will find a very extended use as feeders to railways in old countries, and as the cheapest mode of transport in new countries. In presenting this view to you, I rest my argument mainly on the cost of different modes of transport, which may, I believe, he stated approximately as follows:—Railway, 1d. per ton per mile; cartage, 1s. per ton per mile; telpher lines, 2d. per ton per mile; and let it be remembered that, in taking the cost of cartage at 1s. per mile, the first cost and maintenance of the road is left wholly out of account; whereas in my calculations for the telpher line, allowance has been made both for establishment and maintenance.

DISCUSSION.

Prof. PERRY said he never remembered feeling so much the want of his colleague, Professor Ayrton, who was unfortunately engaged elsewhere. At a very early period in the history of this invention, Professor Jenkin did his colleague and himself the honour to associate their names with his own, but their contributions, perhaps because they had in view the future much more than the present, were as nothing, compared to what had been done by Professor Jenkin. He never seemed to be floored when a difficulty presented itself, but after a month or two, when every body had fancied the difficulty was insuperable, he showed how he had overcome it. He could only say, therefore, that the success which had been achieved in the special form of telpherage exhibited there that evening was almost entirely due to Professor Jenkin's efforts.

Mr. ALEXANDER SIEMENS thought, that in working out the cost, Professor Jenkin had been in one direction too low, and in another perhaps too high. He did not think steam power could be obtained at the rate of £6 per horse-power per annum, but would cost nearer £10 or £12. On the other hand, these lines would be most generally useful, perhaps, in mountainous countries, were water power would be available at much less cost.

Mr. A. RECKENZAUN said Professor Jenkin had given a most elaborate account of the beautiful working of his telpher line, and he felt certain there was a great future for this method of transporting goods. In many cases, especially in mountainous countries, it would be exceedingly economical, and would be available where a railway would be quite out of the question, from the necessity of making expensive tunnels.

Mr. T. R. CRAMPTON thought every one must have been much pleased with the explanation which had been given, and that most persons would share his feeling of astonishment at the results which had been attained by such simple means. There was no part of the apparatus in which wear and tear might not be reduced to the minimum. The grip could not be expected to last for ever, but it was most simple in construction, and with the materials at command, could be made to last the maximum time. He thought Mr. Siemens was right in his statement of the probable cost of steam power, in the majority of cases, though no doubt £6 might be correct, if a large amount of power were required, and every modern improvement were brought to bear. The cost of 2d. or 3d. per mile was really nothing, for the purposes to which this mode of transit was proposed to be applied. In many cases, such a cost would be considered heavy, but in others, such as this would be applied to, people would gladly pay 6d.

Prof. GEORGE FORBES remarked that Professor Jenkin had evidently not brought forward this invention until he had got it into thorough working order, and he was surprised at the complete success that he had attained so soon. He should like to ask, however, whether he had succeeded in running several trains on the same line. Professor Jenkin had told them that any number of trains might be run simultaneously, in the same way that any number of lamps could be switched on to a circuit for electric lighting. But the analogy was not quite exact, because in the case of trains the length of the leads would vary, while in the case of incandescent lamps it was constant. One would expect that the electromotive force would fall off so much between the near train and the distant one, that the near one would overtake the other, and that even an attempt to equalise the resistance of the circuit through each train by a return wire would not be completely satisfactory; and that even with such a device there would still be such a difference of electromotive force as would tend to make one train pick up the other. He should be glad to know, therefore, if several trains had been run on one line. This had been done on an electric railway, where the same difficulty occurred, the only case which had come under his observation being the one at Vienna, but there the conductors of each car had the power of interposing resistances, so as to diminish the power if required. It would be very interesting to know if the same thing could be accomplished automatically.

Mr. Walter Hancock said he had not quite gathered what was the speed which could be obtained on this line, but he thought he understood Professor Jenkin to say that he had attained a speed higher than he considered it desirable to employ.

Prof. Jenkin, in reply, said he had invited Professors Ayrton and Perry to assist him, because they had already contemplated working electric railways automatically, and, therefore, the fundamental idea of telpherage was already familiar to them; and knowing their great abilities he anticipated that they could give him valuable aid. It had so happened, from various circumstances, that the working out of this particular form of idea had fallen more especially to his lot, but he had little doubt that, in a short time, those gentlemen would come forward with something quite as interesting as what he had now explained. This being his own particular idea, he had chiefly worked it out, and probably that was the way in which the best work would be done. With reference to Prof. Forbes's question he might say that there were a whole set of problems connected with the running of several trains together, which required special attention. Up to the present he had only run two trains, one each way, and there the special difficulty to which he had alluded did not arise, though another did, viz., that if one train ran away, it tended to send all the current through the other, and you had to provide for a certain balancing between the two. It was impossible to go into all the questions of electric arrangements at that moment, besides which he had determined to limit himself to a description of what had actually been accomplished. He might, however say this much. They had to provide for what might be called the electric governing of the train. Trains must sometimes be run down hill, sometimes up hill, and sometimes on the level, and they did not all take the same amount of power. Each must take just the amount it required, and the electromotive force along the line tending to drive the train must at every point be considerably above that which the train would require at the maximum. With a fall from 840 to 746, it would be easy to realise these conditions; but they were really much more complex than Mr. Forbes had assumed, necessitating such an arrangement of the electric governing that each train, while running at the same speed, should take just the amount of power required. At some future time he would explain that, but he preferred waiting until it had actually been done. Meanwhile, to prevent anyone supposing that he had set himself an impossible problem, he would say that he saw his way to doing it without ever interrupting the current, except between the rod and the wheels, where experience already showed that the interruption was harmless, the great difficulty in all these electrical manipulations was, that these powerful currents, which conveyed 1, 2, 20, or 40 horse-power, could not be broken and made without danger of arcing and sparking, and all sorts of difficulties which must be met. The governing which he had described, by means of which just the requisite amount of power should be taken off, existed at the present moment on paper to his own satisfaction, but he preferred not to describe it until it had been tested. The same thing might be said as to the breaking and blocking of trains without interrupting the current, or having a single spark from end to end anywhere, except the sparks between the rolling wheels and the line, and there they knew the maximum effect, which had not created any difficulty. With regard to speed, he might say that speed had nothing to do with the power or application of electricity. If a sufficient sum of money was placed at his disposal, he would design trains which should run at a speed of 150 miles an hour; it was entirely a question of cost. Such rapid travelling would cost a great deal, because you must have a rigid road, with very large curves. Where you had a flexible line, in which there were considerable dips, if the trains ran at a high speed, serious strains were thrown upon them, due to centrifugal force in going down the incline and up towards the supports; moreover, the acquired momentum would tend to throw the vehicles off the line at the vertical curves over the posts. He, therefore looked on the suspended line as essentially a carting, or low speed line. A high speed railway must have a rigid road, and was not the sort of thing he was competing with.

The Chairman remarked that the concluding observations of Professor Jenkin had pointed out a number of difficult problems which he had had, and which he might still have, to contend with; but they must all have been struck with the charming manner in which he had worked out the subject so far, and they would go away with a feeling of admiration for the manner in which he had applied his reatg scientific knowledge to this important purpose. He himself could see many directions, some of which might not have occurred to Professor Jenkin, certain paths of work in which he was engaged, in which telpherage ought very soon to be introduced, and he had no doubt that there were many respects in which this might be considered one of the most important applications of electricity in the future. He concluded by proposing a vote of thanks to Professor Jenkin, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

VEGETABLE RESOURCES OF BRITISH HONDURAS AND ST. HELENA.

The development of the economic resources of our colonies is a subject to which considerable attention has been given of late, not only to the indigenous production, but also to the products of other climes, which have been introduced and become acclimatised. The very general desire to spread the cultivation of useful plants in our colonial dependencies has resulted in the establishment and extension of many very valuable commercial plants in widely different regions of the globe, and a great deal has been written on the commercial aspect as well as on the modes of cultivation. The establishment of nurseries and plantations, and the development of the resources of the botanic gardens already in existence, and the formation of other departments of a similar character, have all helped the work forward, of late years, in a wonderful degree. In connection with this subject, Mr. D. Morris, the Director of Public Gardens and Plantations in Jamaica, has recently published an account of a visit he paid, in 1882, to the colony of British Honduras. This account treats of the resources and prospects of the colony "with particular reference to its indigenous plants and economic productions." The first thing that needs attention in a hitherto uncared for land is the preservation of its forests, and what is still more important is the checking of the reckless cutting down of forest trees in inhabited or cultivated countries. Mr. Morris draws especial attention to this point, and expresses a hope that the question of retaining in permanent forest the chief watersheds of the country, as well as wooded belts in the neighbourhood of streams and springs, will receive the earnest and careful attention of the Legislature. "At present," it is stated, "several thousand acres of some of the finest lands to be found in any British dependency, produce an annual export value (in mahogany) of only £50,000. This sum is attained in Jamaica in the export value of such a minor product as oranges. That the export value of oranges from Jamaica is equal to that of mahogany—the great staple industry of British Honduras—is a new and somewhat startling fact. It serves, however, to show what a change is gradually taking place in the development of the West India Islands by means of the fruit trade with America.

"Wisely and generously regarded, the development of small industries, and especially the fruit trade i the West Indies, should lead, little by little, to th building up of a more wholesome as well as a mor permanent prosperity than anything which existed during the days of slavery.

"The fruit trade has initiated a system of cash payments on the spot which is fast extending to other industries; the result is, that the cultivator and the planter are placed at once in possession of means for continuing their cultural operations, and for extending them to their fullest extent. As a case in point, it may be mentioned that the development of the fruit trade in Jamaica is the means of circulating more than £150,000, annually amongst all classes of the community, and this large sum is immediately available, without the vexatious delays formerly experienced in establishing other and more permanent industries. Under the old system, the planter was for the most part in the hands of merchants and agents; he seldom had full control of his produce; and was so restricted in his selection of a market, that he often suffered much thereby.

"The new departure in the sale of West Indian produce is only beginning to be felt, but its ultimate effects will, no doubt, tend to such an emancipation of the planter, that these tropical lands will, in time, become as prosperous as they are beautiful and fair." Bananas, plantains, and cocoa-nuts are the staple articles of export to the American market; the prices are from 1s. 9d. to 2s. per bunch for bananas, 3s. to 4s. per 1,000 for plantains, and 70s. to 100s. per 1,000 for cocoa-nuts."

As is well known, the principal staples of British Honduras are mahogany and logwood, the average annual export of the former being about 3,000,000 feet, and of the latter 15,000 tons. Much of the finest timber, within easy reach of the principal rivers, has been cut down, but a good deal of fine timber is stated to be found in the interior.

Most of the mahogany forests are in the hands of a few proprietors, who adopt a rude system of forest conservancy, backed by a very strict trespass law. Government land may be bought at a dollar an acre, or, if preferred, short leases of five years are issued to persons desirous to occupy waste lands of the Crown, not less than fifty acres, at a yearly rent of 10 cents an acre, with right to purchase at any time during the tenancy.

To start a mahogany works, the first step is to employ a "hunter" or experienced woodman, who devotes several days to prospecting in the forest, after which he reports on the number and character of suitable trees to be found within easy reach of the works, which are always placed at a convenient place on the bank of the river, where the mahogany logs can be manufactured and easily tumbled into the river.

"The 'hunter' is paid so much for every tree which, on examination, is found suitable for cutting, *i.e.*, squaring 18 inches and upwards. The next step is to open a track to it, and proceed to cut it down. Owing to the huge buttresses which many mahogany trees possess, a platform is sometimes erected so as enable the men to cut the tree above them; when lopped, cleaned, and sawn to the available length, the log is ready to be handed to the works.

"During the dry months of the year, the logs are carried on trucks, drawn by bullocks. The truck is a ponderous framework, mounted on four broad wheels about 3 ft. in diameter, with 9 in. tread, the latter being made in a most primitive fashion by sawing pieces across from a log of Santa Maria. During wet weather, when the ground is too soft for the trucks to travel, mahogany is drawn on slides, or a kind of sleigh, which pass over 'skids.' The latter consist of long, hard wood posts, about 3 in. in diameter, placed across the track about a yard apart.

"Being imbedded in mud, the fresh slippery bark affords a suitable and handy surface for the passage of the slide with its heavy load. Sometimes mahogany logs are drawn, in the manner above described, distances of eight or ten miles. Mahogany is always trucked in the middle of the night, the cattle not being able to perform such laborious work during the heat of the day. It is a picturesque and striking scene this midnight trucking. The lowing of the oxen, the creaking of the wheels, the shrill cries of the men, the resounding cracks of their whips, and the red glare of the pine torches in the dense, dark forest, produce an effect approaching to sublimity.

"At the works the logs are regularly squared and prepared for the market. If, however, they are likely to be chafed and injured in transit, by going down shallow creeks, the squaring is done at Belize, or at the river's mouth.

"Trucking is generally carried on during the month of April and May, when the ground is hard, after a long period of dry weather. About the middle of June, after the May "seasons," or rains, the rivers are swollen, and advantage is taken of this opportunity to tumble the logs into the water, and float them down to about ten miles from the rivers mouth. Here a large iron chain or 'boom' is fixed, which stops the logs as they float down. At this point, the several owners select the logs by their respective marks, form them into rafts, and so float them down to the sea, and ultimately to Belize, whence they are shipped abroad.

"Logwood cutting appears to be a much simpler and much less laborious work. After the trees, which are seldom more than a foot in diameter, but often only half this size, are cut down, the outer or sage wood is removed, leaving nothing but the inner dark coloured heart wood. When thus prepared, the logwood is carried on trucks or "crooked" to the nearest bank, where, to prevent it from sinking, it is packed in "bark logs" or light, boyant cradles, capable of carrying a ton or two of log logwood. An immense train of these heavily freighted "bark logs" is often met with on its way down the river, or anchored at night in the middle of the stream.

"Most of the logwood is found in damp, moist districts of the north; but there are also many tracts to the south, where logwood is very plentiful.

"Growing with the mahogany is a member of the same family, the common cedar *(Cedrela odorata)*, which is in great demand for light indoor work, and from which the fragrant boxes for Havannah cigars are made. In the colony the trunks of the largest trees are hollowed out to make bungays, dorays, pitpans, and canoes, purposes for which, on account of the light and durable character of the wood, they are admirably adapted. The export of British Honduras cedar for the last five years amounts, on an average, to about 130,000 feet."

On this same subject of colonial planting, and the development of colonial resources, Mr. Morris has also written an account of a recent visit to St. Helena, made by him with the special intention of bringing about a more healthy and profitable state of things than already exists in the island. The title of this account is "A Report upon the Present Position and Prospects of the Agricultural Resources of the Island of St. Helena. Printed for the use of the Colonial-office." Notwithstanding the smallness of this island, being only $10\frac{1}{4}$ miles long, and $8\frac{1}{4}$ miles broad, and notwithstanding its present neglected condition, Mr. Morris looks upon St. Helena as a likely ground from whence many valuable economic vegetable products may be obtained. It has been proved that several species of cinchona will flourish, notably *Cinchona succirubra* and *C. officinalis*, but all things considered, Mr. Morris thinks it would not be well to continue their cultivation with the view of making it a commercial success, other valuable plants being very easily grown; of these, several well-known fibrous plants are enumerated, as coffee, tobacco, oranges, limes, citrons, lemons, the Cassava plant, and many others.

One of the few indigenous plants of the island still found growing there is thus described:—"A small vegetable much resembling celery is found growing wild on Diana's Peak, which formerly was sold, and eagerly bought, in the market at Jamestown. This is the Angelica (*Sium Helenium*, Hook. F.), a handsome umbelliferous plant, growing to the height of 6 ft. or 8 ft. amongst the cabbage trees and ferns on the central ridge. The inner portions of the stem, which is of a tender succulent character, may be eaten raw, and form an excellent substitute for celery. The native people eagerly eat it; as brought to market it is in short tubes, much like bamboo stems, and is sold under the name of 'Jellico.'"

As a recommendation for the better utilisation of the St. Helena soil, Mr. Morris proposes the appointment of an intelligent and competent gardener "to take up the entire question of the revival of agricultural pursuits."

Considering the fine and equable climate of St.

Helena, it is somewhat surprising that it has not become much more frequented as a health-restoring resort.

Correspondence.

THE WATER SUPPLY OF LONDON.

An action of considerable importance to London, in connection with its water supply, lately tried in the High Court of Justice, owing to the political excitement of the day, did not receive that attention which, in my opinion, it deserved. The action I refer to was brought by the Lea Conservancy Board against the Corporation of Hertford and the Rivers Purification Company to prevent the further pollution of the river Lea by effluent sewage water, and recover the sum paid for dredging 2,500 tons of mud from the bed of the river. The practical breakdown of the legal proceedings, so far as the prevention of pollution is concerned, show plainly enough that vested interests have got the whip-hand of public rights in all matters that relate to a pure water supply for London.

The great importance of the question must be my excuse for troubling you with a few remarks on the Hertford Corporation claim to pollute an open river of the importance of the Lea. The broad issue raised by the action of the Conservancy Board was whether, if an Act of Parliament gives a power of disposing of sewage treated in a certain way, and upon certain conditions observed and complied with as far as possible, an action is maintainable for pollution of a stream or river by the effluent water sent into it? The judgment delivered by Mr. Justice Williams in the Hertford case seems to imply that it is not. It must be observed, however, that the question of pollution became quite a secondary one, for the action turned upon points of law, as affecting the rights of the Corporation and the Purification Company acting for and under this body, and the Lea Conservancy Board.

The brief facts of the case are as follow:—

The town of Hertford, having a population of about 7,000 souls, down to 1854, was entirely without any regular system of drainage. The whole of the sewage, together with subsoil and flood water, was allowed to flow through ditches, black with mud and filth, directly into the River Lea. For very many years a large proportion of sewage found its way into the river at the north end of the town, above the "intake works" of the New River Water Company; and when, from increase of population and other causes, a larger quantity of sewage was daily sent into the stream at this point, it became absolutely necessary to take means to put some check upon the nuisance. An Act of Parliament was obtained, and intercepting sewers were constructed, which, when united, were made to terminate in a foul tributary of the Lea—"Manifold Ditch." So little was gained in the way of purification that, in 1860, further powers were sought and obtained; ultimately the Corporation, after having expended considerable sums, handed over its powers, with certain restrictions, to the Rivers Purification Company. Notwithstanding, numerous indignant complaints continued to reach the Lea Conservancy Board of the foul smells emitted by the effluent water, and the accumulations of stagnant mud about the banks of the river, so that ultimately it became necessary to frequently dredge the river below Ware Lock. The stuff dredged was described by the navigation engineer, "as sewage mud, the like of which he had only seen near the Tottenham Sewage Works." After many ineffectual efforts on the part of the Lea Conservancy Board to bring about some abatement of the nuisance, legal proceedings were commenced. the action was tried at great length, and at an enormous cost to the Board, the inquiry lasting some twelve or fourteen days; ultimately the judgment went in favour of the Hertford Corporation, virtually for the continuation of the pollution of the Lea.

That there is a very serious pollution of the river going on, no one who knows the river can possibly deny; indeed this was sworn to by a number of experts, supported by very many credible resident witnesses. The judge took the trouble to satisfy himself on the point by a visit to Manifold Ditch. His words were—"I went up the Lea along the towing path opposite the Priory Gardens, and here the river was tolerably clear, with ordinary weeds growing in it; but on proceeding towards Ware Lock the water became of a dark colour, and at Manifold Ditch there were pieces of matter floating on it (sewage fungus), and it emitted a decided smell of sewage. A little higher up, and near the point where the effluent water issues from the works of the company, the fluid had a peculiar metallic appearance (floating masses of living bacteria), with small particles of matter floating on it (more confervoid and fungus growths), and a very decided smell of sewage." This testimony is both conclusive and instructive, and places the question of pollution beyond a doubt; indeed, the dangerous state of the river is a grievous scandal, for with all the supervising care of the Lea Conservancy Board, it has been observed to be on the increase; in truth, it has increased during the past decade 136 per cent. The utter collapse of a constituted authority for the prevention of pollution is a lamentable fact—one which demands the attention of a Legislature that called it into existence in the public interest. Some two or three months ago I drew attention to the polluted condition of the River Lea. This fact was impugned by certain interested parties; but if one thing was more clearly brought out at the Hertford trial than that of another, it was the filthy pollution of the River Lea by effluent sewage, both above and below the in-take of two of the largest purveyors of London water—the New River and the East London Waterworks Company. JABEZ HOGG.

1, Bedford-square.

THAMES COMMUNICATIONS.

Reverting to remarks at the meeting on the 23rd ult., as to the present commercial condition of the Thames, as evidenced by empty premises, allow me to hand you the following list of such properties between London-bridge and Blackwall:—Springall's-wharf, Surrey side, to let, opposite London-docks, Hermitage entrance; Phœnix-wharf, above Tunnel-pier, Middlesex side; small wharf below Ferry-pier, Middlesex side; small wharf below New Crane-wharf; Queen's-wharf, above London-docks, Middlesex side; Globe Granary, &c., small property, Surrey side; Lavender-dock, old timber graving-dock, Surrey side; Limehouse-cut, small warehouse; "Bond's," mast-makers, Limehouse-reach;" small wharf three doors below; Nelson-dock, small wharf; small wharf, next Byas's, Rotherhithe; Napier's, Millwall; Scott Russell's, Millwall; wharf, Millwall, near Church; Blackwall-point, near Police-station, new frontage; number fifteen, in all. Not one-fifth of these are of any importance, and this on frontages of nearly fifteen miles of river, or one per mile.

Practically, the whole commercial portion of the river is actively employed, with small signs of "exodus" in the present, whatever may be in store for it in the future. Every foot of frontage, with the above exceptions, is fully utilised; and it must be remembered that one-fourth of it, viz., The Isle of Dogs and Bugsby's Marshes, half a century back, was composed of earthen river walls fronting open marsh.

J. W. REDMAN.

May, 10, 1884.

Obituary.

DR. ANGUS SMITH.—Robert Angus Smith, Ph.D., LL.D., F.R.S., F.C.S., the well-known Inspector-General of Alkali Works for the United Kingdom, died on the 12th inst., at the age of 67. Dr. Smith studied under Liebig at Giessen from 1839 to 1841. Among his works may be mentioned a "Life of Dalton," "Air and Rain," and papers in the "Philosophical Transactions" of the Royal Society, and the "Journal of the Chemical Society." He also contributed to this *Journal*, and frequently spoke at the meetings of the Society of Arts, when questions relating to the prevention of smoke arose for discussion.

DR. GOODFORD.—The Rev. Charles Old Goodford, D.D., Provost of Eton, who died on the 9th inst., had been a member of the Society of Arts since 1869. He was born in 1812, and was edncated upon the foundation at Eton. He held the office of assistant master at that school for many years, and became head master in 1853. In 1862 he succeeded Dr. Hawtrey as Provost.

H. BADEN PRITCHARD.—On Sunday last, Mr. Baden Pritchard expired at his residence at Blackheath, in consequence of an attack of pneumonia. Mr. Pritchard, third son of the late Mr. Andrew Pritchard, the author of the "History of Infusoria," and the constructor of the celebrated diamond microscope objectives, was well known in literary and scientific circles; his novels, together with his sketches, entitled "Peeps at the Pyrenees," and "Beauty Spots on the Continent," obtained for him a literary reputation, while his work in connection with photographic literature is well known to all photographers. Since 1861, he has been engaged in the Chemical Department at Woolwich Arsenal.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock:—

MAY 21.—"Telegraph Tariffs." By Lieut.-Col. WEBBER, R.E. Dr. CAMERON, M.P., will preside.

MAY 28.—"Primary Batteries for Electric Lighting." By I. PROBERT. W. H. PREECE, F.R.S., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings:—

MAY 22.—"Economic Applications of Seaweed." By EDWARD C. STANFORD, F.C.S. W. H. PERKIN, F.R.S., will preside.

MAY 29.—"Some Economical Processes connected with the Woollen Industry." By Dr. WILLIAM RAMSAY.

INDIAN SECTION.

Friday evenings:—

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Sixth Course will be on "Fermentation and Distillation." By W. N. HARTLEY, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin.

LECTURE II.—MAY 19TH.

Fermentation proper. The cause of fermentation. The nature of the yeast cell. Its mode of growth. The chemical action of fermentation. Rapidity of growth of yeast. Charasteristic appearances of exhausted and revived yeast. Of "high" and "low" fermentations. Conditions of a good fermentation. Healthy and foul yeast. Explanation of the custom of a "change of yeast." Methods devised for purifying yeast. Exhausted yeast not necessarily foul. Mineral food necessary for yeast. Explanation of the reason for fermenting with mixed yeast. Influence of temperature on fermentation. Heat evolved during fermentation. Methods of warming and cooling mash. The products of alcoholic fermentation.

LECTURE III.—MAY 26TH.

Alcohol produced by mould. Its existence in rain, river, and sea water. Its presence in the soil. The process whereby alcohol is separated from water. The simplest form of distillation by a still and worm. The boiling points of water and alcohol. Boiling of mixtures with low boiling points by means of vapours with high boiling points. Pot stills and patent stills. Langier's still. The principle of Coffey's still. Its mode of action described. Improved forms of still. Alcoholic beverages and other products.

HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. N. Hartley, "Fermentation and Distillation." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. H. H. Smith, "The Inclosure and Regulation of Commons."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. Emerson, "A Description of some Newly-erected Buildings at Allahabad and Bownuggur."

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m.

TUESDAY, MAY 20...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gamgee, "The Anatomy and Physiology of Nerve and Muscle." (Lecture III.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. R. W. Peregrine Birch, "The Progress of Upland Water through a Tidal Estuary."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. C. Walford, "Statistical Review of Canada, including its Confederated Provinces."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "Preliminary Notice of the Isopoda collected during the Voyage of H.M.S. *Challenger.*" (Part I.) "The Genus *Serolis.*" 2. Dr. J. Gwyn Jeffreys, "The Mollusca procured during the *Lightning* and *Porcupine* Expeditions, 1868-70. (Part VIII.) 3. Prof. Bell, "The Structural Characters of the Cotton-Spinner (*Holothuria nigra*), especially of its Cuvierian Organs." 4. Mr. F. Day, "Hybrids among the Salmonidæ." (Part II.)

WEDNESDAY, MAY 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Lieut.-Col. C. E. Webber, "Telegraph Tariffs."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Note on the Proceedings of the International Polar Conference, held at Vienna, April 1884." 2. Dr. A. Tucker Wise, "Meteorological Observations on the Maloja Plateau, Upper Engadine, 6,000 feet above the Sea." 3. Mr. A. Naylor Pearson, "Some Results of an Examination of the Barometric Variations in Western India." 4. Mr. Richard Inwards, "Illustrations of the mode of taking Meteorological Averages by the method of weighing paper diagrams." 5. Mr. Rupert T. Smith, "Ten Years' Weather in the Midlands."

Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual Meeting.

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition of Plants, Flowers and Fruits.

Archæological Association, 32, Sackville-street, W., 8 p.m. Signora Campion, "The Ancient Port of Luni, Italy."

Hospitals Association, 11, Chandos-street, Cavendish-square, W., 8 p.m. Mr. Henry C. Burdett, "How can the Hospital Sunday and Saturday Funds be made more useful to the Hospitals?"

THURSDAY, MAY 22 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical and Physical Section.) Mr. Edward C. Stanford, "Economic Applications of Seaweed."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture V.)

Telegraph-Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Mr. W. H. Preece, "The Electrical Congresses of Paris."

FRIDAY, MAY 23...United Service Inst., Whitehall-yard, 3 p.m. Lord Charles Beresford, "Machine-Guns in the Field."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Dr. David Gill, "Recent Researches on the Distances of the Fixed Stars, and Some Future Problems in Sidereal Astronomy."

Geologists' Association, University College, W.C. Excursion to Epsom and Dorking under the direction of Mr. W. H. Dalton and Mr. French.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Paper by Miss Drewry.

SATURDAY, MAY 24...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Bonney, "The Bearing of Microscopical Research upon some large Geological Problems." (Lecture II.)

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr. W. H. Stone, "An Immersion Galvano-Meter; and Kohlransch's Metre Bridges for Alternating Currents." 2. Mr. Walter Baily, "A Speed Indicator." 3. Dr. Guthrie "Eutexia or Lowest Temperatures of Fusion."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Linnean, Burlington-house, W., 3 p.m. Anniversary.

Journal of the Society of Arts.

No. 1,644. Vol. XXXII.

FRIDAY, MAY 23, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Professor W. N. HARTLEY delivered the second lecture of his course on "Fermentation and Distillation," on Monday evening, 19th inst., in which he explained the cause of fermentation and its chemical action, and described the different classes of ferments. He treated of yeast, and showed the characteristic appearances of exhausted and revived yeast. In conclusion, he drew attention to the influence of heat on fermentation.

The lectures will be printed in the *Journal* during the autumn recess.

COMMITTEE ON PHYSICAL EDUCATION.

On the motion of Mr. EDWIN CHADWICK, C.B., the Council of the Society of Arts have appointed a committee to consider the question of the physical training of children in elementary schools.

HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

Proceedings of the Society.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 21, 1884; Dr. CHARLES CAMERON, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Ashworth, Edward, J.P., Staghills, near Waterfoot, Lancashire.
De Salis, Rodolph F., B.A., 1, Westminster-chambers, S.W.
Goolden, Walter T., M.A., 28, Westbourne-park, W.
Talbot, Colonel the Hon. Wellington Patrick M. C., 15, Cromwell-road, S.W.
Theobald, John Wilson, 1, Macaulay-road, Clapham-common, S.W.
Watson, John Cecil, The Rhyddings, Church, Accrington.

The following candidates were balloted for and duly elected members of the Society:—

Flew, John Pearce, Fulham-park-gardens, S.W.
Habershon, Matthew Henry, Eversley, Richmond-road, New Barnet.
Harris, David, Caroline-park, Edinburgh.
Hope, R. C., F.S.A., Albion-crescent, Scarborough.
King, G. Swinburn, 1, Devonshire-terrace, Hyde-park, W.
Phillips, John Orwell, Gas Light and Coke Company, Horseferry-road, S.W.
Pocknell, George, Lonsdale, Exeter.
Shuter, James Legasick, 9, Steele's-road, Haverstock-hill, N.W.
Watson, Thomas Donald, 23, Cross-street, Finsbury, E.C.

The paper read was—

TELEGRAPH TARIFFS.

By COLONEL WEBBER, C.B., R.E.

The subject which your Council has requested me to bring before you this evening, is one that would require far longer than the limited time at our disposal, to permit of its being exhaustively dealt with in all its branches.

As the introduction of the sixpenny rate in our own telegraph service has been so long under discussion, in and out of Parliament, and as a resolution "that the time had arrived for a reduction" was adopted by the House of Commons in March, 1883, and as the Chancellor of the Exchequer has, since that date, been carefully considering the conditions under which the reduction to a sixpenny uniform rate can be brought into force, it is hoped that the public ventilation of the subject within these walls may have the effect of establishing a cheaper rate, in one form or another, at an *earlier date* than is anticipated by the latest official announcements on the subject.

I am in great hopes that officers of the Post-office now present will find themselves in a position to discuss, criticise, or overthrow in fair argument, if they can do so, the propositions which I, as an old brother officer who hopes he has kept up his knowledge of telegraphy and its traffic, am able to lay before you.

In the public interest I shall urge on all who may wish to speak to endeavour to confine their remarks to the very narrow issue which you will find in the outcome of this paper.

To assist the audience in dwelling on the subject, tables are given with some foreign inland rates, and the corresponding value in English money for thirty-two words. Practically our rate of one shilling includes an average of twelve words in the addresses. By the following comparison, the figures of which are only approximate, it will be seen that, with the exception of Belgium, Holland, Switzerland, and Italy, we get most for our money, when it is considered that our free delivery is for one mile, and theirs for one kilometre.

INLAND TARIFFS.

Word rate with a minimum, addresses not free.

	At 32 words in message. s.	d.
France.		
First 10 words, 50 centimes	1	3
Belgium.		
First 15 words, 50 centimes	0	10¾
Each additional 5 words up to first 50, 10 centimes	0	8½
Each additional 10 words up to first 100, 10 centimes	0	4¾
Italy.		
First 15 words, 50 centimes	0	10¾
Each additional word, 5 centimes	0	5¾
Spain.		
First 15 words, 100 centimes	1	9½
Each additional word, 10 centimes	0	1
Local telegrams (half-rates)	0	10¾
Russia.		
First 10 words, 11d.	3	1½
Each additional word, 1d.	0	1
Local telegrams, 8d.	2	3
Holland.		
Surtax, 3d.; Each word in the message, ¼d.; Lowest charge ½ a franc.	0	11½
Switzerland.		
Nearly the same as Holland.		
Portugal.		
Surtax, 25 centimes; Each word in message, 5 centimes	1	6½
Germany.		
Surtax, ·20 marks; Each word, ·05 ,,	1	9
Towns, ·02 ,,	0	8½
Austria and Hungary.		
Surtax, 24 kreutzers, 60 centimes; Each word, 2 ,, 5 ,,	1	10
Towns, 1 ,, 2½ ,,	1	1½
New South Wales.		
Between all stations, except surburban—First ten words, 1s.; Each additional word, 1d.	3	0
Between suburban offices—First ten words, 6d.; Each additional word, 1d.	2	6
Delayed messages—First ten words, 6d.; Each additional word, ½d.	1	6

Some distances to which messages are transmitted at the above rates:—

Sydney to Tenterfield, North	475	miles.
,, Albury, South	386	,,
Tenterfield to Albury	161	,,
Sydney to Hay, S.W.	454	,,
,, Wentworth, S.W.	731	,,
,, Wilcaunia, N.W.	711	,,
,, Menindie, West	830	,,
,, Bourke, N.W.	574	,,

Account of the Nature of the Service Rendered by the Post-office in the Transmission of a Telegram.

The machinery of transmission may be classed as follows:—The offices; the *personnel;* the mechanical means; the electrical means; the porterage.

The public does not probably realise the extent or nature of these means, nor the organisation that is necessary to set them in motion, to keep them at work, to provide supervision, and to utilise these means profitably.

The Office.

Each telegram must pass through two, the forwarding office and the receiving office; often through more than two, having, more frequently, to be *transmitted* at one or more intermediate offices.

The forwarding office requires a counter where the sender writes his message, another where the clerk receives, passes, and prepares it, and a third where the telegraph clerk signals it to the next station on its route. For this operation the white paper Form A is used, and this, the original message, remains the property of the Postmaster-General.

The tariff of this message, as is well known, includes free addresses, one shilling being paid for twenty words; but as this rate increases for every additional five words, the principle is that of a word rate; in fact, it is altogether an empirical tariff. The *postal* feature of it is, that encouragement is given to full addresses. The counter clerk is not saved the labour of counting the words if the message is not written clearly in the spaces provided on the form, or if the four lines are nearly or quite filled. Passing twenty-one words by accident for twenty, and charging 1s. instead of 1s. 3d., would be visited on a clerk by the punishment of fining. If the sender's message is for a place beyond the United Kingdom, the counter clerk must also understand how to charge and deal with it.

The Instrument and its Clerk.

The instrument clerk, or the operator. His knowledge must not only include what may be called the language of telegraphy—meaning the various classifying code signals, which must be sent as well as the message itself—but also the actual art of signalling with the Morse code.

Omitting reference to the use of telephones or alphabetical instruments for signalling purposes, I will only draw your attention to this art, in which the young alone can become really efficient. Few realise its difficulty, and the fact that no one can become a thorough Morse clerk without years of practice. I do not refer to those who are just efficient enough to spell out the words slowly, either in sending or receiving, or who, even when quick at sending, must resort to the use of the printed Morse slip of paper to read, and whose ears have not acquired the wonderful power of reading groups of signals as words, but to those to whom the whole operation of sending and receiving has become a language of the hand and ear.

The Mechanism.

Part of the mechanical means by which the message reaches its destination sometimes consists of a pneumatic tube from the counter to the instrument-room, occasionally worked by a bellows.

The well-known mechanism of the Morse printing key, by which the long and short electrical impulses are communicated to the conductor, the source of energy in the battery, and the insulated conductor starting from the instrument, at first covered with gutta-percha, then crossing house-tops, roads, fields, and rivers, insulated by the air throughout its length, except where carried on insulators at the points of support, and so away to the distant station containing the receiving instrument, are too well known to need description. It is sufficient to give an idea of the value of such a line of communication 100 miles long, to say that if the poles conveying it carry several wires besides, the cost of such a plant is, roughly, not less than £1,300.

The Intermediate and Terminal Offices.

But if the message has not completed its journey on reaching the station at the first 100 miles, the receiving clerk, who has been warned by a special prefix, selects a yellow coloured form (B) in place of a red one, and the message, when taken down, is passed to the clerk working the instrument on the line reaching to the office of destination. Again, similar means, physical, mechanical, and electrical, are brought into use, very slightly varying in operation according to distance, and the message eventually reaches its terminus, to be taken down on a red coloured or C. Form, and duplicated by means of a second sheet with carbon paper between. The original is kept, and the manifold copy sent to the counter clerk in the public office, who, having recorded it, places it in an envelope, addresses it, marks outside the time of despatch, the charge of porterage beyond one mile, and despatches it by a telegraph messenger boy in waiting. The Post-office, it will be seen, preserves at least two, most frequently three, copies of each message that is carried. These copies are eventually brought together and checked in a clearing-house.

Approximate Cost.

The annual cost of the route for the transmission of the message described above may be very roughly computed as follows, excluding the value of adminstration, which it would be difficult for anyone outside the Post-office to assess.

Let us adopt, as an example, the case of three offices, containing, on an average (what would give) five instruments per office; and a route not passing through a first-class central station, the conditions of which are more complicated. Let us also use the simple example of a wire carried on a road line of telegraph, not on a railway line, where the Post-office pays exceptionally high rates for way leave and maintenance.

It works out as follows :—

Share of 3 offices at £20		£60
Share of 2 counter clerks at salaries of £70		30
3 instrument clerks at £50		150
1 boy (less receipts for delivery beyond 1 mile)		14
Share of office superintendence		30
Plant.—Cost of.		
3 instruments and batteries	£60	
200 miles of line	£2,600	
	£2,660	
Interest and depreciation at 7 per cent.		186
Maintenance of road line at 12s. a mile		120
Supervision and sundries		30
Total		£680

This total, after striking off a few for Sundays, represents an average of forty-three shilling messages a day.

At a low rate of speed this work would occupy two hours a day. Probably in practice it would be spread over three or four hours. Thus, taking this example as a mere indication for the guidance of my audience, there remains twenty-one hours out of the twenty-four for this route to earn a profit. As the conditions of no two routes are precisely similar, and as some vary widely from that which has been given you, there is no desire to quote these figures as the basis of any but the most general conclusions. The object in laying this example before you is to give as simply as possibly a general idea of the nature and value of the service rendered.

The Distance Rate.

At the earliest establishment of the electric telegraph, every one connected with it seems to have thought of no other classification of rates except that governed by distance. This was rational enough, as the administration of those early lines was largely in the hands of people who were connected with railway traffic, who at once turned their attention to making each communication pay for itself. While there were comparatively few messages, and any speed greater than that of a railway train was worth paying for, no better mode of charging could be suggested. All the means were expensive, the manipulation, the instruments, and the line, and no acceleration was attempted which increased their cost; hence distance rates commended themselves at once. With three great companies competing before 1870, the mode of charging by distance lent itself effectively to competition. The United Kingdom Company, which started with a uniform shilling rate, was nearly stifled, and had to adopt the distance rate.

Sir James Anderson on the Effect of Reduced Tariffs on Telegraphy.

In 1872, this well-known telegraph manager published a pamphlet on telegraph tariffs. At the time he wrote (1872), it was still under discussion if private undertakings could afford to reduce rates, although the results in Switzerland, Belgium, and the United Kingdom gave ample proof that judicious reduction gives splendid results. His conclusion was that the highest return upon the capital invested is obtained from a high tariff, and that competition would always check the extension of unproductive facilities to the public. Hence he believed that a monopoly was essential to the creation of a system which would be self-supporting, for the benefit of the public. We know that Mr. Scudamore never shared that belief with the Government of the day which obtained it from the House of Commons, and we know how that monopoly acted fatally in checking the reduction of tariff in this country (long since overdue), by inflating the capital account of the business.

Sir James Anderson goes carefully into the reports from Belgium, and shows how the conditions of the *international* differ from those of the *internal* traffic. He eliminates from actual returns the abnormal stimulus of increased facilities, and discovers a normal rate of progression in the fourteen years with which he deals, of 12½ per cent., which being independent of increased plant, is a measure of the clear natural increment. He then obtains a comparison between the rate of progression of expenses and that of the abnormal augmentation of correspondence. With each of these figures he endeavours to show the large amount of profit sacrificed by lowering the tariff. His contention that the results of the working of *international* service in Belgium, on which reductions of tariff to the same extent did not take place, at first covered a deficit on the *internal* traffic, seems to be proved, and makes us cautious in accepting the Belgium figures of those days in their entirety.

There is one point which I wish you to consider, which is that Sir James's personal experience was more built on the service of great arterial communications than on a network system. From this point of view, a word rate, subject to distance, would be most rational. Cables have a different capacity. If there is but one communication, nothing can prevent delay on messages. For example, if the offices at both ends are clear of message work at 9 a.m., and messages at the rate of twenty an hour be handed in by the public up till twelve o'clock, and the cable can only carry ten an hour, it is plain that the message handed in just before noon cannot be sent on till three o'clock, bearing with it three hours' delay in comparison with the message handed in at 9 a.m. Acceleration, therefore, in the first instance, would have little affect on the calculations of a tariff for such a line.

Competition, as between the United Kingdom and America, immediately gives rise to the obligation to accelerate by duplication of the cable. The rate founded on distance, or in other words, on outlay, then becomes subordinate to time, and the application of that coefficient becomes a source of expense, showing that acceleration raises working cost.

The converse of this receives illustration in the Proceedings of the Select Committee of the House of Commons in 1868 on the Electric Telegraphs Bill. In the Appendix to the Report, No. I., page 8, there is a quotation of the view then held in Belgium by the Director of Telegraphs. He points out "that in fixing lower rates the Government by no means assured the same facilities to the public." They were told that—

"They must not consider the half-franc telegrams would assure them either speed or accuracy. The message at the reduced rate should be considered as one that would be conveyed at about the speed of a railway train. If the public require acceleration they must not rely on the half-franc message. For extra speed, or preference, or an 'express message' two higher rates must be used."

No really important sacrifice of speed was contemplated, for in the same report he claims for Belgium, then, a higher mean speed than in any other country; in fact, he made the ordinary message third class, and accelerated messages, for which more was paid, as second and first class messages.

The Telegraph Circuit, and its Working Conditions.

The term circuit, as many of those present know, is a telegraphic expression, intended to describe the popularly understood path, between the terminal offices of the electric current in the one direction by the wire, in the other or return direction through the earth. A completely equipped circuit must include the operators.

The conditions under which a telegraphic circuit is worked vary considerably in one country, and between countries. Some of these conditions may be described briefly, for instance, as regards the services of operators. They may be highly skilled male clerks, able to work at high speed for many hours at a stretch, possessing great readiness of resource; equally skilled female clerks, but with less physical capacity for endurance, and less resource in difficulties; clerks who, in addition, understand the simple maintenance of the instruments and batteries; others who require more or less the assistance of skilled maintenance men; clerks who are mere learners, or who have only experience acquired on needle instruments; others in country post-offices, who are members of the postmaster's family, and occasionally his aged wife, or youthful grandchild.

In the United Kingdom there is a considerable variety of instruments in use, partly due to the original acquisition by the Post-office of the plant of various companies, and partly to the varying powers of the operators that have been mentioned.

I am indebted to my friend Mr. Preece for an approximate list of the number of instruments of each kind in use in the postal telegraphs, exclusive of telephones.

Wheatstone A B C instruments	4,183
Needle instruments	3,883
Morse recording instruments	1,107
Morse sounder instruments	1,712
Morse recording instrument, worked duplex	283
Morse sounder instrument, worked duplex	357
Quadruplex, worked with sounders ..	27
Wheatstone automatic	173
Wheatstone automatic, worked duplex	64

Besides, there are conditions of speed of minor importance to the subject before us, and also conditions of maintenance of the lines due to weather, which are certainly different in a mild and moist, to those in a rigorous or dry climate.

Lastly, there are conditions of supervision and superintendence, which are most evident to those who have been engaged in the operations of the service. It may be said that, in common with kindred operations, efficiency of service and remunerative results largely depend on these. A telegraph system such as ours is a huge machine, working day and night, stretching over a vast area, dependent on varying local circumstances, and yet subject to one general code of laws, rigid and yet elastic in their imposition. With nothing else that I know of can it be so well compared as the nervous system as described by Herbert Spencer. It is the most perfect example of centralisation, tempered by decentralisation, the balance between them being preserved exactly as the administrators are guided by the indications of demand and supply. And the more I have studied the subject, the more it has struck me that only where the administrators have strained the application of natural laws, there only has the service failed to extract the maximum of possible result.

The superintendents of this beautiful machine must have an intimate acquaintance, not only with the best possible work obtainable from the means used, both human and material, but also with the thousand militating occurrences to which every part of it is liable; so that, while always striving for excellence, too much shall not be demanded, and waste arise in the opposite direction.

That this supervision has been well guided, experience proves. And I will endeavour to show you that the success of the ultimate objects for which it is contending, namely, producing efficiency of service for the public, must all turn on the proper understanding and use of one co-efficient, namely, *time*. That the measure of cost and of accuracy must be subordinate to the expenditure of *time*.

Those who have been engaged in this supervision, and who have had to investigate complaints about accuracy or delay, will be the first to acknowledge that the ultimate conclusion of their research had been chiefly governed by the condition of *time;* if any improvement in the future is to be reaped, it will be through tracing the fault, whether physical, mechanical, or electrical, home to its true cause.

The Capacity of a Circuit.

Like other machines, a telegraph circuit has a measurable capacity for work. As in the case of a line of railway, it can carry traffic continuously, subject to working conditions of speed and safety, service and maintenance. Railway managers could give you many examples of lines worked fully up to their maximum capacity, even verging on the insecure, and they would add that out of the needs of the public have arisen classifications of traffic, namely, into various speeds, that some lines have to be devoted entirely to high speed, other to slow speed traffic, and that from some lines the maximum result of capacity is obtained by working both, confining each to different periods of the 24 hours.

We can all understand that in few cases will practice attain the theoretical capacity of a line worked with trains following one another, travelling at equal speeds, and with safe intervals, and equally we can understand that the best commercial result will be obtained by the manager who best adopts and dovetails all the means at his disposal to meet the demands of his customers.

Again, we can all clearly appreciate that traffic itself is subject to classification in its varieties. Thus with passenger traffic: it can be subdivided according as persons are ready, from various motives, to pay for various rates of speed. Similarly with the carriage of live animals, and perishable and imperishable goods. But while the powers of the railway manager to meet these demands in equal variety are limited, it is undoubtedly the case that the first object is to do so, especially when under the pressure of competition.

Telegraph Traffic Commercially Worked.

Now, to a much smaller degree, telegraphic traffic is subject to the same influences, if its management is truly commercial in its instincts. In using the word "commercial," I ask my audience to admit that in whatever way we regard the service of the public by a Department of the State, the word "commercial" equally applies whether the system is worked at a loss, or without loss, or at a profit. Whatever the result, "commercial" working will mean working on a basis. First, of extending telegraphic facilities to every point to which private undertakings would extend it under the influence of competition. Second, of working on sound economical principles.

It is true that when the State first took over the telegraph companies' business, many of the early extensions were very uncommercial, but this was a weakness from the effects of which fifteen years working has long ago recovered, and which for many years has been counteracted by the exactions from localities of guarantees to cover at least working expenses, before extensions are permitted.

If true commercial instinct is to be exercised in the management of our telegraphy, it would appear that, somewhat in the way I am attempting to describe, every circuit should be used in such a way as to obtain from its use the maximum gross revenue. As for all other kinds of means of transport there is a market; the commercial instinct seeks the market and developes it, which means organising a system which will extract from it all that can be gained. Thus Pickford, Chaplin and Horne, in England, and Bianconi in Ireland, created a business; if the demand had not been latent, they could not have made it pay.

A Department of the State serving the public, if the object is not to pay, should obtain still better results. If it is seeking to bring revenue into the Exchequer, it ought to produce quite as good results, with several advantages which no private undertaking can have.

Development of the Postal Telegraphs.

Let us inquire for a moment how far the Post-office has developed the latent telegraph business in the country. They carry, say, 26,000,000 of telegrams, as against 8,000,000 before 1870 carried by the companies. This marvellous result has been obtained, working on almost precisely the same main lines as when the Government first took the telegraphs in hand.

Those broad lines have been a maximum of speed at a nominally uniform charge; and, without considering the lessening of speed due to the means, which, for economy of working, have been adopted in circuits of least importance, doubtless the highest results possible under those conditions have been obtained.

The question then remains—Has the rigid adherence of these main lines of procedure obscured their vision, and prevented their discovering outlying regions of profit waiting to be reaped, greatly to the advantage of the public, and to the increase of revenue on the lowering of rates? Ought we, out of pure gratitude for what has been done, to shut our eyes to this inquiry, and decline to allow that the Post-office may err, or have its vision narrowed within the range of the great reservoir of custom, which it has not only tapped exhaustively, but also developed in size?

The Society of Arts, years ago in the van of the movement which led to the acquisition of the telegraphs by the State, and always ready to place its arena at the disposal of the public for discussion, ensures, by its countenance of such an investigation as this, that it will be treated in the fairest spirit, and that every question or objection shall have the most serious consideration.

Possible and Actual Capacity of Existing Circuits.

Let us look at the possible capacity of the instruments of which I have already given a list.

	Messages per annum.
A Wheatstone A B C instrument has an hourly capacity for 34 word messages of 15, or in 12 hours of 180. This, for 2,092 instruments for 310 days, gives a total of	116,705,700
A needle instrument has an hourly capacity for 25 messages of 34 words each, or in 12 hours of 300 messages. This for 1,942 instruments in use gives for 310 days..	180,559,500
	297,265,200

The figures are so enormous, and representative of nothing within the range of probability, that it is only necessary to mention the gross receipts at a shilling a message would amount to £14,863,260.

In actual practice these instruments, at a very low estimate, probably forward on an average—

Every 2 A B C instruments, 6 } messages a day.
,, 2 needle ,, 10 }

		Per annum.
Representing—	A B C	3,891,120
	Needle	6,018,200
	Total....	9,909,320

Which, at one shilling, amounts to £495,466, or 1-29th of the possible capacity.

The same calculation applied to the Morse recorders and sounders, allowing them a message of 34 words capacity of 30 and 35 respectively, gives a possible capacity representing £8,663,880; and this in actual practice, allowing 20 messages a day for recorders, and 25 for sounders, amounts to £513,440, or 1-17th of the possible capacity.

These figures, however approximate in their accuracy, are sufficiently based on fact to convince you that there is a very large margin of time during each day when circuits are idle, and when the mechanical and electrical machinery is at a stand-still.

Utilisation of Spare Capacity.

The question immediately arises how to utilise a portion of it. I have only dealt with twelve out of the twenty-four hours. The Post-office already utilises a proportion of the remainder of the twenty-four hours on many circuits, by working them for press messages, at rates so unremunerative that it is doubtful if they pay for the actual manipulation. I have only dealt with twelve hours of the twenty-four because all offices are already open during that time, and in offices with one instrument only, a manipulator is always present. This manipulator, I have assumed, now deals with 6, 10, 20, or 25 messages a day, according to the class of office and instrument. If he worked away steadily for eight of the twelve hours he would deal with 120, 200, 240, and 280 messages. It is not straining this demand on his or her powers to expect that half those numbers could be dealt with without increasing the labour staff. Again, in offices with two or more instruments, periods occur daily when neither instruments nor clerks are fully occupied. The larger the offices, the fewer or less frequent are these periods, for the following reason :—Although an office may open at 7 a.m. and not close till 9 p.m., the time during which all the instruments are at work, is probably limited to between 11 a.m. and 3 p.m., then all the clerks are hard at work. For about two hours before and after those hours but half the clerks need be present, probably early and late, only one or two are wanted. Thus, by judicious dovetailing of the hours of work of each operator, the full time of each is fairly occupied throughout most of his working hours. In the largest offices this can be carried out with great perfection, but in the vast majority of medium-size offices there exists a margin of available labour which can only be adjusted by having too small an establishment of clerks. Its effect is a certain delay in every message during the busiest hours, and the accomplishment of work during times of slight abnormal pressure of business, by allowing the operators to work *overtime*.

High Standard of Time aimed at in Postal Telegraphs.

Fortunately for the public, and the well-earned and maintained credit for speed won by our postal telegraphs, the Department has always aimed at accomplishing what is highly creditable, and unequalled in most other countries, namely, that a message is considered to be delayed when the time taken to deal with it in any one office exceeds ten minutes.

Now, this is a very high standard to aim at, and it can only be maintained, in all but the largest offices, by a redundancy of the manipulating staff, so that the very effort to serve the public will, in the matter of time, necessarily result in a margin of unutilised labour, as well as of mechanical and electrical means.

I know that post-masters exercise great judgment in applying spare telegraphic labour to postal work, and *vice versâ*, but there must still remain hours during which some labour is still available to work the machinery lying idle under its hand.

But where are the messages which will require transmission ? My answer is, they will be forthcoming by a lowering of rates, when accepted on the understanding that they are to be sent during those periods that the machinery is now idle. The history of all telegraphs places it beyond discussion that every lowering of rates of any kind produces increased traffic of one kind or another.

If the increase proves to be greater than can be dealt with by the margin of labour I claim to exist, then additional labour and working expenses at cost price must be added. I believe that 1½d. per message in each office which deals with it, will amply suffice.

If the demand exists for cheap telegraphy under conditions of speed less than those now aimed at by the Post Office, why not supply it ? Why give the public a uniform speed on all messages ? Is it not rational to suppose that these are messages which will fulfil their purpose equally well in the mind of the sender if delivered in three or four hours after being handed in ? Does it not at once appear evident that the elimination of every fresh message, now sent in its code turn with the most pressing messages, will add to the punctuality of the latter ? Whether we call the first messages express, or the slow-speed messages, deferred, does not matter. Does not a classification of this kind coincide with the fundamental law of the government by time of all the conditions of telegraphic supply and demand ? If we analyse the means used in telegraphy for increasing speed, we find that it is entirely a question of cost.

Cause of Delay.

If a message is handed in at an office between 11 and 11.5 with six others, including counter work, the first of the seven is completed in, say three minutes, the next in three minutes more, and so on, the seventh message will have accumulated over sixteen minutes delay on reaching the transmitting stations. Here other delays may occur, and while the first is got through within ten or twelve minutes, the fifth is not ready for delivery for more than half an-hour after receipt.

All delays of such a kind can be lessened by increasing means, duplexing wires, doubling the operators, and so on. The greatest speed of a Wheatstone automatic circuit is achieved by costly apparatus and unlimited labour at each end of the wire. Increasing the wire, accommodation may have to be resorted to to keep down delay when all other means fail. Is it not a much simpler experiment, to save expenditure and maintain speed, to offer the public inducements, by cheaper rates for less speed, to select of its own accord the slower route, when first-class speed is not essential? If the only gain were to reduce the work during the busiest hours of the day, and confine it to the supply of the demand for higher speed, the result would justify the change. When it also means the occupation of circuits, where otherwise they would be comparatively idle, by work eminently not suffering from such delay, through the selection of the customers, there would appear to be a large balance of evidence in its favour. But if, also, the cheaper rate taps a reserve of message-sending not now sounded, and if the increase of traffic of this character largely exceeds the loss on the messages for which the cheaper means have been selected by customers in preference to the old rate, surely this increased efficiency of the fast service, and the added facility to the public of the slower service, would alone more than prove the soundness of such a measure.

Dr. Playfair's Committee.

I will now refer my hearers to a paper laid by me in evidence before Sir Lyon Playfair's Committee of the House of Commons, in 1876, suggestive of a scheme of "deferred" or "second-class" messages, and descriptive of the means by which I proposed to bring it into force. This had been the result of several years of constant observance of the daily working of the system in the district of which I was the divisional engineeer, and of careful inquiry amongst all the persons in that district upon whom would fall the labour of bringing it into force. I was not met by one dissentient as to the practicability of the proposal. If I ever encountered objections, they were derived from the experience of the great central stations, where slackness of work is never apparent.

I claimed, in 1876, no novelty for the proposal except that its essential feature was its perfect adaptability to the postal telegraph system. It claimed to tap a new source of revenue without materially diverting existing channels, and to utilise existing spare means with little change. It designs to leave the one shilling message alone with its existing conditions and facilities, and that the Post-office should accept a new kind of *petite vitesse* message, and forward it under certain conditions for sixpence. This message, if thought well, might be called "second-class" or "deferred." The main condition of transmission of the messages to be, that no second-class is forwarded while a first-class message is on hand. The effect of this would be:—

1. That the 1s. message would remain as it is (subject to alterations as to payment of sender's address).

2. In practice, the second-class messages would only experience serious delay in busy offices, on busy lines, during busy hours.

3. Local telegraphing in country districts and towns would be developed; and circuits now only occupied with a dozen messages a day at 1s. would probably lose half these, but carry twenty or thirty at 6d., when it was found that on local traffic no real delay occurred by using the lower class.

4. It was suggested that this class of message should include only ten words, and that free delivery should be only for half a mile, and the second half-mile be charged 3d.; but there is no reason why the delivery should not remain as it is for 1s. messages.

5. It was foreseen that the public might at first adopt more largely the use of second-class messages than the revenue could bear, but it was pointed out that as soon as those who did so found their messages suffer in speed, they would revert to the shilling rate, with the greater satisfaction of obtaining a somewhat accelerated service for their money.

The working was provided for by distinguishing second-class message of forms by a different tint, or by strongly marked black bands, or by large figures.

At the instrument it was proposed that second-class messages should be placed at the bottom of those lying before the operator, below the first-class ones, and as long as any of the latter were waiting to be sent, to allow the former to accumulate. But immediately a clerk had "got off" all his first-class, he was to go on with the second-class till a fresh first-class reached him.

A Table is exhibited showing the number of words that would be transmitted under the two rates. It will be seen, assuming that a wire carries on an average twenty words a minute, it could earn 6d. a minute at the second rate.

First Class.				Second Class.			
Estimated words in address.	Words in message.	Total.	Charge.	Estimated words in address.	Words in message.	Total.	Charge.
			s. d.				s. d.
12	20	32	1 0	12	10	22	0 6
12	25	37	1 3	12	20	32	0 9
12	30	42	1 6	12	30	42	1 0
12	35	47	1 9	12	40	52	1 3
12	40	52	2 0	12	50	62	1 6
12	45	57	2 3	—	—	—	—
12	50	62	2 6	—	—	—	—

The report of the House of Commons Committee referred to this in the following terms:—

"The essence of this plan is that in small localities telegrams would be largely multiplied, and that wires which now remain comparatively idle for a considerable portion of the day would have fuller and more evenly distributed work. This proposal has the merit of not disturbing the ordinary 1s. messages, and offers cheaper rates for such as can be delayed with a minimum dislocation of the present system. There is no greater disturbance of uniformity in this plan than in the various changes of the postal system, in which higher rates are charged for greater facilities."

The Postmaster-General's Opinion on Deferred Messages.

On 23rd July, 1880, Mr. Fawcett expressed himself adverse to the proposal, when replying to a deputation of this Society, in the following terms, thus:—

"There has been another suggestion made which I think it well to refer to, as I believe it has been discussed in public, that you should have two rates of charge; what are known as 'deferred' telegrams, charged at cheaper rates. For instance, those persons who go to a City telegraph office and pay 1s. for a telegram, should have it sent off at once; those persons paying sixpence, should have their telegrams sent off when all the shilling telegrams have been got rid of. So far as I am concerned, I never could sanction such a scheme as that. It seems to me to have this fatal blemish, that it would always impress the public with a sense of unfairness, and every person who did not get his telegram sent off, or receive it so quickly as he expected, would think the delay was owing to a preference given to a more influential or wealthy sender. It seems to me a principle of cardinal importance to maintain that there should be no distinction of persons—no distinctions with regard to preference—but that, as regards the first person who goes into a telegraph office, that the office should send his message first. If any departure is made from this principle, I am afraid that all confidence in the fairness of the telegraph service would be removed."

It is with the greatest deference to his wisdom and position, that I venture to ask the meeting to consider, for one moment, the Postmaster-General's objections to establishing two classes of speed, for two rates of payment, for the carriage of telegrams.

How far his reply was satisfactory to the deputation from this Society I cannot say, but you will not be surprised if I ask you all not to feel in any way satisfied with it.

The Postmaster-General recognises none of the financial and commercial advantages of the plan; he offers no objections to it on account of any difficulty in working; it he simply adopts what I may call an eminently postal view of it. When I call it by that name, I mean that it is one of the oldest forms of answer employed by the Post-office, when pressed from the outside to make any changes not originating within its own walls, namely, to say that the public would not like any change. This well-known objection has been in its time used against the Post-office Savings Bank, Insurance, and Parcel Post, prior to the birth of each, and their greatest opponents dwelt within the walls of St. Martin's-le-Grand. However, like all sound schemes, after an interval in each case, the wisdom which predominates within that world-famed establishment weighed down the scale, and the boon was granted.

I must say that I am too great a believer in the soundness of Mr. Fawcett's own teaching, to believe that he really thinks the public will object to two kinds of telegrams, more than they object to two classes of railway carriages or trains.

They do not object to the different speeds in book and parcel post. They are quite able to understand paying differently for different speeds, and when the payment and selection is in their own hands, where is the reasonable suspicion of preference or unfairness?

Uniform rates possess a fascination for some people, but what has become of the uniform rates within the Post Office itself? Is not its uniformity subject to the co-efficient of weight for letters, and number of words for telegrams? Why not try the time rate?

It is true the British public has been educated by the postal telegraph system, on unsound principles, to know nothing about the costliness of speed in respect of telegrams, and they mostly believe that the value of the service rendered is measurable by the number of words. But is it ever too late to restore the British mind to a healthy state on any subject?

In Belgium the value of acceleration in the transmission of letters is recognised as having a distinct value, and facilities are given by which letters can be sent from place to place in less time than is occupied by the ordinary post. By writing the word "express" conspicuously on the envelope, and attaching an additional stamp of the value of 25 centimes to a letter bearing a 10 centime stamp, the sender secures preference for his letter over others, and it is sent to its destination by the quickest means. For instance, an "express" letter is sent by the next train leaving the place of collection by the Post-office, and is delivered at the other end of its journey by a special messenger. We do not hear that the Belgians look upon this as conducive to unfairness, or as giving the rich a preference over the poor man.

One word more about the uniformity of rate question. There is a good deal about it in the proceedings of the House of Commons Committee, on the Electric Bill of 1868; and it is frequently alluded to in the examinations of the late Mr. Scudamore; also of Messrs. Harrison and Patterson, and of Professor Jevons.

I am led to think, by a careful perusal of their evidence, that the uniformity they were advocating was, as against what they called, the irregularity and even "injustice" of the old companies; and that the uniformity to which there has since been a tendency to wed us is an exaggeration and distortion of their views.

Mr. Scudamore speaks of the advantage of uniformity of rate, as "permitting the use of stamps," and as "simplifying telegraphy." He evidently alludes to the complications of the existing distance tariff, for later on, he approves of the twenty word message at 1s. and to the fifteen word message at 6d., with a 1d. added for five words additional.

Again, uniformity was advocated by several witnesses as a necessary consequence on obtaining from Parliament a monopoly for the Post-office; but Professor W. S. Jevons considered that the "sounder" principle was to arrange rates so that each communication should more or less pay for itself, and he expressly stated that he did not advocate a monopoly, and would rather re-arrange rates than protect the sytem in that way.

All the witnesses referred to the success of the uniform rate for postage, and examples were given. How, in some cases, the actual cost of the transport of letters to the Post-office was 2d. and 3d., in others only ½d., as a justification for doing away with the distance tariff, then in existence, of 1s. for 100 miles, 1s. 6d. 200 miles, and so on. Looking back on these records, it looks as if the dislike to the existing tariffs, more than a real similarity between telegraph and postal work, weighed most with the advocates of a uniform word-rate under all conditions (amongst whom Mr. Goschen was prominent).

Lastly, all the witnesses who spoke on the subject had then had no practical experience of the working of telegraphs. The difficulties which influenced their minds have long since disappeared, and exceptional alterations in tariff have been introduced into the postal Telegraph Service without observation. The caution which is slow in adopting alterations as improvements, cannot be too much admired; but it is well known that the backwardness of public Departments in this respect is more due to the inertia which "rests and is thankful," to the instinct of heavily worked officials to retard the introduction of thankless reforms, and to the deadening effect of official routine, which nips in the bud the energy of most of the men who, in other walks, would be in the van of advancement.

The Indian Telegraph Department.

Although administered under several essentially different conditions, its working and procedure as regards tariffs will interest the audience. One or two great differences are worth bearing in mind. The telegraph in India is esentially a European service, and English is used; it cannot yet be said to be in use by the millions of our fellow subjects in that country. It is much used by the State and by local governments, the numbers in 1882-3 of State messages to private having been as 247,000 to 1,103,688. The distances in India being very great, a telegram often takes the place of a letter. As regards a very large proportion of the traffic, time is of less importance than here, distance is a more influential condition.

Founded on the experience of a far longer period of State control than this country has enjoyed, we find the Government of India expressing itself in November, 1881, as "willing and anxious to forward any scheme for developing and facilitating communication by telegraph, so for as this can be done without risk to the interest of the general tax-paying community; but in the interest of that community it is esential that the telegraph service should be self-supporting."

In pursuance of this object, we find that the Government approved on that date of a scheme for the "revision of the tariff, which, affording room for a very considerable future reduction in rates, will admit of a large expansion of the traffic without necessitating additional expenditure on increasing the number of the wires. The main feature of this scheme consists in the introduction of arrangements which will permit of the disposal of message traffic in order of urgency. instead of, as at present, in order of presentation of messages. The minute in Council recognises that in the case of commercial and State telegrams, almost the whole are tendered for transmission during the business hours of the day, the result being a great pressure of work for a few hours, while for the rest of the day and night the wires are comparatively idle."

As the "telegraph officials cannot be the judges of the comparative urgency of messages," it authorises the "Director-General to introduce, in addition to the 'ordinary' class of messages, two other classes, 'deferred' and 'urgent;'" the latter taking priority, and the former following the ordinary, when they have been worked out, the rates being:—

	Rs.	
Urgent	2	With free address.
Ordinary	1	
Deferred	½	

His Excellency the Governor-General in Council "believes that the introduction of the deferred message system . . . . will prove a very great convenience to the public in improving the service for transmission of really urgent messages, and will enable a large reduction in average cost of telegraphing to be made, owing to the facilities it would give for utilising the wires for a greater proportion of the twenty-four hours than is possible under the present system."

The special suitability of the deferred system to the long distances in India is exemplified by the condition that the Department does not bind itself to deliver these messages at their destination before early the following morning.

Although the nature of traffic thus provided for in India, would largely be carried by the post in this country, it is vital evidence to the existence of unearned revenue and undeveloped public facility, that the system of "deferred" messages has been adopted in our great dependency.

The Departmental Report for 1882-83, gives the total per-centage of each class of inland messages, dealt with in the last two years, as follows:—

STATE MESSAGES.

	1881-82.	1882-83.
Local	0·65	1·04
Deferred	62·70	56·06
Ordinary	7·12	11·10
Urgent	29·53	31·80

PRIVATE MESSAGES.

	1881-82.	1882-83.
Local	0·43	0·64
Deferred	22·03	32·06
Ordinary	72·64	60·90
Urgent	4·90	6·40

The large increase in the last year of private deferred messages over ordinary, shows the popularity of the former class. The value of the inland traffic in the above two years, and in the previous two, before the new system was introduced, shows great encouragement, viz., under private messages.

	Number.	Value Rs.
1879-80	1,037,330	15,32,153
1880-81	1,044,107	14,08,582
1881-82	1,035,137	13,16,851
1882-83	1,189,437	13,86,630

The increase in wire mileage between the last two years was as 58,219 to 61,184.

DISCUSSION.

The CHAIRMAN said he had much pleasure in presiding on this occasion, because the Society had done good work in the matter of telegraph reform; it pressed the acquisition of the system by the State, and advocated very powerfully the adoption of sixpenny telegrams. He was a member of the committee to which Colonel Webber had referred, and he remembered the difficulty which was found in getting evidence in favour of telegraph reforms. The system was not then paying, and the Treasury proposed to increase the charges for press messages, to add an extra 6d. for Sunday and night messages, and an extra 3d. for those handed in at railway stations. On the committee, he opposed the Treasury, and found great difficulty in getting witnesses to support him. At that time the Post-office was against any increase of facilities, and said that deferred messages could not be introduced with any hope of success. Colonel Webber was then the telegraph officer in charge of the one district in England which was managed by the Royal Engineers; he was free from departmental trammels, and came forward with the courage of his profession, and gave most valuable evidence. They were now within a measurable distance of sixpenny telegrams, the House of Commons having passed a resolution in favour of such a change, but he did not think that had any direct bearing on the question of deferred messages. The public had been educated to look for despatch, and the Post-office was preparing to lay out £500,000, to increase the wire accommodation on the main lines, which were at present most busily occupied; so that the increased number of messages which were expected to arise from the reduction to 6d. must be dealt with without any deterioration in speed. This would leave them in the same position as at present, with the wires lying idle for the same proportion of time. There were some six thousand telegraph offices in the kingdom, and the total number of messages gave an average of only about fourteen per day to each office. Now, a very second-class instrument and operator would send off fourteen messages in a little over half an hour, so that the telegraph offices, on the average, were doing half an hour's work per day each. That seemed to show that there was a large field open for deferred messages, and he did not see why, after the 6d. rate had been introduced, deferred messages might not be taken at a further reduction. He looked upon the 6d. telegram as simply the commencement of reforms which would at last place them far ahead of any other country in this respect. They were already in that position with regard to Press telegrams. Mr. Saunders pressed the committee which sat to consider the acquirement of the telegraphs by the State very much on that point, and, the Government being then very squeezable, he obtained such good terms that press messages were sent at the rate of 1s. for 100 words to one address, and 2d. extra for every additional address. Thus, a message could be sent to 100 newspapers at a cost of 2d. each, and $\frac{1}{100}$ of a shilling for the original. It was at one time proposed to raise the press tariff, but the Committee of 1876 at once put its foot down on any such proposal. Several schemes for the 6d. telegram were put forward; one, 12 words for 6d., and $\frac{1}{2}$d. for every word afterwards, including the address; another, that the address of the receiver should be free, with a $\frac{1}{2}$d. per word, and a minimum charge of 6d; and a third, that the address of both sender and receiver should be free, with a scale of $\frac{1}{2}$d. per word for the message, and a minimum of 6d. On the whole, he should prefer the second, which he thought would be an excellent plan for the public. But even then they need not consider that as final. If with a 1s. rate deferred messages could be sent for 6d., he did not see why, with a 6d. rate, a deferred message should not be taken at 3d. or 4d., or longer messages for 6d. Again, it had been suggested by the postmaster of Glasgow that, in many instances, persons in the country who wanted to come to London on business, could transact their business quite as well if they were allowed the use of a wire for an hour, with an operator at each end, at a specified chaage—say £5 from Glasgow to London. In many cases that would be a great convenience; and of course the wire would be only used in such a way at a time when it would otherwise be idle; so that the only cost incurred would be a few shillings for the clerks. Another suggestion was for an increased use of pneumatic tubes. In Paris, this system had been developed to a large extent, there being two classes of pneumatic telegrams—the card, and the closed telegram; the charge for the former was 2$\frac{1}{2}$d.; it could be handed in at any office, and was despatched by pneumatic tube to its destination; the other was practically a letter, which was sent in the same way at double the charge. It might be said that this was a slow method, but the greater the variety of accommodation offered to the public the better. There seemed to him to be no substance whatever in Mr. Fawcett's objections to different rates; there were already differences in the Post-office charges—different rates for letters, books, and parcels, and also for expediting letters, late letters being sent on if they bore an extra stamp, while others, posted at the same time, were delayed. Service telegrams, again, were expedited, and so were Government messages, and very properly. He had seen so much accomplished in the way of telegraphy, that he hardly despaired of anything, and he thought these Government experiments ought not to be regarded from too narrow a commercial standpoint. If narrow views had prevailed at the outset, the public would never have had the telegraphic service; in the same way the sixpenny telegrams might cost something at first, but he believed any loss would soon be made up. He agreed with Jeremy Bentham, that the Minister of Public Communications was one of the most important ministers in the country, and that his operations should be carried on with a view to the convenience of the public, rather than with an eye to making as many pence as he could.

Mr. MATHEW, as an old military officer who had considerable experience in India, had been very much pleased with the paper. He did not think cheap telegrams need necessarily be slow, but the highest profit to the public, and the greatest benefit to the country, would be obtained by the lowest possible rates.

Mr. WM. SAUNDERS said the observations of Colonel Webber were so eminently sensible that it was very difficult to criticise them. He had said all that could be said, and as well as it could be said, in favour of his proposal, and he (Mr. Saunders) certainly had no wish to say anything on the other side. He must, however, first refer to two instances in which the system of deferred telegrams at a cheaper rate was found to work well. The first was that of Press messages between England and the United States, which were taken at one-fourth the ordinary rate, subject to being sent when the wires were at liberty. That enabled a large amount of communication to take place between the two countries which would otherwise be impossible. Again, in the United States there had been for many years a system of half-rates after six in the evening. That was of great importance there, because in some cases the postal system extended over a period of several days, and commercial men found it an immense advantage to be able to send a telegram in the evening instead of of waiting for the post. In England, night messages would not be so useful, but Colonel Webber's proposition of receiving deferred messages, to be sent on whenever the wires were unoccupied, would exactly meet the case. It scarcely meant slow traffic; it simply meant distributed traffic, and those who wished to take advantage of the cheap rate would simply have to ascertain the time when the wires would be free from pressure. It was quite certain that the adoption of this system would tend to prevent the delay of urgent messages, which now often arose from the pressure of unimportant work. With regard to press messages, he noticed that Colonel Webber had omitted reading one paragraph in the paper where he said it was doubtful whether those messages paid. If they did not it was not because the messages were not profitable, but because they were limited to one class of the community instead of being extended to the whole. Press messages were only sent to newspapers, clubs, and newsrooms; but if they were also sent to private persons, a large profit would be made. Perhaps a thousand persons wished to know the result of the Oxford and Cambridge boat race. To send a separate message to each one involved the transmission of about 15,000 words, whereas if it were done in the same way as press messages were carried, viz., if all who wished to receive the result were placed on a list at the Post-office, and their addresses given to the various post-offices from which the message had to be delivered, about ten words only would have to be transmitted instead of 15,000. The addresses being prepared beforehand, they would only have to send from Mortlake, "No. 7"—which would represent the list, —"Cambridge has won;" and the Government would receive for sending those five words a thousand two-pences. Now they would receive a thousand shillings, but they had an immense deal of work to do to earn it. Every item of important general news might be treated in the same way, and he thought this was a species of economy in telegraphic work which was well worth attention.

Mr. Graves remarked that Col. Webber, in inviting officers of the Post-office to express their opinions on this question, had apparently overlooked the necessity they were under of being reticent. The matter was now under the consideration of the Post-office authorities, and he could not separate his personality from his official position, because, if he expressed his own individual views, he might be understood to be indicating the official opinion. He should have much liked to express his assent to, or dissent from, many of the propositions Colonel Webber had advanced; but the remarks which had fallen from the chairman and Mr. Saunders showed him that the subject branched out into so wide a field, and covered so many controversial points, that he had better remain silent. He might, however, say that he was quite certain the Postmaster-General had no other wish than to introduce as low a tariff as possible for the convenience of the public, provided it did not throw a burden on the general body of tax-payers.

Mr. Walter Hancock, although he had for many years been connected with one branch of telegraphy, must admit that the paper had opened up a number of points which had never occurred to his mind; and it certainly was very rich in suggestions for the improvement of the telegraph system. The main point, no doubt, was that of deferred messages, and he thought there were very many who would prefer a cheaper message, even with some delay, whilst others would always prefer to pay the full rate, or even something extra, for the sake o expedition. Again, much labour would be saved by shorter messages, which, in many cases, would answer every purpose. They had been accustomed to a uniform rate on account of the postal system, but in telegraphy the same conditions did not apply.

Mr. Alexander Siemens said he should welcome 6d. telegrams, of course, but there were some points which seemed to have been overlooked. Who were the people who telegraphed, and what was their object? In most cases it was expedition. They could not compare England with India, or with the United States, where the distances were so great that a letter took several days, and a deferred telegram, which took only a night, would ensure a great saving of time. In England, a letter was delivered the next morning at almost all the important towns, and a deferred telegram would possess no advantage. It seemed to him that the present charge could not be reduced without causing a deficit, because more wires would have to be employed. The chief telegraphic traffic was between business firms, who wanted speed above all things; and if with a 1s. telegram they could ensure speed, and for 6d. they had to take their chance, no man of business would adopt them. Other people only used the telegraph occasionally, and a reduction to 6d. would not much affect them. It seemed to him, therefore, that cheaper telegrams meant either delay or more taxes.

Colonel WEBBER, in reply, said this was a subject which required a great deal of consideration, and he could hardly expect much to be said on the details. They were much indebted to the Chairman for the interest he took in the subject, and for the very clear manner in which he had enlarged on the propositions brought forward in the paper. The American practice to which Mr. Saunders had referred was within his knowledge, and he should have referred to it as well as to India, and pointed out that, as Mr. Siemens had remarked, the conditions were not quite the same as in England, the distances being so great; but the experience of telegraphy in America was much more difficult to get at, and, therefore, he preferred relying on the published statistics of India. It would be a great advantage if the Americans would publish their results, showing the average distance over the wires which these deferred messages were carried. In inviting Post-office officials to join in the discussion, it was very far from his intention to suggest that they should deal with any points which were under the consideration of the Postmaster-General; but he thought there were some points on which they might have spoken; and he was particularly anxious to hear any objections they might have to his proposal. The great difficulty he had encountered during the last eight years was to find out the objections; for, with the exception of those who had to deal with large central offices, he had failed to meet with any. Of course, in those large offices there was no idle time; the work was so dovetailed in, and there was so much press work at night that the want of work was not appreciated; but when you went to country districts and small offices, and found that the operator was standing idle nine hours out of ten—when there were hundreds of people willing to send messages at 6d., and the postmaster was obliged to refuse them, it seemed to him that the policy was purely that of the dog in the manger. It was chiefly at the extremes of this great system that the wants of the public could be felt. Then came the objection of Mr. Siemens—what sort of messages would be sent under this category? It was always difficult to say exactly what the demand would be until they were prepared to supply it. He could only say that the experiment had been tried in other countries, and had succeeded. In New South Wales there were "delayed" messages, sent for 6d. in the least busy hours, over a circuit of 830 miles. There was also the experience of India and America; and though the conditions were not the same, it afforded some ground for supposing that there would also be a demand for deferred messages here. There were many messages which would answer every purpose if they were delivered the same afternoon or evening; and a person who knew that such would be the result would not mind the delay, even if he handed the message in at eleven o'clock in the morning. Within distances of 60 or 100 miles of London, a letter posted in the middle of the day would indeed be delivered the same night; but a telegram delivered before 5 would have an advantage. Again, there would very likely be a large traffic on Sundays, when no letters were delivered. No one could say what the exact nature of the traffic would be; but it was undeniable that a reduction of rate produced an increase of messages.

The CHAIRMAN having proposed a vote of thanks to Colonel Webber, which was carried unanimously, the proceedings terminated.

Miscellaneous.

REPORT ON TECHNICAL INSTRUCTION.

The second Report of the Royal Commissioners on Technical Instruction has just been published. The first volume contains the general reports, and the second volume a report by Mr. H. M. Jenkins, on Agricultural Education in North Germany, France, Denmark, Belgium, Holland, and the United Kingdom, and another by Mr. William Mather, on Technical Instruction in the United States of America and Canada. The third, fourth, and fifth volumes will contain the evidence and the remaining appendixes.

Public attention was first directed to the influence of technical instruction on Continental industry by the letter of Dr. (now Sir Lyon) Playfair, of May 15. 1867, to Lord Taunton, Chairman of the Schools Inquiry Commission. In that letter, Dr. Playfair, who was one of the jurors at the Paris Exhibition of 1867, stated his opinion, which he shared with "some of our chief mechanical and civil engineers," and with "our chemical and even textile manufacturers," that other nations were making "wonderful advances," while with us there was "want of progress.' "So far as he could gather opinions by conversation, the one cause upon which there was most unanimity of conviction was, that France, Prussia, Austria, Belgium, and Switzerland possess good systems of industrial education for the masters and managers of factories and workshops, and that England possesses none." The Schools Inquiry Commission, on receipt of this letter, addressed a circular to a number of "eminent English jurors," asking whether they agreed with its substance. The replies were such as to induce the Commission to report that the "inferior rate of progress recently made in manufacturing and mechanical industry in England, compared with other countries," was "due in a great measure to the want of technical education," and they suggested for the consideration of the Government, whether a special inquiry into the state and effects of technical education abroad should not be instituted.

In conformity with this recommendation, inquiries on the subject were addressed by the Foreign-office to our representatives abroad, to which numerous replies were received; and Mr. Samuelson, M.P., made a report (Parl. Pro., Nov. 26, 1867) to the Vice-President of the Council, of his observations during a journey in France, Switzerland, Germany, and Belgium, in the autumn of 1867, undertaken with the special object of inquiring into the industrial and educational establishments of those countries. In the following year, a Select Committee of the House of Commons, of which Mr. Samuelson was the chairman, inquired into the education of the industrial classes in this country, and the subject has since been followed up abroad by various other persons, among others, by Messrs. Beaumont and M'Laren, Dr. Silvanus Thompson, and Mr. Felkin; and it was also dealt with incidentally by the Royal Commission on Scientific Instruction. In consequence partly of these inquiries, there arose a movement in favour of technical education in this country, among the practical results of which may be mentioned the foundation or enlargement of several technical schools, of which the Bradford Technical School, opened by the Prince of Wales in 1882, is probably the most conspicuous example; the technological examinations founded by the Society of Arts; and the scheme for technical instruction of the City and Guilds Institute, &c. The demand for informa- as to the state of technical education in other countries led to the appointment of the Commission whose report has just been printed as a Parliamentary paper.

The following are the recommendations made by the Commissioners:—

I.—As to Public Elementary Schools.

(*a*) That rudimentary drawing be incorporated with writing as a single elementary subject, and that instruction in elementary drawing be continued throughout the standards. That the inspectors of the Education Department, Whitehall, be responsible for the instruction in drawing. That drawing from casts and models be required as part of the work, and that modelling be encouraged by grant.

(*b*) That there be only two class subjects, instead of three, in the lower division of elementary schools, and that the object lessons for teaching elementary science shall include the science of geography.

(*c*) That, after reasonable notice, a school shall not be deemed to be provided with proper "apparatus of elementary instruction" under Article 115 of the Code, unless it have a proper supply of casts and models for drawing.

(*d*) That proficiency in the use of tools for working in wood and iron be paid for as a "specific subject," arrangements being made for the work being done, so far as practicable, out of school hours. That special grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums.

(*e*) That in rural schools instructions in the principles and facts of agriculture, after suitable introductory object lessons, shall be made obligatory in the upper standards.

(*f*) That the provision at present confined to Scotland, which prescribes that children under the age of 14 shall not be allowed to work as full timers in factories and workshops unless they have passed in the Fifth Standard, be extended to England and Wales.

II.—As to Classes under the Science and Art Department, and Grants by the Department.

(*a*) That School Boards have power to establish, conduct, and contribute to the maintenance of classes for young persons and adults (being artisans) under the Science and Art Department. That in localities having no School Board the local authority have analogous powers.

(*b*) That the Science and Art Department shal arrange that the instruction in those science subjects, which admit of it, shall be of a more practical character than it is at present, especially in the "honours" stage; that payment on results be increased in the advanced stages of all subjects, at least to those now made for practical chemistry and metallurgy, and that greater encouragement be given to grouping.

(*c*) That the examinations in agriculture be made to have a more practical bearing.

(*f*) That it shall not be a requirement of the Science and Art Department that payment of fees be demanded from artisans for instruction in the science and art classes.

(*g*) That in the awards for industrial design more attention be paid by the Department, than is the case at present, to the applicability of the design to the material in which it is to be executed, and that special grants be made for the actual execution of the designs under proper safeguards. That the limits of the building grants, under the Science and Art Department, to £500 each for schools of art and science should be abolished.

III.—Training Colleges for Elementary Teachers.

(*a*) That the teaching of science and art in training colleges, and its inspection by the Science and Art Department, be made efficient, and that arrangements be made for giving to selected students in those colleges greater facilities and inducements for the study of art and science in the National Art Training School and the Normal School of Science at South Kensington, the Royal College of Science for

Ireland, and other institutions of a similar class approved of by the Government.

IV.—Secondary and Technical Instruction.

(*a*) That steps be taken to accelerate the application of ancient endowments, under amended schemes, to secondary and technical instruction.

(*b*) That provision be made by the Charity Commissioners for the establishment, in suitable localities, of schools, or departments of schools, in which the study of natural science, drawing, mathematics, and modern languages shall take the place of Latin and Greek.

(*c*) That local authorities be empowered, if they think fit, to establish, maintain, and contribute to the establishment and maintenance of secondary and technical (including agricultural) schools and colleges.

V.—Public Libraries and Museums.

(*a*) That ratepayers have power, by vote, to sanction the increase of the expenditure, under the Public Libraries Act, beyond its present limit, and that the restriction of the Acts to localities having 5,000 inhabitants and upwards be repealed.

(*b*) That museums of art and science and technological collections be opened to the public on Sundays.

The sixth division consists of special recommendations in regard to Ireland. The first three being (*a*), "that steps be taken at the earliest moment for the gradual introduction of compulsory attendance at elementary schools in Ireland;" (*b*), "that payments be made by the National Board under proper regulations on the results of the teaching of home industries to children, young persons, and adults, as well as in aid of the salaries of industrial teachers;" (*c*), "that systematic instruction be given to primary school teachers, qualifying them to teach the use of tools for working in wood and iron, in the primary schools." The Commisioners make some further suggestions which do not necessitate action on the part of the legislature or of the public authorities.

IMMIGRATION INTO THE UNITED STATES.

Her Majesty's Minister at Washington says, that the immigration into the United States during the last year, ended June 30, 1883, was more than 25 per cent. below that of the preceding year, and 10 per cent. below that of the year before. The total number of immigrants arriving during the year 1881, was 669,431; in 1882, 770,422; and in 1883, 599,114. The total arrivals for the past ten years have been less than 4,000,000, and in no three years preceding had the total ever been much above 1,000,000. The number of immigrants who have arrived in the United States during the last fifty years exceeds 10,000,000. The smallest number of arrivals during this period was, in 1838, when only 38,914 arrived, and it was not until 1842 that the number for the first time exceeded 100,000. As regards the nationality of the immigrants who arrived during the last year, Germans showed the highest number, namely, 191,643, England furnished 79,852, Canada 64,000, Ireland 63,700, Scotland 19,612, Italy 31,715, Norway 21,894, Sweden 34,596, and other countries 92,102. Nearly three-fourths of the arrivals come in at the port of New York. The number of foreign-born persons, residents of the United States, is now about 7,000,000, or nearly one-eighth of the present population. Out of a total population of 5,000,000, New York contains 1,250,000 foreigners. 500,000 of these are from Ireland, and 350,000 from Germany. Pennsylvania and Illinois have each 600,000, and Ohio 400,000. Out of the 7,000,000 of foreign population, 2,225,600 are of German nationality, and nearly 2,000,000 are Irish. The per-centage of arrivals during the last few years shows a large increase from Germany, and a falling off from Ireland. During the last fifty years it is calculated that 3,500,000 Germans have arrived in the United States. Mr. West says that the German immigration generally tends to the Western States, and engages in farming enterprises; and the English and Scotch has the same tendency. The Mormons are still recruited in Wales. The Irish immigrants congregate in the large cities. The German element exercises decided influence in the State of Ohio, as does the Irish element in New York. The Swedes and Norwegians are to be found in the coasting trade navigation; and the Italians take their chance in any line of business which presents itself. French and Spanish immigration are insignificant; and Russian still more so.

ITALIAN CORAL INDUSTRY.

A pamphlet has lately been published under the auspices of the Italian Ministry of Agriculture and Commerce, relative to the coral industries in Italy, and contains some interesting information respecting the coral and its formation. It appears that of late years the most favoured localities for the fisheries have been the waters about the island of Sicily, the sea of Sciacca on the south coast of the island, Trapani, the island of Ustica, north of Sicily, and also the waters about the islands of Corsica and Sardinia, and the bays and seas upon the coast of Algeria. About five hundred Italian ships are engaged in the industry, either upon the Italian banks or upon those of foreign nations, giving employment to about 4,200 sailors. Of these five hundred ships, over three hundred sail from Torre del Greco. The quantity of coral collected annually by the vessels sailing under the Italian flag amounts to 56,000 kilogrammes, valued at 4,200,000 lire. In Algeria 10,000 kilogrammes of coral are taken annually, representing a value of 750,000 lire. Much of this is accomplished by fishermen from Torre del Greco, Leghorn, and other parts of Italy, who have emigrated and established themselves at La Calle and other points on the Tunisian coasts, where with more than a hundred vessels sailing under the French flag, they engage in this industry. In addition to the figures above given, the Spanish ships, about sixty in number, gather along the coast of Spain and elsewhere, about 12,000 kilogrammes of coral, in value about 800,000 lire. From these figures it will be seen that the quantity of coral gathered annually by ships not bearing the Italian flag, amounts to 22,000 kilogrammes, of the value of 1,550,000 lire. This, added to the figures already given as the direct results of Italian fisheries, amounts to 78,000 kilogrammes, valued at 5,750,000 lire, and these figures represent approximately the annual gathering of coal in different seas by Italian and foreign ships, and its value. There are in Italy sixty coral workshops, giving employment to about 6,000 men, women, and children. The men employed earn from 10d. to 3s. 6d. a-day, and the women and children from 8d. to 1s. 8d. At Torre del Greco there are forty workshops, where 3,200 persons are constantly employed, of whom 2,800 are women. The other workshops are situated in Genoa, Naples, Trapani, and Leghorn. A portion of the best coral is sent to England; much of a fine quality to France, whence it reaches Germany and America; but the greater part goes to Madras, Bombay, and Calcutta, and through them to Indo-China and Africa. The author of the pamphlet referred to says that although the profits of the fisheries are great, the condition of the fishermen themselves is "the most miserable that one can imagine."

THE TEXTILE INDUSTRIES OF AUSTRIA.

All the branches of textile industry are represented within the limits of the Austrian Empire, and the stage of development which has been attained in many cases bears witness to the energy and perseverance which have been brought to bear upon the advancement of manufactures.

Regarding cotton goods, there is less reason for approval than with respect to other branches of industry. On the other hand, the linen yarns produced are of excellent quality. The number of spindles at work in this trade is 350,000, and the manufacture of linen piece goods forms an important element in the industrial activity of Austria.

Woollen goods are largely made for men's and women's use, as well as for upholstery purposes.

Vienna is the centre of the silk trade, but some factories are established in the provinces. It would seem (according to a French paper) that the Austrian manufacturers purchase in Lyons certain articles and colourings which they cannot produce, and by mixing these amongst their own manufactures, give to the latter a character which they do not intrinsically possess. The same may be said of trimmings and buttons. There are 12,000 lace workers; and boot elastics are made in large quantities.

Correspondence.

WATER REGULATION.

Mr. J. S. Watson's estimate (*Journal*, March 14th) which provides an 18 horse-power engine, moving 450 cargo-tons 49½ miles daily, but ignores return trips, analyses thus:—

Motor (engineman, coal, oil, incidentals, and hire of machinery)	·027d.
Vehicles (boat-hire, crew-wages and incidentals)	·071d.
Profit	·005d.
	·123d.

The first only of these entries seems to correspond to ·034d. per ton-mile, on the Aire, which flows past pit mouths.

It does not appear whether Mr. Watson expects to pass 450 cargo-tons at one lockage; but if so, a mile of suitable canal cannot be made for £15,000. Mr. Conder, C.E., thinks that one for a 180-ton boat would cost that (Q. 2,489). The expediency of buying existing canals seems often doubtful. They were made when work was cheap, but engineering was timid, and are puny and indirect. Their curves would hardly suit General Rundall's 150 ft. boat.

The engineer of the Warwick canals, says (Q. 506), "I do not know that there would be a very large traffic right through from London to Liverpool."

Totals and averages are risky; but the following may be approximate. It rests on Continental precedents, but allows for higher wages here and for our national habit of loading useful works with costly preliminary struggles:—

Motor (as above)	·050d.	·160 boat-costs.
Vehicles (as above)....	·085d.	
Profit and management	·025d.	
Interest on £20,000 at 4¼ per cent.	·227d.	·280 way-costs.
Upkeep and management, at £200	·053d.	
	·440	
Add 10 per cent. contingencies	·044	
	·484	

Even if another 10 per cent. were added, the result would be less than half the present rail-rate.

Loss of cargo-space makes steam dear for light work. The "Baxter" experiment seemed to show that mules hauled a 246-ton boat for less. The cheapest ordinary unit of dispatch may prove to be two boats, one of them engined. The above assumes a normal annual traffic equal to that on the Willebroek Canal (Brussels to tide), say 900,000 tons a mile.

The interest provided corresponds to the average railway dividend; but if half the cost of works were lent by Government to local trusts, $4\frac{1}{4}$ per cent. would provide for its gradual redemption, and railways would feel the stimulus which cheap transport would give the country before having to compete with the lowest rates. When a local trust had repaid the first State loan, the Government might lend the other half at $4\frac{1}{4}$ per cent., but always with the right to accept 3 or $2\frac{1}{2}$ per cent. interest only, or even to remit that. In France, State aid was conditional on local co-operation, and each river basin was specially studied.

Unlike a railway, a waterway is for all vehicles, whether owned by a company or by individuals. The adoption of steam creates a parallel to a county road, open to traction engines as well as carts; and this new departure suggests special legislation, to protect the bye-trader and the public.

I regret that others have not joined in the correspondence begun by the two distinguished Indian engineers, whose main ideas I heartily follow. Ireland has certainly suffered from abortive attempts to sever those Siamese twins—navigation and drainage.

If each of our river-basins had water wardens, reporting to a "Waterstaat," the capabilities of rainfall might be gradually realised; and dams, of Settons or Gouffre d'enfer type (made, perhaps, by convicts), might enrich our valleys.

Meanwhile, public ideas are widening; land is cheapening; and the national rate of interest is falling.

WALTER M. J. CAMPBELL.

19th May, 1884.

Notes on Books.

PRACTICAL GUIDE TO PHOTOGRAPHY. London: Marion & Co. 1884.

This guide seems to be principally intended for the use of that numerous band of amateurs who have been led to take up photography by the recent improvements in photographic processes, improvements which, as is well known, have rendered the art one of the easiest known. Though published by a firm of photographic dealers, the book is not in any way a price list; it is what it pretends to be, a manual of the art, and beyond an occasional reference to the fact that some special piece of apparatus is produced by the publishers, or a casual statement as to the qualities of a particular "brand" of plates, there is really nothing of an advertising character about it. It assumes that (as is, of course, generally the case) the amateur photographer prefers to get everything he can ready-made, that he gets his plates ready prepared, and his solutions ready mixed. It also assumes (as is unhappily not always so true) that his selection of apparatus need not be limited by want of funds, and that he is in a position at once to possess himself of all the ingenious (but not absolutely necessary) appliances for facilitating the production of photographic pictures which dealers are so constantly producing, and photographers have so often to do without. The make-shift devices to which many artists are rendered are ignored by the authors; but apart from this excusable weakness, they give full direction for all the various manipulations required in the interesting art with which the manual deals.

SCIENCE AND SINGING. By Lennox Browne, F.R.C.S. Ed. London: Chappell and Co. 1884 8vo.

This essay is founded on a lecture delivered before the Society for the Encouragement of the Fine Arts. The author, after pointing out the necessity for scientific knowledge, as shown by instances of unscientific teaching, draws attention to the advantages of laryngoscopic self-observation of the mechanical art of singing as a groundwork of its development as a fine art. He also treats of the importance of pure air, and the danger to the voice of the impure air often breathed by singers. The concluding portion of the essay is occupied with tone production, and the various questions concerning the registers and the need of rest when the voice is breaking.

General Notes.

EXHIBITION OF GOLDSMITHS' WORK.—Information has been received from the Foreign-office, through the Science and Art Department, that an International Exhibition of Gold and Silversmiths' Work, Jewellery, and Bronzes, will be held at Nuremberg, in the summer of next year. The Exhibition will be held under the patronage of H.M. the King of Bavaria, and will be held in the Bavarian Museum of Industrial Art of Nuremberg, from 15th June to 30th September, 1885. Steps have been taken to ensure the admission free of duty of objects sent for exhibition, and for the return duty ree of objects which remain unsold. Measures will also be taken with a view of obtaining a reduction in the carriage of objects sent for exhibition. Applications for space and all communications should be addressed Bayrisches Gewerbe Museum, Nuremberg.

TAHITI.—The *Industriel Français* calls attention to the natural and climatic advantages which are enjoyed by the above island, the connection between which and France is a feature in the scheme of French acquisitions in the Pacific. For many years business was to a great extent monopolised by a few houses, but competition has now greatly increased, with the result of a diminution in the profits of trading. Special importance is attached to the position Tahiti will probably attain in the future, when the Panama Canal is completed, and the efforts of the French Government and of the mercantile community have succeeded in obtaining for French commerce a higher position than it now holds amongst the general trade of European nations in the Pacific waters. The necessity of improved harbour accommodation at Tahiti is likewise dwelt upon.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, eight o'clock:—

MAY 28.—"Primary Batteries for Electric Lighting." By I. PROBERT. W. H. PREECE, F.R.S., will preside.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings:—

MAY 29.—"Some Economical Processes connected with the Woollen Industry." By Dr. WILLIAM RAMSAY.

INDIAN SECTION.

Friday evenings:—

MAY 30.—"Street Architecture in India." By C. PURDON CLARKE, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Sixth Course will be on "Fermentation and Distillation." By W. N. HARTLEY, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin.

LECTURE III.—MAY 26TH.

Alcohol produced by mould. Its existence in rain, river, and sea water. Its presence in the soil. The process whereby alcohol is separated from water. The simplest form of distillation by a still and worm. The boiling points of water and alcohol. Boiling of mixtures with low boiling points by means of vapours with high boiling points. Pot stills and patent stills. Langier's still. The principle of Coffey's still. Its mode of action described. Improved forms of still. Alcoholic beverages and other products.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. N. Hartley, "Fermentation and Distillation." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m.

Geographical, University of London, Burlington-gardens, W., 2 p.m. Annual Meeting.

TUESDAY, MAY 27...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gamgee, "The Anatomy and Physiology of Nerve and Muscle." (Lecture IV.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. George H. Stayton, "Wood Pavement in the Metropolis."

Anthropological, 3, Hanover-square, W., 8 p.m. 1. Mr. Theodore Bent, "Notes on Remains from Cemeteries in the Island of Antiparos." 2. Mr. H. O. Forbes, "The Koeboes of Sumatra." 3. Dr. J. G. Garson, "The Osteology of the Koeboes of Sumatra."

East India Association, Westminster Town-hall, S.W., 3½ p.m. Dr. G. W. Leitner, "The Indigenous Elements of Self-Government in India, especially in the Panjab, and in matters of Education."

WEDNESDAY, MAY 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. I. Probert, "Primary Batteries for Electric Lighting."

Geological, Burlington-house, W., 8 p.m. 1 Dr. C. Callaway, "The Archæan and Lower Palæozoic Rocks of Anglesey." With an Appendix on some Rock-specimens, by Prof. T. G. Bonney. 2. Lieut.-Col. H. H. Godwin-Austin, and Mr. W. Whitaker, "The New Railway-cutting at Guildford." 3. Mr. Herbert Green Spearing, "The Recent Encroachment of Sea at Westward Ho, North Devon." 4. Mr. George Varty Smith, "Further Discoveries of Footprints of Vertebrate Animals in the Lower New Red of Penrith." 5. Mr. R. Kidston, "The Fructification of *Zeilleria (Sphenopteris) delicatula*, Sternb, sp., with remarks on *Ursatopteris tenella* and *Hymenophyllites quadridactylites*."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, MAY 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Dr. William Ramsay, "Some Economical Processes connected with the Woollen Industry."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 9 p.m. President's Conversazione at the South Kensington Museum.

FRIDAY, MAY 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. C. Purdon Clarke, "Street Architecture in India."

United Service Inst., Whitehall-yard, 3 p.m. Mr. R. Cust, "The Railway over the Sahara from Algeria to the Senegal, and the Destruction of Colonel Flatters."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Monsieur E. Mascart, "Sur les Couleurs."

SATURDAY, MAY 31...Royal Institution, Albemarle-street, W. 3 p.m. Prof. Bonney, "The Bearing of Microscopical Research upon some large Geological Problems." (Lecture III.)

Journal of the Society of Arts.

No. 1,645. Vol. XXXII.

FRIDAY, MAY 30, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione is fixed to take place at the International Health Exhibition, South Kensington, on Wednesday evening, 2nd of July.

Further particulars will be duly announced.

CANTOR LECTURES.

The third and last lecture of the sixth course of Cantor Lectures was delivered by Prof. W. N. Hartley, on Monday evening, 26th inst., the subject being "Fermentation and Distillation." The lecturer pointed out that alcohol existed in rain, river, and sea water, and explained the process by which alcohol is separated from water. He then described the simplest form of distillation by a still and worm, and showed the improvement that had been made in the forms of still.

On the motion of the Chairman (Dr. Mann), a cordial vote of thanks to the lecturer was passed unanimously.

The lectures will be printed in the *Journal* during the autumn recess.

FOG SIGNALS.

An abstract of the various Codes and Suggestions for Fog Signals, submitted to the Committee of the Society of Arts on Collisions at Sea, has been printed, and copies can be obtained on application to the Secretary of the Society of Arts.

EXHIBITION OF THE UNION DES ARTS DECORATIFS, PARIS.

The Council of the Society Arts desire to bring under the notice of English manufacturers the Exhibition of Art Industries which is being organised by the Central Union of Decorative Arts, Paris.

This Exhibition is the third of a series of Technological Exhibitions of Art Industries formed by the Union. That of 1880 was specially devoted to Metal Industries; that of 1882 to the Industries connected with Wood (Furniture), Textile Fabrics, and Paper. The forthcoming Exhibition will be devoted to Stone, Wood (Building), Ceramics, and Glass; and will be held in the Palais de l'Industrie, in the Champs Elysees, Paris, from the 1st of August, to the 21st November, 1884. It will comprise—

A Modern Exhibition, and a Retrospective Museum.

The heads of the classification to be adopted in the Exhibition are as follows:—

Group I.—Stone (Section 1, Natural Stone. Section 2, Artificial Stone. Section 3, Precious Stones and Gems. Section 4, Designs and Models.)

Group II.—Wood (Section 1, Natural Woods. Section 2, Decoration and Imitation of Wood, Lacquer Varnishes, &c. Section 3, Designs and Models.)

Group III.—Pottery and Glass (Section 1, Ceramics. Section 2, Glass. Section 3, Enamels. Section 4, Mosaics. Section 5, Designs and Models. Section 6, Application of Photography to Decoration.)

Further particulars can be obtained on application to the Secretary of the Society of Arts.

EXAMINATIONS, 1884.

The list of successful candidates in the examinations for the present year has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies will also be sent to the various committees for the successful candidates.

HEALTH EXHIBITION PRIZES.

Mr. J. Sargeant Stacey has placed the sum of £20 at the disposal of the Council of the Society of Arts for a prize to be offered in connection with the International Health Exhibition, and it has been decided to offer the prize for the best exhibit in Class 30 (objects for internal decoration and use in the dwelling; fittings and furniture).

Proceedings of the Society.

INDIAN SECTION.

Friday, May 9, 1884; Sir LEPEL GRIFFIN, K.C.S.I., in the chair.

The CHAIRMAN, in introducing Dr. Leitner, said it was now twenty years since he went to India as Principal of the Lahore Government College, when there was, indeed, a department, so called, of popular education in North India; but it was not popular education in the truest sense of the term. Dr. Leitner, first of his Department, understood that for education to be popular it was necessary for it to enlist in its favour the sympathies of the people, and these could only be secured by drawing to the side of progress and education the ruling classes—the chiefs and the gentry—not only those, but also the priestly classes; in India, as with all Orientals, religion and knowledge went hand-in-hand. The success had been conspicuous, as was proved by the establishment of the Oriental University of North India, at Lahore, which had been been founded to encourage popular education, and with a view not only of fostering the ancient classical languages of India, but also of creating a new vernacular literature, and being the germ of education for the people, and by the people.

The paper read was—

THOUGHTS SUGGESTED BY THE PAST AND PRESENT CONDITION OF INDIGENOUS EDUCATION IN INDIA.

By DR. G. W. LEITNER.

EXTENT OF INDIGENOUS EDUCATION.

In thanking the Chairman for his kind remarks, I would preface the communication which I intend to submit to you by the observation that the subject is not entirely new to the Society. In 1875, in a paper on the Roman Urdu question, from which I venture to dissent, with due deference for the authorities who are in favour of it, I gave expression to the following remarks, which may be deemed to be some sort of introduction to this paper:—"I find a panacea for the existing evil of ignorance in the development of the vernaculars through their legitimate sources—the Persian, Arabic, and Sanskrit—and in the co-operation of those very classes whose Oriental learning, and consequent influence, have been ignored under our present system." This was true then; it is not quite so true now, because I believe that the intention, and to a certain extent the practice, of the present Government is in favour of recognising indigenous education that had so long been ignored or persecuted. Whether they recognise that education on its own lines, which are the only ones that are likely to lead to success, is another question; but that the intention is thoroughly good for a hitherto neglected and most important agency of education, there can be no doubt. I went on to say; "Whilst, however, less than 100,000 are known to come under instruction (in the Punjab Government schools) there are many hundred thousands whom our system ignores. These learn, if Mohammedans, Arabic and Persian; or if Hindus, Sanscrit for religious purposes. Besides these, there are the traders, shawl-weavers, bankers, and others, who learn a peculiar kind of ciphering traditional to their occupation. The Sikhs learn Gurmukhi, the character in which their sacred books are written." Such a very strong influence had indigenous education on every class of India, which it endeavoured to train for the purpose for which either the Indian legislator or traditional circumstances had assigned it, that there was not a trade in India which did not possess a literary or a quasi-religious basis.

I will pass round for your inspection an "Analysis" of the shawl writing, which explains the fabrication and the use of colours in that manufacture. The volume is part of a series of what is called "a selection from the records of the Punjaub Government," showing that not only was there a technical but also a literary and linguistic basis to the trade of shawl-weavers, carpenters, masons, and others.

It is now known that there was scarcely a single village in which there was not at least one school for the denomination of the bulk of its inhabitants; that all the persons connected with the village were, to a certain extent, but no further—and that was precisely the beauty of the indigenous system—acquainted with whatever of religion and whatever of learning bore on their own work. This is very different indeed from the present state of things, which reminds us very much of what there is in France, where you will find in a recent book that you may have seen, that the prize pupil of a school, fought for among masters, gradually finds himself encumbered with an amount of information, and medals which his shabby coat and other surroundings do not set off to advantage, and finally vanishes into one of the French penal settlements, after trying everyone of those various occupations which attract educated despairing men, including that of sedition.

Caste.

The Indian legislator sought, above all, to make everybody satisfied with his work in life. And here I may point out that there is a great misconception existing on the subject of caste. It is not as class in Europe weighing on class, and where the way upwards has to be, more or less, forcibly broken through by superior merit, or luck, or intrigue; but the caste system seeks perfection within itself, and the lowest outcaste—the sweeper — the "mahtar," humorously called "the prince" —has his prototype in the House of God, where he performs his functions with a golden vessel. Now, this outcaste would be as much degraded by mixture with a class above him as that higher class would be degraded. I believe it is perfectly possible to conceive in Europe that if a king, whatever his origin, married a peasant, the relatives of the peasant would feel honoured. Now none of our great Chiefs who belong to the "kalal," or wine-selling class, would be allowed to intermarry with the lowest Brahmins, so far as social position is concerned; and it seems to me, that after many years of struggle, as regards social questions, we may yet arrive, in Europe, at conclusions that may not be altogether different from those of the Indian legislator, when he sought, within certain limits, and allowing certain latitudes, to make each class content.

I should be sorry to see the experiment fail of a Trade University, where carpenters and others would be brought up to consider there was nothing more glorious than the lives of illustrious carpenters and other artisans, and nothing better than to do their own work well, a view which may perhaps be impressed on the British workman of the present time, who seems very often to take his work rather easy.

One great advantage of the native system was that each man had a character to keep up, and would not disgrace himself. The village watchman, for instance, as he was—not the policeman with yellow inexpressibles, as he now is—was part and parcel of the village community, and so with the Maulvi, or other indigenous and often hereditary teacher, who dared not commit at any rate a great wrong, whereas the stranger who is imported now may do anything, as long as he pleases his official superior. We have destroyed the real native public opinion, which alone keeps teachers and officials in check. As to the greater safety of life and property, which our rule is supposed to have given, although the European is safe, it would be a bold assertion to say that a native is more safe than he was. The European is safe from plunder because he carries nothing about him that could be of any use to the plunderer. His clothes would not suit a Thug, or other native robber; his cheques could not be cashed; his pots and pans might defile the capturer's caste; he rarely carries jewels or gold mohurs about him, as a native traveller might, and there would moreover arise a hue and cry over the robbery that would not be worth the game. But it is a different question whether such a state of things now exists as is described in the days of Runjeet Sing, when it is currently stated that a maid could travel at night decked in jewels, and be perfectly safe.

Indigenous Literature.

I do not know that there is any subject in which we have not quite as much to learn as to teach in India. There is no science, even including engineering, in which a receptive mind may not learn much in India. In medical knowledge I am convinced that, although as far as surgery is concerned we have undoubtedly gone very much ahead of our Indian fellow-subjects, yet in the use of the drugs, and often in the theory and practice of medicine, there is much to be learnt from our Indian colleagues, for, after all, the leading European physicians would admit that our medicine is still in the empirical stage. I have been very much struck with certain remarks I heard made, only a few days ago, in Edinburgh, by the masters of the science in Europe—Virchow, Helmholtz, and others, who certainly do not share the impatient disregard of native systems which our more young and ardent medical men, who leave Europe with the fulness of newly acquired knowledge, are apt to show in dealing with indigenous fellow-practitioners. Instead of identifying in that branch of learning, and in every other, the traditional possessors of the lore with the cause of progress through the comparative method, and of identifying their children with a progressive profession, very much to the good of society, a class of men that has, as a rule, little hold on the confidence of the people is assuming the position of native doctors; whereas some members of that class would be better employed in earning larger sums by making better sweetmeats, or by tanning the hides confided to their care with the most modern appliances. Indeed, barring certain mechanical appliances, there is scarcely a subject, except that of sculpture—the delineation of the human figure, not architecture—in which we, as feeble imitators, after all, of the Greeks—can teach anything to India without having something to learn in return.

Greek Influence on India.

Once Europe endeavoured to discharge that duty in a manner which is not without its lesson on this occasion. In those classical books that we read at school, perhaps admire, and generally forget, there are references to Greek influence on India which are suggestive to ourselves, though we may not fully subscribe to the statement of Plutarch, who, after all, echoed the opinion of his contemporaries, that Alexander the Great—who preceded us in the conquest, and I hope in the true indigenous civilisation of India—is supposed to have permeated India with Greek arms, Κατέσπειρε 'Ασίαν 'Ελληνυυ κοῖς τέλεσι, a quotation to which Sir Edward Fry first drew my attention nine years ago.

The word "Asia" being used there, may perhaps lead you to believe that the whole of that Continent is vaguely meant; but we find that when Alexander's soldiers would not go beyond the Punjab, one of their chief grounds of complaint was "You have brought us here to make Asia Greek, but you are turning us Greeks into Asiatics."

Now, considering that where they spoke was the Punjab, I do not thing we are wrong in assuming that the word "Asia" used in the above narration by Arrian, a most accurate historian, in this instance means anything but India. We find that Aelian and others considered—I should be sorry to say they wrongly considered—that so great had been the Greek influence on India, that the Indians learnt to sing Homer in their own vernacular. If you pay attention to these photographs of sculpture found in India, of which I hand round specimens, you will be convinced that some of them have certainly been made by Greek sculptors, or by their Indian pupils. Indeed, there are striking analogies between the Indian and Greek mythologies, and it is a question how far the worship of idols may not have been introduced or promoted by the Greek invasion, the Hindus seeking to represent the supernatural by the exaggerated natural, and the Buddhists by the refined human. I might add, that Alexander receiving an Indian deputation, shortly before his death, congratulated himself on the fact of having recovered so many sculptures that Xerxes had taken from the Greeks and distributed all over "Asia." The lesson which I would draw is in the statement of the soldiers: "You have brought us to 'Asia' in order to make Asia Greek, but you are making us Greeks into Asiatics." If we are to identify and closely knit that Asiatic civilisation and all its treasures with ourselves in the maintenance of good government, and for the benefit of India and of science, then I think we should rather incur the reproach addressed to Alexander. Going as we must go to India, with the object of giving India the best of our associations, and the treasures of our language, as a complement to what exists, I think it would be infinitely better if the reproach could be addressed to us which amongst many reproaches could not now be addressed, that we have in any way become Oriental. If we were to become more Oriental than we are, I think we should make many more English in the best and truest sense. I do not know whether this was in the mind of the eminent Indian statesman and historian of the Punjab who now occupies the chair, when he wrote, as I believe he did, a passage in a "Review of Education in the Punjab," which I find in a Parliamentary report to the following effect. Whoever wrote it I think had imbibed some of the true spirit of sympathy which is to make India more English by making ourselves more Indian :—

English Education in India.

"Neither the English language nor literature is taught upon any scientific or intelligent system, and the success of English education, as a consequence, has not hitherto been marked in the Punjab. Nor has the system which produces few scholars been more successful in producing gentlemen. The Lieutenant-Governor desires that the department take especial care that the good manners natural to Oriental youth are not lost at school. This matter has hitherto been neglected. If the result of sending boys of good family to school is, as is now often the case, that they return pert, conceited, and studiously rude and familiar, - it is no wonder that parents desire to educate their children at home. English education is not a desirable thing if it only signifies sufficient acquaintance with the English language to write and speak ungrammatically, sufficient acquaintance with English literature to be shallow, and with English history to be insolent. English education is to be penetrated with the spirit of the great English authors, to imbibe some portion of their strength and beauty, and nobility, and gentleness, and wisdom; to mould the life and character upon the models they have furnished. This is the standard of education to which the department must endeavour to rise."

There is one other preliminary remark which I hope I may be allowed to make for fear of being misunderstood, viz., that if I criticise I do not mean to intimate that there are not a great many subjects on which I might not enlarge in terms of praise; probably no other country has done more for a foreign country than England has done for India, but "Excelsior" should be written on our standard, and if I ask for more sympathy, I do not assert that none already exists. I think that we can all cordially agree in this, that there is ever both room and desirability for more knowledge and sympathy.

Practical Philology and Indigenous Systems of Education.

To deal satisfactorily in the course of an evening's lecture with the indigenous systems of education of a population so vast and varied as that of India, would at first sight appear to be as hopeless a task as to give a lecture on the "Education of Europe." To have announced my communication as the possible forerunner of a series, might have reduced my audience to a few officials and specialists interested in the subject, while there is no branch of science, and no section of an educated public, which is not directly interested in a careful inquiry into matters apparently so removed from our intellectual horizon. Indeed, to take up one point only—that of an ethnographical and historical grammar—we can learn lessons from India which would be of the greatest importance in our relations not only with Eastern races, but also in our political and literary intercourse with the nations of Europe, in which misunderstandings often arise in consequence of the inadequate apprehension of shades of meanings in words and ideas common to them all. There is a task which yet remains for our philologists to undertake. That science has remained too much a matter of technical or scholastic skill instead of being brought into daily life. Yet language is of the very essence of everything that is expressed as regards daily life. So little have our greatest masters of the science attended to the historical, the traditional, the ethnic, and other meanings of words, that even in the relations of Frenchmen and Englishmen, misunderstandings arise which a more practical and, if I may say so, a more sensible method of dealing with the subject of language might have obviated. In Oriental languages we constantly have to deplore this. I may quote, as an instance, our translation, in Arabic, Turkish, Persian, and Hindustani missionary works, of such a word as "salvation" by "khalás," which means "getting out of a difficulty"—the Gnostic heresy; whilst the orthodox apprehension of the word would be that Christ *was* crucified. I have only hinted at one of many, in fact innumerable instances, in which error arises from the want of treating the science of language from an ethnographical and historical point of view.

The Genius of Europe and India.

Latet dolus in generalibus, and yet I may have to make general statements without having the opportunity of proving them. A further difficulty arises from the fact that the modern genius of Europe is analytical, whilst that of India has remained synthetical. Our danger, therefore, is, that we are often apt to criticise before we construct and to improve away, instead of improving those survivals that do not answer every modern requirement. *Ex oriente lux*, and whilst the Indian sun has his spots, which demand a careful scientific analysis, he can still throw, it may only be a side-light, or even a half-light, on questions that make all mankind kin in a common heritage of knowledge. I would even solicit your generous sympathy with the errors that incrustate the ancient civilisation of the great dependency entrusted to the care of an Empire on which the sun never sets.

Our immediate task is lightened by two considerations—the first, that, whereas the analytical spirit of Europe has constantly to seek a compromise with the abstract, generalising and impersonal phraseology, in which has to find expression, the East gives its thoughts in language that is concrete, personal, and dramatic, and, therefore, nearer to nature and to facts before they are grouped under one idea, as is the process in the West. Even the apparently far-fetched Oriental allegories are, after all, only pictures, whilst the subtle and bold reasoning that has forestalled several of our philosophical acquisitions often possesses the simplicity of a fairy tale, when studied by the light of customs, traditions, and local natural phenomena. For instance, a careful inquiry would show us in the words, say, for "mass" a peculiar tribal combination in some languages; in other languages, even such simple words as "up" and "down," would indicate the topography of the country in which they are used; words used for numbers are often connected with gestures which alone explain them.

The second consideration is that the history of European education offers a parallel to the "Indigenous Education of India." The study of Latin in the Middle Ages may be compared with that of Sanscrit. Hebrew is scarcely different from the more comprehensive Arabic, and the Rabbinical methods, in their often grotesque though ever instructive details of exegesis, greatly resemble those of Maulvis or Mahommedan learned priests. Persian holds the place in diplomacy and culture from which French has scarcely been dispossessed; even the development of Indian vernaculars from the above sources may be compared to the process that has given a national literature to the various countries of Europe, founded on the kindred faiths of Judaism, Christianity, and, in the south-eastern corner of our Continent, Mohammedanism; on the same basis of Roman laws, and, more or less, on a common civilisation. The comparatively homogeneous nations of Europe have, moreover, a classical and modern literature in which they all participate; and the 254,000,000 of Indians, who are far more divided by differences of race, creed, and caste, have also a common educational basis, in Sanscrit learning for Hindus; in Arabic learning for Mohammedans; in Persian literature for men of culture of all denominations; in Urdu for native officials, and, if I may seek for a specimen of a vernacular literature, in Gurmukhi for the Sikhs.

As regards so-called English education in India, it is, as yet, unfortunately, too bureaucratic and foreign an importation to belong to my subject this evening. I advocate its extension on both practical and literary grounds, as a complement to indigenous education, but not as a substitute for it, for then it becomes a mere word-teaching, unconnected with surrounding associations that alone can give it life.

Instances of the Misapplication of European Ideas.

I know a case of the grossest ingratitude justified by the ungrateful man saying, "Well, I am the Brutus of my country." Another person, "cutting" an examination for which he had been trained at the public expense, explained his sudden and dishonest departure on the ground of his wishing to become "the Messiah of India." This he hoped to achieve by studying commerce at Calcutta, where he became the sub-editor of a seditious paper. Take the case of Surendra Nath Banergi, who was imprisoned, rightly or wrongly, for contempt of court, referred to in Anglo-native papers as the beginning of an era of regeneration for India, just as Christianity dated from the advent of Christ. Nothing but a smattering of English, now the merest word-teaching, could, in my humble opinion, have led to such illustrations.

I am afraid I have already taxed your patience by this long introduction, and I will now address myself to give an account, as brief as I can make it, with any justice to the subject as well as to your forbearance, of the principal features of the indigenous educational systems among Mohammedans, Hindus, and Sikhs, including the ruling, the learned, the commercial, and the agricultural classes.

Buddhism at Home and Abroad.

Before doing so, I should like to say one word about the corners of India round which the Buddhists still cling, whereas from India they are expunged. The question of Buddhism, unfortunately, I think, has received too fashionable a prominence lately in English circles, and I was very glad to find in a lecture by Professor Max Müller on Buddhist charity, the statement that he was not dealing with any fancy Buddhism, esoteric or exoteric, such as seemed to engross a section of society, but with historical Buddhism. Buddhism, or the fringe of Buddhism, in Lahul, Spiti, and Burma is a very apt illustration of indigenous education. Every man and woman can read. This is due to education being a religious duty, and being in the hands of the priests; whether all can write is another question. The principal lesson of Buddhism, if I may be allowed this digression, is pity for all that has life. It looks upon even the worst of animals as erring brethren to whom sympathy should be shown. Its advantage is to dissipate that fear of death which I believe is the great curse of even those European nations that face death on the battlefield with the greatest fortitude. Another advantage of Buddhism, so far as I have seen it illustrated in the countries which I have visited—which are Middle, Southern, and Little Thibet—is that of bringing to bear the idea of pity on every relation of life. I should be very glad indeed were it possible for me to say that I know of any other country in which people are so honest, so truth-speaking, and so forbearing as are the Buddhists of Middle Thibet; where I have seen the nearest approach to the Christian injunction of giving one cheek when the other was struck—not that I have ventured on the experiment. The ease with which the Buddhists seem to bear privations, the care which they take of life, and yet the placidity with which they meet death, are lessons far more important, in my humble opinion, than those communications in excellent Yankee-English which are addressed through the ceiling to the esoteric school of Buddhists from "the brethren" in Thibet, of whose existence, while I was at some of the principal monasteries in Middle Thibet and elsewhere, I never heard at all.

Piety and Knowledge are One.

With all denominations piety is the basis of knowledge which, whether religious or secular, is treated as one and indivisible; a view that has insured the dissemination of education in India, unchecked by the dualism which threatens to dissociate religion from science in Europe. Taking the Punjab as a specimen province, respect for learning was its redeeming feature. All classes and sects vied with one another in preserving, and adding to, educational endowments. There was not a mosque, a temple, a Dharmsala (Sikh Hospice), that had not a school attached to it. Religious susceptibilities were consulted, by forbidding Hindus from learning the Koran when they attended a Mohammedan school for instruction in Persian, the official language. Elsewhere—to quote from Ludlow's "British India"—"In every Hindu village, there was not a child, except those of the outcasts, who was not able to read, to write, or to cipher."

Distribution of the "Three R's."

This is not quite correct. Some sections of the community can read, others can write, others can cipher, some can read and write, others write and cipher, others read and cipher; therefore the Census returns on this question must be taken with a grain of salt. The questions put were such as are couched in the peculiar Anglo-Urdu idiom, which is becoming almost a literary language. "*Can* you read or write?" is somewhat different from the ordinary question put in a Native State: "Are you *read?*" If that question were, for instance, addressed to a grain dealer or Mahajan, he would say "no;" because he is not a "read" or a "learned" person, and his not being able to read would mean that he could not read Hindi, or Sanskrit, or perhaps Persian. Yet the man can read something: what he can read is his own writing, which is the Mahajani writing. Even a Hindi or Nagari-reading person might also answer a question of the kind in the negative, yet he could read, and I have no doubt could also write, Hindi. At any rate, he could read his own writing, and that of his commercial correspondents. Different as the various specimens of commercial handwritings all over Upper India may appear to be, which I am now handing round for your inspection, they form a basis of elementary instruction which our official Educational Department has ignored. Again, if a woman were asked, as in the late Census, can you read *and* write (there was a note added that if a person could not do both, the answer should be "no.") she would say no, because no respectable woman will admit that she can write in Northern India. Very many more women than we think can read their religious books, and are indeed often proficient in poetry; but to be able to write is an accomplishment of the superior *hetairae*, and therefore would not be admitted by respectable women, except those who attend the Government female schools, and who are known to be able to write, unfortunately for themselves, and unfortunately for the spread of female education. Again, if a man were to ask a teacher in a Koran school, "can you understand the Koran?" the question at once implies a proficiency in the knowledge of the exegesis connected with the placing of the Arabic vowel points, and an ordinary priestly teacher or Mullah would not claim such knowledge. It would be very much like the question addressed to the Ethiopian of Queen Candace, "Dost thou understand what thou readest?" whose reply was, "How can I, unless some man should guide me." If an English Bishop were to go to an ordinary Sunday-school teacher, and ask him, "Do you understand the meaning of this passage?" the chance is that he would say, "No;" although, in a kind of way, I dare say, the teacher would understand, by his surrounding associations, by the prayers he is supposed to offer, and by the religious periodicals he reads, something or other of the meaning of the passage. So that a question like the above might lead to a mistake, unless the inquirer has a knowledge of surrounding circumstances. In fact, there was a larger proportion of persons who could read before the annexation of the Punjab, than there are now who cannot read after twenty-eight years of wasteful expenditure on the administrative portion of the Educational Department. In Hoshiarpur, for instance, there was one school to every 19·92 males. In Jullundur there was one to every 20·69. The girls were also instructed, though in reading only, writing being deemed an unwomanly accomplishment, because of the temptation to write a love letter. However, as it is the religious duty of a husband to teach his wife, and of a brother to teach his sister, a duty of course which is not always fulfilled, and which has not been fulfilled since the decay of the religious spirit in India to the same extent as before, the girl learns to write by just nestling up to her brother when he is engaged at home in that occupation, and by looking over his shoulder, and picking up what she can. To say, therefore, that women in India are absolutely ignorant of writing is not correct. There are some very superior women indeed, educated in their own way. A year after we had taken the province of the Punjab, a Sikh published a book on the illustrious women of the world, and pointed out that with such examples, and under the rule of Her Majesty the Queen Victoria, there was no reason why native women should not feel encouraged. Now, if there had not been a reading public among Sikh women, I do not think he would have published this book.

There are now, according to the last returns, only about one per cent. of the population under instruction, in both Government and indigenous schools. This is due to the decay of the religious feeling, the neglect of the traditional learned professions, including that of the teacher, the monopoly of education by the office-seeking community, and the resumption of a large number of rent-free tenures, formerly devoted to the support of teachers.

The Indigenous Teacher.

In the Punjab, I am glad to find that the Lieutenant-Governor has suggested "that much may be done towards developing and improving primary schools by granting small areas of land revenue free, and organising collections of grain at harvest time for their support." If this example were followed elsewhere, there might be a prospect of the revival of mass education; but so long as the native priesthood is not encouraged to resume its traditional position as teachers in various branches of knowledge, so long will intellectual darkness practically continue to reign over India as a whole. As regards the quality of these teachers, including the fakirs, who have been the chief means for the popularisation of religion, irrespective of caste, the Right Reverend T. V. French, D.D., Bishop of Lahore—whose opinion on the subject of fakirs is not likely to lean on the side of undue partiality in their favour—deposed in his evidence before the recent Education Commission, that "some of the best teachers in the world, I should think, are the Hindu fakirs, Sanyassis, Jogis, and the like, doing Guru's work; but they teach nothing at present except their own philosophies and religious systems."

There is not the least doubt that in the constant effort made by the indigenous teacher to illustrate his lessons by the natural, the concrete, the objects which are immediately surrounding the pupil, he comes nearer to eliciting that "development from within" in the direction that he means to guide the pupil than by our system of class-instruction, in which very often the dullard is sacrificed to the cleverest boy of the class—in which, for the sake of facility of returns and cheapness of teaching, the object of the teacher, which is simply and solely to develop the qualities of all his pupils, is often frustrated. Here, for instance, is an exercise by a humble indigenous teacher, which has been made over to me by Mr. Purdon Clarke. He is a Pundit, such as there are thousands, by no means a very learned Pundit, as will be obvious from the style of his communication, but I think Mr. Herbert Spencer need not be ashamed to endorse the sentiments which he expresses. He points out the various systems of philosophy which exist, as it really does not much matter what system of philosophy one endorses, so long as one philosophises to cultivate the mind—a latitudinarian spirit which very often induces Hindoos to accept Mohammedan or Christian principles, considering that there are many roads to a city, and that it is not necessary that every one should travel by the same road. He then goes on to show that the development of the pupil's mind is the main object of the teacher. He, finally, launches into the questions of government, showing that learning causes humility, humility causes ability, ability causes progress, and so forth, which, when put into the more generalising and abstract language of the West, would read like superior wisdom.

Mohammedan Education.

As regards Mohammedans, they emphatically value education for its own sake, and not for the sake of worldly advancement. I have myself been partially educated in a Mohammedan school, where I learnt Arabic, and committed large portions of the Koran to memory, as it has always been my practice "to go to school" among the various races or creeds which I desired to study. "Read" was the very first word which the Angel Gabriel told to the Arabian prophet. It is the first word of the Koran, though the order of its chapters is now changed. It is the key-stone of the Koran, which means, "the book that pre-eminently deserves to be read." Nor is reading to be confined to the study of the Mohammedan religion, or of any one religion, for when Abul Fazal, the wise minister of the wise Emperor Akbar, was called upon to justify his supporting all denominations alike as a Government official, he quoted the significant saying, which shows the duty of the State towards religion:—"Government and Religion are twins," for no Government can expect to be permanent that neglects the religion of its subjects. Again, "learning is obligatory on every Mohammedan man or woman," and the Hadis, or the tradition of the sayings and doings of the prophet, explains "learning or science" to consist of two integral parts, "the science of bodies (or of the material world) and the science of religions." Again, "Seek for knowledge even if you have to go to China," which clearly shows that whatever reputation for the cultivation of sciences distant China may have had in Arabia, these sciences were certainly not orthodox from a Mohammedan standpoint.

Advice to Reformers.

When I see all this, I marvel at the shortsightedness of statesmen, scholars, and missionaries—not all, but, alas, too many—in rather seeking for points of difference in dealing with Mohammedan and other creeds, than for common grounds of agreement It seems to me that we should further the common interests of humanity far better if we first ascertained what there is in the religion or belief of those with whom we have to deal before we discuss with them what there ought to be, and if we endeavoured in all our appeals to seek those methods that are most intelligible to those to whom they are addressed. I think, although they may require to be expressed with some circumlocution, it would be better to follow the native saying, that "the success of the teacher is in the hearer," and rather to say things in an Oriental way, with the view of uniting those with whom we have to deal in common aims of charity and progress, than to put things in a way that may, perhaps, only tell best when reported to a British audience. I believe that the eagerness for reform of British audiences is due to the best intentions; that they, above all, wish for information. If they were to get this information, they might be less eager in urging such reforms as I heard advocated the other day about child-marriage—the immediate abolition of which would give great latitude to immorality, whereas now it confers on betrothal, which precedes marriage, a dignity as well as a sense of domestic responsibility. Their sympathy, however, for India would not be a bit less warm, and, indeed, would be far more effective because more intelligent, and because based on accurate knowledge.

Arabic Literature.

What European science and literature owe to the Arabs can never be sufficiently recognised. The problems of ancient Persian chronology, which have baffled the most careful inquirers, have lately been solved by the production of a forgotten, or long supposed to be lost, manuscript of Al Birûni; and I cannot help regretting that the unchecked progress of a foreign veneer of civilisation in places like Batala, a former indigenous university town, should have led to the sale of several hundred-weight of Arabic, Persian, and Sanscrit manuscripts, amongst which there may have been some of importance, to the waste-paper merchants. I think the wholesale destruction which must come on an ancient literature by ignoring its traditional representatives, is a process that must be looked upon with grief by all, whatever view they may take as to the question of the precise value of indigenous education.

In comparative chronology Al-Birûni is still a master, whilst in saving portions of Plato and Aristotle from oblivion, and in laying the foundation of clinical medicine, the Mohammedans have laid Europe under an obligation which it has not yet discharged to the adherents of that creed in India. I may also refer to the important medical, legal, mathematical, astronomical, and philosophical works still studied in their schools. The following passages from the Koran or Hadis are interesting:—

"Of God's creation those alone fear God who are learned."

"One hour's teaching and learning is more righteous than a whole night's prayer."

"When a man dies his acts die with him, except three, namely, a perennial charity (a permanent charitable endowment) or his learning, whereby (posterity) is benefited, or a virtuous son."

"Two men are enviable; he who spends his wealth in alms and he who benefits others by his learning."

The very word for charity, "Sadaka," means a particular action which leads to religious righteousness, and it is the confusion of the application of these terms, which are common to both Arabic and Hebrew, that has led to the interminable struggle between "faith" and "good works," which in their etymology and in their essence are one.

The humblest kind of Mohammedan school is the Koran school, which is generally attached to mosques, or held in private houses, often by pious widows. Even where the meaning of the volume is not explained, the repetition at home of passages from it and of the usual prayers revives the recollection of the parent, who co-operates with the teacher in impressing their lessons on the youthful mind. Especially interesting is "the contract with the Deity" which the child enters into on leaving the Koran school for the practical duties of life; and it were to be wished that our "Bible schools" similarly consecrated each child to duty, God and the country. Then comes "the Arabic school," properly so-called, where that noble and most logical of languages is taught on a system that has extorted the admiration of our leading Arabic scholars in Europe.

Arabic in itself, not even counting its enormous literature, deserves to be called a science. As the Orientals define it, Arabic is science; Turkish is art, owing to the complication of its forms; Persian is sugar, owing to its elegance, it being emphatically the language of gentlemen; and Hindustani or Hindi is salt, owing to the piquancy of that vernacular. There is a school, a very large school, at Deoband, in the North-West Provinces, which, so far as it gives class-instruction, is like an English school or college, but, in so far as it follows native methods in the treatment of subjects, is an indigenous school which is attended by Hindoos as well as Mohammedans. In that school all sciences are taught, so far as they are found in Arabic literature. Putting India aside, it must not be thought for a moment that even in the trans-frontier districts there do not exist centres of learning. For instance, in the little known Gabriál, almost every third man is said to be a well-read Maulvi, and from Gabriál as well as Bokhara, and other places in Central Asia, we have had pupils to the Lahore Oriental College whose knowledge of Mohammedan law, of logic, and even mathematics, was surprising. The Lahore Oriental College, or the Punjab University in its teaching aspect, is the greatest recent instance of educational enterprise in India, and combines Eastern with Western instruction. As a centre of enlightenment among the traditional learned classes of the Punjab, if not of India, and of countries beyond the "frontier," its importance to the cause of comparative studies, to civilisation and to the Government cannot be overrated, and has been admitted by more than one Viceroy. It is, therefore, to be hoped that any attempt to conform it to the model of an English College will fail, that no official will be allowed to interfere with its management, and that its indigenous professional classes will be preserved. Otherwise faith will not have been kept with the donors, and an important lever to the confidence, affection, and further liberality of the contributing classes will be destroyed.

I would refer to the instance of the Bokhariot, Maulvi Abdulla, who, as so many others, teaching himself from Arabic mathematical works, aided by his genius, sought out the Mathematical Professor of our College, Professor Lindsay, a high Wrangler, who confessed that he had nothing to teach him in that discipline. Alas, this promising Central Asiatic, when he fell ill, insisted on being attended at an European hospital, where he died and was dissected, his remains being thrown in a sack to a Badakhshani fellow student Since this occurrence the class of native Hakims, or physicians, has had few accessions from those distant parts, much to the injury of the dissemination of European medical science beyond our frontier. In Mohammedan law, more than one Judge of our Punjab Chief Court has availed himself of the knowledge of some of the Maulvis of the Lahore Oriental College, whilst in engineering and architecture there still exist in India worthy successors of the great men who constructed the Mogol palaces and aqueducts. As for the books in use in the various Mohammedan schools, I must refer to the first volume of my "History of Indigenous Education," whilst, as regards the questions of discipline and of the remuneration of teachers, these are solved by the already mentioned co-operation with the parents, the personal interest of the teacher to secure both the affection of his pupil and a higher reward in the next world, without any of these formal rules which are the snare of official inspections and the delusion of Government schools. As stated in my evidence before a recent Education Commission and elsewhere :—

The Abolition of Mere Administrative Agencies.

"The abolition of the higher Inspectorships and of the Directorship in the Punjab only would eventually set free for purely educational purposes a saving of about Rs. 173,000 per annum; and if the pernicious book depôt were also abolished, which costs about Rs. 50,000, a spirit of educational and literary freedom would breathe throughout the country, the moral, intellectual, and pecuniary benefits of which cannot be over-estimated.

"The District Inspectors might remain for the present, but I would not fill up their places on vacancies occurring. If every Head-master of a High School were to inspect the Middle Schools of his district for a fortnight in the cold weather and for a month in the hot weather, as part of his regular duty, making arrangements for the conduct of his work during his absence, not only would there be relief afforded to him from constant teaching, and his subordinates learn to manage a school, but he would also exert a beneficial and constant influence on the schools in his district, which are the natural feeders of his own school. In the same way, each Head of a Middle School could inspect a certain number of Primary Schools, and with the same beneficial result of co-operation throughout the district.

"The High Schools themselves, which are generally at the head-quarters of the district, could easily and constantly be inspected by the district officers and by the Central Local Board, which would count a certain number of educated European non-officials and others among its members, the head-master, of course, also being one and possessing a vote, which I consider to be essential to his dignity and proper influence.

"In the course of a few years this system would work so well as to give an opportunity to dispense with the services of the district inspectors, should Government wish to avail itself of this opportunity, or should municipal and district committees prefer to give a larger proportion of their educational allotment to the substance of education, the teaching itself, than to its present expensive framework, the inspecting of the work of others. We should thus have gradually more and more schools, inspired by a healthy emulation, and under the supervision of those whose interest and sympathies alike must combine to render them more and more efficient and numerously attended.

"I would also point out that the various Indian Universities, like the Senate of the Punjab University College, now raised to the status of a complete University with extensive privileges, might, with propriety, be constituted Provincial Boards of Education. In the Punjab the Senate has already had twelve years' experience in educational administration, including matters connected with an extensive and varied system of examinations, teaching, and the encouragement of literature. Itself a pre-eminently representative body and the creation of people, it would be in natural sympathy with the Local Boards, and assist them with advice and the results of examinations. Any further inspection than that by district inspectors, head-masters, and the various Local Boards themselves already alluded to, can be provided by the Universities if required."

The Sanscrit Schools and the Brahmins.

I think I ought to say this much about the Sanscrit schools, that the ascendancy of the Brahmin was due to his imposing on himself a system of moral obligation and an onerous ceremonial, together with the obligation of teaching, which was to take away the envy of the other classes. Not to seek power; not to seek money; to have life made a burden to him by austerities and by innumerable ceremonial practices was the way by which the Brahmin thought, and rightly, that he would preserve his ascendancy in the Indian polity. It is true that he reserved to himself the teaching of religion and philosophy, but he allowed the Sudra to learn secular subjects. If any class in India, however low, such as the Baidyas, raised themselves in the social scale, as in this instance, by medical knowledge, they were welcome, and, indeed, even the lowest can rise superior to the gods by the practice of virtue and austerities, for whereas the gods chiefly represent one quality in nature either good or bad, which, for its strength, deserves worship, man, by the practice of virtue, is in a position to unite the various qualities of which the so-called deities are single representatives, and from that union must rise above them. So is it that Brahma means little more than the embodiment of the highest perfection of the Brahminical class, if it remains true to itself. The Brahmins might say, the supreme deity which we are to worship is the highest perfection of knowledge reached through the path of virtue, which, if our class reaches it, personifies

Brahma, who, therefore, has no temples, because he is to live in the good deeds of the most perfect men. The two principal deities are the Aryan Vishnu and the aboriginal Shiva, above whom rises the aspiration of Brahma, together with a number of personified qualities.

The work of the Brahmin, after being a pupil to his master (when he has to beg for him, more as an educational tax on the community than as charity), is after his student's life to devote himself to the life of a household. He is the worthy Brahmin who, after having been a successful student, becomes a good husband, and brings up virtuous sons. The saying is, "A father who contracts debts is an enemy, an unchaste mother is an enemy, a son that has not learning is an enemy;" meaning that these are sources of danger to the welfare of the Indian family. After having brought up his son in the path which he trod before him, he retires, first into ascetic life, in which he has to practise hospitality; and, finally, on the near approach of death, he has to throw everything aside, and become a wanderer, so as to be able cheerfully to enter into the unknown world. It is easy to laugh at the various regulations concerning the demeanour of pupils towards a master; the eating of certain food when prosecuting certain studies, and so on; but, believe me, it is better to examine these subjects, and when they are examined, a profound vein of wisdom will be discovered to underlie these maxims as regards food and demeanour. Even in our own experience, we must have noticed the difference of sensations connected with certain kinds of food. We might also be inclined to smile if a Buddhist, for instance, said that association with animals is a thing that enlarges the mind. I daresay there may be someone in this room who has had an animal as a pet, and who, if he will answer truly, will have to admit, on reflection, that he felt himself the better for caressing and being kind to an animal; the sensation of pity when we see overworked animals, and all those fellow-sentiments have their rise in that universal feeling of brotherhood in which should be contained not only our own kin but the whole of animate life. The Brahminical system of studies is both comprehensive and profound, and should be imparted for nothing. The probibition—which we condemn on a cursory examination—of widow-marriage, and other matters, have their roots deep in the sacredness of the marriage institution, and in the great ideal of the married life in India; and it is wrong to describe it as immoral, as I have often heard it described by well-meaning men. The philosophic teachings of Brahmins have forestalled, discussed, and dismissed many acquisitions which we consider to be European monopolies, and they are still a mine of information. As regards physical subjects, let me draw your attention to those monographs which will continue to perish day by day, unless scholars in Europe will come to the rescue, such as the inquiry into the influence of various sounds of nature on the senses and on the passions; the observations on the diseases of animals, and a number of other monographs which most certainly do not deserve the sweeping condemnation which is so often passed upon them.

The Sikhs and their Education.

Then coming to the Sikh; the Sikh is the Protestant of the northern part of India. His name shows that he is a "learner" or pupil. Men and women are equal, and there is no man or woman deserving the appellation of "Sikh" who cannot write. In this instance writing precedes reading. The initiation of the Sikh in the Amritvidia, or the instruction for giving the sacred drink of immortal learning, begins with the necessity of prayer and truthfulness; the obligation of respecting other Sikhs; the importance of learning Gurmukhi; and I wish to remark that Gurmukhi is not, as has been thought, a mere character, it also means the *language* which flowed from the mouth of Guru, or first teacher of the Sikh religion. The character, as may be seen in several mausoleums, is older, indeed, than the rise of Gurmukhi as a language. Sikhism was a protest, like Buddhism, against the monopoly, however deserved, of the Brahmins. Just as Buddhism sought a shorter cut to salvation, to getting rid of the troubles of life by doing away with the preliminary stages of studentship and householdership, and immediately launching into monkdom, so did the Sikhs endeavour to popularise Sanscrit learning by writing it in a vernacular, composed of several mediæval Hindi dialects, which is of the greatest importance for studying the vernaculars and the Punjabi of the present day. In this composite dialect is written the Adi Granth, a book which, if translated literally (as it has been by an admirable scholar, Dr. Trumpp), reads like nonsense; but if read by the light of custom, and with the traditional explanation of its indigenous expounders, is indeed wisdom.

There is another point which I may refer to. After all what we look upon as Sanscrit manuscripts are mere indexes, a mere *memoria technica* of the treasure which is handed down by oral communication from teacher to pupil, and which explains the hiatus between one sentence and the other, so that you can see the danger and unwisdom of ignoring the traditional exponents of Sanscrit learning, the Pandits.

Well, the Sikhs take the Amrit, or beverage of immortal learning, which is better than any Ambrosia, or drink of Valhalla: the component elements of it are sugar, spice, and honey. It may be administered by the teacher to the pupil, and by the pupil to the teacher. The fact that physical strength is considered one of the necessary elements of Sikhism, reminds one very much of what the ancient Persians were supposed to be, namely, brave, good horsemen, and truthful, which latter, it is said, the modern Persians are not. Anything more practical than the stages of instruction in the Sikh's school cannot be imagined. Of course, he begins writing his letters on the ground, but this is a very great advantage in countries that have to be economical in the use of paper. Indeed, some of our officers, like General Pollard and others, have themselves benefited by that system.

Then comes something like the "Kindergarten" system. Words are put down which are in immediate relation with surrounding objects. When the alphabet is taught, it is taught along with moral maxims, as, for instance, "G. g.—God is great." Other letters illustrate that virtue does not consist in the worship of the Brahmin's salver with its oil-lamps, bells, &c., but that it consists in doing good, and so forth. Lessons are taught of tolerance to members of other creeds. All miracle-worship is deprecated, and there is one instance on record in which Guru Govind anathematised a relative for having performed the miracle of recalling a dead cow to life. Anyhow, miracles, because they inflate the miracle-worker with pride, are against the essence of Sikhism. The Sikhs meet on platforms or Takhts; on the one platform sit the men, and around, divided by a groove, are women, and they, although they very rarely have been known to give expression to their views, are under a distinct obligation to express their opinion in matters on which they *can* speak. So that, after all, we are not even ahead of India in our theory of female emancipation. In the new Guru Singh Sabha Society, started at Amritsar, "the right of women to express an opinion, or to send it in writing," is expressly reserved. At the same time, when they do speak, I believe they speak with that modesty and self-respect, that faithfulness and tender regard for their families, which, I believe, are characteristics of native women.

The Commercial School.

One could not go very very much lower than the Landé or Commercial School. Here is a book, a dozen copies of which would cost a halfpenny. On the frontispiece you have the Elephant Deity of Wisdom, sitting under a rising sun, and the pupil presenting the book to the master; you are led by gradual stages into those "gurs" by which boys can solve problems in prices of grain which often puzzle our mathematical M.A.'s. Indeed, in the highest schools also, simple sentences connected with daily life illustrate even mathematical problems. For example, "if a mouse were to run along a certain wall, and then fall to the ground at a certain angle," and so on. These "gurs" are simpler than the examples of the Sanscrit Lilavati, but the pupils attain to a readiness in mental calculation which is perfectly astounding.

Photography and Persian Caligraphy.

In schools chiefly or mainly intended for the study of Persian, which is the language of gentlemen, just as Arabic is the language of scholars, and which bridges the way to other studies, caligraphy is considered to be of high importance. The day will come when we shall have a simpler and more beautiful process for the multiplication of books than printing, to which we owe so much. I hold in my hands several books which have been brought out by an improved photographic process, which is in its infancy as yet. Here is a *Hitopadesa*, which, in print, costs 7s. 6d., and which may be brought out by means of photography for a shilling. It is beautifully done. Here, again, is a Koran produced by a similar process. Surely those in India who practise caligraphy—and it is an art taught by absolute rules as to the distance of the dots between the curves of letters, &c.—are not wrong when they pay so much attention to it; and the lithographs of India, which spread education so cheaply, would be worse than they are—and some of them are very beautiful—if that art were not cultivated. I hope the day may come when England or Europe will be able to give her best teaching to the natives of India, and when the best native editions of Oriental poets and philosophers may be circulated at a cost which may place a whole literature within the reach of the poorest, just as the French have attempted to do it in the "Cent bons Livres" at ten centimes each, when a man can buy the little library for eight shillings. Here is a Persian book, brought out by a relative of the Shah, correcting the pictures that are drawn in it of ancient rulers by corresponding coins. The Shia Mahommedans, it may be incidentally stated, allow pictures of living objects, the Sunni Mahommedans do not; at the same time the latter cultivate the design of inanimate objects. When it is alleged that pupils in Government schools do not object to pictures, it is evidently forgotten that the first thing a Mohammedan boy does in a Government school is to drive his pen or a bit of wood through the eye of a picture of a human being, in order to reduce it from the condition of an animate being to that of an inanimate object.

Urdu and Hindi Schools.

Urdu and Hindi schools are of our creation. It would be a loss to discountenance any kind of school meant for any section of the community; every class should have its own share, and no more, in the good things of a country. It would be a misfortune if the clergy or the bar had everything in this country, and so it would be unfortunate for India, were the traditional office-seeking class to monopolise all the "loaves and fishes." Whilst, therefore, I have great admiration for Urdu, our official vernacular, I cannot conceal from myself that the Urdu schools are preferentially attended as an avenue to employment; and that our first duty would be rather to encourage the vernacular —whether it is in the form of Urdu, or Hindi, or Punjabi—of the agricultural classes, from whom the Educational Cess is raised, than to devote that fund to the education of classes that can pay for themselves.

Suggestions for the Revival and Improvement of Indigenous Education.

I would, in conclusion, submit a few suggestions for the revival and improvement of indigenous education :—

1. The assignment in every village of from one to five acres of land out of the Shamilát or common land to the best Maulvi, Pandit, or Guru of the place, to be held in perpetuity for the purpose of teaching; his lineal descendant or a relative, if competent, being appointed his successor, subject to the approval of the village Panchayet, or council of "five" elders. I believe that there will be no difficulty in inducing the village communities to give a few bigas of their common land to the permanent endowment of a school appreciated by them. In some cases waste lands would be available for the purpose; in others, the present jaghirdars would gladly "release," for the sake of establishing an indigenous school, the "Muafi" or rent-free land that they have resumed. In every case, Government revenue would be an eventual gainer by the endowment with land of indigenous schools, whilst the cost of primary education would actually be reduced rather than increased in proportion to the contemplated extension of mass-instruction.

2. The distribution, on public occasions, of presents of Oriental text-books, and of khillats or presents (not cash), to successful teachers, managers, and pupils, and the deferential treatment of recognised Maulvis, Pandits, Gurus, and other representatives of indigenous learning, when attending district durbars, municipalities, &c., for which they ought to have a vote irrespective of income, for poverty is the glory rather than the curse of native learning. The revered teacher or priest has as much right to a vote as the Anglicised youth who has taken the B.A. degree, or who has passed the entrance or even the middle school examination. I would deprecate any money grant being given to indigenous schools through any departmental agency, whether directly or indirectly, for this will at once induce their managers and supporters to look to Government for remuneration as well as compensation for having complied with official regulations, and for having departed, to however small extent, from their own systems of education. If, *e.g.*, in the Punjab a staff of nearly fifty inspectors and their assistants are unable to visit the 1,280 so-called Government village schools, they are manifestly unable to visit *in situ* the 13,000 indigenous schools which have now been ascertained to exist. To inspect them properly would require a staff of 100 inspectors, which could not be done without an increase of taxation. Now, the agriculturists are not willing to be taxed any more for schools, having paid to the Village School Cess hitherto, and not having, as understood by them, received a school in any locality of less than 3,000 inhabitants. Worse than all, any Government interference, whether to tax or to reward, would convert thousands of men, now studying for study's sake, into office-seekers, who like the present alumni

of Government schools, will consider that they have a claim to Government for employment, failing to obtain which, they edit seditious newspapers, chiefly intended for consumption in England. Any official supervision would be worse than the neglect or persecution from which indigenous schools have hitherto suffered. "The real education of the country, instead of being preserved and developed, will then give way to a pretentious and shallow system of preparation for office-hunters; the trades and traditional professions of the pupils will be abandoned; the religious feeling will be destroyed, and the country will be overrun by a hundred thousand semi-educated and needy men for whom it will be impossible to provide, and who will have been rendered unfit for their own occupations. I should indeed regret if my persistently drawing the attention of Government and of the public since 1865 to the neglect of indigenous and of religious education should only result in inflicting a death-blow on India's last hope of a genuine, because indigenous, civilisation." The above remarks would describe the success of such increased inspection or official interference as is contemplated. Should it, however, fail, as is probable from the circumstance that the inspectors have either no knowledge of or sympathy with Arabic or Sanscrit learning, their visits to mosques and temples with the bait of grants of money for secular subjects, will kindle a flame all over India to which the Mutiny may be a child's play, and they will do so at an increased annual cost to the State of, at least, 54 lakhs, if the recommendations of the recent Indian Education Commission are carried out in the spirit of their report. These recommendations are also calculated to suppress the traditional motives of native liberality, by ignoring the religious element as well as the independent action of donors, and the sense of obligation between the teacher and the parent who pays him in a direct manner, and not indirectly and problematically through a fee to a school, which is sent away into the Treasury. All that is required is the spread of a belief among the people that Government is friendly to indigenous primary and higher education, when I have no doubt, from my own very large experience of what can stir natives to liberality, that "all the noble, wealthy, and religious, of whatever denomination, will come forward in the traditional munificent support of an education, however advancing with the age, which they can understand, and that they will spare neither time nor thought in its efficient management. With the accretion of funds and the revival of the educational spirit, all education, including the spread of Western science and of the English language, will also prosper, whereas, without such funds and such spirit it must continue to starve," as I have already pointed out on another occasion.

3. The utilisation of the existing divisions of castes or classes in the cause of progress, by identifying the indigenous teachers, physicians, jurists, &c., with their respective professions, under the more enlightened or different auspices of the age. In other words, our native doctors should be recruited from the ranks of traditional Hakîms or Baids; our teachers should, preferentially, be the sons of Pundits, Maulvis, or other men belonging to the traditional learned classes, which still have the greatest influence, as is shown by natives allowing their girls to be taught by young Pundits, who have a character to lose if they misbehave.

The problem of female education, if it exists, can best be solved by employing the wives of priests, hakîms, &c., as teachers to women in their homes, and not in public schools. By doing this, we will encourage the religious obligation of husbands, especially if priests or professors, to teach their wives. In the same way, the commercial, industrial, and agricultural classes should be educated in a manner which will promote their traditional spheres in life, as far as possible, on indigenous lines. Without either barring the road to merit, or actually declaring the ascetic sweeper superior to the gods, it is caste that has preserved Indian society from disintegration, and that is the main cause of the "*pax britannica*" in India. After another century of struggle in Europe, where class weighs on class far more heavily than caste in India, we may arrive at conclusions not widely differing from those that inspired the Hindu legislator, when he endeavoured to make each section of the community seek perfection in its own work or station in life, whatever that may be, instead of intruding on another. It cannot be sufficiently made clear that "the Hindus are an agglomeration of innumerable commonwealths, each governed by its own social and religious laws. Each race, tribe and caste, cluster of families and family, is a republic in confederation with other republics, as the United States of Hinduism, each jealous of its prerogatives, but each a part of a great autonomy, with Panchayets in every trade, village, caste, and subsection of caste invested with judicial, social, commercial, and even sumptuary authority discussed in their own public meetings. What did it matter who the tyrant was that temporarily obscured their horizon, and took from them the surplus earnings which his death was sure to restore to the country? Even now, if the bulk of the lower castes did not settle their differences at the Councils of their Boards, and if the respectable and Conservative classes did not shrink from attendance at Courts of Justice, we might increase the area of litigation a hundredfold and yet not do a tenth of the work that is still done by the arbitration of the "Brotherhoods."

4. That the Indian Universities hold Oriental examinations to test the subjects taught in indigenous schools and colleges, without unnecessary prescriptions and over-regulations, and that these universities confer accepted indigenous titles on indigenous lines, such, for instance, as was done by the Punjab University College, in awarding various grades of Pandit, Maulvi, Bhai, Kazi, Munshi, Hakim, &c. There can be no objection to a National University giving scholarships to the successful indigenous pupils or teachers, in order to enable them to prosecute their studies to higher standards. Indeed, mere examinations and the award of degrees are the least important work of a national university.

5. The great importance, however, to science and to Government of indigenous learning will never be recognised unless a larger number of European Orientalists, than has hitherto been the case, is appointed to Professorships in Government and other colleges. The knowledge of Arabic, or Sanscrit, is the best if not the only key to the sympathies of Mohammedans and Hindus respectively, to whom Orientalists can appeal with effect, and whose learning they can help to preserve. Indeed, higher education requires to be strengthened, not in the direction of an increase of administrative machinery, which experience has taught me is *the* great obstacle to the progress of Indian education, but in that of more teachers and more colleges. Colleges are quite able to administer their own affairs, and, practically, already do so, whilst their studies are sufficiently guided by the requirements of Universities, and of the public without any further administrative interference from without.

6. The ability to read or write any of the vernacular characters might, after three years' notice, be insisted on as one of the *sine qua non* qualifications of a voter, or elector, a course by which an immense stimulus will be be given to primary education throughout the country.

7. "Whatever view may be held as regards the expediency of the so-called experiment of self-government in India, there can be little doubt as to the appropriateness of its introduction as regards education, at once the safest and the best concession. There should be no question as to the fulness of the educational powers at all events entrusted to Local Boards. Natives have at all times been anxious and scrupulous guardians of such education as they could appreciate, and this applies to those who, in the course of things, will take charge of primary, middle, and high schools respectively. There will be a saving and impetus to education in the abolition of the offices of the Director and the higher Inspectors of schools, who should retire on their pensions," whilst their work will be done with infinitely greater efficiency by following the course recommended in my evidence before the Education Commission, and in my draft on "Self-Government in the Punjab," from which I have quoted several passages.

8. "As regards the existing Government schools to be made over to local Boards, the first hour in each school should be devoted to the separate religious instruction, by accredited teachers, of the members of the various denominations attending such school, the remaining five hours of school-instruction being devoted, as hitherto, to the joint secular instruction of all denominations. Government may not be able to do this, but local bodies should have no difficulty in introducing a measure into the schools taken over from Government which will eventually tend to make education, to a very great extent, self-supporting, in accordance with the spirit and letter of the Educational Despatches of the Secretary of State for India. Solely to increase the number of grant-in-aid schools, however desirable as a recognition of private enterprise, side by side with the regular system of national education, would press hard on the poorer communities, especially on Mohammedans, and would, if successful, develop the spirit of sectarianism in the denominational grant-in-aid schools; a spirit which is modified by the joint secular instruction, as proposed, of all the denominations and their separate religious instruction. The suggested measure would also economise State aid, and conduce to efficiency in teaching, whereas the illimitable development of separate denomina-

tional grant-in-aid school, would involve the State in endless expenditure on generally less efficient schools." On this subject I have to refer to the resolution of an important native society, the Anjuman-i-Panjab, which has successfully endeavoured, since 1865, to popularise Government measures.

9. The only way in which Government could, with any advantage, encourage indigenous, or indeed, other learning, is by liberally rewarding research, discovery, and erudition, of which a brilliant example has been lately reported in the *Times*. I refer to the munificent reward and high decoration which have been given by the German Emperor to Dr. Koch on his return from Calcutta. In India the higher decorations are, apparently, reserved to civilians, military men, and native chiefs, whatever may be the services of others to Science, Education, and the State.

10. The co-operation of the European learned societies and authors with the Punjab University in the spread of Oriental learning and the diffusion of western knowledge through the medium of the vernaculars. This is being attempted here by the establishment of an Oriental University, Museum, and Free Guest house, at Woking, regarding which you may have seen particulars in the *Times* and the *Athenæum*.

11. "The immediate, instead of the prospective, abolition of the departmental monopoly in books would also throw open a large market to the enterprise of publishers and authors in Europe and India. I need not point out what wide field this offers for the activity of Orientalists, but when I add further that the University in question has already issued over 190 works, no doubt of varying degrees of merit, and chiefly translations or editions of existing works, that several hundred thousand copies of popular Persian, Urdu, and Punjabi poets are yearly lithographed by the unaided activity of the people of the Punjab; and that the 2,000 State schools of that province absorb about 68,000 copies of one Urdu reader only, while the 13,000 indigenous Arabic, Sanscrit, Gurmukhi, and other schools have more or less extensive courses of reading; and that all this only refers to one province of the Indian Empire, a vista for literary enterprise is still further opened for Oriental authors and publishers, whose publications will be as valuable to us as those of India may be to them."

12. The establishment of a Linguistic School in England, similar to that in Paris, for the study of the languages, customs, religions, &c., of the East. Had such a school, for which I have agitated since 1859, been started, many of the difficulties that confront us in Egypt, and, indeed, that confront Gordon in Khartoum, would have been avoided. We shall have another Soudan in the so-called "neutral zone" in Asia, unless we establish a School of Interpreters, and utilise all existing linguistic material regarding that region.

I will conclude with the words which, on a kindred subject, I addressed a quarter of a century ago, alas, in vain, to a meeting at the College of Preceptors. I hope that everything I have said to-night will not share the same fate; it was as regards Turkey I then said:—"It is almost too late, as France and Russia have a great start; but 'better late than never.' The character of the English inspires more respect, it seems, in Orientals, than that of almost any other nation. . . . . Yet we carelessly forego the national advantages of character, and sacrifice our commercial interests. In a higher point of view, it seems but fair that we should carry back to the East some of the enlightenment to which it gave the first inspiration; and that there, if anywhere, our Societies, as well as our Government, should not shirk the duty; the former of increasing the usefulness of their appliances, and the latter of appointing competent representatives of British policy, and of the cause of education."

The CHAIRMAN said he regretted that, owing to the length of the lecture, there was no time for discussion, but he was sure the meeting would all agree in a cordial vote of thanks to Dr. Leitner for his most valuable and interesting lecture.

The motion was carried unanimously, and the meeting separated.

Mr. FREDERIC PINCOTT writes as follows:—

"The inevitable tendency of an Education Department is towards extravagance; and this arises from the desire to show good results, and from the absence of personal interest in the ultimate cost. When unlimited funds are not available, as in India, an expensive system can be maintained only by limiting the area of its operation. This accounts for the fact that the Indian Education Department has tried to give a high education to a limited number, rather than to the task of giving an elementary education to the masses. It is clearly impossible, with the funds available, to extend the operation of the costly Department beyond its present limits, without the imposition of oppressive taxation. This elementary fact shows that education can never attain national expansion, except through the agency of the inexpensive indigenous schools. The great value of native agency can easily be demonstrated by the following comparison. The Anglicising Departmental system is in operation throughout Bombay, North-West Provinces, Punjab, Central Provinces, Coory, and the assigned districts of Haidarabad, and thus attends to the educational wants of 99,000,000 of people. Throughout Madras, Bengal, and Assam, however, another system prevails, which, although to an extent departmental, is based on a recognition and encouragement of indigenous schools. The united populations of these three latter places is 105,000,000; thus we find that about half the people of India are under the Anglicising system, and half under a modified indigenous system. But mark the difference in the result. In Bombay, and its associated districts, with a population of 99,000,000, the total number of children under instruction amounts to 807,801; while in Madras, &c., with a population of 105,000,000, there are no less than 1,476,807 children under instruction. We thus see that in populations almost equal in numbers, the indigenous school method reaches nearly twice the number of children as the departmental methods. These figures may be taken as trustworthy, for they are given in the recent report of the Indian Education Commission, and in themselves constitute a thorough condemnation of the departmental system. It is simply amazing that, after establishing such a fact, the Commissioners should actually recommend an extension of the Department's influence."

Mr. Hyde Clarke writes:—

"It is very much to be regretted that there was no discussion on Dr. Leitner's most valuable paper, for we did not hear Sir Lepel Griffin, Sir W. Robinson, or others well acquainted with the subject. From the very diffusion Dr. Leitner was in some cases misunderstood, and in discussion many points would have been cleared up, and many important subjects would have received explanation.

"It was certainly not clear to many whether Dr. Leitner preferred Arabic and Persian as instruments for the diffusion of higher civilisation, or whether he advocated the study of English. In following him, I believe I correctly understood him to recommend to Englishmen the study of Arabic and Persian, as means of intercourse with the higher classes of Mussulmans, and that he relied on the extended cultivation by natives of English for their full advancement in the teachings of modern knowledge and thought. Indeed, to stint natives in the study of English, is to stint their intellectual and political growth. After all, Arabic and Persian are available only with a portion of the vast population of India.

"Indeed, the advocacy by Dr. Leitner, of vernacular education, implies the cultivation of the vernaculars, Dravidian, Kolarian, Burmese, Prakrit, or other; and, consequently, the diminished ascendancy of Persian, Arabic, and Sanscrit, which have been most stimulated, of late years, by the patronage of English officials awakening native effort.

"It was the more necessary to have some explanation, as while the doctrines of Dr. Leitner applied to vernacular education, throughout India, his illustrations referred to the schools of the Punjab and North-West, and were not applicable to Madras and the South. There we have vernaculars neo-Aryan, the whole body of Dravidian languages, derived in uninterrupted tradition from ages long anterior to the introduction of Sanscrit. It is when we concentrate our attention on particular regions only, where some foreign influence has attained pre-eminence, that we forget the general conditions, and that all such languages have been introduced into India as English has. Those who wish to exclude English as foreign, and to promote Persian, forget that Sanscrit, Arabic, and Persian are not indigenous to India, and have all been imported.

"Arabic and Persian, to all intents and purposes, are foreign to India, and they only obtain in degree a higher antiquity than the three centuries of English. Foreign conquest and foreign influence have ever dominated in India. Race has followed race, dynasty dynasty. The English are expected to enforce Persian as a public language, and yet are expected not to employ English, or to allow the natives the privilege of acquiring the greatest of European languages, the tongue of one hundred millions of English-speaking people.

"Dr. Leitner had only one word at the end for a most important subject, his effort to endow London with a high school of the Oriental languages, which may enable us to vie with other countries. No one knows the value of this better than Dr. Leitner; no one is better able to accomplish this than the Professor at King's College, who formed pupils in Arabic and Turkish, whose distinction, it must be said with regret, was more marked than their number. We want for success something more than the scholastic method hitherto in force, or the attempt to confine Oriental studies to schoolboy colleges.

"If once Oriental studies were put on their proper footing in London, they would obtain the same cultivation as is awarded to other branches of knowledge, and it may be that the energetic efforts of men of independent means and position will enable us here also to compete with the professional students of the Continental countries."

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 22, 1884; W. H. Perkin, F.R.S., in the chair. The paper read was "Economic Applications of Seaweed," by Edward C. Stanford, F.C.S.

The paper will be printed in next week's *Journal*.

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 28, 1884; W. H. PREECE, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Burroughs, Silas Manville, Snow-hill-buildings, Holborn-viaduct, E.C.
Fremersdorff, William Frederick, Roseneath-villa, Castle-road, Cardiff.
Hodgson, Christopher, 144, Blake-street, Barrow-in-Furness.
Kilburn, Charles Conning, 3, Cannon-place, Hampstead, N.W.
Sandford, Henry, 31, Ferndale-road, Clapham, S.W., and 36, King-street, E.C.
Wellcome, Henry S., Snow-hill-buildings, Holborn-viaduct, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Atkins, Richard Day, 3, Sidney-place, Cork.
Chapman, Spencer, 84, Eccleston-square, S.W.
Clarke, Stewart, M.P., Bailey's Hotel, South Kensington, S.W.
Kendrew, John Anthony, The Ollands, Reepham, Norfolk.
Paget, Sir James, Bart., F.R.S , 1, Harewood-place, Hanover-square, W.
Pearson, Rev. Henry Daniel, M.A., St. James's Vicarage, Clapton, E.
Phillips, Henry Dominic, J.P., The Maples, Hampton-wick.
Stotherd, Colonel Richard Hugh, R.E., Ordnance-house, Southampton.

The paper read was—

PRIMARY BATTERIES FOR ELECTRIC LIGHTING.

By ISAAC PROBERT.

It has been said that "history repeats itself," and this quotation was never more appropriate than to the subject that will engage our attention this evening.

All of us probably know that it was by a primary battery that the electric light was first produced. So far back as 1802, Sir Humphry Davy, using a battery consisting of plates of copper and zinc dipping into dilute acid, obtained the electric arc between poles of carbon. In the *Journal of the Royal Institution* for that year, Davy, in describing some experiments on the spark yielded by the newly-invented galvanic battery, uses these words:—"When, instead of the metals, pieces of well-burned charcoal were employed, the spark was still larger, and of a vivid whiteness." He also pictures an apparatus for, as he says, "taking the galvanic electrical spark in fluids and aëriform substances." It consisted of a glass tube, open at the top, and having a tubular outlet at the side through which a wire tipped with charcoal was introduced, another wire, also tipped with charcoal, being cemented in a vertical position through the bottom.

In the same year, the electric light, sustained by voltaic action, was publicly shown in Paris by the citizen Robertson. Professor Silvanus P. Thompson, in an interesting communication to *Nature*, has quoted a passage in the *Paris Journal* of March, 1802, from which it appears that the experimenter used a voltaic pile of 120 elements of zinc and silver, to each pole of which he attached a carbon. On bringing the carbons into contact, a brilliant spark was obtained of extreme whiteness.

A few years later, Davy, with the large battery of 2,000 cells, which the munificence of some members of the Royal Institution placed at his disposal, obtained an electric light of a power that has rarely been surpassed, even in our own day.

Thanks to the kind efforts of our Chairman, one of Davy's original battery cells is on the table to-night. The complete battery, to use Davy's own words, consisted "of 200 instruments connected together in regular order, each composed of 10 double plates arranged in cells of porcelain, and containing in each plate 32 square inches. The battery, when the cells were filled with 60 parts of water, mixed with one part of nitric acid, and one part of sulphuric acid, afforded a series of brilliant and impressive effects. When pieces of charcoal about an inch long and one-sixth of an inch in diameter, were brought near each other (within the thirtieth or fortieth part of an inch), a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness, and by withdrawing the points from each other, a constant discharge took place through the heated air, in a space equal to at least four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle."

The electrician, Children, constructed a battery of twenty cells having huge double plates four feet by two, of which the whole surfaces were exposed, in a wooden trough, in cells covered with cement, to the action of diluted acids. It was the grandest combination ever then constructed for exhibiting the effects of extensive surface. To quote Davy's words:—"Points of charcoal ignited by it produced a light so vivid, that even the sunshine, compared with it, appeared feeble."

The light obtained by these experimenters was beautiful in the extreme, and naturally excited the admiration and the hopes of the public, or at least of that educated section of the public to whom the advances of science are not unknown; but it was in no way a practical light. The copper-zinc battery used in the experiments was crude, and quite incapable of sustaining a constant current, the carbon points employed for the arc to play between were mere sticks of wood charcoal, which gave an unsteady light and rapidly consumed, and the beautiful regulators with which we are familiar, for keeping the length of the arc constant, were then quite unknown.

It has just been said that the current obtained by the battery employed in those early experiments was not constant. This want of constancy is due to what is called the polarisation of the battery—that is, the deposition of hydrogen gas upon the copper plate. In the working of the battery, the zinc plate is oxidised and transformed into sulphate of zinc by the sulphuric acid in which the plates are immersed. At the same time, hydrogen gas is liberated on the surface of the copper-plate, where it collects and forms a layer of appreciable thickness, which offers considerable resistance to the transmission of the electric current. It also gives rise to an electromotive force opposed in direction to that of the copper zinc couple. The effect of the polarisation of the battery is then to considerably reduce the current flowing, and worse than this, the amount of deposited gas varies with time and other circumstances, and the current likewise varies. Such a battery, when used to produce the electric light, furnishes a light of constantly varying intensity which is extremely painful to use, and possesses other drawbacks also.

It is evident then that a battery, to be of any use for practical electric lighting, must be capable of generating a constant current. It should also possess these other qualifications, viz., a high and constant electromotive force and a small and constant internal resistance. It should consume inexpensive materials, and should consume nothing when it is producing no current. It should be capable of being easily cleaned, and of being supplied with fresh materials. It should require no skilled attendance. Unfortunately, no battery hitherto invented possesses all the required qualifications.

So long as constant batteries were unknown, the electric light remained a scientific curiosity, but the invention, by Grove, in 1836, of his nitric acid battery, gave a fresh impetus to the subject. Of all the points enumerated, the power to furnish a constant current is the most important. As the want of constancy of a battery is due very largely, although not exclusively, to the deposition of hydrogen gas upon the copper plate, inventors naturally turn their attention to the devising of methods of ridding the battery of this objectionable feature. Mr. Alfred Smee was very early in the field; he found that by roughening the copper plate, the disengagement of the bubbles of hydrogen from its surface was greatly facilitated. The gas, instead of forming a smooth layer upon the copper, collected upon the rough portions, and was discharged upwards through the liquid in streams.

On further investigating the subject, Smee found that it was not necessary that these roughenings of the surface should have appreciable size. In fact better results were obtained with a multitude of small points, from which the gas could be disengaged as quickly as it was liberated by the electrolytic action of the battery, than with a few points of large size, which, although capable of releasing big bubbles, yet permitted the gas to remain on the plate until the big bubbles had been formed by the aggregation of the tiny particles of gas which first appear. He therefore abandoned the copper plate, roughened mechanically, with which his earlier experiments were performed, in favour of a platinum plate, coated with a deposit of very finely divided platinum, obtained by exposing the plate to the action of solution of chloride of the metal, under the influence of the galvanic current. In our own day, platinised silver is often, through a false idea of economy, substituted for the platinised platinum.

This was a very great advance. The Smee battery was justly esteemed at the time for its great constancy as compared with the batteries previously in use. But its constancy, although great in comparison with that of the other batteries then known, was still very far from perfect.

Smee's method of eliminating the ill-effects of the layer of hydrogen was but a method of removal, and the question naturally presented itself to the minds of inventors whether a method of prevention could not be devised. An answer in the affirmative was given by Professor J. F. Daniell, of King's College, who invented a battery which remains to this day unequalled in constancy. You may be interested to hear the description of this first constant battery worthy of the name, in its first form, in the inventor's own words. They are these:—

"A cell of this battery consists of a cylinder of copper three and a-half inches in diameter, which experience has proved to afford the most advantageous distance between the generating (that is the zinc) and conducting (that is the copper) surfaces, but which may vary in height according to the power which it is wished to obtain. A membranous tube, formed of the gullet of an ox, is hung in the centre by a collar and circular copper plate, resting upon a rim placed near the top of the cylinder, and in this is suspended, by a wooden cross bar, a cylindrical rod of amalgamated zinc, half an inch in diameter. The cell is charged with a mixture of eight parts of water and one of oil of vitriol, which has been saturated with sulphate of copper; and portions of the solid salt are placed upon the upper copper plate, which is perforated like a colander, for the purpose of keeping the solution always in a state of saturation. The internal tube is filled with the same acid mixture without the copper. A tube of porous earthenware may be substituted for the membrane with some little loss of power. A number of such cells admit of being connected together very readily into a compound circuit, and will sustain a perfectly equal and steady current for many hours together, with a power far beyond that which can be produced by any other arrangement of a similar quantity of the same metals.

"The surface of the conducting metal is thus perpetually renewed by the deposition of pure copper, and the counter-action of zinc or any other precipitated metal effectually prevented. The minor affinity of the copper for the acid, however, still remains, and such an opposition could only be effectually avoided by the employment of platinum plates, perpetually renewed by the decomposition in the circuit of chloride of platinum; such an arrangement would be perfect, but too costly for ordinary applications."

This battery, the prototype of all chemical depolarising batteries, is worthy of attentive study. In it the hydrogen, instead of being deposited upon the copper plate, is oxidised to water by the solution of copper sulphate, and metallic copper in place of hydrogen is thrown down upon the copper plate. Polarisation is thus entirely prevented.

If constancy of current were the sole requisite of a battery for electric lighting, the Daniell battery would be admirably suited to the purpose, but it will be remembered that a high electromotive force and a low internal resistance are also essential, and here the Daniell battery fails. The electromotive force of any copper zinc couple is low, and the internal resistance of the Daniell cell is high. The electromotive force might be raised by the device suggested by Daniell of employing platinum in place of copper, and solution of chloride of platinum in place of solution of sulphate of copper, but the expense would militate against the practical success of such an arrangement.

It was reserved for Grove—now the Hon. Sir W. R. Grove, one of her Majesty's Judges, but then Professor of Chemistry at the London Institution—to overcome this difficulty, and to produce a chemical depolarising battery of high electromotive force, low internal resistance, and employing a comparative cheap depolarising liquid. Daniell, as we have seen, had appreciated very clearly the advantage of a platinum plate, but his mind seemed so engrossed with his original idea of a metallic solution, as depolariser, which in decomposition deposit upon the plate dipping into it a layer of the same metal, that the possibility of finding a non-metallic depolariser does not appear to have suggested itself to him. Grove, however, saw this possibility, and by the substitution of strong nitric acid for the metallic solution, achieved the success which Daniell had vainly sought for. For the first time, the production of the electric light by the acid of a primary battery became possible on a practical scale; and the very year of Groves' invention, the electric light was used for theatrical purposes, at the Opera House, in Paris.

Suggestions by Cooper, Walker, Bunsen, and Archereau, quickly followed, and in the course of a few years the nitric acid battery had assumed its present convenient form.

It would be tedious to tell you of the many attempts to practically introduce the electric light which now rapidly succeeded one another. One of the most noteworthy instances of the employment of this battery is the electric lighting of the Cherbourg Docks, during their construction in 1858, whereby 1,800 men were enabled to work during the night, when work must otherwise have been suspended.

In 1831, Faraday made the important discovery that when a closed circuit of conducting material—a ring of copper, for example—is moved in the neighbourhood of a magnet, so that the conductor passes from a position of one magnetic intensity to a position of a different magnetic intensity, a current of electricity is generated in the conductor, and that when the conductor is moved, so that a current is generated in it, more mechanical work is done in producing the motion than when no current is generated. In effect, this great discovery was that, by the intervention of a magnet and a coil of wire, mechanical energy—the energy of the arm or of the steam-engine—can be transferred into electric energy. Out of this discovery have grown the huge dynamo-electric machines of to-day, which, as generators of electricity for lighting purposes, have almost driven voltaic batteries from the field of competition.

Why is this? Why is it that a dynamo-electric machine should be almost universally preferred to a voltaic battery for the production of the electric light? It is a question of cost—of the relative cost of the two methods of producing an electric current. Let us examine this point a little in detail.

Both in a voltaic battery and in a dynamo-electric machine, the electric energy is ultimately referable to combustion, or, more strictly, to chemical combustion. In each there is a combustible substance, oxygen or an equivalent substance, to sustain the combustion, and the means wherewith to collect and utilise the energy liberated. In a voltaic battery, the combustible substance is usually zinc, and the oxygenous substance sulphuric acid. In a dynamo-electric machine—or rather in the furnace of the engine that drives it—the combustible substance is coal, and the oxygenous substance air. The question, therefore, as ordinarily presented, resolves itself into this:—Required a certain quantity of electric energy; can it be more economically produced by burning zinc in sulphuric acid in a voltaic battery, or by burning coal in air in the furnace of the engine of a dynamo-electric machine. In answering this question, we must consider the relative cost of zinc and coal, their thermal equivalents—that is, the amounts of heat obtainable by the combustion of equal weights of the two materials; the efficiency of the battery and the engine and machine—that is, the proportion of useful work obtained to the total energy generated; the cost of the oxidant of the zinc-air—the oxidant of the coal costing nothing; the relative cost, both original and for maintenance of the battery and the dynamo and engine; and the relative cost of attendance. In the case of the battery, there is also the possibility of the utilisation of the bye-products to be considered.

To make the matter quite clear, let a practical illustration be taken. Let it be supposed that a house has to be lighted by a hundred incandescence lamps, each requiring a current of ·75 of an ampère urged by an electromotive force of 100 volts. The rate at which energy is expended in each lamp, expressed in volt-ampères or watts, of which 746 were equal to a horse-power, will be ·75 × 100, that is 75. The energy expended in the 100 lamps will be at the rate of 7,500 watts, which are equal to 10·05 horse-power. But this, it must be remembered, is the actual rate at which energy is expended in the lamps. The energy that has to be developed by the engine is greater, for no dynamo-electric machine is perfectly efficient, no dynamo machine gives out as electrical energy the exact equivalent of the mechanical energy expended upon it. Let it be supposed that the machine used in our installation has a "commercial" efficiency of 80 per cent., that is, that 80 per cent. of the mechanical energy put into the machine reappears in the external or lamp circuit as electrical energy, the balance being wasted in heating the armature coils, and the friction of axles, slipping of belts, and other mechanical sources of loss. Then the rate at which energy is generated by the steam-engine must be 10·05 + 1·25, that is 12·55 horse-power. This mechanical energy is to be produced by the combustion of coal, and if all the heat liberated in the combustion of the coal could be collected and utilised, the supply of coal required to generate energy at the rate of 12·55 horse-power would be very small; but, unfortunately, steam-engines, even of the best make, have but low efficiency, and a horse-power-hour of energy requires in practice somewhere about 4½ lbs. of coal for its production; 12·55 horse-power-hours will therefore require about 56½ lbs. of coal—say, roughly, half a-hundredweight, the cost of which is not more than 6d. Assuming that the lamps were required to burn for 1,800 hours a year—that is on an average nearly five hours a day—the annual cost for coal would be £45. The prime cost of a suitable dynamo-machine and engine (with boiler) would be, say, £300, the interest on which, at 4 per cent., would be £12, and the annual depreciation, at 10 per cent., £30; the cost of attendance would be about £60, so that the prime cost would be £300, and the total annual cost £147, or £1 9s. 5d. per lamp.

If a galvanic battery is used to supply the current to the lamps, the energy will require to be produced at a rate of somewhere between 10·05 and 20·1 horse-power, for the efficiency of a galvanic battery depends upon the relation subsisting between the resistance of the battery itself and the resistance of the external circuit. When the greater resistance is reduced until it exactly equals the smaller, the greatest possible current is obtained from the battery, but exactly one-half of the energy liberated is wasted in heating the battery. When the external resistance is high, as compared with the internal, the current is less, but the per centage loss of energy is also less. As a matter of practice, therefore, it becomes advisable to arrange the resistances so that the external is greater than the internal, whereby the efficiency of the latter is made to as nearly approach a hundred per cent. as we wish. Let it be supposed that in our installation the efficiency is, as in the dynamo just considered, 80 per cent. To liberate a horse-power-hour of energy, a quantity of zinc must be oxidised equal to 2·022 lbs. divided by the electromotive force of the galvanic couple in use. It is calculable that the highest electromotive force obtainable in any zinc sulphuric acid battery is 2·248 volts, from which, however, a deduction must be made on account of the energy absorbed in the chemical action of depolarization. The amount of the deduction will depend upon the nature of the depolarizer: with nitrate of soda and sulphuric acid it is ·708 volt, with bichromate of potash it is ·343 volt, and with fuming nitric acid ·284 volt. In order to do fullest justice to batteries, let it be assumed that strong nitric acid is the depolariser used in our installation. The deduction to be made from the total electromotive force of the battery is, therefore, ·284 volt, and the net electromotive of the battery is 1·964 volt, which corresponds to a consumption of 1·03 lb. of zinc per horse-power-hour of energy. To liberate 12·55 horse-power-hours, 12·93 lbs. —say 13 lbs.—of zinc must be used. If the price of zinc be taken at 2½d. per lb., the zinc used per hour costs 2s. 8¼d. But the expense does not end here. Air, the oxidant of coal, costs nothing; whereas sulphuric acid, the usual oxidant of zinc, is of considerable value, costing, even on the commercial scale, ¾d. per lb.

To oxidise a pound of zinc, 1½ lb. of sulphuric acid is required, as is shown by the equation, $Zn + H_2SO_4 = ZnSO_4 + H_2$. To oxidise 13 lbs. of zinc, 19½ lbs. of acid are therefore required, which costs 1s. 2⅝d.; this, added to the cost of the zinc, makes about 3s. 11d. But we cannot stop even here. In order that the zinc may give the greatest possible return of energy, the electromotive force of the voltaic arrangement must, as has been stated, be high, and this—as a net result, at least—can only be obtained by the aid of a good depolarising liquid. We assumed ourselves to be using strong nitric acid, and if we suppose that the average effect of nascent hydrogen upon this substance is to produce nitric oxide (N_2O_2), the amount of acid required will be shown by the equation, $2\,HNO_3 + 3H_2$ (equivalent to 3 Zn) $= N_2O_2 + 4\,H_2O$. It follows, therefore, that the solution of every pound of Zn is accompanied by the deoxidation of ⅔ lb. of nitric acid. In the production of 12·55 horse-power-hours of energy, 8⅔ lbs. of nitric acid will therefore be deoxidised, the cost of which, at 6d. per lb., is 4s. 4d. This, added to the cost of zinc and sulphuric acid, gives 8s. 3d. as the total cost of materials.

But we have not yet done. A battery cannot be charged, and then kept in action until every grain of zinc, and every drop of acid have been consumed. It has been found by experience that no more than about 20 per cent. of the acid can be utilised. When this proportion has been used, the battery begins to flag, and is soon of no further use for electric lighting until the solution has been changed. The greater part of the acid is thus removed as spent solution. But neglecting this source of waste for the moment, and assuming that by a careful process of "refreshing" it is possible to completely exhaust the acid solution, let us see what the cost of our 10·05 horse-power is when generated by a galvanic battery. We have seen that the cost of materials per hour is 8s. 3d., and assuming, as before, that the light will be required for 1,800 hours a year, the annual cost for materials only is £742 10s. od. The prime cost of the battery may be taken at £120, the interest, at 4 per cent., on which is, say, £5, and the annual depreciation, at 10 per cent., is £12. The cost of attendance is very difficult to determine. Primary batteries have as yet been used for electric lighting to such a small extent, that there are, practically, no records of experience whereon to base an opinion. It is claimed by the inventors of batteries that the cost is very small; they say that no skilled attendance is required, and this seems reasonable; and that there is nothing further to do than might be done by a domestic servant in the ordinary course of his duties. Let us assume that this is so, and that the cost of attendance is so small as to be negligible.

If we divide the total annual cost (that is £759 10s.) by the number of lamps, the annual cost per lamp is found to be £7 11s. 8d., as against £1 9s. 5d., when a dynamo machine is used. The difference is great, but it becomes even greater when we remember that it is never possible to completely use the acid solution.

From what has been said, it will be gathered that, in a comparatively large installation such as has been sketched, primary batteries have little chance of success; but for smaller installations, of, say, ten to twenty lamps, there may, perhaps, be a field of action open to them. Few people occupying a house requiring so few lamps as this would incur the trouble of a dynamo and engine, although for health's sake they might not object to the cost of the light as produced by a battery.

In what way is it possible to reduce the cost of electric lighting by galvanic batteries? It is evident that there are four ways open; and invention has been active in all. In the first place, a cheaper oxidisable substance than zinc may be employed; and in the second, possibly a cheaper oxidant than sulphuric acid. Next, contrivances may be adopted by which the solutions are more completely exhausted; and lastly, the bye-products—the substances formed during the action of battery—may be utilised in the arts.

In the first place, as to the oxidisable substance:—Zinc is almost universally employed, but lead and iron have been suggested, and a battery using the latter substance is now before the public.

Next, as to the oxidant, or, speaking more generally, the solvent of the positive element of the cell:—Sulphuric acid has been replaced, among other substances, by hydrochloric acid, and the battery employing this liquid has been introduced by Mr. Ross.

As to the bye-products, little can be said, except that the less said the better. Some promoters of patent batteries make a great point of the value of the bye-products of their batteries, but, as a matter of fact, their statements on this point will seldom bear investigation. A zinc residue contains a certain percentage of the metal in a state of chemical combination, from which it has to be recovered by a somewhat costly process, and one hardly likely to afford any profit to the person using the battery.

It may be interesting to notice that, in the Telegraph Department of the Post-office, no residues are thought worth preserving, except the "black mud" (technically so-called) from the Daniells, which contains a very large percentage of pure copper in the metallic state. Last year, there were 69,323 Daniell cells in use, and the sum realised by the sale of the year's "black mud" was £167 14s., or rather more than a halfpenny per cell per year. An idea may be formed from these figures of the magnitude of the sum likely to result from the sale of the zinc residues—which in the Post-office are thrown away as worthless—in the case of an ordinary householder using some ten or twenty cells.

During the past few years, several batteries especially designed for use in electric lighting have been devised, and the inventors of the more important have been good enough to bring their batteries here to-night, or to furnish descriptions of them. These batteries may be divided into two classes; those in which the liquids are kept in motion, and those in which they are allowed to remain in a state of quiesence. Of the latter, one of the most important is that devised by Messrs. Holmes and Burke. A description which these gentlemen have been good enough to furnish reads thus:—

"Each battery of eight cells can be charged or discharged at two operations, by means of a system of syphons formed partly in the substance of the outside cells. In order to charge the battery it is only necessary to fill a wooden measuring vessel with the exact quantity of fluid necessary to run into the battery, to connect this vessel with the long leg of one of the syphon systems, and to raise the vessel to a certain height, when the liquid immediately distributes itself amongst the cells, and is bound to attain a uniform height in each of them. To discharge the battery, it is only necessary to reverse the process.

"The fumes are collected and suppressed. The porous pots are sealed into wooden covers, which contain passages for the escape of fumes. The passages communicate with one main pipe formed in the substance of the cells, and the fumes can thence be led away to the fume box, where they are either dissolved or chemically absorbed, according to circumstances.

"The connections between the cells are so simple that they can never be coupled up wrongly, and they are placed beyond the reach of injury by acids or fumes. They never require disconnection when the battery is discharged or re-charged. They require partial disconnection when the plates have to be amalgamated, but the latter, when once thoroughly amalgamated, hardly ever requires re-touching. Plates have been run for two months without re-amalgamation.

"The depolarizing liquid is cheap and easily handled. It is made of nitrate of soda dissolved in solution of sulphuric acid of a particular strength. It depends for its action on the formation by the current of nitric acid in the porous pot. The hydrogen entering decomposes the nitrate of soda by the aid of the acid, forming sulphate of soda and nitric acid. The liquid is of very good conductivity, and as the nitric acid is only formed as it is wanted, the inconvenience of handling this very disagreeable acid is avoided.

"The cost of the liquid is only 5½d. to 6d. a gallon. Each gallon furnishes from 750 to 800 ampère-hours of electricity at an electromotive force of 1·92 volt—*i.e.*, about 1,536 watts, or very nearly two hour horse-power.

"The internal resistance of the battery is very low for a primary cell, and equals ·02 ohm. as nearly as possible."

It may be added that, like the generality of electric lighting batteries, the batteries of Messrs. Holmes and Bourke employ carbon and zinc as the elements.

The battery which next claims attention is that of Mr. O. C. D. Ross, of which a model is on the table. The chief point of novelty distinguishing it is the ingenious arrangement for charging and discharging the depolarising liquid.

The battery itself is enclosed in a box, about 1 ft. square by 7 ft. long, which contains thirteen double cells, the plates in each of which weigh about 10 lbs; the whole box when charged weighs about 2 cwt. Each cell contains two carbon plates (formed of ½ in. carbon rods placed side by side) which are immersed in dilute hydrochloric acid mixed with one-sixth of its bulk of a mysterious compound, called by Mr. Ross "Eureka," but which might doubtless be replaced, without materially affecting the action or the cost of the battery, by nitric acid. The zinc plates dip into a solution of common salt, the liquids being kept apart by porous partitions. The mechanical arrangement by which the carbon cells are filled and emptied is very simple; a horizontal pipe connected by flexible tubes to the bottom of each inner cell is raised or lowered; one end is attached by a flexible tube to a cask of acid, and the other end is led to a waste tank. When the horizontal pipe is raised, and communication with the waste tank cut off, the acid flows, on turning the tap of the acid cask, into the inner cells. When spent liquid is required to be removed, the horizontal pipe is lowered, and the liquid flows from the cells to the waste tank. The outer cells are filled with solution of salt, in one operation, by pouring the solution into a groove extending the whole length of the box, and connected by side passages with the cells.

The Ross battery has been examined by Dr. Hopkinson, who reports that:—

"Comparing this battery with others, a great deal may be said in its favour.

"Its constancy with a large current is remarkably good.

"The liquids used in the cells are less expensive than in any battery having any pretence to constancy.

"Mr. Ross's method of drawing off and replenishing the liquid is very convenient."

The electromotive force per cell is stated to be 1·82 volt, and the resistance 0·06 ohm.

Another battery, introduced some time back, is that known as the "Edeo" or "Heap" battery. It is a carbon-zinc couple using bichromate of potash as the depolariser, and dilute sulphuric acid as the excitant. The cells are lined with lead, and hold each 1½ gallon of the bichromate mixture (which can be purchased ready prepared at 1s. per gallon). The zinc plates are 10 × 6 inches, and so offer a total surface of 120 square inches to the action of the acid; they weigh 3 lbs. each. The electromotive force is stated to be 2 volts per cell, and the resistance 0·2 ohm. The point of novelty is claimed to lie in the preparation of the bichromatie solution, the description.of which is best given in the manufacturers' own words. They are as follows:—

"In each lead cell pour six pints of water, and in each repeat the following operation:—

"Fill the colander (which is supplied with the battery) with bichromate of potash, and hang it in the cell so that the crystals are just immersed in the water. Pour about one-fourth of three pounds of sulphuric acid over the crystals in the colander slowly, stopping occasionally when the liquid boils. As fast as the bichromate of potash gets dissolved, add more, and continue pouring in sulphuric acid as before, until there are used up for each cell all of one and a-half pounds of bichromate of potash, and three pounds of sulphuric acid. When the liquid is entirely cool, it is ready for use. . . . . This fluid will last twice as long as the . . . fluid ordinarily supplied."

Mr. Heap is good enough to exhibit a three-cell battery in action to-night.

In the other or circulating class of batteries, there is one deserving of notice. It is the invention of Messrs. Oliphant, Burr, and Gowan. It is a two fluid bichromate battery, having zincs coated with an extremely thin film of gold before amalgamation. The exciting liquid is a solution of salts of mercury. The liquids for the outer jars and inner porous pots are pumped out of separate tanks into distinct pipes communicating with the first jar and the first porous pot. They then rise up syphon pipes into the adjoining cell, and flow onwards in this way through the whole series. To avoid any possible stoppage through friction in the pipes, it is advisable to have the first cell half-an-inch higher than the second, and so on. Thus, in a series of six cells, the last cell will be three inches lower than the first. The last jar and porous pot are connected to their respective tanks. The tank holding the bichromate solution is fitted as a cell, and works a Griscom or other motor, which causes two small pumps to keep the liquids in constant circulation. The pumps raise two cubic inches of liquid per stroke, and work at the rate of thirty strokes per minute. The pumps are constantly at work day and night, whether the battery is in use or not.

The effect of gilding the zincs before amalgamation is, it is stated, to materially decrease local action.

Many other batteries might be described, and it may be interesting to note that, during the past three years, about 150 patents for improvements in primary batteries have been applied for in Great Britain alone.

A question which presents itself in connection with the problem of economical lighting by primary batteries is this :—Is it not possible to effect economy in the lamps—to so improve the lamps that a given expenditure of energy on the part of the battery will develop more light in the lamps than is now obtained? Yes; it is possible. It would be troubling you too much to enter here into a lengthy account of the scientific principles which should guide the designer of the luminous conductors of incandescence lamps. It must suffice to say, that the ideally perfect conductor would assume a spherical form; its mass would be very small, and its surface also, and the material of which it was composed would possess the power, possessed unfortunately by no known substance, of enduring without change for an unlimited time the passage of a very powerful electric current. Of all substances hitherto used for incandescing conductors, carbon obtained by the intense heating of a pure hydro-carbon is the best. It will give a greater returning light for a given expenditure of energy, and will withstand the action of the conductor longer than any other substance. It will become possible, therefore, by its aid to approach more nearly to the ideally perfect form of luminous conductor than we should otherwise be able to. If also we can so fashion the intimate structure of the carbon, that the particles already have that arrangement which they tend to assume under the action of the current, the type of perfection can be approached even more nearly. This has been done. In a patent obtained in November, 1882, by Messrs. Boullon and Soward, in conjunction with myself, a method was described by which luminous conductors can be obtained of pure deposited carbon formed under the influence of the electric current. By suitable means, these conductors can be obtained of any required degree of approximation to the theoretically perfect form. What thickness they will ultimately assume it is impossible yet to say. The shorter and finer they are made, the greater is the economy, but the shorter is their life. The thickness at which the economy in action is just balanced by the increased cost of renewal of lamps is the practical working thickness, but this can only be determined by lengthy experiments, which are still in progress.

It may be noted in passing that high resistance luminous conductors—and they can be made without difficulty with a resistance of 1,000 ohms and upwards to the inch—have the great advantage that they work with a small current, although they necessarily require a somewhat high electromotive force. This enables the copper leads to be much thinner, and therefore less expensive, than in the case of a low resistance luminous conductor, worked by a large current, which is an important point worth bearing in mind. Messrs. Woodhouse and Rawson have quite recently introduced a new lamp, which they call their "hair filament lamp." These lamps have an extremely thin, hair-like filament, whence their name. No particulars of the method of manufacturing these filaments have been published, but it appears that, like the filaments of my colleagues and myself, they are made of deposited carbon. The method of their preparation is carefully kept secret, doubtless for fear of piratical imitations, which although generally easily detected, are yet often hard to prove in a court of law. These filaments are stated to be very efficient. It is said that they will furnish a given amount of light with less than half the expenditure of energy necessary to furnish the same amount in an ordinary thick filament. This is doubtless true: the experiments of my colleagues and myself with our own filaments perfectly support this statement, and we have had the opportunity of experimenting with filaments of much greater length, and therefore light-giving power, than Messrs. Woodhouse and Rawson seem to have had, if a conclusion may be formed from the lamps before the public.

It is hoped that the many inventors of primary batteries, who are doubtless present, will favour us with a fuller description of their inventions than the limits of this paper have permitted, and that an interesting and valuable discussion will ensue.

DISCUSSION.

The CHAIRMAN said, when it was remembered that during the last three years no less than 150 patents had been taken out for new primary batteries, no one could wonder that Mr. Probert had only been able to refer to three or four of the number; but he was somewhat surprised that he had omitted all reference to one which had created as much interest as any he had named, one devised by an extremely clever Russian officer, who had unfortunately succumbed to the English climate—Mr. Skriwènoff. This battery was very remarkable for its compactness and power; when visiting Vienna lately he carried one in his waistcoat pocket, and had a small lamp in his scarf, and he now had one concealed about him connected to a little lamp in a flower in his button-hole, and by simply bringing the two wires together it was put into a state of incandescence.

Mr. HOLMES then exhibited a model of his battery, and described its construction and mode of operation. The fumes from the nitric acid were conveyed to a box, where they were either absorbed by a solution of sulphate of iron, or converted by a solution of sulphate of ammonia into nitrate of ammonia. The cost of the nitrate of soda which formed the polarising liquid, was only £10 a ton, or a little over 1d. per lb., and the total cost of the sulphuric acid solution was from 5½d. to 6d. a gallon, each gallon giving from 700 to 800 ampère hours of electricity.

Mr. ROSS next exhibited a model of his battery, and described its mode of action. There was no attention required beyond removing about one-seventh of the liquid each day, and replacing it by fresh acid, which was effected by lowering and raising a tube at the side. For a battery lighting 50 lamps of 20 candle power, the quantity of liquid required to be drained off each day was about 10 gallons, and smaller batteries in proportion; any domestic servant could manage it without difficulty, and the battery would work for two or three weeks without anything else being done to it; but he arranged for an inspector to go round once a fortnight, and attend to the zinc plates. The liquid was very cheap, being principally water; the outside cells were filled with salt water, and the inside with water and acid, mostly hydrochloric acid, the cheapest in existence, being, even in London, only ⅓d. per lb. In Newcastle it was only 3s. 6d. per cwt., and, in fact, large quantities were taken out to sea in barges, and thrown away; to this was added a very small portion of a solution, the nature of which was a secret. He had made a calculation showing the relative cost of electric lighting by batteries, as compared with gas, and though he did not pretend that the battery could compete with gas, yet the expense of the zinc in the battery was less than the price of gas. The product of a ton of coals—say, 10,000 cubic feet of gas—when burned in Argand burners, would give a light of 30,000 candles for an hour, which, at 3s. per 1,000, would be 30s. Now one ton of zinc would give 1,280 horse-power, which, at the rate of 333 candles per horse-power, would be 426,240 per hour, or more than fourteen times as much light as was obtained from a ton of coal; while the cost of zinc at £18 a ton was only twelve times as much as the 30s. which the gas cost. That was a strong argument against the popular belief that the cost of zinc was absolutely prohibitory of its use in lighting. He did not for a moment suppose that galvanic batteries as now made could compete with dynamos when used on a large scale, because the economy of the dynamo was shown to be very great when used for large installations; but a dynamo could not be put into a cellar, and a battery could. Central stations would not exist in many parts of London, at any rate, for many years to come, and meanwhile there were many persons who would willingly introduce the electric light. Its wholesomeness was one very great point, and it was innocuous to books and gilding, so that there was a large field for it where wax candles or lamps were now used, the former of which cost fifteen times, and the latter five times as much as they would, even when supplied by a battery.

Mr. BURR next explained the battery made by his firm, which he said had three peculiarities. In the first place, they endeavoured to minimise the destruction of the zinc, by coating it with gold previous to amalgamating with mercury. They had great difficulty in obtaining patents in America and Germany for that process, but ultimately succeeded. Secondly, in place of mercury they employed chloride of mercury, a small portion of which had the same effect, and avoided the bad effects of mercury fumes being given off. The third improvement was due to the late Mr.

Spottiswoode, the object of which was to prevent the polarisation of the carbon by the formation of hydrogen bubbles. This was effected by keeping up a circulation in the liquid; Mr. Spottiswoode's suggestion only went to circulating the liquid in the carbon cells, but they found the results so excellent that they applied it to both sets; the circulation being effected by means of syphons, and small pumps worked by a dynamo, as described in the paper. The solution they found to act best in the carbon cells was $3\frac{1}{2}$ parts, by weight of bichromate of potash, to 1 of sulphuric acid, and 10 of water. For the zinc cells, water only with the addition of about $\frac{1}{2}$ oz. of chloride of mercury was used. This cost 2s. 6d. per lb., and a pound would supply 30 cells for three months. It was necessary to add to the zinc cells about a pint of water every three days, for the water appeared to be consumed far more rapidly than would be accounted for by evaporation. In the carbon cistern was hung a small colander filled with bichromate of potash, and when that got empty you simply had to refill it, and, provided the circulation was kept up, there would be no formation of chrome alum crystals. The cost of the zinc was hardly worth considering. They had worked a battery constantly day and night for 100 hours, and the consumption of bichromate of potash was about 1 lb. per week, while the amount of chloride used was hardly worth mentioning. When they commenced, the bichromate of potash cost 7d. per lb., but it was now reduced to $3\frac{1}{2}$d., and no doubt it would come down still further.

Prof. GEORGE FORBES said Mr. Probert had giveu a very impartial view of the relative merits of dynamos and batteries, and of course the enormous economy of the former, on a large scale, was obvious to all. The merits of the different batteries had also been well brought out. He had examined one or two of these batteries, and certainly some had great advantages, but he must say that claims were sometimes put forward by inventors which were not borne out; for instance, the economy which was promised in the consumption of zinc and so forth, had not been found to exist. He would not go into particulars on this point, as some of the information he had obtained was confidential, but he must admit that all who had tested this class of primary batteries found that great improvements had been made in the depolarising agent, and especially in the economy of it. The nitric acid which had generally been used was an expensive material, and great economy had been introduced in this respect by more than one inventor. Still more advance was shown in the mechanical improvements which had been made, by which the process of charging and discharging the batteries from day to day had been rendered very simple, and thus a very important obstacle to their use had been removed. He regretted the reader of the paper had not gone more fully into some other batteries introduced, not only in this country, but also on the Continent. For instance, there was the interesting battery of Lalande, in which oxide of copper was used as the depolariser, from which it was hoped considerable results might come. Again, Mr. Probert told them that the substitution of some other material for zinc was a possible line of economy, but up to the present he had no advance to announce. It would have been interesting if he had given some information about the attempts to use carbon as the positive plate. These experiments had been chiefly made in France, and some in America. He believed some of the first experiments were made by himself in 1879, when he thought he saw a twofold advantage from the consumption of carbon. Since you must consume carbon in a furnace in order to produce steam, and then afterwards convert steam-power into electricity, it seemed much simpler to produce the electricity from the consumption of carbon direct. Secondly, if you could consume carbon to give a fair amount of electromotive force in combination with any other material, the atomic weight of carbon being so small, the weight required to be used would also be very small. Again, considering that in the Bessemer furnace, the carbon consumed the oxygen of the air which was blown in, and the iron did not, it seemed probable that in that case the carbon would be positive to the iron. The first experiment, therefore, was made with black oxide of iron in Professor Crum Brown's laboratory in Edinburgh. The oxide of iron was melted, and a plate of iron and a plate of carbon were immersed in it, and the carbon was found to act as a positive plate. The intense heat required, of course rendered that method useless practically, and he then tried litharge, but found that that melted the vessel in which it was put. Then they passed to the use of melted salts, in which the chemical action appeared to be the consumption of oxygen in red-hot water; but that was rather trenching on Professor Guthrie's subject of cryhydrates. These experiments had been carried farther on the Continent, and he thought it would be in this direction that they must look for the next advance, for the consumption of zinc must always be an expensive way of getting electricity. When he heard the figures given of the amount received by the Post-office for the bye-products of their batteries, he could not help asking the Chairman whether those products were utilised as well as they might be, and whether they did not get much more for them in Germany. The value of these bye-products was another point on which more information would be welcome, as they were accustomed to hear statements which, if true, would lead one to believe that electricity could be had for nothing, and the bye-products into the bargain.

Mr. SHOOLBRED asked the size of the battery which had worked continuously for 600 hours.

Mr. BURR said it was a 12-cell battery, and the same cells were on the platform and could be examined, only the porous cells were round instead of square.

Mr. WHARTON said he had had a fair amount of experience with one of Mr. Holmes's batteries. No doubt dynamos were more practical things and he would far sooner use them than batteries, where the installation was of a size of from 100 to 1,000 lights; but if they could approach anything like the economy claimed by Mr. Burr, where water was oxidised, there might be more to be said for the batteries, or if they could succeed in oxidising coal in a battery, and getting a better proportion of the theoretical heat value out of it. With any combination of a steam or gas-engine to a dynamo they only got about 4 or 5 per cent., whilst in Mr. Holmes's battery about 60 per cent. of the theoretical efficiency of the zinc was obtained. He had used a battery on many occasions for real practical work, and had found it useful, and far superior to accummulators. On one occasion, he lit 48 lamps 8 hours a-day for 6 days consecutively, under a contract; the current was uniform, 65 ampères; the external resistance was constant because he kept the same number of lamps on the whole time, and the fall of potential between the mains was *nil*. That was about as large a practical use of a primary battery as had ever been made, and was for lighting a bazaar in a building underground. If he had used accumulators, he should have had much greater difficulty, more weight to carry, and would have had to bring them back each day to be re-charged. The cost was, perhaps, more than that of a large dynamo and steam-engine, but the convenience was very great. Again, for small installations in houses, where one or two rooms only had to be lit, it was quite out of the question to use a dynamo and steam or gas-engine, and for such purposes these batteries might be very useful. There was also a great improvement going on in the lamps; a short time ago, 3 watts per candle was considered very good, but the lamps on the table were running at 1·7 watts per lamp.

Mr. FERGUSON said he had been using the Lalande and Chaperon battery, to which Professor Forbes referred, for electric lighting; he had one in his office, at 31, Lombard-street, which had been at work without being touched at all for four or five weeks, giving light for about six hours a day. He had sent down a couple of the cells, which were on the table, and if a little more attention were turned to the use of alkalies for these batteries, they would be much improved. The acids made a horrible smell, and there was some trouble in getting rid of the fumes, but by the use of caustic soda or potash, he thought that might be avoided. He should be glad to show the battery to any one who would call at his office.

Mr. PROBERT, in reply, said he had not forgotten the Lalande and Chaperon battery, but it only came under his notice the previous day, and he had not had much time to examine it. He could not say anything about the carbon theory; his feeling was that thermopiles would ultimately become the most efficient generators of electricity for domestic lighting. There you certainly had heat transformed directly into electricity, and it seemed to him a much neglected subject which deserved more attention. He would also drew attention to a table lamp of 3-candle power lent by Mr. Smith (Elliott Brothers). The base box contained five small Skrivanow cells of the kind alluded to by the Chairman. This form of battery is a costly luxury, being chiefly used for buttonhole or necktie pin lamps on special occasions. The compounds and elements are chloride of silver, caustic potash, silver and zinc. In conclusion, he desired to mention the fact that the forty-five Swan 10- and 12-candle lamps, so artistically arranged by Messrs. Wharton and Down, and so efficiently worked during the evening, derived their energy from thirty-three Holmes and Burke cells, the area occupied by each cell being 4 in. by 13 in.

The CHAIRMAN, in moving a vote of thanks to Mr. Probert, having drawn attention to one of Messrs. Woodhouse and Rawson's small lamps attached to a laryngscope, said he must first refer to the question of the waste products in the Post-office. Mr. Probert had referred to 69,000 Daniell cells, but that was but a small part of the total battery power employed; altogether it would be more like 200,000 cells. But the consumption of material in each cell, per annum, was quite insignificant. Taking the maximum current employed for telegraphic purposes, he made out the resulting product for twelve months was only equivalent to that resulting from the production of 30 ampères in one hour; so that the whole product from one cell in a year in the telegraphic service was only half that of one of Mr. Holmes's batteries working for an hour. But the real point was that the cost of collecting the waste far exceeded the amount realised by selling it. In Germany they might do better, because there the railways were practically in the hands of the Government, and carriage was free. He did not take such a pessimist view as some people of the future of primary batteries; there was plenty of room for them, not only where dynamos and secondary batteries were out of the question, but even in economy, as compared with other modes of producing electricity. On the other hand, he could not go so far in their favour as some ardent inventors. One of his duties was to examine inventions, and as he had to inquire into about three a day on an average, it might easily be imagined that he got rather sick of inventions, especially when the same thing was brought forward again and again. The gist of what many of these inventors claimed was to this effect, that their new battery cost nothing; it never required charging; its electromotive force was infinite, and the residuals were of great value; its internal resistance was nothing, and its current absolutely constant; in fact, if Mr. Chamberlain and the Chancellor of the Exchequer availed themselves of the invention, they would very soon pay off the National Debt. It was a pity inventors should go so far as that, but there were some exceptions, and certainly some of the instruments brought forward that evening were really doing very good work. He had seen Messrs. Oliphant, Burr, and Gowan's battery at work after it had been at work for some hundreds of hours; and he had seen one of Mr. Holmes', lighting up a train on the London and South-Western Railway very successfully, and was informed that another was employed on the Midland line. Mr. Probert had brought out the cost of 100 lamps for 1,800 hours, but no one wanted to use a battery for 100 lamps; they wanted a small battery to give a light in a dining-room or library, where the consumption was very small; or in City offices, where it got dark at 4 o'clock, and they wanted to remain an hour longer. How pleasant it would be to turn on a battery to give that hour's light, instead of having to submit as at present to the poisonous fumes of gas. Mr. Ross had given a curious calculation as to the cost of zinc, as compared with gas, which he should be interested in verifying when he saw the figures in print, but that was not the proper way of estimating the cost of a battery. You must take into account the capital charges, depreciation and renewals, and above all the cost of supervision and attendance; and when all these were examined carefully, it would be found that batteries, though they were very nice fore some purposes, were expensive luxuries. Experience was the only test, and he should strongly urge inventors to apply it to their batteries, and bring forward the actual results, showing how they behaved. One of the most important points in connection with this question was the efficiency of the lamps. Edison lamps were used in that hall, and though one would occasionally give in, he believed nine-tenths of those now in use were the same which were originally put up. The efficiency was indicated by the number of watts consumed to produce one candle power; the Edison required four; some Swan lamps exhibited that evening required three-and-a-half, and he had recently been experimenting with some of Woodhouse and Rawson's, which only required two, so that in less than two years the efficiency of incandescent lamps had been doubled, and probably, before they met again, some one else would have made a still further improvement.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

A Conference, arranged by the Mansion-house Council on the Dwellings of the Poor, will take place on June 4th, 5th, 6th, at 2 p.m. The chairman, on June 4th, will be the Lord Mayor, M.P., and the papers to be read, "The Population of London and its Migrations," by G. B. Longstaff, M.A., M.B., F.S.S.; "The Treatment of the London Poor," by Miss Gertrude Toynbee; "Overcrowding," by Rev. A. Mearns. On June 5th, chairman, the Archbishop of Canterbury; papers, "Suburban Dwellings and Cheap Railway Fares," by James Hole; "The Treatment of the London Poor," by Miss Lidgett; "On the Creation of a Building Fund," by H. D. Harrod. On June 6th, chairman, Cardinal Manning; papers, "Some Difficulties of Sanitary Legislation in the Metropolis," by Shirley F. Murphy, M.R.C.S., and B. C. Whitelegge, M.D.; "Suggestions to the Royal Commissioners," by C. M. Sawell.

Further conferences, the dates of which are not yet fixed, are as follows:—

Society of Medical Officers of Health; Parkes Museum of Hygiene; Sanitary Institute of Great Britain (these three institutions are amalgamated for the purpose of a conference)—"Domestic Sanitation in the Urban and Rural Districts; Industrial Diseases; How Infectious Diseases are spread; Notification of Infectious Diseases; Disposal of the Dead, Cremation."

Central Chamber of Agriculture—"Meat Supply."

Society of Arts—"Water Supply and Distribution."

Royal Institute of British Architects—"Construction of Houses with regard to Sanitary Arrangements."

Association for the Oral Instruction of the Deaf and Dumb—"Oral Instruction of the Deaf and Dumb."

Society of Telegraph Engineers and Electricians—"Electric Lighting—Municipal and Domestic," or on other subjects connected with application of Electrical Science.

Institute of Chemistry—"Food Adulteration and Analysis."

Social Science Association—"Sanitary Legislation."

National Health Society—Some subject cognate to the work of the Society.

Medical Society of London—"The Effect on the Health of Teachers and Children of Overwork in Schools."

St. John's Ambulance Association; National Society for Aid to Sick and Wounded in War—"Ambulance Work in Peace and War."

British Bee-keepers' Association—"Bee-keeping generally."

Epidemiological Society—"Tropical Sanitation."

The following lectures will be given during June, July, and August:—Mattieu W. Williams, F.C.S., "Science of Cookery;" Prof. Charles Graham, D.Sc., "Chemistry of Bread-making;" Edmund Owen, "Rearing of Hand-fed Infants;" R. W. Wigner, "Pure Milk;" Miss M. Smithard, "Dairy Management;" Prof. de Chaumont, M.D., F.R.S., "Practical Dietetics, especially in relation to Preserved and Condensed Food;" Professor T. Spencer Cobbold, M.D., F.R.S. (two lectures), "Parasites which infest Meat and Food generally;" Hon. S. Lewis Wingfield, "History of English Dress;" Wm. Morris, "Textiles Generally," and "Artistic Furniture;" Caspar Purdon Clarke, C.I.E., "Oriental Dress;" T. Pridgin Teale, "Healthy Houses;" Thomas W. Cutler, "Sanitary Furniture;" Malcolm Morris, "Ethics of the Skin;" S. D. Darbishire, M.D., "Recreation;" Henry Carr, "Our Domestic Poisons;" Harold B. Dixon, "Domestic Use of Gas;" W. H. Preece, F.R.S., "Domestic Use of Electric Light;" Leopold Field, "Candles;" Charles F. Cross, "Soap;" Ernest Hart, "How to Burn Coal."

INTERNATIONAL INVENTIONS EXHIBITION, 1885.

His Royal Highness the Prince of Wales, the President, has nominated the following Executive Council for the International Exhibition of New Inventions and of Musical Instruments, to be held next year:—Sir Frederick Bramwell, F.R.S., Chairman; The Marquis of Hamilton, Vice-Chairman; Sir Frederick Abel, C.B., D.C.L., F.R.S.; Mr. Edward Birkbeck, M.P., Hon. Treasurer; Mr. J. Lowthian Bell, F.R.S.; Colonel Sir Francis Bolton; Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.; Professor Dewar, F.R.S.; Mr. Joseph Dickenson; Sir B. T. Brandreth Gibbs; Sir George Grove; Mr. Edward W. Hamilton; Mr. Harry Jones; Mr. W. H. Preece, F.R.S.; Sir Edward James Reed, K.C.B., M.P., F.R.S.; Prof. W. Chandler Roberts, F.R.S.; Mr. John Robinson; Dr. John Stainer, M.A., Mus. Doc.; Mr. Richard Webster, Q.C.; with Mr. Edward Cunliffe-Owen as Secretary.

The first division of the Exhibition will comprise apparatus, appliances, processes, and products, invented or brought into use since 1862; the second division will be devoted to music since 1800.

Correspondence.

TELEGRAPH RATES.

Mr. John Ruscoe writes respecting Colonel Webber's paper:—

"It is evident that by the use of some code or regulation, whether it be by adopting time or urgent messages at 1s. each per twenty words, and messages of the same number of words at 6d. each, to be sent as soon as the wires are freed from pressure of urgent or 1s. messages, or what in a vast number of cases would amount to the same thing, 20 words for 1s., and 10 words for 6d., the Department will be kept in more regular and continuous operation, for should the introduction of 6d. telegrams, on the base of the paper, or some other similar basis, become a matter of fact, the State will reap substantial financial benefit, not only from the increased messages which will be sent, but by the more regular and continuous employment of their staff. There can be no doubt that urgent and delayed messages will both be appreciated by the commercial community. I could enumerate cases where a speeded telegram, at an increased price to an ordinary message, would be frequently adopted. To reduce all to one level would, in my humble opinion, be a great mistake. The offices now in busy centres from 11 to 3 are fairly engaged; to double their labour by a uniform telegram rate of 6d. each would choke those offices in the best and most business part of the day, with the result that the general telegraphing public would bitterly, and very justly, complain; but by express and secondary messages, all such complaints would be avoided.

"Dr. Cameron, M.P., in his advocacy of this scheme, deserves to be, as I feel sure he will be, supported in his efforts in this matter."

General Notes.

Telpherage.—Professor Fleeming Jenkin, LL.D., F.R.S., wishes it to be known that the model of the telpher railway can be seen in action at No. 18, Fitzroy-street, W., on Friday afternoons, by members of the Society of Arts and others, on presentation of their visiting cards.

Grocers' Company's Research Scholarships.—At a Court of Assistants of the Worshipful Company of Grocers, held on Wednesday, May 21st, 1884, the following candidates were elected to the Company's Scholarships for Research, into the causes of important diseases, viz.:—1. W. North, subject, "Ætiology of Ague." 2. Leonard C. Wooldridge, D.Sc., M.B., subject, "Hœmorrhagic Disease, Pernicious Anæmia, and Blood Clotting." 3. Alfred Lingard, M.R.C.S., subject, "Intimate Ætiology of Enteric Fever."

Oranges in New South Wales.—The orange-tree was first introduced into Sydney, New South Wales, from Brazil, in 1788. Captain Hunter says, in his "Journal of Transactions at Port Jackson and Norfolk Island," that they took on board at Rio de Janeiro, among other seeds and plants, "orange, lime, and lemon trees," and further states, that at Sydney "vines, orange, and lemon trees are in a very thriving state." These were introduced from Sydney into Norfolk Island, when Lieut. King observes in his Journal of 1788, at that island, "Two orange-trees, which I brought with me (from

Sydney) were kept in tubs until I should find a sheltered situation to plant them in." He afterwards says they were planted in the vale; and in March, 1790, observes, "Vines, orange, and lemon trees are in a very thriving state." Thus we find that they appeared to be well established in Norfolk Island; and at this time they were also thriving at Sydney, as we learn from "Phillips's New South Wales in 1790," from which date we may consider the cultivation of the orange-tree as permanent in the Colony. Orange cultivation is now a leading industry in New South Wales, its head-quarters being at Paramatta, near Sydney, where millions of oranges are annually grown, both for home consumption and for export. The orange is also largely grown in other parts of the Colony, being in some measure to the colonists what the apple and pear are to residents in the United Kingdom.

Antwerp International Exhibition.—This Exhibition will be held next year, under the patronage of the King of the Belgians. Failing any vote from the British Government, in order to facilitate English exhibitors, the Local Committee propose defraying all the expenses of decorating the British section, London offices, staff, and advertising, bringing in and taking out goods, and storing cases, so that exhibitors will have only a fixed charge for space to pay. Mr. P. L. Simmonds has been appointed British Commissioner, and has already formed an Honorary Committee, which comprises the Lord Mayor and Sheriffs, many of the leading Aldermen, the Provincial Mayors, the Agents-General for the Colonies, and Members of the Council of the Royal Colonial Institute, the Marquis of Hamilton, Lord Thurlow, Lord Claud Hamilton, Lord Alfred Churchill, Sir Lyon Playfair, K.C.B., M.P.; Sir Drummond Wolff, K.C.M.G.; Sir Philip Cunliffe-Owen, K.C.M.G.; Sir George Birdwood, C.S.I.; Sir Daniel Cooper, Bart, K.C.M.G.; Sir Francis R. Sandford, K.C.B. Our imports from Belgium has increased in value by 3½ millions in the past three years, and our exports of British produce and manufactures have increased in value from a total of 5 millions sterling in 1879, to over 8 millions in 1882, to say nothing of the foreign and colonial merchandise shipped there to the value of 7 millions. Our cotton and woollen manufactures sent there have doubled very lately, and the Board of Trade returns for 1882 show the following figures:—Exports of cotton manufactures, £2,260,808; wool, woollens, and woollen yarn, £1,713,226; total, £3,974,034.

MEETINGS OF THE SOCIETY.

Indian Section.

Friday evenings:—

May 30.—"Street Architecture in India." By C. Purdon Clarke, C.I.E. This paper will be illustrated by means of the Oxy-Hydrogen Light.

Health Exhibition Season Tickets.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 2...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Tuesday, June 3 ...Royal Institution, Albemarle-street, W., 3 p.m Prof. Gamgee, "The Anatomy and Physiology of Nerve and Muscle." (Lecture V.)
Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Society's Menagerie in May." 2. Mr. F. E. Beddard, "Some Points in the Structure of *Hapalemur griseus*." 3. Mr. A. D. Bartlett, "Some Hybrids of Bovine Animals bred in the Society's Gardens."

Wednesday, June 4...Entomological, 11, Chandos-street, W., 7 p m.
Archæological Association, 32, Sackville-street, W., 8. p.m. 1. Mr. C. Roach Smith, "The British Oppidum at Old Winchester." 2. E. P. Loftus Brock, "Ancient Chapel at Dover." 3. G. Grover, "Mount Nod, Clapham."
Obstetrical, 53, Berners-street, W., 8 p.m.
Shorthand, 55, Chancery-lane, W.C., 8 p.m.

Thursday, June 5...Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. R. Hunt, "Influence of Wave Currents on Fauna inhabiting Shallow Seas." 2. Mr C. B. Clarke, "The Flora of Parnsnath, North-West Bengal." 3. Mr. H. W. Bates, "Longicorn Beetles of Japan." 4. Mr. P. H. Carpenter, "Remarkable Forms of *Metacrinus*."
Chemical, Burlington-house, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Flame and Oxidation." (Lecture VII.)
Archæological Institution, 16, New Burlington-street, W, 4 p.m.

Friday, June 6...Royal Institution, Albemarle-street, W., 8 p.m. Mr. Willoughby Smith, "Electric Induction Experiments."
Geologists' Association, University College, W.C., 8 p m. Mr. T. V. Holmes, "Some Curious Excavations in the Isle of Portland." Mr. Charles E. De Rance, "The Underground Waters of England and Wales."
Philological, University College, W.C., 8 p.m. Prince L. L. Bonaparte, "Modern Basque and Old Basque Tenses."

Saturday, June 7...Royal Institution, Albemarle street, W., 3 p.m. Prof. Bonney, "The Bearing of Microscopical Research upon some large Geological Problems." (Lecture IV.)
Actuaries, The Quadrangle, King's College, W.C., 3 p m. Annual Meeting.

Journal of the Society of Arts.

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FRIDAY, JUNE 6, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

A Conversazione will be given at the International Health Exhibition by the Council of the Society of Arts, in conjunction with the Executive Council of the Exhibition, on Wednesday evening, 9th of July.

It has been found necessary to change the date of the Conversazione from the 2nd of July, as announced in the last number of the *Journal*, in consequence of that being the day fixed for the evening *fête* of the Royal Botanic Society.

Further particulars will be duly announced.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 22, 1884; W. H. Perkin, F.R.S., Vice-President of the Society, President of the Chemical Society, in the chair.

The paper read was—

ON THE ECONOMIC APPLICATIONS OF SEAWEED.

By Edward C. C. Stanford, F.C.S.

In 1862, twenty-two years ago, I had the honour of reading a paper before the Society of Arts, on this subject, in this room. The Council marked their appreciation of that paper by awarding me a silver medal, and I cannot forget that the honours of that year were shared by another chemist, my friend, Dr. Crace Calvert, once so well known here, but who has since passed away. When, therefore, I was again invited a little while ago to read a second paper, I felt that some apology was due for not returning to report progress before. I am bound to admit that, like some wanderers through space, the period has been long and the orbit eccentric. For the former, I must plead the difficulty of the subject; for the latter I must remind you that any one who follows seaweed must go to the wildest and most inaccessible shores.

It is extremely interesting to me, and I trust it may be made somewhat entertaining to you, to look back on that paper, with the light of over twenty years' experience, and see how far the views then put forward were right, and how far they were wrong, premising that even failures are excellent lessons. "Many things have happened since then," and new and better sources have been discovered of many of the products then brought forward for the first time. As, however, it may be advisable to follow the lines of that paper, I shall first briefly allude to the uses of seaweed for food and for manure, and then speak more at length on the important application of these in the manufacture of kelp, and the production of iodine.

Seaweed as Food.

In this country, little advance has been made in the use of the algæ as food. The algæ generally contain important nitrogenous constituents, and form nutritious articles of diet, but they have not been popular. We all like a "sniff of the briny," but we do not cultivate a taste for the internal consumption of our marine vegetables. We are equally guilty, however, in rejecting the majority of the fungi, so largely consumed as an important article of food on the Continent. The algæ are closely allied to these, but have the advantage of containing, as far as is known, no poisonous species. The algæ also contain a large proportion of salts which, however, are easily removed, if desirable.

Ulva latissima, or green laver, and *Porphyra laciniata*, or pink laver, are occasionally used in soups. *Rhodomenia palmata*, or dulse, is still sold in the streets of Edinburgh and Glasgow. *Aliara esculenta*, or murlins, is also eaten in Ireland; some others are occasionally used, but, as a general food, the algæ are almost unknown. The sweetest species is the *Laminaria saccharina*, which is usually covered, when dry, with an efflorescence of mannite; a large quantity of this plant yielded me 7·47 per cent. of mannite. It appears to be a product of fermentation, and does not exist in the fresh plant. This plant is found only on sandy or gravelly shores.

The best known British species of the edible algæ is the *Chondrus crispus*, or Irish moss; this grows far down on the rocks, and is only uncovered at low spring tides. It is obtained mostly from the west coast of Ireland, and after being bleached by exposure to sun and rain, is largely exported to this country and to Germany. It is a gelatinous species, containing a principle known as carragheenin; it yielded me 63·7 per cent. of this substance.

The only other gelatinous British species is the *Gelideum corneum*; this is not very common, but it furnishes the import known as Japanese isinglass, of which it contains 50 per cent. This substance, known also as gelose, was first imported into France, from China, in 1856; it has great gelatinising power, much higher than any other material. It is not nitrogenous, and contains carbon 42.8, hydrogen 5·8, oxygen 51·4.

The following table shows the value of these species in making jelly. The melting point of the jelly is also appended.

1,000 parts of water require of—

	Parts.	Proportion.	Melting point.
Gelose	4	1	90° Fahr.
Gelideum corneum	8	2	90° ,,
Irish moss (*Chondrus crispus*)	30	75	80° ,,
Isinglass	32	8	70° ,,
Gelatine	32	8	60° ,,
Carragheenin	36	9	70° ,,
Agar-agar (*Euchemia spinosa*)	60	15	90° ,,

It will be seen that gelose has eight times the gelatinising power of isinglass and gelatine; but the melting point of the jelly is too high to melt quickly in the mouth, hence gelatine is still the favourite.

The carragheenin has evidently become altered by evaporation. Gelose jelly keeps well, the others soon get mouldy. Although not fit for jelly, gelose may be valuable in the arts as a substitute for gelatine, which it so much exceeds in gelatinising power. I would specially suggest its use as a substitute for gelatine in the production of instantaneous photographs.

The *Euchemia spinosa*, or agar agar, is an Australian alga, and another important gelatinous species. The algæ form a large article of food consumption in China and Japan; some years ago I procured some of these samples, one was a dark green frond, and the other two were cut up from it, about the size of vermicelli; I append the analyses of there and of a sample of our own laminaria from Loch Eport in North Uist.

EDIBLE SEAWEEDS.—JAPAN.

	I.	II.	III.	IV.
Water	19·20	19·20	21·50	41·00
Volatile matter	59·50	48·20	49·70	32·29
Ash	21·30	32·60	28·80	26·71
ANALYSIS OF ASH.				
Soluble salts	74·18	74 85	61·81	72·50
Insoluble	9·84	5·21	33·68	18·69
Carbon	6·58	6·44	1·04	3·60
Silica	9·40	13·50	3·47	5·21
	100·00	100·00	100·00	100·00
ANALYSIS OF SALTS.				
Potash	31·90	16·10	40·95	28·26
Carbonate soda	14·61	14·41	5·35	5 00
Sulphuric acid	9·58	8·99	12·33	13·34
Chlorine	39·28	27·52	44·74	51·74
Iodine	0·3171	...	...	0 2946

No. I.—"This is a good average sample, worth to-day, in this market, 11 taels, which at 6s. 6d., the average value of the tael, is 71s. 6d. per picul of 133 lbs.; therefore one ton (16·75 piculs) would cost, in Shanghai, £57 4s. It can be cut finer, and then the price, if it is of the deep green which this is when it leaves me, would be about 14 taels per picul, or £72 10s. per ton."—*Extract from letters.*

The sample is green, and evenly cut about as fine as vermicelli.

No. II.—"This is the worst sample I can find, worth 2 taels, which is £11 8s. per ton. The uncut leaf would be more valuable than this if of the colour of No. I. It would fetch £16 per ton."—*Extract from same letters.*

This sample looks like the former deteriorated.

No. III.—This was apparently the uncut weed. It much resembles in colour and appearance No. IV.

No. IV.—Laminaria, cut in Loch Eport, North Uist; colour, dark green. Quotations by Mr. Frazer, Yokohama, September 18, 1868:—Fine cut, £17 9s. 8d.; fine brown, £15 10s. 9d.; large green, £9 14s. 2d —per ton. Specimens of No. IV. were sent out to Yokohama, but they did not take the market. It is remarkable that so high a price as 72s. 6d. per cwt. (or nearly 8d. per lb.) should be realised there for this seaweed for dietetic purposes.

The taste for marine vegetables must be acquired, but those who have eaten them often are said to become very fond of them; and I have known some gentlemen in the Highlands, no mean judges of diet, who consider a dish of dulse, boiled in milk, the best of all vegetables. There is no doubt that a valuable food is lost in entirely neglecting the algæ; but I shall show, presently, how much of this may be recovered in an available form.

Seaweed as Manure.

This appears to me to be one of the worst applications of seaweed, and I do not think it has increased; farmers are beginning to find out that it seldom contains less than 80 per cent. of water, often more; and that for the actual manurial value in it, it may be very expensive if a long cartage is required. Four tons of water, at least, must be carted for every ton of dry manure, and when dried there is much additional expense, and it is very bulky. The dry weed contains an average of 2 per cent. of nitrogen, so that, as it is used, it contains less than ½ per cent. The chemical value is very little, except from the potash contained; but the mechanical value may be greater, as in covering root crops as a protection from frost, or where the soil is simply sand, and it binds it together. However, the cartage of water, and the manufacture of soil, are expensive amusements, and seaweed is not much used where there is high farming. It appears also, where continually used alone, to impoverish the soil; it is like feeding a dog on butter. The residue of seaweed ash, or kelp waste, one ton of which is equal to forty tons of wet seaweed, and contains all the phosphates, is quite unsaleable for manure in this country. It may be remarked, too, that in the wet climates of the west of Ireland, and of Scotland, where it is mostly used, the application of water is quite a superfluous operation for the farmer.

Another application of seaweed, which I mentioned before, was the manufacture of paper. As far as I know, this has only been carried out in France, on one plant, the *Zostera marina*, or grass wrack, a material largely used in this country for stuffing mattresses, and for packing light furniture. Some curious specimens of this plant, rolled up in little balls of fibre, were shown here at that meeting, as thrown up by the sea at Majorca and Minorca; and soon after it created a good deal of attention, having been proposed as a substitute for cotton; it contains litle fibre, however. It grows in enormous fields, on sand-banks, and is widely distributed, and is to be found in almost every ocean; it is a pure marine plant, with flowers, having nothing in common with the algæ except the habitat. It is often found on the shore perfectly bleached. All the algæ are cellular, and contain no fibre, but properly treated they make a tough transparent paper, to which I shall have to allude presently.

The Manufacture of Kelp.

This crude substance which, for many years, made the Highland estates so very valuable, was at first made as the principal source of carbonate of soda. At the beginning of this century it realised £20 to £22 per ton, and the Hebrides alone produced 20,000 tons per annum. The importation of barilla then began, and for the twenty-two years ending 1822, the average price was £10 10s. The duty was then taken off barilla, and the price of kelp fell to £8 10s.; and in 1823, on the removal of the salt duty, it fell to £3; and in 1831, to £2. It was used up to 1845 in the soap and glass factories of Glasgow, for the soda. Large chemical works were then existing in the island of Barra, built by General McNeill, for the manufacture of soap from kelp, and a very large sum of money was lost there. Two tall octagonal chimneys were still standing not long ago, but have now succumbed to the gales. In the meantime, soda was being largely made by the Le Blanc process, and superseded kelp, which was always a most expensive source, yielding only about 4 per cent., often less than 1 per cent.; it must have cost the soap-makers what would be equal to £100 per ton for soda ash, the present price of which is £6.

The manufacture of iodine and potash salts then began to assume some importance, but the kelp required was not the same; that which contained the most soda containing the least iodine and potash. Chloride of potassium, the principal salt, was at one time worth £25 per ton. The discovery of the Stassfurt mineral speedily reduced this price to about a third, and the further discovery of bromine in this mineral, also reduced the price of that element from 38s. per lb. to 1s. 3d., its present price. The amount of bromine in kelp is small, about a tenth of the iodine, and not now worth extracting. Large quantities are now produced in Germany and America. More recently, the manufacture of iodine from the caliche in Peru has attained large proportions, and has so far reduced the price of that article, as to make its manufacture from kelp unremunerative. In a paper, compiled for the British Association, published in 1877, I estimated the then total production of iodine in Great Britain and France, at 2,000 kegs of 1 cwt. each; and the future production of Peru at 6,000 kegs; an estimate which is now being rapidly realised.

In 1882, the amount of iodine exported from

Peru was 205,800 kilos, or 4,116 kegs, divided as follows:—

To London	120,900	kilos.
,, Hamburg	62,100	,,
,, New York	22,800	,,
	205,800	,,

The present annual output is estimated at 300,000 kilos, or 6,000 kegs.

On the other hand, the present manufacture of Great Britain and France is less than 1,000 kegs, the production of France being now reduced to almost nothing, and the kelp sold as manure.

I append an abstract of a table in that paper, showing the imports of kelp into Glasgow, to which city or its district the manufacture of British iodine has always been confined.

The prices given are the average prices for the year; higher than the maximum, but not lower than the minimum, have been reached. It is remarkable that we are now coming back to exactly the price of 1841, forty-three years ago, and also exactly to the price of twenty-two years ago, when my first paper was written. Potash salts, however, were then three times the present price.

IMPORTS OF KELP INTO CLYDE.

Five years, 1841 to 1845.

Tons of kelp, 1,887 in 1844 to 6,086 in 1845; average 3,133. Price of iodine per lb., 4s. 8d. in 1842 to 31s. 1d. in 1845; average 11s. 9d.

Ten years, 1846 to 1855.

Tons of kelp, 3,627 in 1846 to 11,421 in 1850; average 3,627. Price of iodine per lb., 8s. 8d. in 1851 to 21s. 3d. in 1846; average 12s. 11d.

Ten years, 1856 to 1865.

Tons of kelp, 6,349 in 1856 to 14,028 in 1863; average 9,730. Price of iodine per lb., 5s. in 1863 to 13s. 8d. in 1856; average 8s. 10d.

Ten years, 1866 to 1875.

Tons of kelp, 8,116 in 1868 to 10,923 in 1874; average 9,187. Price of iodine per lb., 10s. in 1866 to 34s. in 1872; average 15s. 11d.

Seven years, 1876 to 1883.

Tons of kelp, about 6,000 to 8,000; average about 7,000. Price of iodine, 5s. in 1883 to 15s. 6d. in 1879; average about 10s. 2d.

Total average kelp import, 1841 to 1883 (42 years) 6,750 tons. Average price of iodine per lb., 12s.

So that the present price is only about 40 per cent. of the average value. The great fluctuation in the price, and the small bulk of the article in proportion to its value, and the limited production, have led to great speculation, and I have no doubt a few kegs might still be found here and there in London which were bought some years ago at a pretty high price, and are still waiting the improbability of a turn in the market.

The amount of iodine in sea water is so minute, that it is extremely difficult to detect by ordinary tests; by evaporating down two portions of sea water filtered and unfiltered, each over 14 gallons, and by employing a delicate colour test, I have succeeded in estimating it. The sea water was collected carefully in the Atlantic, west of the island of Tyree. I found in 1,000,000 grs. measure (14·2857 gallons) of unfiltered sea water, ·003572 or 1 in 280,000,000; in 1,000,000 grs. measure of filtered sea water ·003442 or 1 in 291,000,000. The unfiltered water might be expected to contain more iodine from minute algæ in suspension, although it appeared clear. Kortstoffer, who estimated it in the Mediterranean, puts it at 1 part in 50,000,000. Bromine is easily detected; sea water generally contains about 6 parts in 100,000, and of chlorine about 2 per cent. Professor Dittmar, who has been working out the sea water samples of the *Challenger* expedition, has discovered a remarkable relation between this element and that of the chlorine which he has kindly communicated to me. He finds the relation in the great number of samples examined (77) to be constant in the proportion of ·340 bromine to 100 chlorine. He finds the average amount of chlorine to be 1·9 per cent., or 19,000 parts in 1,000,000, and of bromine ·00646 per cent., or 64·6 parts in 1,000,000, or 18,422 times as much as my mean result for the iodine. The Woodal Spa has been long known to be very rich in iodine and bromine; a recent analysis by Wright giving of chlorine 1113·73 parts per million, bromine 49·7 parts per million, iodine 5·21 parts per million. Here the relation of bromine to chlorine is ·44 to 100, and the iodine about a tenth of the bromine; in sea water the proportion of iodine is a very minute fraction of this. Examination of the brine and the mother liquor from the salt mines of Cheshire failed to detect iodine. The algæ possess the power of assimilating the iodine to about ten times the extent of the bromine. I append estimates of iodine in a number of algæ, those of the Laminaria and Fuci are the average of a great number of specimens collected at different times of the year, and all round Great Britain and Ireland, the Channel Islands, and the Isle of Man, and including Orkney and Shetland, Iceland, Denmark, and Norway. I append also estimates of the iodine in several of the giant algæ in the Falkland Islands, for which I am indebted to Governor Kerr, and Mr. F. G. Cobb, of the Falkland Islands Company.

These gigantic species are seen in this country for the first time in the fresh state, and little is known about them. The macrocystis is said to grow to a length of 1,500 ft., or over a quarter of a-mile in length. It grows in 10 fathoms water in Stanley harbour.

The *d' Urvillea* forms stems branched like trees 12 ft. or 14 ft. long, and a foot in diameter. All these weeds are thrown up in enormous quantities on the shores of the Falkland Islands, and along the Straits of Magellan, making it difficult for a boat to approach them.

DRY WEEDS.

	Per cent.	lbs. per ton.
Laminaria Digitata, tangle stem	0·4535	10·158
,, ,, Bardarrig frond	0·2946	6·599
,, Stenophylla stem	0·4028	9·021
,, ,, frond	0·4777	10·702
,, Saccharina, sugar wrack	0·2794	6·258
,, Bulbosa	0·1966	4·403
Fucus Serratus, black wrack	0·0856	1·807
,, Nodosus, knobbed wrack	0·0572	1·281
,, Vesiculosus, bladder wrack	0·0297	·665
Halidrys Siliquosa, sea oak	0·2131	4·773
Hymanthalia Lorea, sea laces	0·0892	1·998
Rhodomenia Palmata, dulse	0·7120	1·594
Japanese edible seaweed	0·3171	7·102
Zostera Marina { Nat. order Zosteraceœ }	0·0457	1·023
Rhodomela pinnastriodes	0·0378	·468
Chordaria flagelliformis	0·2810	6·294
Chorda filum, sea twine	0·1200	2 688
Chondrus crispus, Irish moss	Trace	—
Enteromorpha compressa, sea grass	Nil	—
Gelideum corneum, Japan	Trace	—
,, ,, Cornwall	,,	
Euchemia spinosa (agar agar)	Nil	—

FALKLAND ISLANDS GIANT ALGÆ.

	Per cent.	lbs. per ton.
D'Urvillœa utilis, No. 1	0·0075	·179
,, ,, No. 2	Trace	—
Lessonia No. 1	0·0284	·636
,, No. 2	0·0181	·405
Macrocystis Pyrifera	0·0308	·690

In the foregoing table the Laminariæ and the Fuci are the kelp-producing species.

It is remarkable that the three gelatinous species, *Chondrus*, *Gelideun*, and *Euchemia* contain little or no iodine.

It is noticeable, too, that the *Enteromorpha*, or sea grass, a plant which retains, when dry, a very strong odour of the sea, contains no iodine.

It is also remarkable that the giant algæ contain so little iodine, growing outside the influence of the Gulf Stream, which, rightly or wrongly, has been supposed to be the iodine carrier. It is a curious fact that there are certain seeds, supposed by the natives to grow on the tangle, and called "tangle nuts." A specimen here from Tyree is evidently the seed of a leguminous American tree, brought over by the Gulf Stream.

It is probable that all animal substances from the sea contain iodine; its presence has been long known in cod-liver oil, a substance supposed to be rich in it, and to owe most of its valuable medicinal property to it, but I found, after investigating a good many various specimens of this oil, that the amount is infinitesimal. The liver itself contains double as much; oysters, especially the Portuguese variety, have also been said to contain a good deal. The following are my results:—

		Per cent.
Cod-liver oil, average of six specimens		·000322
Cod-liver, fresh		·000817
Salt cod fish	48·5 per cent. water	·000255
Salt ling fish	50·25 ,, ,,	·000150
Fresh cod fish	80·7 ,, ,,	·000160
Scotch herring, salt		·000650
Scotch herring, brine		·000120
Oysters, Portuguese		·000040
Whale oil		·000100
Seal oil		·000050

There are two distinct and well-defined varieties of kelp. Cut weed or black-wrack kelp, and drift weed or red ware kelp. Cut weed kelp is the old soda-producing variety, and is made from the three *Fuci*, *Fucus vesiculosus*, *F. nodosus*, and *F. serratus*; these grow on the rocks in the order named, the latter being the most submerged and containing the most iodine, though all contain but little. The plants are cut at low tide, floated ashore, dried and burnt; the weed does not soften much by rain, and it can always be obtained in the fine natural harbours of the West of Scotland and Ireland. This kelp, burnt into a dense fused slag, contained the most carbonate of soda, and was that variety which employed so many poor crofters and cottars, and enriched so many highland lairds. It is now worthless, and the Fuci, which hang from the rocks at low water in luxurious festoons in these lochs, are now entirely unutilised. I have seen 10,000 tons of this weed cut in a single loch, in a few weeks of summer.

The drift kelp is made from two varieties of red weeds, or Laminaria, the *L. Digitala*, and the *L. Stenophylla*, the former known as tangle; both are always submerged, and are torn up by the violent gales, so common on the west coast; both are sometimes cut in Ireland with long hooks under water from boats. These plants, especially the latter, suffer very much from rain, and are often, after drying, almost valueless; but if well saved, contain ten times as much iodine as the Fuci.

This is the only kelp now used for making iodine, and it ought to be burnt into a loose ash; but although they employ a different material, we have to deal with the same people, and they still insist on raking it into a molten slag, with iron clauts, at great extra trouble, so much so that the men of the family are obliged to do this part of the work, under the erroneous impression that it will weigh heavier, thus mistaking specific gravity for weight; the fact being that they drive off more than half the iodine, and a great deal of the salts, spending several extra laborious hours in reducing the value to a half. It may be asked why we allow it? An incident which occurred to me may answer that question.

Some years ago, when I had to take a large quantity of black-wrack kelp in North Uist, it was made to enable the people to pay their rents, and could not then be given up, though it has been since. I tried hard to get some improvement made in the direction of burning the weed at a lower temperature. The people were assembled in great numbers, and the sheriff eloquently harangued them in Gaelic for me. Their objections were threefold: it would not yield so much, it would not be so good, and it would take too long. The late Sir John P. Orde, the proprietor, and his factor were present, and it was agreed at last that the most experienced kelper and myself should try the experiment, each to have a certain quantity of weed weighed out to him, and each to burn it his own way. As I expected, my lot was finished first. The yield was 25 per cent. greater, and the product was also, weight for weight, 25 per cent. more valuable. Any one can understand this double advantage of ash *versus* slag. The old man, my opponent, on the result being explained to him, made a remark in Gaelic, which was translated for me as follows:—"I have been making kelp for fifty years and more, and am I to be taught by a young Sassenach with no beard on his face to speak of?" That was the only result of the experiment. How could I explain to him, especially in Gaelic, the difference between specific gravity and weight, to say nothing of quality? As they would not improve the process, the work had to be stopped, and their evidence before the Royal Commission shows how much they have missed it. We took away their clauts, but it was no use; landing once in the middle of the night, I came upon a group hard at work with new irons, raking off the salts, and making themselves hideous, for so intense is the heat, that the soda volatised gives a strong monochromatic yellow flame which does not improve the beauty of the workers.

To show that this extraordinary idea still prevails, I quote the following from a daily paper, referring to the island of Tyree this year:—

"The men attending the kilns used to turn over the burning mass with iron 'clauts,' but about two years ago the company forbade the use of the 'clauts,' and the kelp is simply reduced to ashes instead of a hard substance. It may be better fitted for manufacture in this state, but it is also evident that it will take more of it to make a ton than by the old process."

It has one advantage for them, being on the sandy shore, or shingle, it enables them to rake in, and embody with the fused kelp a quantity of sand and stones. We sometimes get a block of granite thinly veneered with kelp from our Irish friends, to remind us, I presume, of their national wrongs, and take a slight revenge.

The great heat involves the additional disadvantage that the carbon reduces the sulphates to sulphides, which involve considerable expenditure of oil of vitriol to decompose them, so that sulphur thus deposited is one of the bye-products of the lixiviation of kelp. We are, therefore, compelled to reverse the ordinary process, and manufacture sulphur from sulphuric acid.

The usual yield of kelp from 100 tons of wet seaweed is 5 tons, and as only half of this is soluble, 2½ tons forms the total valuable product of the labour of cutting, carrying, drying, and burning 100 tons of wet seaweed; the burner, in many parts, does not receive more than £2 per ton, sometimes less, so that all this labour is done for 2s. per ton of weed. When it is also remembered that bad weather often reduces this payment to nothing, it is easy to understand that this occupation is soon given up where any other employment can be obtained. Moreover, the weed is dried in a climate where a native comes up to you with the rain pouring off his hat and nose, and outrages your sense of sight by informing you, if he knows "the English," that it is "a wee misty." The large mass of material to be dealt with, the stormy character of the coasts, the constant moisture of the climate, all tend to still further reduce the quantity obtained. Even with favourable conditions, the yield is only 5 per cent., which is quite inadequate to afford profit either to the maker or to the lixiviator.

These evils were fully pointed out in my former paper, and a method was then suggested by which several new products could be obtained, and the whole of the iodine secured. I proposed to submit the seaweed to destructive distillation in iron retorts, thus obtaining a loose, porous charcoal, which retains the salts and the iodine; ammonia, acetic acid, and tar were obtained from the distillate. In looking over the tables published in my former papers, some of the diagrams of which are once more on the wall, I notice that the amount of iodine lost in kelp was much underestimated; much too low a figure having been taken for the produce of iodine. The amount of kelp then made was 10,000 tons in this country, and 24,000 in France; and I estimated the loss of iodine, in this country alone, at 50,000 lbs. annually, it really was about three times that amount, or 150,000 lbs., worth, even at the present low price, £37,500, a sum in excess of the whole value of the additional new products proposed to be recovered.

The Duke of Argyll was the first to see the value of the improvement suggested, and the new process was first carried out in his island of Tyree, in 1863, where works were erected for the purpose; soon afterwards works were also erected in North Uist, under an arrangement with the late proprietor, Sir John P. Orde; and more recently in Ireland.

In some respects, Tyree was the best place that could have been selected, in others, the worst. The wildness of its shores, and its numerous outlying rocks, make it the deposit of much drift weed. The inaccessibility and the great difficulty of landing heavy machinery, &c., made the erection of works extremely difficult. The factor calculated that 30,000 tons were used annually for manure, and that four times that quantity was lost. Our calculations were based on recovering 16,000 tons of this, and if even that quantity could have been obtained, the works there would have had a very great success, and turned out more iodine than all the other Highland shores put together. It is impossible, however, to estimate the amount of seaweed thrown up in a storm, and the sea has an awkward habit of calling again, and removing a good deal of it, or covering it over with sand. This seaweed is also much injured by rain, which soon washes out the salts and iodine. It is a nitrogenous substance, and is quickly devoured by maggots, which become flies, and the material, like some other riches, speedily takes to itself wings and flies away, so that when once I carted a large quantity to the works for experiment, some knowing ones observed that the Sassenach had taken a great deal of trouble to put in the material, but it would not give him any kind of pains to put it out, as it would leave him of its own accord. I may add that it did not; there is nothing so offensive as rotten seaweed, but I had preserved the weed with chloride of calcium. In the winter the long sea rods are thrown up, and these when properly stacked bear a good deal of exposure. There was much difficulty in getting the people to collect these at first, for it was a new thing, and they did not believe in it. They soon found out, however, that it affords winter employment for what they call "a lairge sma' family," and which, to do them credit, most of them possess, as children can work at it. It consists simply in stacking the tangle out of reach of the tide. This work has been going on ever since 1863, and none is lost that can be secured. The works in Tyree and in North Uist are still continued, to the great advantage of the people. For the latter the tangle is also collected in South Uist and shipped to Loch Eport. Both these islands also yielded large quantities of black-wrack kelp, which is now entirely given up.

The works were lighted with the gas obtained by distillation, but after the gas has passed through all the purifiers, it still burns with a strong monochromatic yellow flame. The ammonia obtained is all used as manure for the farm; for whatever other business you follow in these outer islands, you must be a farmer, to feed your horses, &c. The tar is used for the roof of the works; and I may state here, that after great experience of large roofs, many of which have been blown away, I prefer a lattice girder low felt roof. No one who has not witnessed a winter gale in one of the Hebrides can form an idea of it. We find it advisable to raise the walls two feet above the girders on each side. I would also mention here that there is no building so efficient or suitable for the damp climate of these outer islands as concrete. The shingle of the shore is always there as the bulk of the material, and cement only has to be sent out. A vessel loaded with quick lime, anchored off one of these islands in a gale, is not a happy or a safe possession, and I know from experience that it does not contribute to the sweetness of sleep.

Iron retorts, heated by coal or peat, were at first used, but these were superseded by brick ovens, which are now employed without fuel. The tangle swells in the retort, and produces a charcoal of great porosity, from which the salts are easily washed out, and there are no sulphides. The residual charcoal is a very efficient decoloriser and deodoriser, but has never been largely used for these purposes. I shall mention presently an application of it.

The following analysis shows the comparison of this charcoal with that from bone. It does not in any way approach the composition of that from wood :—

	Seaweed.	Bone.
*Carbon	52·54	11·77
Phosphates	10·92	77·70
Calcium carbonate	15·56	8·43
Calcium sulphate	—	·35
Magnesium carbonate	11·34	—
Alkaline salt	5·70	1·09
Silica, &c.	3·94	·66
	100·00	100·00
*Containing nitrogen	1·75	1·5
Containing ammonia		

My experience in the use of peat may be worth recording. I found it give a very fair red heat; we cut and stacked about 600 tons a year of good quality in North Uist, it cost 2s. 6d. per ton, and I do not think it can be obtained for less. There was no royalty or rent, and the bog was close to the works. It required three times the quantity compared with coal, which greatly increases cost of firing. There is this peculiarity about peat that, where a large supply is required, its cost increases with the quantity collected, because a larger area must be worked.

The winter tangle forms but a small part of the seaweed used for kelp. In the spring and autumn large quantities of Bardarrig or tangle top come ashore, and this is the substance most difficult to deal with. It is ruined for kelp-making by rain, and it will not repay cartage to a long distance. Even washing about in the sea spoils it. To work it by my process would require a large number of small works, which is out of the question, so that it is still mostly made into kelp in the old way, with all its attendant evils. It is this substance which I propose now mainly to deal with. I am convinced that no process will deal effectually with it unless it will afford the means of removing it to central works, say at Glasgow, involving a cost for carriage equal probably to the cost of the weed, doubling in fact its first cost. There are two ways of removing it, either wet or air dry. I prefer the latter, although I have proved that it can be perfectly well kept in a silo, a specimen so kept for several months having reached me perfectly good, and still containing 83·8 per cent. moisture; and it has been also proved that such a covering of earth as that used for potatoes is an available silo. Most of this material can, however, be got air dry, if, as soon as obtained, it is put in a rick and thatched over, a good deal of it being lost at present while they are waiting for enough to burn into kelp, which cannot be made in a small quantity, and for a way they have of putting it in small stacks to get damp again, because they object to burning it too dry. Twenty thousand tons of this dry material could easily be got in Ireland alone. Four hundred thousand tons of the black wrack was the usual annual collection in the Hebrides in former years, now all unutilised, so that there is ample material if use can be found for it. It is a well known fact that the Fuci grow better when regularly cut.

We are not, of course, limited to Ireland and the Highlands, as any demand for the raw material would offer up new and very extensive sources of supply.

The difference between kelp-making and distillation in retorts is shown by the following actual experiment on eight tons of tangle. Four tons were burnt with great care into kelp, and four tons were carbonised in a retort with the following results :—

	Cwt.	Per cent.
Kelp produced	15	18·7
Char ,,	30	37·5

	Salts. cwt.	Iodine. lbs.
Produce of char	8·77	29·25
,, kelp	6·57	13·27
Loss in kelp	2·10	15·98
,, per ton of tangle	0·53	4·00

As a rule the kelp does not contain anything like this. The presence of sand particularly, adds much to the volatility of the iodine.

A rich sample of seaweed ash, exposed in a platinum capsule over an ordinary Bunsen burner for twenty-four hours, will not retain a trace of iodine.

The sand in kelp is either shell sand, which is mostly carbonate of lime, or flint sand, which is silica; both are highly prejudicial, as the following experiment shows—100 grains of a rich seaweed ash was in each case heated for ten hours over an ordinary Bunsen burner.

	Per cent.		lbs. per ton.
The ash contained of iodine....	·8930	..	20
The ash after heating ten hours	·4911	..	11
The ash with 50 per cent. limestone	·3572	..	8
The ash with 50 per cent. sand	·2235	..	5

NEW PROCESS.

The salts made from kelp at present are as follows, taking an average on 20,000 tons:—

	Per ton.	
Muriate (95 per cent. potassium chloride)	5	cwt.
Sulphate (75 ,, potassium sulphate)	1·8	,,
Kelp salt (sodium chloride, containing carbonate = 8 per cent. alkali............	3·8	,,
	10·6	

Iodine, 12½ lbs. per ton.

I found, in the first instance, that these salts could be easily extracted from the seaweed, by simple maceration in cold water; the amount so removed from air dry Laminaria is pretty regularly about one-third of the weight, or 33 per cent., of which 20 to 22 per cent. are mineral salts, and the balance consists of dextrine, mannite, and extractive matter; leaving two-thirds of the plant, or 66 per cent., for further treatment, apparently unaltered.

This residue contains a peculiar new substance, to which I have given the name of Algin; and the cellulose; the whole plant being thus utilised.

The comparison between the three processes will, therefore, be as follows, on 100 tons of air dry Laminaria:—

KELP PROCESS.

Per cent. utilised, 18.

Kelp, 18 tons.	Salts, 9 tons. Iodine, 270 lbs.	Residuals—Kelp waste, 18 tons, valueless.

CHAR PROCESS.

Per cent. utilised, 36.

Char, 36 tons.	Salts, 15 tons. Iodine, 600 lbs.	Residuals—Charcoal, 36 tons, tar, and ammonia.

WET PROCESS.

Per cent. utilised, 70.

Water extract, 33 tons.	Salts, 20 tons. Iodine, 600 lbs.	Residuals—Algin 20 tons, cellulose 15 tons, dextrine, &c.

Showing that the last process has the first advantage of taking out more salts and iodine from the weed than any other; and these, even at present prices, are sufficient to recoup all the expense of carriage and working. Moreover, in the two prior processes, the residuals are those of the first product, in the last these are from the weed itself.

The water extract is carbonised, and the salts extracted. I append analyses of these; they differ from the kelp in containing no sulphides, and in containing calcium and magnesium salts.

AIR DRY (LAMINARIA STENOPHYLLA).

21 per cent. salts.

	Per cent.
Calcium sulphate	1·93
Potassium sulphate............	9·72
Potassium chloride............	31·97
Sodium chloride	48·67
Sodium iodide.................	1·79
Sodium hydrate	0·13
Magnesium chloride	5·74
	99·95

RESIDUAL WEED (LAMINARIA STENOPHYLLYA).

2·32 per cent. salts.

	Per cent.
Potassium sulphate............	35·27
Potassium chloride............	6·72
Potassium carbonate	5·00
Sodium carbonate	49·97
Sodium iodide................	2·63
	99·49

It will be seen that 90 per cent. of all the salts are thus removed, and much of those that remain are products of decomposition. These salts are obtained by the carbonisation of the water extract. This is not necessary, and may not be advisable, the salts can be fished out during evaporation. I append analysis of a 2 cwt. sample so fished:—

Calcium sulphate	1·18
Potassium sulphate............	14·20
Potassium chloride............	27·81
Sodium chloride..............	55·11
Sodium iodide................	1·69
	99·99

Iodine 32 lbs. to per ton.

Also of the mother liquor 54° Twad. evaporated—

Potassium sulphate	16·35
Potassium chloride............	17·48
Sodium chloride..............	54·98
Sodium carbonate	5·13
Sodium iodide................	5·27
Water	·70
	99·91

Iodine 100 lbs. per ton.

We now come to the treatment of the residual weed. If the long fronds of the *Laminaria stenophylla* be observed after exposure to rain, a tumid appearance will be noticed, and sacs of fluid are formed from the endosmosis of the water through the membrane, dissolving a peculiar glutinous principle. If the sacs be cut, a neutral glairy colourless fluid escapes. It may often be seen partially evaporated on the frond as a colourless jelly. This substance, which is then insoluble in water, is the remarkable body to which I have given the name of Algin. The natural liquid itself is miscible with water, but coagulated by alcohol and by mineral acids. It contains calcium, magnesium, and sodium, in combination with a new acid which I call alginic acid. When this natural liquid is evaporated to dryness, it becomes insoluble in water, but it is very soluble in alkalies. This new substance is so abundant in the plant that, on maceration for twenty-four hours in sodium carbonate in the cold, the plant is completely disintegrated. The mass thus obtained is a glutinous mass of great viscosity, and difficult to deal with on that account. It consists of the cellulose of the plant mixed with sodium alginate. The cells are so small that they pass through many filters, but by cautiously heating it, the mass can be filtered through a rough linen filter bag, the cellulose being left behind, and after the algin is removed, this is easily pressed.

The solution contains dextrine and other extractive matter, and it is then precipitated by hydrochloric or sulphuric acid; the alginic acid precipitates in light grey albuminuous flocks, and is easily washed and pressed, in an ordinary wooden screw press. A filter press, made for me by Messrs. Johnson and Company, answers perfectly well for this operation, but not so well for the preceding. It forms a compact cake, resembling new cheese, and has only to be stored in an ordinary cool drying-room, where it can be kept any length of time. If desired, by adding a little bleach during the precipation, it can be obtained perfectly white. The algin can be sent out in this state, it is only necessary to dissolve it in sodium carbonate in the cold for use. If, however, it be sent out as sodium alginate, it must be dissolved to saturation in sodium carbonate, the carbonic acid is disengaged, and sodium alginate is formed. If potassium or ammonium carbonate be used, the alginates of potassium or ammonium are formed, which are similar to the soda-salt. The bi-carbonates of these alkalies may also be used; but the caustic alkalies are not such good solvents.

The sodium alginate forms a thick solution at 2 per cent., it cannot be made above 5 per cent., and will not pour at that strength. Its viscosity is extraordinary. It was compared with well-boiled wheat starch, and with gum arabic in an ordinary viscometer tube; the strengths employed were as follows; it was found impossible to make the algin run at all over the strength employed:—

			Seconds.
Gum arabic solution,	25 per cent.	took	75 = 1 in 3
Wheat starch ,,	1·5 ,,	,,	25 = 1 in 8
Algin ,,	1·25 ,,	,,	140 = 1 in 112

So that the algin has 14 times the viscosity of starch, and 37 times that of gum arabic.

I append analyses of two samples of commercial sodium alginate of average composition:—

	No. 1.		No. 2.	
Water	17·13		19·30	
Organic matter	59·97		58·125	
Carbonate soda	18·32	P.C. ash 22·90	17·78	P.C. ash 22·575
Neutral salts..	2·98		2·77	
Insoluble ash..	1·60		2·025	
	100·00		100·00	
Dry algin	67·58		65·50	
Soda (Na_2O)	10·71		10·40	
Per cent. of Na_2O	15·85		15·87	

Showing that, excluding the water, salts, and ash, the composition is uniform.

The solution may be alkaline, or neutral, or acid, according to the degree of saturation; if alkaline, it may be made distinctly acid by the addition of hydrochloric acid, but any excess at once coagulates it; a 2 per cent. solution becomes semi-solid on this addition.

The evaporation is effected in a similar manner to that of gelatine, in thin layers on trays or slate shelves, in a drying room with a current of air, or on revolving cylinders heated internally by steam; high temperature must be avoided. The solution keeps well. Thus obtained, the sodium alginate presents the form of thin, almost colourless, sheets, resembling gelatine but very flexible. It has several remarkable properties which distinguish it from all other known substances.

Algin, or sodium alginate in solution is precipitated or coagulated by alcohol, ethylic and methylic, acetone, and collodion (but not by ether) by acid hydrochloric, sulpho-indigotic, nitric, sulphuric, sulphurous, phosphoric, citric, tartaric, lactic, oxalic, and picric; salts of cobalt, copper, platinum, nickel, silver, bismuth, antimony, zinc, cadmium, aluminum, chromium, uranium, barium, calcium, strontium, and tin chloride and bichloride; mercury pernitrate, and protonitrate; iron sulphate (white), and iron perchloride (brown); lead acetate, and basic acetate; lime water, and baryta water.

The solution is not precipitated nor coagulated by alkalies and salts of alkalies, including lithium, alkaline silicates, potass bichromate, (not coagulated by boiling), and chromate; sodium stannate, succinate, biborate, and tungstate; magnesium and manganese salts, starch, glycerine, ether, cane sugar, amylic alcohol, boracic acid, acetic, carbolic, tannic, butyric, benzoic, gallic, pyrogallic, arsenious, and succinic acids; potass ferrocyanide, mercury iodide, ferricyanide, and permanganate; bromine, iodine, and chlorine water; molybdate ammonia, tartar emetic, and peroxide hydrogen. It does not precipitate the ordinary alkaloids.

It is distinguished from albumen, which it most resembles, by not coagulating on heating, and from gelose by not gelatinising on cooling, by containing nitrogen, and by dissolving in weak alkaline solution, and being insoluble in boiling water.

From gelatine, by giving no reaction with tannin; from starch, by giving no colour with iodine, from dextrine, gum arabic, tragacanth, and pectin, by its insolubility in dilute alcohol and dilute mineral acids.

It is remarkable that it precipitates the salts of the alkaline earths, with the exception of magnesium, and also most of the metals, but it gives no precipitate with mercury bi-chloride nor potassium silicate.

It has a strong rotary power on polarised light; Mr. Tatlock estimated it for me as having a specific rotary power of 86·5° on Laurent's polariscope. This again fixes its position amongst animal bodies, gelatine, and albumen, and not amongst such vegetable products as pectin, which is neutral.

Alginic acid is insoluble in cold water, very slightly in boiling. It is insoluble in alcohol, ether, and glycerine. The proportion of soda ash used is one-tenth of the weight of the weed, and the cake of alginic acid obtained, is usually about the same weight as the weed. The quantity of dry alginic acid is given below:—

	Laminaria Digitata. Stem.	Laminaria Digitata. Frond.
Water	37·04	44·0
Alginic acid	21·00	17·35
Cellulose	28·20	11·00

	Laminaria Stenophylla. Stem.	Laminaria Stenophylla. Frond.	Laminaria Bulbosa.	Fucus vesiculous.
Water	34·5	40·02	43·28	40·10
Alginic acid	25·7	24·06	17·95	12 22
Cellulose	11·27	15·06	11·15	..

FALKLAND ISLANDS GIANT ALGÆ.

Nos.	1	2	3	4	5
Alginic acid	11·21	10·09	5·56	7·44	3·34
Cellulose	8·13	7·25	3·50	12·95	9·68

The three gelatinous algœ, already referred to, contain no algin.

The cellulose in the tangle is higher than in any other weed, the outside of the stem being rather fibrous. I append also analyses of the ash of three varieties of cellulose dry, unbleached to show the trace of iodine still retained:—

	Laminaria Digitala.	Laminaria Stenophylla.	Fucus vesiculus.
Yield of char.	38·36	36·41	44·62
Soluble	11·08	5·27	11·06
Carbon	12·73	14·27	15·93
Ash	14·55	16·87	17·63
Iodine	·12	·06	·05
On air dry plant about	·012	·006	·005

The new process may be tabulated as follows:—

		Per cent.
Extracted by water—		
Salts	20	
Sugar, mucilage, &c.	10	
	—	30
Extracted by sodium carbonate—		
Algin	20	
Dextrine, &c.	10	
	—	30
Cellulose		10
Moisture		30
		100

Of these, I have accounted for the salts, the algin, and the cellulose, leaving the mucilage, dextrine, and sugar for further investigation.

It is not necessary to extract the salts first with water, it comes to the same thing to act on the seaweed at once with soda ash, and to recover the salts by evaporation of the solution, after the alginic acid has been precipitated. In this case chloride of calcium, or of aluminium may be employed, the alginate of calcium or aluminium being precipitated. With either salt the alginate is thrown down instead of rising to the surface of the liquid, and the cakes are more compact and easily pressed. In addition to the cheapness with which it can be procured in almost any quantity, as a bye-product in alkali works, now all thrown away, the calcium chloride has the advantage of throwing down the sulphates in the salts, and decomposing them into chlorides, so that the salts consist of chlorides of potassium and sodium, which are easily separated, and do not require the tedious and expensive processes necessary in the lixiviation of kelp. The same remark applies to aluminium chloride, which can be cheaply obtained by dissolving banxite in hydrochloric acid. Either salt can be decomposed by hydrochloric acid, and the calcium or aluminum chlorides recovered; or the salts can be decomposed by sodium carbonate. The calcium alginate, when dry, is very like bone, as the dry alginic acid is like horn. The aluminum alginate is soluble in caustic soda, forming a neutral solution, and giving, on evaporation, a substance like algin, but harder and making a stiffer finish; it is also soluble in ammonia, the salt becoming an insoluble varnish on evaporation. The alginates of copper (blue), nickel (green), cobalt (red), chromium (green), and zinc, are all soluble in ammonia, and form beautiful coloured insoluble films on evaporation. So also do the alginates of platinum, uranium, (yellow), and cadmium. The latter is exceedingly soluble in ammonia. The alginate of chromium is also soluble in cold water, and it is deposited on boiling the solution, becoming then insoluble.

With bichrome, algin acts as gelatine, the mixture becoming insoluble under the influence of light. The silver alginate darkens very rapidly under exposure to light, and suggests applications in photography. Algin forms a singular compound with shellac, both being soluble in ammonia; it is a tough sheet, which can be rendered quite insoluble by passing it through an acid bath.

Commercial Application of Algin, or Sodium Alginate.

For Sizing Fabrics.—A soluble gum of considerable elasticity and flexibility is a great desideratum; so also is a soluble substitute for albumen, which can be easily rendered insoluble and used as a mordant. As a finish, algin has the advantage over starch, that it fills the cloth better, that it is tougher and more elastic, that it is transparent when dry, and that it is not acted upon by acids. It imparts to the goods a thick clothy elastic feeling, without the stiffness imparted by starch. It has the additional advantage, which no other gum possesses, of becoming insoluble in the presence of a dilute acid, which decomposes starch or dextrine. No other gum has anything like the viscosity in solution, and therefore none will go as far in making up the solution or cover such a large surface. Lime-water, salts of calcium, barium, and various metallic salts can be employed for rendering the coating insoluble. If greater stiffness be required, the algin can be mixed with gum arabic, starch, dextrine, gelatine, albumen, or glue, in any proportion.

The alginate of alumina, in caustic soda, is a stiff dressing, and in the crude, unbleached state, will be a cheap dressing for dark materials; and in the colourless state for finer fabrics. The ammoniated alginate of alumina can be used to give a glossy surface, which is quite insoluble after drying.

As to its use as a mordant in dyeing, I quote from Mr. John Christie, of J. Orr Ewing and Co., to whom I am indebted for the fine specimens of Turkey red dyeing exhibited, some of which are finished and mordanted with this new substance instead of cow dung:—"There is another application of the alginate of soda that occurred to me might be of some interest, namely, in the fixing of mordants, such as alumina, or iron, upon cotton fibre. I find, so far as I have gone with the experiments, very encouraging results. I believe a very large application will be found for the alginate of soda as a dunging substitute. The mordants, when precipitated, seem to have full dyeing power, the results indicating that this substance is capable of taking the place of cow dung, as used in print and dye-works; also as a dunging substitute it will rank with arseniates, phosphate, and silicate of soda, and a number of other salts, which are now largely used for the precipitation of mordants previous to the dyeing of cotton fabrics and yarns."

As an Article of Food.

Algin contains—carbon, 44·39; hydrogen, 5·47; nitrogen, 3·77; oxygen, 46.37; or about the same amount of nitrogen found in Dutch cheese. It has a slight pleasant marine taste, easily overcome if objected to, and may form a useful addition to the kitchen for thickening soups and puddings. It appears specially adapted to replace gum arabic in the manufacture of jujubes and lozenges. To make it into jelly, requires addition of gelose or gelatine, or admixture of lemon juice.

It will be useful for some pharmaceutical purposes, as for emulsion of oils, as an excipient for pills, and for fining of spirits.

For Boiler Incrustation.

The sodium alginate has a remarkable effect in resolving and preventing the incrustation of boilers. My friend, Mr. Spiller, who introduced the first, and one of the best fluids for this purpose, first suggested this application. He found it to precipitate the lime in a state in which it could be easily blown off. Further experience has fully corroborated his opinion. The solution is pumped in with the feed water, in the proportion of 1 lb. to every 1,000 gallons. Where hard waters are a necessity, the saving of fuel is considerable.

For Covering Boilers.

The seaweed charcoal, in conjunction with algin, is used for this purpose, and has been largely applied under the name of "carbon cement." It is nearly all charcoal, 3 per cent. of the algin being sufficient to make it cohere. Charcoal is known to be the best solid non-conductor of heat, and in this way its application to steam boilers has been made practicable. It forms a cool, light, and efficient covering.

Algic Cellulose.

This substance bleaches easily, and under pressure becomes very hard, and can be turned and polished with facility. It also makes a good paper, tough and transparent, but with no fibre. Alone, or mixed with algin and linseed oil, or shellac, it may be used as a non-conductor of electricity, where a cheap material is required.

Although there is still a small portion of the plant not accounted for, which will, I hope, also soon be worked out, I think enough has been discovered to justify the following conclusions:—

1. The only way to effectually utilise seaweed is to import it in the raw state.

2. By following the wet process, the additional cost is fully made up by the greatly increased amount of iodine and salts obtained from the water solution, leaving two-thirds of the plant for further treatment.

3. That by extracting from this the algin and the cellulose we utilise the whole plant, and obtain two new products of considerable commercial importance.

4. That the process is extremely simple, and requires no extravagant plant; nor do operations on the large scale present any serious practical difficulties.

5. That the new substance, algin, has very remarkable properties, which may find many applications not yet known, when it can be put on the market.

6. That the demand for such a substance in fixing and mordanting fabrics alone is enormous.

Our annual export of textile manufactures and yarns is valued at £40,000,000, or more than half the value of our total exports; and a large portion of this requires some dressing material to fit it for the market. We import about £200,000 worth of gum arabic, a good deal of which is used for this purpose; and the war in the Soudan is raising its price, and making it scarce.

7. That the supply of raw material is almost unlimited. Seaweed damaged by rain is equally available for the manufacture of algin.

I will only add that I bring forward this process with some confidence, as the result of a quarter of a century's scientific work, and an almost equally long practical experience—an experience gained in a wide and wild school. I am satisfied, whether it may be given to me to carry it out or not to the extent it should be, it will become the process of the near future. It immediately possesses the advantage of obtaining known marketable products of considerable value, and it bids fair to open up a new industry which may become one of large extent, supplying, as it will, new products for which there is an absolute want. On the other hand, the importance of attaching a marketable value to seaweed can scarcely be overrated. No Royal Commission will give the crofters and cottars on the shores of the Hebrides and the West of Ireland anything like the satisfaction that the offer of £1 per ton for all the seaweed they could gather would. In all these places the sea quest might soon become more important than the land question. Moreover, a shipping trade in the raw material itself, is a great benefit to the out-lying islands where it is obtained, it necessitates cartage, it tends to the improvement of roads and harbours, it improves communication by bringing steamers, and necessarily brings the people closer to civilisation, and the great centres of industry. This is especially the case where the expenditure of every thousand pounds on the raw material means the expenditure of about as much on carriage. I have reason to know that the lairds of all these shores would not be entirely dissatisfied with such a result. We should all share in the satisfaction of knowing that one more waste product had been effectually utilised.

DISCUSSION.

Dr. REDWOOD had listened with great interest to this paper, and all the more so from his early associations with the author, and from a recollection of his previous paper on his improved method for obtaining iodine from seaweed. It was very satisfactory to find that Mr. Stanford had persevered in the subject he then took up, and had succeeded in obtaining from seaweed these new products he had described. It was, perhaps, to be regretted that, owing to other sources of iodine having been discovered, his process for its manufacture from kelp had been to a great extent superseded; but that being so, it was all the more satisfactory to find there was a probability of rendering this industry advantageous from the discovery of another and very valuable product. Mr. Stanford drew his attention to the product some months ago, and he had satisfied himself experimentally of the facility with which algin could be isolated, whilst the author had shown that evening how extensive was the field for its application.

Mr. E. M. HOLMES said the thanks of the whole country were due to Mr. Stanford, for suggesting what might prove a very extensive industry, and one which might benefit the poorer classes of the population in districts where at present many of them were nearly starving. He had recently, at Swanage, noticed cows and donkeys on the beach eating the seaweed thrown up on the shore, and it occurred to him that seaweed might perhaps be utilised as food for animals. When they considered the immense amount of seaweed sold in China and Japan, it was astonishing that so small a use was made of it as food in this country. Laver (*Porphyra vulgaris*) was used to some extent in Devonshire, and it was by no means disagreeable in taste. Mannite, which was another product mentioned by Mr. Stanford, was principally obtained from Italy; but some algæ contained it in considerable quantity, and he saw no reason why it should not be utilised. With regard to the use of seaweed as manure, he knew it was constantly so employed in the Channel Islands, and we certainly obtained our earliest vegetables from those islands. He thought it was an error to regard the manurial value of seaweed merely from the point of view of the salts which they contained. Gardeners distinguished between what they called live and dead soil, live soil being that in which the decomposition of either animal or vegetable matter was going on; and this process apparently had an influence in causing changes of a chemical nature in the soil which promoted the growth of plants; it could, therefore, be reasonably supposed that the algæ might be more beneficial in the fresh state than when dried. He understood Mr. Stanford to say that the algæ from deeper water contained more iodine than those which grew nearer the shore, but in the table given, the largest amount was from the *Laminaria stenophylla*, which always grew higher on the shore than the *Laminaria digitata*. Another interesting point was that some of the gigantic algæ contained less iodine than the common Laminarias of our own shores. In the "Flora antarctica," published by Dr. Hooker some years ago, it was stated that Dr. Stenhouse had analysed these algæ, and had found in them a large quantity of iodine, and in one of them a considerable quantity of mannite; but probably so much was not known at that time about iodine, and no doubt Mr. Stanford's analyses were the more correct. But the interesting questions remained, where the iodine came from, and whether, as he believed Mr. Stanford thought, it came from the warm waters of the Gulf of Mexico. He should like to ask Mr. Stanford to what he attributed the strong odour of sea water possessed by the *Enteromorpha*, as he stated that contained no iodine. To show the rapid growth of the Fuci, he might refer to a statement in Dr. Landsborough's little book on marine algæ, that at one place in Scotland, where the rocks had been scraped quite bare, the algæ grew to a length of 6 ft. in six months. The idea of keeping seaweeds in a silo seemed a very excellent one, because under certain circumstances, as in wet weather, it was almost impossible to keep it without losing the salts. With regard to the use of algin for pharmaceutical purposes, it had already been employed for emulsifying cod-liver oil, and was found very superior to other agents, especially as it contained a small quantity of iodine. Some time ago he read that some parts of the coast of Mauritius was covered at certain times with immense quantities of foam, caused by mucilage apparently derived from Laminaria; and it occurred to him that perhaps the algæ might be employed for producing a head on beer, in preference to quillaia bark, which he understood was now used for that purpose, and which must be of a somewhat irritating character, from containing saponin; whereas the algin would certainly be of a harmless character. It occurred to him, from the insolubility of the salts of alginic acid, that it might perhaps be useful for waterproofing purposes. He should also like to ask whether textile fabrics became less combustible from its use. With regard to its substitution for gum arabic, he might say that it was almost impossible of late years to obtain this gum of good quality. That which they now obtained made a mucilage more like that of white of egg than that from good gum. The bean found with the sea wrack was one which was found in the West Indies, commonly called the asses'-eye bean (*Mucuna urens*).

Mr. CROSS said it would be very interesting to see

Mr. Stanford's results correlated with the main principles of cellulose chemistry. Perhaps the most interesting feature of the algin was the presence of nitrogen, but he had not said anything about the products of decomposition of the algin, such as would throw light on the point whether the nitrogen was essentially connected with the carbon molecule which presided over the whole. It would be very interesting to have some information on these points. There was certainly some evidence of its having the general properties of an aldehyde, and, in some respects, it reminded one of the body recently described as oxycellulose. Whenever cellulose was oxidised, it yielded these peculiarly gelatinising bodies. It was impossible, in a few words, to even indicate the enormous field which was opened up for investigation by the discovery of this substance, and he hoped it would be thoroughly taken up.

Mr. T. Christy said he had brought with him some *Eucheuma speciosa* from the western shore of Australia; and amongst several seaweeds which he had put into commercial use, none gave such excellent results in dyeing and the preparation of mordants. He had had several requests from France to procure further supplies, but though he held out every inducement to the traders on the west coast of Australia to forward this seaweed, he had not succeeded in getting any more. Mr. Greth, in making some experiments with it, and also on some Japanese seaweed, found that it took up 500 times its weight of water, and as a sizing material there was nothing equal to it. He had also tried it in several preparations for damp walls, and found it most effectual, both with plaster, lime, and brick walls. Mr. Greth was still working at this subject in Berlin. The use of the algæ in combination with shellac was of great importance, as it prevented the extreme brittleness which arose from the use of shellac alone. It was largely used for this purpose in France, where they were very particular as to the class of seaweed, and next to that from Australia, the weed from Singapore met with most favour. He had lately, however, received some *E. Spinosa* from Borneo, which was even superior to that from Singapore. There was an immense field for the use of seaweed, if a regular supply could be depended upon of these qualities,

Mr. Lloyd said everyone who had passed a heap of seaweed must have noticed the disagreeable smell which came from it, showing that it was most liable to decomposition, and this was the root of the difficulty of dealing with it as food; besides which, few, if any people, knew how to cook it. In Wales it was largely used fried in oil, and he believed it was also used in London to some extent boiled like greens. He was much surprised to hear that seaweed had been kept in a silo, and retained 80 per cent. of moisture, knowing its liability to decompose, and the immense difficulty which farmers had found in keeping grass with only 75 per cent. of moisture; it would be interesting to know what changes had taken place, and whether the preservation was due to the formation of some acid, or to the presence of salt in considerable quantities. Looking to the precipitating power of one of the products Mr. Stanford had obtained, it occurred to him that possibly it might be useful in the purification of sewage, at any rate in the initial operation of throwing down the solid matter.

Mr. J. M. Thomson said he understood Mr. Stanford that this new substance might be used in photography, and would produce a harder film than gelatine, but he thought there might be a difficulty in easily softening it with water for the purpose of making an emulsion with salts of silver. One point mentioned in the early part of the paper, viz., the affording occupation to the crofters, was of great importance. He could speak from experience of the west coast of Scotland, and if by the aid of the system of telpherage, lately brought forward by Professor Fleeming Jenkin, this industry could be developed, it would be of immense advantage to the inhabitants. If there were more men like Mr. Stanford in that district, indicating, as he had done, the directions in which the crofters might make their work remunerative, less would be heard of crofters' commissions.

Mr. Stanford, in reply, said that algin had been tried in photography, but there was one disadvantage about it, that the silver coagulum was not such a strong one as any of the others. What he had suggested for photography was gelose; it made a good emulsion, and dry plates had been worked with it. With regard to the preservation in the silo, he could only say that the seaweed had been kept for six months, and it was of a kind very difficult to keep, containing, when dry, about 35 per cent. of salts, and very liable to rot. It was put into a well-built silo, and after six months was taken out apparently unaltered. He could not say what was the exact change which had taken place, nor did he think this was as yet ascertained in the case of hay or grass. He did not, however, think the salt had anything to do with it; it was a description of seaweed which, if air got to it at all became full of bacteria, and rotted very quickly. He might also say that it had been noticed years ago that when a large quantity of this substance was kept under pressure, that which was kept underneath kept very well. He understood Mr. Christy to be referring to the *agar agar* as the seaweed from Australia which had given so much satisfaction. He had always drawn the line between these three gelatine-producing species and any other seaweed. Some years ago he investigated all the species he could get hold of, and could not find gelatine in any but the *Gelideum corneum*, and the *Chondrus crispus*, and it was somewhat remarkable that neither those nor the Australian *agar agar* contained either iodine or algin. With regard to Mr. Cross's remarks, he thought that gentleman had already shown that cellulose was sufficiently difficult to investigate without going into any nitrogenous substances. He had placed algin amongst the albumens and gelatines, and though he had made a great number of experiments on the decomposition products of it, he had not yet arrived at any satisfactory conclusions such as he could lay before a scientific society. This substance had not been known quite so long as gelatine and albumen, and yet the chemistry of both those substances was in almost as unsatisfactory a state as that of algin. He had not tried whether textile fabrics treated with this material would be less combustible, but probably they would be, from its containing soda. As to the odour of the *Enteromorpha compressa*, he had not the slighest idea what it came from, any more than he had what caused the odour of the sea; which again would form an interesting subject for investigation to any young chemist who liked to devote his lifetime to it. As to the important question of the deep-sea algæ, and the *stenophylla* which he had given as containing more iodine than the deep-sea tangle, although it grew higher up, the reason was, that the *stenophylla* varied very much in composition; there was no plant he was acquainted with which varied so much in the amount of iodine it contained. In fact, all the seaweeds varied very much according to the time of year, the age of the plant, and other circumstances. The *Laminaria digitata*, both the stem and the frond, almost always contained a definite amount of iodine, and though in this case the *stenophylla* had come out with the largest per-centage, it might easily have been the other way. With regard to the use of seaweed as food, it was a remarkable fact that in Japan they were used with a large amount of salts in them—as much as 30 per cent. when they were sent into the market. He considered that in isolating the algin, we obtained the whole food value, and the whole of the nitrogen of the plant. He was much obliged to Mr. Holmes for the diagrams and specimens he had lent him, and would draw special attention to a specimen of giant algæ from the Falkland Islands, one of which was supposed to be the longest plant in the world, growing sometimes to the length of 1,500 feet.

The CHAIRMAN said this paper was a most interesting one, and there were many points in which it might be very profitably discussed if time allowed. He could but congratulate Mr. Stanford on his perseverance with this subject, for he must have had a great many things to damp his ardour. Some years ago he (the Chairman) had an opportunity of going over the North British Chemical Works, where Mr. Stanford's process of distillation was going on, and he was much interested in seeing the way in which it was worked. He feared the discovery of new sources for iodine, and bromine which was now about the same price per lb. as it was formerly per oz., must have very much interfered with the success of the undertaking. He concluded by proposing a vote of thanks to Mr. Stanford, which was carried unanimously.

Miscellaneous.

THE COMMERCE OF COREA.

The United States Minister in Corea gives an interesting account of the people, trade, and industries of that peninsula. The territory is bounded on the north by the Shan-yan-alin mountains, and two large rivers, which take their rise in these mountains. The one known as Am-no-kan, flowing westward, empties itself into the Yellow Sea, and forms the natural boundary between Corea and China; the other, known as the Toman-kian, flowing eastward, empties itself into the Japan Sea, and divides Corea from Manchuria and the Russian territory. The kingdom is divided into eight departments, viz., Ham-Keung-to, Whang-hai-lo, Kang-wun-to, Keung-que-to, in which department is situated Seôul, the capital, and the open port of Inchun; Choong-chung-to, Chun-ra-to, and Keung-sang-to, which contains the open port of Poosan. Corea is a land of mountains, and in the central and western portions are several plains or plateaus called Maipo; these are extremely fertile, and for this reason Maipo is called the rice warehouse of Seôul. The country is well watered and fairly wooded, and the Government exercises much care in maintaining the forests. Many wild animals abound in the mountains, such as tigers, leopards, bears, wild boars, &c., and pheasants, water fowl, and other game are abundant. Among the domestic animals the horses are extremely small and inferior, and the swine are poor and ill-flavoured. Goats and sheep are rarely if ever seen. Corea produces apricots, nectarines, peaches, plums, apples, pears, and a variety of other fruits. The variety of vegetables is limited, and the quality poor. In spite of the severe restrictions, no inconsiderable amount of gold is extracted each year, and mines of gold, silver, copper, lead, and iron, are said to exist in the country. In the northern districts, wheat, barley, rye, cattle, ginseng — which is a Government monopoly—medicinal herbs, dried fish, honey, tiger and leopard skins, furs and hides are produced. The products of the central and southern districts are rice, silk, cotton, hemp, tobacco, wheat, corn, barley, beans, millet, dye woods, fruits, vegetables, cattle, and hides. Among the manufactures are silk, cotton, and linen cloths, iron and stoneware, pottery, hats, shoes, paper mats, fans, screens, combs, pipes, brushes, certain kinds of furniture, mechanical and agricultural implements, &c. Cloths are woven in hand looms, and pottery is made by the use of the wheel. The majority of the houses are simply hovels, with mud walls and floors, and thatched roofs. The better class of houses have stone foundations, intersected with flues for heating purposes. Upon this foundation is a wooden building with tile roofs, the floors, walls, and windows of which are lined with paper;

the number of houses is estimated at 1,700,000, and the population at 11,000,000. The clothing of the common people is made invariably of cotton or linen cloth, and in winter is wadded. They wear upon their feet straw or twine sandals, with soles of raw-hide, and upon their heads conical shaped hats made of horsehair. Their breeches are made very full, and are divided below the knee, and fastened at the ankles; over this a long loose robe is worn with flowing sleeves. The people are a hardy, vigorous, well-formed race, of medium stature, and while the yellow skin, almond-shaped eyes, and black hair of the Mongolian race prevail, men with light hair and beards and blue eyes are sometimes seen. The beard is allowed to grow, and the hair is never cut, but is tied in a knot on the top of the head. The wages paid to the labouring classes average about 7d. a day, and to the artisan 1s. Slavery is said to exist in a modified form, and is even sometimes voluntary, as thus the poor man escapes extortion and oppression. The artisans and many classes of labourers, however, belong to powerful organisations or guilds, by which means they maintain a degree of independence and enforce their rights. Crime is severely punished, and questions affecting civil rights are decided by the courts. The women, married and unmarried, are kept in great seclusion. Marriage is a matter of negotiation between the parents and friends of the parties, and is often concluded in childhood. Unmarried persons of the male sex can be distinguished by the method of wearing their hair, hanging down in Chinese fashion. The women adorn their heads with bands of false hair; their dress consists of the broad breeches divided below the knees and fastened at the ankles, over this a short skirt and jacket are worn. Persons in mourning eat no meat and pay no visits, they are dressed in robes of coarse grey cotton cloth, and wear immense straw hats, and when they go abroad, hide the lower part of the face with a mask. In conclusion, the United States Minister says:—"There are many industries here which might, by means of the cheap labour, be successfully promoted. There are mines of gold, silver, copper, lead, iron, and coal to be developed. In the north there are said to be large forests of timber, for which there should be a market near at hand. Agriculture, and cattle and sheep breeding, could be stimulated so as to produce a surplus for exportation, but there are difficulties to contend with; the extremes of heat and cold are great, there are no roads or means of transportation, and the policy of exclusion still has strong adherents."

AUSTRALIAN EXHIBITIONS, &c.

Mr. Samuel H. Roberts, honorary corresponding member of the Society, writes as follows:—

The closing of the Calcutta Exhibition, and the return of the Melbourne Commissioner (Mr. J. Bosisto), has attracted public attention here to the desirability of opening up a trade between Australasia and India; and already a Melbourne firm has laid on a line of steamers between this port and Calcutta; a large carrying and passenger trade is expected. The direct influence of an Exhibition on the industries of a country have seldom been so plainly manifested as in this prompt commencement of commercial relations between two important ports.

Our large Exhibition building (prepared for that of 1880-1) has just been opened with an Intercolonial Exhibition. The majority of the exhibitors, however, are Victorians. At the opening ceremony, the Marquis of Normanby congratulated the committee on their having made all the arrangements independently of Government aid. The Exhibition is worthy of the success that his Excellency wished it, as its main object is to bring the resources of the Colony under public notice, and it is promoted by private enterprise. Flower shows; fruit and grain shows; musical and other entertainments are also set before the visitors. The inmates of the Blind Asylum have their work-benches set up in the Exhibition, and practice basket-making, knitting, netting, brush-making, and other work, to the great interest of the public.

The treatment of boy prisoners has lately been attracting attention, the Hon. G. Coppin having advocated the re-establishment of reformatory training ships, and, with the Chief Secretary, Hon. G. Berry, has visited the prisons and reformatories with a view to their improvement. It is hoped that a vigorous effort will be made for their proper treatment and reclamation.

The discovery of coal in payable seams in Victoria will remove a very serious drawback to our industrial supremacy in these seas. Hitherto we have been dependent upon New South Wales for supplies of coal. Now we have found coal in several parts of the colony, and one company is delivering coal of a good quality from the mine at Kilcunda.

A new method or system of ventilation has just been designed by Mr. Lloyd Tayler, one of our leading architects. It has been put into practical use at one of the banks. The fresh air is supplied by a simple and interesting process. A stream of fresh air is forced down from the roof (by a small fan-blower) into an air-tight reservoir in the vaults under the ground floor, and distributed through smaller pipes to the various chambers of the bank, where it is delivered above the heads of the *employés*. The escape of the vitiated air has also been managed in an equally skilful manner.

The schools of art and design in the colony now number thirty-two, and are progressing satisfactorily. Several new schools are projected in different towns and boroughs of the colony. The Hon. William K. Vale, Chairman of the Commission for Promoting Technological and Industrial Instruction in Victoria (with the members of the Commission) takes an active part in the establishment and maintenance of the schools. There are now 2,700 pupils on the roll.

The sister colony of New South Wales is about taking up the question of technical education in earnest. Parliament has voted £20,000 towards it. A technical college has been commenced under the presidency of Mr. Coombs, M.P.

The study of the Australian flora has lent an attraction to the Art Department of our Exhibition, in the work of Miss Foster, who has gathered her examples on the beautiful slopes of the May-day-hills at Buckworth. The students of the Art Gallery at the Public Library, lately held an Exhibition of their own; and very handsome prizes were given by the trustees and others.

KITOOL FIBRE.

The palm, *Caryota urens* (Linn.), is a native of Ceylon, Malabar, Bengal, Assam, and various parts of India. Amongst natives of Ceylon, it is known as Kitool, Kitoo, Kittul, Jaffery, and Bynee. In India, it is called Bastard Sago, Coonda pauna (Tamil); Erimpana, or Schundra-pana (Mal.); Teeroogoo (Tel.), &c.

It is a beautiful and lofty palm, with a trunk more than a foot in diameter, and 40 ft. high. The large bipinnatisect leaves measures 18 ft. to 20 ft. in length, and 10 ft. to 12 ft. across. The fruit is of the size of a plum, with a thin yellow rind, and is very burning and acrid in taste. From the flower stem, an enormous amount of sweet juice can be obtained; as much as 100 pints in 24 hours. From this juice Jaggery sugar, well known in our markets, is prepared, although it is not the only source, other palm trees yielding it in commercial quantities. The caste who prepare this sugar in Ceylon, are known as Jaggeros. The juice is also pleasant to drink when fresh, and an intoxicating spirit known variously as toddy, arrack, pauna, or pawnee, is obtained by fermentation, and largely used.

The pith of the stem contains a large amount of farinaceous matter equal to sago in quality. The natives use this largely for food in the shape of gruel or a kind of bread. Like its relative, the Coco-nut, Kitool palm is a source of food and profit to its owner. Elephants make of the leaves their favourite food, and the "heart" or expanded leaves can be made into a capital cabbage, or pickled, or candied. The woolly substance at the base of the leaves is used in caulking ships.

The fibres or veins of the leaves furnishes the Kitool fibre, and it is largely used by the natives for the making of ropes, fishing-lines, bow-strings, brushes, brooms, baskets, caps, &c. Its great strength has earned for it the name of "Elephant fibre," and ropes made of Kitool are used to tether and secure wild elephants.

The fibre has long been known in this country, and under the name of "Indian gut," has long been used for fishing-lines. When made into brushes, it is found to be most durable, and some firms will not use brushes made of any other material. It seems to be the best substitute for bristles, as the fibre is strong, tough, and impervious to water. It is, however, rather brittle, and a sudden knot may break it. It can be woven together with cotton for petticoat stuffs, and forms a cheap and flexible fabric for dress-improvers, &c. Steamed and curled, it can be used for stuffing purposes in upholstery, and the refuse may be used instead of hair to mix with mortar for building purposes. When dipped in oil, it turns from a dull brown to a beautiful black colour, and the oiliness may be removed.*

The process of making brushes from this fibre, adopted at the works of Messrs. Horsey and Company, is such that no pitch or glue is required, and each knot is independent. The fibre and wire are driven down into the hole in the stock by means of a punch, which consists of two parts like two fingers. This doubles up the fibre with the wire on top, but as soon as it has reached the bottom of the stockhole, the fingers separate and force tho wire into the solid wood. The wire now flattened and secure, the arms of the punch close together, and ascend.

Correspondence.

MINERAL DEPOSITS IN THE SOUTHERN STATES OF AMERICA.

In the number of the *Journal* for December 28th, No. 1,623, was a "note" on the "Mineral Wealth of Colorado." It has since occurred to me that it might be suitable to bring to the notice of your readers another field of mineral wealth in the United States, much nearer to us than is the far South-West, but one that is comparatively neglected—mainly because of the noise made by the large yields some years ago at Leadville, Denver, and in other of the far western provinces. The paper recently read before the the Society, communicated by Mr. W. H. Penning, on "Transvaal Gold Fields," again reminded me that many readers might welcome a few particulars regarding the remarkable mineral deposits on the eastern slopes and upland valleys of the Appalachian range, chiefly in North Carolina, to which chance circumstances, some time ago, drew my attention.

These deposits, which exist chiefly in North Carolina, but also in parts of Virginia, and further south-east in Georgia, have long been known to scientific men, but are comparatively little known to working mineralogists. The Geological Survey Reports of the United States Government long since indicated the abundance and rich variety of mineral

* See Mr. Rowbottom's remarks, *Jour. Soc. Arts*, Dec. 22, 1882, p. 113.

formation in those regions, more especially in North Carolina. At the Boston Exposition of 1882 the prevalence and accessibility of these deposits were demonstrated by the exhibition of ores of every description from that field, those of argentiferous galena and copper being peculiarly rich, while gold nuggets with gold-bearing quartz and gems were also shown. These "exhibits" were more than sufficient to vindicate the prognostications of the official scientific surveyors. That the English public has not become familiar with the remarkable characteristics of the mineral region in the south-eastern States, may partly be due to the rule-of-thumb methods generally adopted by the unscientific pioneers, to whom our capitalists are content to leave the opening out of new or neglected fields of production. Certain local circumstances special to North Carolina, into which it is not needful to enter here, have also deterred both New England capitalists and British "prospectors" from any systematic examination of those districts, which, there fore, still await the operations of well-directed enterprise. Sufficient mining work has been already done in these fields to bring the subject within the scope of such direct and serious notice as many members of the Society of Arts are well qualified to bestow thereon. It is to Davidson County, in North Carolina, that attention should be specially drawn, as at the Boston Exposition the abundance of valuable ores, already "in sight" in that particular locality, was most manifest. The "Cid" copper mine in that country is very well known, it having been worked on somewhat better methods since ores from it were exhibited two years ago. The "Ore Knob" mine, and two or three others in or near the Blue Wing Mountain, are also tolerably well known; but, as yet, are worked under many disadvantages for want of sufficient capital and more experienced direction. In spite of the lack of efficient smelting and "reducing" works, the "Ore Knob" mine has produced over ten million pounds of copper; and, two years ago, It had paid $210,000 in dividends. In the year 1882–3 it produced $1,600,000 worth of pig copper. The "Conrad" mine, also in the Davidson county, is known as yielding gold in paying quantities; but its chief product is sulphuret of copper. The richness of the copper ores throughout North Carolina is quite beyond all usual averages; the other day I was shown a specimen that must have contained over 70 per cent. of copper. Then, in the "Silver Hill" mining district, also in Davidson county, lead and coppers ore are found in close proximity and great abundance. Mica also is present in bulk and quantity remarkably adapted for manufacturing purposes.

The ores and mineral products of these North Carolina districts have recently been brought under the notice of Mr. J. K. Hallewell, a well-known geologist of Denver, Colorado. He speaks of "the chalcopyrite and black oxide of copper from the Cid mines giving values of 47 per cent. copper, $7½ in gold, and 16 ozs. silver." Also from another district in North Carolina Mr. Hallewell reports on ore "giving value, gangue and all, 20 per cent. copper, and value in silver besides;" also much larger percentage by selection. Professor G. B. Hanna, assayer of the United States Mint, at Charlotte, North Carolina, gives assays as follows:—

"Specimen from Farris mine, $506·41 gold and $6·52 silver, per ton; specimen from Rudisil mine, $204·97 gold and $·53 silver, per ton; specimen from Black's mine, $485·75 gold and $2·37 silver, per ton; specimen from Eureks mine, $46·51 gold $2·78 per cent. copper."

One excuse for the neglect of these districts by British mineralogists and capitalists may be the imperfect state of common road communication in North Carolina; but the Richmond and Danville Railway runs within easy distance of some of the most promising of these mineral tracts. It belies our reputation as practical people, that so much British capital and enterprise have been risked and lost in the remote States of the far south-west; while, here in the eastern States, on the very seaboard, these scarcely worked, but practically inexhaustible, stores of copper and lead, so essential to our electrical and other industries, are disregarded as yet. Though the gold-fields of the Transvaal are tempting, there is far less of political and commercial risk to be encountered in the South-eastern States than in South Africa.

W. MARTIN WOOD.

West Kensington, May 21, 1884.

Obituary.

SIR BARTLE FRERE.—The Right Hon. Sir Henry Bartle Edward Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., F.R.S., died on the 29th ult., at Wressil-lodge, Wimbledon, after a long and painful illness. Born on March 29, 1815, he began his distinguished career in India as early as 1834. After the Indian Mutiny he twice received the thanks of Parliament, and in 1862 he was appointed Governor of Bombay. In 1872 he went as Special Commissioner to East Africa, to inquire into the slave trade, and subsequently he accompanied H.R.H. the Prince of Wales to India. In 1877 he was appointed Governor and Commander-in-Chief of her Majesty's Possessions at the Cape of Good Hope, and her Majesty's Commissioner for the settlement of Native Affairs in South Africa. This list represents a portion only of Sir Bartle Frere's employments during his long public life, but his achievements are fully recorded elsewhere; and in this plaee his interest in the proceedings of the Society of Arts should be more particularly recorded. He frequently took the chair at the evening meetings, and at the first meeting of the Indian Section, in 1873, which grew out of the Indian Conferences of previous years, he delivered an address on "The threatened famine in Bengal, and the means of preventing or alleviating famines in India," which formed the groundwork of his published volume on the same subject. He also gave an address at the opening of the African Section in 1874. In 1881 the Society's Silver Medal was presented to him, for his paper on "The Industrial Products of South Africa."

General Notes.

METAL INDUSTRY OF GREECE.—Since the year 1862, considerable attention has been paid to the above industry, which had been brought to a high degree of progress in Ancient Greece. More than 1,000 workpeople are now engaged in connection with the metal trade, and the capital employed is about £3,000,000 sterling. Saurium, the most important seat of the industry, has only commenced its existence as a populated centre since 1863, and it numbers at present 16,000 inhabitants. There are also, throughout Greece, mines of argentiferous lead, zinc, and iron; quarries of ochre and carbonate of magnesia likewise exist, but are not being worked on account of the necessary capital not being available for the purpose.

HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 9...Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. J. C. Fell, "Soft *v.* Hard Water for Manufacturing Purposes."
Chemical Industry (London Section), Burlington-gardens, W., 8 p.m. Mr. W. S. Squire, "Th Processes Concerned in the Conversion of Starch into Alcohol, and their Relation to Brewing and Distilling." (Illustrated.)
Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. W. W. Graham, "Travel and Ascents in the Himalaya."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. T. Wood, "The Temple of Diana at Ephesus."

TUESDAY, JUNE 10...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Gas Institute, 25, Great George-street, S.W., 10 a.m. Annual General Meeting. Inaugural Address by the President. Reading of papers and discussions.
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8 p.m. 1. Mr. A. W. Howitt and Rev. L. Fison, "The Deme and the Horde" 2. Mr. C. A. Gollmer, "Africian Symbolic Language." 3. Dr. S. M. Curl, "Phœnician Intercourse with Polynesia."
Colonial Institute, St. James's Banqueting-hall (Regent-street Entrance), W., 8 p m. Governor Sir Frederick A. Weld, "The Straits Settlements and British Malaya."

WEDNESDAY, JUNE 11...Gas Institute, 25, Great George-street, S.W., 10 a.m. Reading of papers and discussions, continued.
Geological, Burlington-house, W., 8 p.m.
Microscopical, King's College, W.C., 8 p m. 1. Dr. J. Anthony, "The Camera Lucida." 2. Mr. G. F. Dowdeswell, "Some Phenomena of the Red Blood Corpuscles of Vertebrates, with reference to the occurrence of Bacteria normally in Living Animals." 3. Mr. C. D. Ahrens, "A New Polarising Prism." 4. Mr. G. F. Dowdeswell, "The Constancy of Specific Morphological Characters in the Bacteria."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

THURSDAY, JUNE 12...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. C. M. Campbell, "What Health owes to Art."
Gas Institute, 25, Great George-street, S.W., 10 a.m. Reading of papers and discussions, continued.
Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Mr. S. J. Mackie, "Some Recent Inventions."
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JUNE 13 ... United Service Inst., Whitehall-yard, 3 p.m. Admiral Sir Alfred Ryder, "Fog Collisions."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Researches on Liquefied Gases"
Astronomical, Burlington-house, W., 8 p.m.
Gas Institute. Visit to Hatfield-house. St. Albans.
Quekett Microscopical Club, University College, W.C., 8 p.m.
New Shakspere, University College, W.C., 8 p.m. Mr. Thomas Tyler, "Shakspere's Sonnets."

SATURDAY, JUNE 24...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. D. J. Blaikley, "The Velocity of Sound in Tubes." 2. Mr. H. H. Hoffert, "A new Apparatus for Colour Combinations."
Botanic, Inner Circle, Regent s-park, N.W., 3¾ p.m.

CORRECTION.—Page 710, col. 1, line 14, *for* half an inch *read* one-twelfth of an inch; line 15, *for* six cells, *read* thirty-six cells. Page 712, col. 1, line 8, *for* worked by a dynamo, *read* worked by a motor, actuated by the first cell of the series; line 25, *for* 100, *read* 600.

Journal of the Society of Arts.

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FRIDAY, JUNE 13, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ALBERT MEDAL.

The Council of the Society of Arts have (with the approval of the President, H.R.H. the Prince of Wales) awarded the Albert Medal of the Society for the present year to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirtieth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 25th June, at 4 p.m.

(By order of the Council)
H. Trueman Wood,
Secretary.

CONVERSAZIONE.

A Conversazione will be given at the International Health Exhibition by the Council of the Society of Arts, in conjunction with the Executive Council of the Exhibition, on Wednesday evening, 9th of July.

Further particulars will be duly announced.

Proceedings of the Society.

APPLIED CHEMISTRY & PHYSICS SECTION.

Thursday, May 22, 1884; B. Francis Cobb, Vice-President of the Society, in the chair.

The paper read was—

SOME ECONOMICAL PROCESSES CONNECTED WITH THE CLOTHWORKING INDUSTRY.

By Dr. William Ramsay,
Professor of Chemistry at University College, Bristol.

In this present age of scientific and technical activity, there is one branch which has, I think, been the subject of an article in the *Quarterly Journal of Science*. It is one which deserves attention. It was there termed "The Investigation of Residual Phenomena," and I can conceive no better title to express the idea. The investigator who first explores an unknown region is content if he can in some measure delineate its grand features—its rivers, its mountain chains, its plains; if he be a geologist, he attempts no more than broadly to observe its most important rock formations; if a botanist, its more striking forms of vegetation. So with the scientific investigator. The chemist or physicist who discovers a new law seldom succeeds in doing more than testing its general accuracy by experiments; it is reserved for his successors to note the divergence between his broad and sweeping generalisation and particular instances which do not quite accord with it. So it was with Boyle's law that the volume of a gas varies in inverse ratio to the pressure to which it is exposed; so it is with the Darwinian theory, inasmuch as deterioration and degeneration play a part which was, perhaps, at first overlooked; and similar instances may be found in almost all pure sciences.

I conceive that the parallel from the technical point of view is a double one. For just as every technical process cannot be considered to be beyond improvement, there is always scope for technical investigation; but the true residual phenomena of which I would speak to-night are waste products. There is, I imagine, no manufacture in which every substance produced meets with a market. Some products are always allowed to run to waste, yet it is evident that every effort consistent with economy should be made to prevent such waste; and it has been frequently found that an attempt in this direction, though at first unsuccessful, has finally been worked into such a form as to remunerate the manufacturer.

It is my purpose to-night to bring under your notice methods by which saving can be effected in the cloth industry. I am aware that these methods have not much claim to novelty; but I also know that there are, unfortunately, few works where they are practised.

The first of these relates to the saving and utilisation of the soap used in wool scouring and milling. It is, perhaps, hardly necessary to explain that woollen goods are scoured by being run between rollers, after passing through a bath of soap, and this is continued for several hours, the cloth being repeatedly moistened with the ley, and repeatedly wrung out by the rollers. The process is analogous to ordinary washing; the soap dissolves the greasy film adhering to the fibres, and the "dirt" mechanically retained is thus loosened, and washed away. Now, in order to dissolve this greasy matter, a considerable amount of soap must be employed; and in the course of purification of the fabric, not merely what may be characterised as "dirt" is removed, but also short fibres, and various dye-stuffs with which the fabric has been dyed, many of which are partially soluble in alkaline water; moreover, it invariably happens that some dye does not combine with the fibre and mordant, thus becoming fixed, but merely encrusts the fibre; hence this portion is washed off when the retaining film of grease is removed from the fibre. The suds, therefore, after fulfilling this purpose, are no longer a pure solution of soap, but contain many foreign matters; and the problem is so to treat these suds as to recover the fat in some condition available for re-conversion into soap.

For this purpose wooden runnels are placed beneath the rollers, through which the cloth passes in the scouring machine, so as to collect the suds after they have been spent. These runnels lead to a wooden pipe or runnel, which receives the spent suds from all the scouring machines, and the whole of the waste, instead of being let off into the stream, polluting it, delivers into a tank or trough, which may also be constructed of wood, but, as it has to withstand the action of acid, is better lined with lead. This tank is necessarily proportioned in size to the number of scouring machines, and the quantity of spent suds to be treated. When a sufficient quantity has collected, oil of vitriol, diluted with twice its bulk of water, is added, one workman pouring it in gradually, while another stirs the contents of the tank vigorously. At short intervals, the liquid is tested by means of litmus paper, and when it shows a faint acid reaction, by turning the blue paper red, the addition of acid is stopped. The acid has then combined with the alkali of the soap, while the fatty acids formerly in combination with the alkali are liberated, and float to the surface of the liquid, carrying with them the impurities, in the shape of short fibres and dye stuffs; the sand and heavier impurity, should any be present, sinks to the bottom.

After standing for some hours, the separation is complete. In order to separate the two layers, the tank is provided with an exit in the side, near the bottom, closed by a sluice or valve. This valve is opened, and the watery portion is allowed to escape into a sand filter-bed. The filter serves to retain any solid impurities which may still remain suspended in the water; but it will be found that the escaping water is nearly pure.

The dark brown fatty acid is mixed with a large amount of impurity, such as short wool fibres, burrs, sand, and dye stuffs washed from the wool. To remove water more completely, the semi-fluid mass is pumped from the tank, and delivered into hair-cloth filters; the liquid which drains from these bags finds its way to the sand filters, joining the drainage which formerly passed out from the tank through the sluice. After being turned over in the filter several times, the residue is transferred to canvas sacks. These sacks are placed in a filter press, where they are exposed to pressure while heated to a temperature sufficient to melt the fat. The solid impurities remain in the bags, while the fatty acids escape, and are received in a barrel or tank for the purpose. The fatty acids, when cold, are of a deep brown colour, and of the consistency of butter. The residue is kept, and the method of treating it for the recovery of indigo will afterwards be described.

The fatty acids are now ready for conversion into soap. It may here be remarked that, on distillation, they yield a nearly white fatty mass, which, when treated with soda-ley, is capable of yielding a perfectly white soap. But, for the clothworkers' purpose, this purification is unnecessary.

The conversion into soap is a very simple matter. As the fats are acids—a mixture of palmitic, oleic, and stearic acids—and not the glycerine salts of these acids, like ordinary fats, soap is made by causing them directly to unite with caustic soda. The fats are melted in a copper, by means of a steam-jacket, or coil of steam-pipe in the copper, and the soda-ley is run in until complete union has taken place. The exact point of neutralisation can easily be found by taking out a small sample after stirring, and dissolving it in some methylated spirits. A few drops of alcoholic tincture of phenol-phthaleïn are then added, and as soon as a faint red colour appears, addition of soda is stopped. This shows that the fatty acids have been over-saturated. Addition of a little more fat renders them perfectly neutral, and the soap is then ladled out into wooden moulds, lined with loose sheets of zinc.

The resulting soap is of a brown colour, but is perfectly adapted for the purpose of wool-scouring. It should here be mentioned that, in practice, the soap is always made somewhat alkaline; in point of fact, it contains about 2 per cent. of free alkali. This is found to assist in scouring; I presume that the free alkali forms a soap with the oil added to the wool during spinning, and if no free alkali be present, this oil would not be so thoroughly removed.

It will be noticed that in this simple method of soap-making, there is no salting out to separate the true soap from the watery solution of glycerine, for no glycerine is present. The apparatus may be of the simplest nature, and on any required scale, proportionate to the size of the mill. It is a process which requires no specially skilled labour; in any works some hand may be told off to conduct the process as occasion requires; and as a very large proportion of the fatty matter is recovered, the soap-bill is reduced to a very small fraction of the amount which would be paid were recovery not practised. And lastly, the streams are not polluted; the only waste is a little sulphate of soda, which can hardly be regarded as a nuisance, inasmuch as it is a not unfrequent constituent of many natural waters.

Let us now return to the solid matter from which the fatty acids have been removed by pressure. This brown earthy-looking cake consists of vegetable impurity washed off from the cloth, of short fibres, and of various dye-stuffs. It is divided into two lots:—That which contains indigo, and that which contains none, or which contains too small a quantity for profitable extraction. And it may here be remarked, that it is advisable to collect the suds from cloth dyed with indigo separate from that to dye which no indigo has been employed. The residue from indigo-dyed cloth has always a more or less blue shade, and if much indigo is present, the well-known copper-colour is evident. Of course, the amount of indigo must greatly vary, but it may rise to 8 or 10 per cent. of the total weight of the refuse.

To recover the indigo from this refuse, the somewhat hard cakes are broken up, placed in a tank, and allowed to steep in water. When quite disintegrated, they are transferred to another tank—a barrel may be used for small quantities—and thus this refuse is exposed to the reducing action of copperas and lime. The indigo is converted into indigo-white, and is rendered soluble, and it oxidises on the surface, forming a layer of blue froth on the top of the liquid, while the remainder of the impurities sinks. This process of reduction may last for twenty-four hours, and is helped by frequent stirring.

The indigo scum is preserved, and placed in filter cloths, where it is thoroughly washed with water two or three times. The residue which has sunk to the bottom is removed, dried, and forms a valuable manure, owing to the amount of the nitrogen which it contains. Its value may be increased by addition of weak vitriol, which exercises a decomposing action on the nitrogenous matter forming with it sulphate of ammonia. The original residue from the filter-press, if it does not contain indigo, may be at once put to similar use.

In large works, which dye their own goods, it is well known that the "fermentation-vat" is in general use for indigo-dyeing. But this vat requires constant superintendence, and must be kept in continual action; besides, it is successful only on a comparatively large scale. And, moreover, it requires skilled labour. Small works, or works in which dyeing is only occasionally practised, find it more convenient to use Schützenberger and Lalande's process. Although this process is well-known, a short description of it may not here be out of place.

The process depends on the reduction of indigo to indigo white, or soluble indigo, by means of hyposulphite, or, as it is generally termed to avoid confusion with antichlore, rightly named thiosulphate of soda, hydrosulphite of soda. The formula of this substance is $NaHSO_2$, as distinguished from what is commonly known as hyposulphite of soda, $Na_2S_2O_3$. It is produced by the action of zinc-dust on the acid sulphite of soda. The zinc may be supposed to remove oxygen from the acid sulphite, $NaHSO_3$, giving hyposulphite, $NaHSO_2$. The reduction of the acid sulphite is best performed in a cask, which can be closed at the top, so as to avoid entrance of air. The acid sulphite of soda, at a strength of 50 or 60 Twaddell (specific gravity 1·26 to 1·3), is placed in the cask, and zinc dust is added, with frequent stirring. The liquid is then mixed with milk of lime, and after again thoroughly stirring, the liquid is allowed to settle, and the clear is decanted into the dyeing-copper. The indigo, in the frothy state in which it is skimmed from the purifying barrels or tanks, is then added, with sufficient lime to dissolve it when it has been reduced. It is heated gently by a steam coil, to about 90° Fahr., and the goods are dyed in it. The colours obtained by means of this indigo are light in shade, and the goods must be dipped several times if dark shades are required. But it is found better in practice not to attempt to dye dark shades by this process; the ordinary indigo-vat is better adapted for such work. The object of not wasting indigo is sufficiently attained by employing it for the purpose to which it is best adapted. Of course the recovered indigo may be used in the ordinary manner. I merely mention the most convenient way of disposing of it in works where only a small quantity is recovered, and which do not practice dyeing on an extensive scale.

I have now to ask you to turn to a different subject, namely, the scouring of wool, not by the usual agent, water, but by a liquid, bisulphide of carbon, made by the action of sulphur vapour on red hot coke or charcoal.

This, again, is not wholly a new process, for various attempts have been made to dissolve out the yolk, or *suint*, or greasy matter from unwashed wool, as it comes from the back of the sheep. Fusel oil has been patented for this purpose. Carbon disulphide has also been patented, but, as will afterwards be shown, the old method of removing it from the wool injured the colour and quality of the fibre, so as to make the application of this scouring agent a failure.

Wool in its unwashed state contains a considerable proportion of what is termed *suint*. This consists of the fatty matter exuded as perspiration from the sheep, along with, or in some form of combination with, potash derived from the grass on which the sheep feed. *Suint* was first investigated by Vauquelin. He obtained it by evaporating, after filtration, the water in which raw fleeces had been washed. The residue is of a brown colour, and has a saline, bitter taste. On addition of an acid to its solution in water, it coagulates, and a fatty matter rises to the surface. It is, in fact, a potash soap, to a great extent containing carbonate and acetate of potash, along with chloride of potassium and lime, probably in combination also with fatty acids. It is usually mixed with sand and carbonate of lime.

In 1828, M. Chevreul, who is still alive in Paris, although nearly a century old, published an analysis of merino wool. It consisted of:—

	Per cent.
Pure wool	31·23
Soluble *suint*	32·74
Insoluble ,,	8·57
Earthy matter	27·46
	100·00

It is easily seen that *suint* forms a very important constituent of raw wool. Its proportion varies, of course, according the nature of the pasture on which the sheep are fed, the climate, &c. Wool from Buenos Ayres, for example, contains much less than that analysed by M. Chevreul; its amount is only 12 per cent. of the weight of the raw wool.

This *suint* contains always about 52 per cent. of residue when ignited. The composition of this residue is:—

	Per cent.
Carbonate of potash	86·78
Chloride of potassium	6·18
Sulphate of potash	2·83
Silica, alumina, &c.	4·21
	100·00

In 1859, MM. Maumené and Rogelet patented the use of the water in which wool has been washed as a source of potash, and at present the extraction of potash from *suint* is practised in France on a large scale. The wool is washed in a systematic manner, in casks, with cold water, which runs out of the last cask with specific gravity 1·1. These washings are evaporated to dryness, and the residue is calcined in iron retorts, the gas evolved being used for illuminating purposes. The remaining cinder, consisting of a mixture of charcoal and carbonate of potash, is treated with water, whereby the latter is dissolved out. The residue left on evaporation of this water consists largely—almost entirely—of white carbonate of potash. At present there are works at Rheims, Elboeuf, Fourmier, and Vervier, which yield about 1,000 tons of carbonate of potash annually. Now, only 15,000 tons are made per annum by Leblanc's process. In 1868, 62,000 tons of wool were imported into Britain from Australia alone, and from this 7,000 to 8,000 tons of carbonate of potash might have been recovered, the value of which is £260,000. Yet it was all wasted! And this this estimate does not include the fats of the *suint*, which are worth an even greater sum.

Now, it is evident that there is here a profitable source of economy. So far as I am aware, no work in this country saves its washings. The water all goes to pollute the nearest river.

The use of carbon disulphide has again been introduced, and it is to be hoped with better success, for methods have been devised whereby the wool is not injured by it, but is even rendered better than when scoured by the old process of washing with carbonate of soda and water, or by soap. The process is due to Mr. Thomas J. Mullings. Briefly described, it consists in exposing the wool, placed in a hydro-extractor, to the action of bisulphide of carbon; the machine is then made to revolve, and the excess of solvent is expelled, carrying with it the fatty matters; the solvent finds its way into a tank, from which it flows into a still, heated with steam; the carbon disulphide, which boils at a very low temperature, distils over, and is again ready for use, while the residue in the still consists of *suint* washed from the wool. To remove the last trace of carbon disulphide from the wool in the hydro-extractor, cold water is admitted, and when the wool is soaked, the machine again revolves. On expulsion of the water, the wool is ready for washing in the ordinary machines, but with cold water only instead of hot soapsuds.

The distinguishing features of Mr. Mullings's process are, the method by which loss of carbon disulphide is avoided, and the extraction of that solvent by means of cold water. The apparatus consists of a hydro-extractor or centrifugal machine of special construction, fitted with a bell-shaped cover, which can be lifted into and out of position by means of a weighted lever. The rim of this cover fits into an annular cup filled with water, which surrounds the top of the machine, forming an effective seal or joint. Upon the spindle of this machine is suspended, as in ordinary forms of the hydro-extractor, a perforated basket, and in this basket is placed the wool to be treated. The cover being closed, the carbon disulphide is admitted, and passing through the wool, the greasy matter is dissolved, and along with the solvent, enters a reservoir. The machine is now set in motion, and the bulk of the solvent is drawn off. Cold water is then admitted, and the machine being again caused to rotate, the whole of the bisulphide is expelled. It is a curious fact that, although wool soaks remarkably easily with carbon disulphide, and at once becomes wet, cold water expels and replaces almost all that liquid. This operation takes about twenty minutes, and at one operation about 1½ cwt. of raw wool may be treated. The wool is then washed in suitable washing-machines of the ordinary type, but with cold water, no soap or alkali being employed. The bisulphide of carbon, mixed with water, flows into a reservoir, provided with diaphragms to prevent splashing, and consequent loss by evaporation. From its gravity it sinks, forming a layer below the water; it is then separated and recovered by distillation, and may be used in subsequent operations.

The point in which this process differs from the old and unsuccessful ones formerly tried, is in the expulsion of the carbon disulphide. It was imagined that it was necessary to expel it by means of heat or steam. Now, when wool moist with bisulphide is heated, it invariably turns yellow. No heat must, therefore, be employed. As already remarked, the solvent is expelled with cold water.

The residue, after distillation of the carbon disulphide, is a greyish-coloured very viscous oily matter, still retaining a little bisulphide, as may be perceived from the smell. It has not the composition of ordinary *suint*, inasmuch as it contains no carbonate of potash, and indeed little mineral matter of any kind. A sample which I analysed lost in drying 36·2 per cent., the loss consisting of water and carbon disulphide. It gave a residue on ignition amounting only to 1·6 per cent. of the original fatty matter, or 2·5 per cent of the dried fat. The oil appears, from some experiments which I made, to be a mixture of a glycerine salt and a cholesterine salt of fatty acids. It distils without much decomposition, giving a brown yellow oil, which fluoresces strongly, and has a somewhat pungent smell. The molecular weight was determined by saponification with alcoholic potash, and subsequent titration of the excess of potash employed. This was found to equal 546·3. This would correspond to a mixture of 18·7 parts of stearate, palmitate, and oleate of glycerine, with 81·3 parts of the same acids combined with cholesteryl. But this is largely conjecture. The boiling point of the oil is high, much above the range of a mercurial thermometer, so that it is difficult to gain an insight into its composition.

An objection which has been raised to this process is that the use of such an easily in-inflammable substance as bisulphide of carbon is attended by great risk of fire. Were the bisulphide to be exposed to free air, there might be force in this objection; but there is no reason why it should ever be removed from under a layer of water. The apparatus, to make all safe, should not be under the same roof as the mill; and no open fire need be used in the building set apart for it. It is easy to rotate the centrifugal machine by a belt from the mill, but better by a small engine attached, the power for which can be conducted by a small steam-pipe, and the distillation of the bisulphide can also be conducted without danger by the use of steam, as its boiling point is a very low one. The question may be naturally asked, "How do the wool and fabric made from the wool scoured by this process, compare with that scoured in the usual way?" To answer this question I may refer to a test made by Messrs. Isaac Holden and Co., at their works at Roubaix. A sample of wool was divided into two portions, one of which was scoured by the usual method, and the other by the turbine or Mullings's process. Skilled workers then span each sample to as fine a thread as possible. Now the thinness to which a wool can be spun is evidence of its power of cohesion—in other words, its strength. The weight of 1,000 metres of the wool cleaned by the new process bore to that scoured by the old process the proportion of 1,015 to 1,085, showing that a considerably finer thread had been produced. And in total quantity, 67·53 kilos. of the former corresponded to 71·77 kilos. of the latter, showing a proportionately less waste. Such fine yarn had never before been obtained from similar wool. The yarn of the soap-washed wool could not be spun, for it could not withstand the strain; whereas, that scoured by the new process gave an admirable thread.

Another test to which it was subjected may be cited. It is the custom in France, before the wool is scoured, to put it through a sorting process, by which all the short lengths are weeded out. On a quantity exceeding 11,000 kilograms, half of which was scoured by the turbine process, and half by the ordinary process, the former in scouring lost in weight 2 per cent. less than the latter, although the short length extracted from the moiety thus treated weighed only 10 kilograms, while that taken from the other weighed over 150 kilograms. This saving, even with the unequal treatment, amounted in value to from 30 to 40 centimes per kilogramme.

In order that the importance of this application may be realised, I shall conclude with some figures:—

The raw wool imported into England, in the year 1882, amounted to 1,487,169 bales, its total value being about £22,000,000. The cost of washing this wool by the old process, with carbonate of soda, amounts to about ½d. per lb. of the raw material. The cost for the total quantity of wool imported, is at least £1,214,000. But it is customary to wash wool with soap, especially for the combing trade, and the cost is then about 1d. per lb. The cost of scouring by the new process is about £1 5s. per ton, or 0·13d. per lb. Taking the least favourable comparison, were all the imported wool (home-grown wool is here left out of the calculation, for want of sufficient returns) cleansed by the turbine process, the actual saving would be £1,214,500 *minus* £315,700, or nearly £900,000 per annum.

It is thus seen that there is room for a very important economy in the treatment of wool. I have endeavoured to show how economy may be practised in scouring by the old process with soap, and how one dye-stuff may be profitably recovered. It is to be hoped that means of extracting other dyes from the residue may soon follow. Unless the process were too costly to repay the trouble of extraction, it would be well worth practising; for it would not merely be a solution of the problem of how to avoid waste, but would at the same time prevent the pollution of our streams, now, unfortunately, only too rarely pellucid; and were the last process to have as successful a future as I hope it may have, a very important saving of expense would result, and a large quantity of valuable fatty matter would no longer be thrown away.

DISCUSSION.

Earl CATHCART said it was only due to express the great sense of obligation which he felt to Dr. Ramsay for his most interesting paper. He attended that evening, because he had been informed that Mr. Mullings's process, which had been referred to, was in some way the result of a paper which he wrote some years ago for the "Journal of the Royal Agricultural Society of England;" not that he meant to suggest that he had anything to do with this discovery, but that the reading of his paper had suggested the idea which was afterwards carried out as had been described. Wool was not a profitable business just now in agriculture, but with regard to what Dr. Ramsay had said about the difficulty of obtaining statistics of the home produce of wool, having written upon that subject, he did not think there was any practical difficulty in arriving at a conclusion, seeing that the exact number of sheep in the country was recorded, and knowing what was the average fleece in different districts, a calculation could easily be made. If the learned professor would do him the favour to look at his paper, he would see that in 1875 a fairly correct approximation was made of the home produce of wool. It was perfectly well known that the imports into this country did not represent the manufacture of wool in this country, because London was the great emporium of the wool trade; the material was all brought here, and afterwards exported to different parts of Europe. He was very much surprised, as an agriculturist, to find that Dr. Ramsay did not know the term yolk, because that was the only term known in agriculture, throughout the whole of Great Britain, for what he had termed *suint*. The chemical composition of this substance was also very well known, and if Dr. Ramsay would refer to his paper, he would find there a letter from his friend Dr. Voelcker, which gave extracts from some learned German works, in which the chemical composition of the yolk was thoroughly explained. With regard to the quality of wool, that depended in a great measure, in England at any rate, on the geological formation on which it was produced. In his own immediate neighbourhood round Ripon and Thirsk, in the North Riding of Yorkshire, good wool was produced, owing, no doubt, to the geological formation. In another part of the country with which he was connected, Staffordshire and Derbyshire, the wool was very good, and it was quite common to hear one farmer say, you must give more money for my wool, for my wool is grit and my neighbour's wool is limestone, showing practically how thoroughly well understood was the influence which the geological formation had on the quality of the wool. He should like to ask what was the value of the residue cake after scouring, as far as its nitrogenous constituents were concerned.

Dr. RAMSAY said he thought it would rank along with many other high class manures, blood, for instance. He could not say the actual per-centage of nitrogen.

Lord CATHCART asked what was the value per ton?

Dr. RAMSAY said he could not say, as it was not produced commercially, but these woolly matters were worked into blood manures in large quantities.

The CHAIRMAN, in moving a vote of thanks to the reader of the paper, remarked that Dr. Ramsay did not come before them as a practical agriculturist, but rather as a chemist who wished to bring to their notice the peculiar action of bisulphide of carbon in cleaning and scouring of wool. No doubt this process would be very valuable, wherever it could be used, as a means of cheapening wool, and they all knew that where manufacturers were pushed so close, and profits were so small, anything in the shape of economy such as was now proposed, both in the working of the soap and the scouring, must be very much to the advantage of the country. It was quite true that on different geological formations you got different characteristics of wool, which required different treatment to a certain extent; but still there were the same general features throughout, so also in the case of Australian wools, though amongst them there were even greater variations than in English. The imports of wool, as Lord Cathcart had said, unfortunately, did not all stay in this country, but went to other parts of the world; but he hoped that the publishing of such a paper as the one they had just heard would tend to prevent that export of wool from England. The great competition of our continental neighbours made it desirable that every possible means for economising cost should be adopted. The exports from the Australian colonies were now going to such an extent to European ports direct by foreign ships, sailing under the bounties given them by foreign Governments, and with every facility given them to compete successfully with our own, that it became doubly important that every opportunity should be taken to diffuse valuable information of this kind for the benefit of our manufacturers.

Mr. J. BLAMIRES seconded the resolution, and begged leave to ask Dr. Ramsay if he could explain the reason why the same quality of wool could be spun to finer counts when cleaned by this new process than when the ordinary method was adopted. It occurred to him, having had some experience with wool in various processes, and having found that its power of spinning was much deteriorated when it had been scoured with too strong an alkali, whether soap, ash, or soda, that the crisp, hard, handling of the wool was caused by the absence of the yolk or fatty matter. They all knew that if they washed their heads thoroughly with soap, the hair became harsh and rough, and that the application of a little oil would render it soft and pliable again; and when the fibres of wool were in a similar state, the spinning or drawing process could be carried on better. He therefore came to the conclusion that it was desirable to leave a little fatty matter in the wool. It was well known that when wool had been scoured they used oil, in former times to the extent of two gallons per cwt., but at that time the wool was not scoured so clean as it was now, so a great deal of the oil put on was absorbed by the grit or earthy matter. Within the last twelve or twenty years there had been a great improvement in the scouring of wool, and the fibre being so much cleaner, received fatty matter and became softer and more pliable. He understood Dr. Ramsay to say that it cost ½d. per lb. to scour by the ordinary process, but that it cost more than that to scour for combing, but he did not catch exactly what was the difference.

Dr. RAMSAY said it cost 1d. per lb. for combing; by the new process it was one-eighth of a penny. He was not prepared to give a definite answer to the question why the wool spun finer, but he might say that he had tried the breaking strain of wool under the influence of various scouring agents, including ammonia, carbonate of soda, and carbonate of potash. He used the ordinary worsted, and took the same sample for each, and repeated the experiment a great many times, so as to get a fair average. He did not remember the exact numbers, but he did the order in which the result stood. An old scouring process had the least deleterious action on the wool, though ammonia was equally harmless; that material, however, was too expensive to be used. Soap came next, and very weak soap did a little harm, especially potash soap; it had less action than soda soap; next came carbonate of potash; next carbonate of soda, and lastly he tried the effect of caustic alkalis, which was, perhaps, rather a waste of time, because they were never used, they made the wool much more brittle than any scouring agents. He then examined the fibre under the microscope, and from that examination the fibre appeared to have scales upon it, which in the natural state lay down flat, and did not project at the edge of the fibre; but after treatment with alkalis the scales seemed to be loosened, and to cause the edge of the fibre to have a rough appearance, from the scales being raised. In the case of scouring by bisulphide of carbon, these scales did not appear to be raised, but to lie flat. There was no doubt that all these alkalis dissolved wool; if you used them strong enough, the wool would go into solution; even strong carbonate of soda soon made it into a gluey sort of mass; if the alkali was strong, it penetrated the fibre and disintegrated it to some extent, but if used weak it only attacked the outside. He believed bisulphide did not attack the fibre in any way or loosen the scales, but merely removed the grease; it was always possible to add grease again for the purpose of spinning. If you could remove the grease without injuring the fibre, it was quite possible to add it again, if necessary, which would remove all difficulty. The samples shown were spun from the same wool, and that cleaned by sulphide were stronger than the other. The surface had been less attacked, and so the wool fibre was actually stronger. There was little doubt that in milling cloth, what took place was that these scales were considerably loosened, and then they interlocked with each other, so as to bind two consecutive fibres together.

Lord CATHCART said that was really the felt process, which was the most difficult of all questions. He understood Dr. Ramsay to suggest that the cause of these feltings was the splitting out of these fish-hook like things which stuck out from the wool.

Dr. RAMSAY said that was so, but it was very desirable to keep the fibres down until the felting process was required to be carried out.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The conference arranged by the Mansion-house Council on Dwellings of the Poor was held at the Health Exhibition, on Wednesday, Thursday, and Friday, June 4, 5, and 6, when papers were read by Dr. Longstaff, Miss Gertrude Toynbee, the Rev. A. Mearns, Mr. James Hole, Miss Lidgett, Mr. H. D. Harrod, Mr. Shirley F. Murphy, Dr. Whitelegge, and Mr. C. M. Sawell. The chairmen were the Lord Mayor, the Archbishop of Canterbury, and Cardinal Manning.

On Monday, June 9th, the joint conference of the Society of Medical Officers of Health, the Sanitary Institute of Great Britain, and the Parkes Museum of Hygiene, was commenced. The subjects of the papers read were the sanitary and insanitary conditions in the dwellings of the poor, and improvements which might be made in existing homes, or be introduced in the construction of new buildings. The papers read were on "The Domestic Sanitary Arrangements of the Metropolitan Poor," by Dr. John W. Tripe, and on "The Improvement of the Sanitary Arrangements of Metropolitan Houses," by Mr. Ernest Turner. The chair was taken by Dr. T. O. Dudfield, President of the Society of Medical Officers of Health, and among the speakers were Mr. Rogers Field, Dr. Corfield, Dr. Alfred Carpenter, and Captain Galton.

On Tuesday, Capt. Douglas Galton, C.B., F.R.S., Chairman of the Council of the Parkes Museum, took the chair. The papers read were on "Domestic Sanitation in Rural Districts," by Dr. George Wilson, and on "Sanitary Homes for the Working Classes in Urban Districts," by Mr. H. Percy Boulnois. Among the speakers in the discussion were Sir Henry Acland, F.R.S., Sir Robert Rawlinson, Dr. Thursfield, Dr. Woodford, Dr. Alfred Carpenter, Sir T. Dyke Acland, &c.

KEW REPORT FOR 1882 AND 1883.

From the "Report on the Progress and Condition of the Royal Gardens at Kew during the year 1882," which has lately been issued, the following notes on economic plants have been taken. This document, which is an epitome of work done at the Kew establishment during the year in all branches of botany, not the least being that which concerns itself with the development or extension of the uses of plants, is, in reality, a great deal more than its title would seem to imply. The present report is dated November 1st instead of January 1st, 1883; the delay in its preparation is explained as being due to pressure of work and other unavoidable circumstances; but though dated in November last, it has only just come into the hands of the public. The report gives detailed accounts of the purely horticultural and scientific works carried on at Kew, but the following notes on economic plants are those of most general interest.

Argan Tree *(Argania sideroxylon)*.—Seeds of this tree, a native of Morocco, have been distributed to the Botanic Gardens of Adelaide, Brisbane, Cape Town, Fiji, Hong Kong, Jamaica, Grahamstown, Melbourne, Natal, Saharanpore, and Washington. From the Botanic Gardens, Natal, the Director says that he has failed in raising the plants, but that in Quanda, 2,000 feet above the sea, the plants had been more successful, and several of them were progressing satisfactorily, so that Mr. J. M. Wood says he hopes for success in acclimatising the plant.

Of the Arracacha *(Arracacia esculenta)*, a valuable tuberous rooted umbelliferous esculent, Mr. Duthie reports from Saharanpore as follows:—"Of this valuable South American vegetable there are a few plants still left, and they are in a fairly healthy condition. They do not, however, appear to have formed to any extent the characteristic tubers which constitute the edible portion of the plants so highly valued in its native country. M. Decandolle, in his recently published work on the origin of cultivated plants, observes that this vegetable bears comparison with the potato, and yields a starch which is lighter and more agreeable. It has been tried in England and in several parts of Europe, but without success, the climate being evidently too damp for it. I intend to give it a trial at Arnigádh, where it will at any rate have a better chance of being looked after than it had at Chajuri."

Mr. Morris, the director of public gardens and plantations, Jamaica, writing on the Arracacha, says that it was introduced into the island in 1882 by Dr. Bancroft; it flourishes best in the Blue Mountain districts, at elevations between 2,500 and 5,000, with mean annual temperatures of 72° and 65° Fahr. respectively, and a mean annual rainfall of 100 inches. Mr. Morris adds—"I believe the Arracacha is a most valuable food plant; and for my own part I not only like it, but find that it becomes more palatable and desirable the longer it is used. If the natives of India take to it as an article of food, I can conceive nothing more likely to flourish in the hill districts, and to afford with little labour, the means of sustaining life under adverse circumstances."

Under the head of Cacao, an extract is given of a letter from a resident in Fiji, who says that the plants sent him from Kew in 1881 are all doing well, and that plants introduced from Java three years since are bearing fruit in several places. Altogether about 1,500 trees are established in various parts of the colony, irrespective of a few finer sorts from Trinidad, of which the variety known as yellow criollo are described as "looking splendid."

As might be supposed, considering the importance of the subject, a great deal of space is given to the consideration of the different species and varieties of Cinchona barks, certain forms proving more suitable for cultivation in the soil and climate of some parts of the world than of others.

The East African Copal tree (*Trachylobium Hornemannianum*) seems to have made itself a home in Natal, the trees in the Botanic Garden there having produced some pods. Though the soil in which they grow is stated to be only a poor sand, the plants are reported as growing luxuriantly.

The elephant sugar-cane, which was introduced to the Jamaica Botanic Garden in 1880, is reported to be well established at the Hope Plantation. Of it, Mr. Morris says:—"It is now well established at the Hope Plantation, and is of a most promising character, more especially for moist districts. As showing what may be done in propagating plants of this character, it may be mentioned that this cane, of which only two small plants were received twelve months ago, is now being distributed amongst planters by thousands at a time. As it has been taken up by the most intelligent and enterprising planters, its value as a cultivated cane in Jamaica will soon be known. For eating purposes it is already a favourite among the peasantry; and I have no doubt that its yield under cultivation will prove to be, for certain districts, of a valuable character. A block established at the Hope in June last, in ordinary soil, had canes in October eight feet long, with joints seven inches in length, and with a circumference of six inches." At a later period Mr. Morris again writes:—"The elephant cane, the history of which has already been given in former reports, continues to be in great demand, and is much liked in certain districts. It is evidently best suited for warm, humid climates. In dry districts, even with irrigation, it is not so successful as the Salangore. With such varying conditions of soil and climate as exist on sugar estates in Jamaica, it may naturally be expected that numerous varieties of canes are required to enable the planter to obtain the best results with the means at his command. Hence, I look upon the greater interest which is taken in cultivating new varieties of sugar-canes, and the establishment of nurseries on estates, as most hopeful signs of awakening in the staple industry of Jamaica."

The important question of the acclimatisation of fodder-yielding plants has for some years past occupied the attention of the Kew authorities, and further light is thrown upon these in the present report. The mesquit bean, for instance (*Prosopis glandulosa*), is reported from Lucknow as flourishing most satisfactorily. The superintendent of the Horticultural Gardens at that place says, "It would seem the plants get more prolific with age, as they are bearing an unprecedently heavy crop of pods this year (1883). No water is given, yet the trees make new growth, and produce their crop of pods at the hottest and dryest season of the year. For clothing dry or broken raviny ground, where little else would grow, it would, I believe, prove a success, and is worthy of that on account of the grazing it would afford for goats and cattle at a season, and in places where scarcely any green food exists."

Another plant useful for fodder, and known as the Salt Bush (*Ariplex nummularia*), has attracted some attention. On this head Sir Joseph Hooker says "The desirability of finding any useful plants which will grow on salt in crusted lands in North-West India is a constant topic in Indian correspondence." Mr. Duthie says that the progress which the plant has made at Saharanpore within the last year is decidedly encouraging. Some of the plants raised from seed received at Saharanpore from Australia, in 1881, have now grown into compact healthy looking shrubs, a few of which were coming into flower at the time Mr. Duthie wrote in May last. Should the plants produce flowers and seed annually, large stocks of young plants will be raised for distribution. Other reports likewise speak favourably of this plant.

The Sheep Bush, also a fodder plant, native of the Cape of Good Hope, has been introduced into South Australia as well as into North West India. It is a composite plant, known to botanists as *Pentzia virgata*. It is described by Mr. Duthie as a small bush, something like an *Artemisia*, to which genus it is closely allied. It has been strongly recommended as a suitable plant to introduce into dessert countries, for besides being able to stand long continued drought, it, spreads rapidly by means of its trailing stems, which takes root as soon as they touch the ground. The plant has been tried in Australia for several years, and is highly spoken of as a fodder plant.

The Tagasaste (*Cytisus proliferus*) is still highly spoken of in Australia; Dr. Schomburgk considers that the plant has found a most genial climate in South Australia, the dry season showing not the slightest effect on the plants. He says, "if the seed were sown on the runs, it would soon become acclimatised, and would stock them with a profitable shrub, capable of withstanding the severest drought." As an illustration of the difficulty of introducing new articles of culture, may be mentioned the fact as stated by Dr. Schomburgk, for he says although he offered seed of the tagasaste for distribution, only a few applications have been made in South Australia, but a large number were received from the neighbouring colonies.

From numerous notes on india-rubber, the following are gathered as characteristic of the varied sources and wide distribution of this very important article. First with regard to the Central American rubber (*Castilloa elastica*), Dr. Trimen reports from Ceylon that they have raised some sturdy little seedlings from seeds produced in Ceylon, and he considers that the rubber from this plant is the most satisfactory of all the sorts grown in Ceylon, "the proportion of caoutchouc in the milk being larger than in any of the others." A sample of rubber obtained from plants grown in the experimental garden at Heneratgoda, Ceylon, was submitted to Mr. S. W. Silver for examination and report, which was as follows:—"On working and drying a portion of this sample, the loss is 12·3 per cent.; it is necessary to use warm water in washing this rubber; it becomes, on drying, much darker and shorter than Para rubber. It has a bitter taste, which is not removed on washing. The unwashed sample yields 1·9 per cent. ash, the washed sample gives 1·2 per cent. The shortness of this rubber would restrict its use to some extent, where tensile strength or tenacity is required." It was valued, December 8, 1882, as worth 2s. 9d. to 3s. a pound. The *Castilloa* has also been introduced to Jamaica, and promises well.

With regard to Ceara rubber (*Manihot Glaziovii*) a sample was received at Kew obtained from trees grown at Peradeniya, Ceylon; this was submitted to Mr. S. W. Silver, and reported upon to the following effect:—"Has a dry and compact appearance, is free from extraneous impurities, and from its tolerably uniform condition has been collected with care. It agrees in all respects with Ceara rubber of good and sound quality; when washed and dried gives a loss of 8 per cent. This loss is much less than is met with in Ceara rubber of the finest quality, and may probably be accounted for by the small bulk and facilities offered by time, mode of packing and transit, to the escape of the natural moisture of the product. On incineration it yields 4·13 per cent. mineral ash, which agrees in it chemical composition very closely with the ash obtained from Ceara rubber, the ash from which amounts to 4 or 5 per cent." The value put upon this sample was, in June, 1882, from 2s. 9d. to 3s. per pound. In consequence of this report, Dr. Trimen wrote later on:—"Some planters here are going in for vast quantities of Ceara, as a result of the price put upon the best sort by Messrs. Silver. If it should prove profitable, it will be a great help, as it grows anywhere up to almost 2,500 feet."

In Jamaica, the Ceara rubber tree promises in every way to be suitable for cultivation. The largest tree in the Botanic Gardens is said to be about twenty-five feet high, with a circumference, at two feet from the ground, of thirty inches.

The following interesting account of the plant in Southern India is quoted from the *Madras Mail* of

October 24th last:—"About six months ago some gentlemen imported Ceara rubber seed from Ceylon. The produce of these trees may now be seen flourishing in a wonderful manner at the foot of the Neilgherry Hills, by any one curious enough to look out of the tonga, just before reaching Kallar. Being much interested in the introduction of this comparatively new, but very valuable product, I gladly availed myself of an invitation to inspect these trees more closely. The rapid growth of the Ceara rubber tree is marvellous; some, measured six months old from seed, were fully eight feet high, and a cutting, that I was told had been put down scarcely six months ago, was quite eight feet high, and in blossom. Being of such wonderfully rapid growth, the tree is naturally very susceptible of wind, and liable to be blown over, until it gets firm hold of the ground; consequently a sheltered position is most necessary. It seems to thrive on poor soil, requires no shade, and very little rain. With such moderate requirements, we may expect to hear, before long, that this valuable tree, the demand for the produce of which seems to be unlimited, is being largely planted in India, where there is so much land likely to suit it. I was informed that a considerable quantity of seed has been sent to the S. E. Wynaad, where it is to be tried on some of the unprofitable coffee lands of the various companies. Unfortunately, the unusually heavy monsoon has been rather against the experiment. From what I could gather, it seems that it would be better to plant out the young Cearas after the first heavy burst of the monsoon, say in the months of August or October when the ground is thoroughly saturated, and the showers only occasional, with burst of sunshine between. The germination of seed seems a very simple process, and generally occurs in ten days, and sometimes less, from the time the seed is placed in the damp sand. The seed coat, being extremely hard, requires very careful filing, so as to enable it to burst more easily; if this is not done the seed may take months to germinate."

With regard to *Hevea brasiliensis*, the plant which yields the best Para rubber. Mr. Silver has also furnished a report on a sample of rubber obtained from plants grown in the Experimental Garden at Heneratgoda, Ceylon, which is as follows:—"As far as chemical examination goes, this rubber differs in no respect from the better descriptions of Para bottle rubber, except, perhaps, in having a little more water imprisoned in it than is usual with well-seasoned Para. A portion of this rubber, well washed and dried, gave a loss of 18·7 per cent. The amount of ash obtained on incinerating a portion of the unwashed sample is 0·7 per cent., which is about one-half that from the Brazilian product. There is a great similarity in the composition of the ash of the Hevea and the Para bottle rubber. The ash from the washed and dried Hevea is 0·6 per cent. The sample is almost entirely free from extraneous matter. On digestion in alcohol it yields a slight colouration. Like Para rubber, its fresh-cut surfaces show a slight acid reaction, easily removed by washing. The washed product is free from taste and smell, and turns a dark colour on drying, similar to ordinary Para rubber. As far as can be determined on so small a sample, there is reason to believe that as regards strength and elasticity, it would be fully equal to Para india-rubber." It was valued December 8th, as worth about 4s. a lb.

The other sources of rubber, namely species of of *Landolphia* and *Hancornia speciosa* have continued to receive attention at Kew, and plants have been distributed to various parts of the world. The foregoing are the principal economic plants treated of, but many other of considerable importance, in a commercial point of view, have occupied the attention of the Kew staff during the year and ten months of which its treats.

BOLIVIAN CINCHONA FORESTS.

The great progress made in the acclimatisation of cinchona trees in India, Ceylon, and elsewhere, has awakened the Governments of countries where the plants are indigenous to the necessity of conserving from reckless destruction, and re-planting denuded forests, so as to be able to keep up the supply of this valuable product.

In Bolivia, since 1878, according to the report of the Netherlands Consul, private individuals and land owners have taken up the question with great earnestness, and at the present time on the banks of the Mapiri, in the department of La Paz, there are over a million of young trees growing.

New plantations have also sprung up in various other localities, either on private ground or that owned by Government. The competition of India and Ceylon in supplying the markets, has had also the effect of inducing more care in collecting and also of revisiting old spots, often with the result of a rich harvest of bark which had been left on partly denuded trunks, and the opening up of new localities. The new shoots springing up from the old stumps have yielded much quill bark, and the root bark of the old stumps has also been utilised.

The re-planting entails very little expense. The Indian tenant on an estate has a house and land from the owner (hacienda) of the estate. For this he binds himself to work for two to four days a week, at from 28 to 36 cents per day, women and children obtaining 16 to 21 cents. per day. Thus the planting, weeding, &c., during the first two years, is but nominal in expense; after this period the trees may be left to themselves.

On Government land the expense is greater, as after an application being made, the land is put up to public auction, and may fetch a very low or a higher price, according to the bidding. The land secured, contracts are made with natives of the lower class to clear the forest and plant cinchona. The contracts are often sublet to Indians. The young plants are planted from five to six feet apart, with banana trees between, on account of their rapid growth and the shade the latter afford. From March to June, after the wet season is over, is the best time for planting, and the contractor keeps the plantation free from weeds and in good order for twelve months, when it is handed over to the owner. The following is given as the cost of the Mapiri river plantation of an area from 60 or more miles in extent :—

Ground	$1,200
300,000 plants at $ 0·14	42,000
Superintendent, buildings, &c.	4,400
Interest	4,800
Total	$52,400

Till the plants are above two years of age, they are liable to die from drought or the attacks of ants, and during 1878 many thousands died from these causes. At the end of the fourth year some proprietors begin to collect the quill bark by the method of coppicing.

It is feared by some that should this new venture be successful, it will prove a dangerous rival to the plantations of India, Ceylon, and Java, and lower the price of bark considerably.

General Notes.

PHILADELPHIA ELECTRICAL EXHIBITION.—In connection with the International Electrical Exhibition to be held under the auspices of the Franklin Institute, from September 2nd, to October 11th, it is proposed to form a Memorial Library. The Franklin Institute has appointed a Committee on Bibliography, to collect and arrange the library for exhibition. After the Exhibition is closed, the collection will be placed in the library of the Franklin Institute for permanent reference, as a suitable memorial of the state of electrical science at the time of the Exhibition. The committee ask for the presentation of a copy of all publications, papers, reprints of articles, or notes on or relating to electricity, which should be sent direct, addressed to the Committee of Bibliography, Franklin Institute, Philadelphia, U.S.A. ; or to the care of Mr. Frederick Ransom, Rushmere-lodge, Lower Norwood, Surrey.

HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 16...Asiatic, 22, Albemarle-street, W., 4 p.m. 1. Prof. Lacouperie, "Three Embassies from Indo-China to the Middle Kingdom, about B.C 1110, and the way thither." 2. Dr. Duka, "The Tibetan MSS. of Csoma de Körös, given by Dr. S. C. Malan to the Hungarian Academy of Sciences."

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Annual General Meeting.

TUESDAY, JUNE 17...Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Frederick Holmwood, "The Employment of the Remora by Native Fishermen on the East Coast of Africa." 2. Mr. R. Bowdler Sharpe, "Further Notes on Whitehead's Nuthatch." 3. Mr. Oldfield Thomas, "The Muridæ collected in Central Peru by M. Constantin Jelski." 4. Colonel C. Swinhoe, "New Asiatic Butterflies of the Genus *Teracolus*."

WEDNESDAY, JUNE 18...Meteorological, 25, Great George-street, S.W., 7 p.m. Mr. Robert H. Scott, "The Equinoctial Gales—Do they occur in the British Isles?" 2. Hon. Ralph Abercromby, "The Physical Significance of Concave and Convex Barographic and Thermographic Traces." 3. Mr. Charles Harding, "Maritime Losses and Casualties for 1883, considered in connection with the Weather." 4. Rev. Joseph Brunskill, "The Helm Wind." 5. Mr. W. T. Black, "Climate of the Delta of Egypt in 1798-1802, during the French and British Campaigns."

Hospitals Association, 11, Chandos-street, Cavendish-square, W., 8 p.m. Rev. Canon Erskine Clarke, "Is it desirable that Hospitals should be made self-supporting, and, if so, to what extent?"

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Second Summer Exhibition of Plants, Flowers, and Fruits.

United Service Inst., Whitehall-yard, S.W., 3 p.m. Captain Claude E. Buckle, "Sir William Thomson's Sounding Machine, and its advantages both in Peace and War."

THURSDAY, JUNE 19...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. G. Baker, "Flora of Madagascar." 2. Mr. J. W. Davis, "Species of *Cœlacanthus* from the Yorkshire Cannel Coal." 3. Mr. C. T. Druery, "Development of the Lady Fern." 4. Mr. A. G. Bourne, "Remarks on Marine Fauna of Naples."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Perkin, "The Magnetic Rotation of Chemical Bodies in Relation to their Composition and Constitution." 2. Drs. Armstrong and Miller, "The Effect of High Temperatures on Petroleum Hydrocarbons." 3. Mr. R. Warington, "Nitrification." (Part III.)

Historical, 11, Chandos-street, W., 8 p.m. Mr James Heywood, "The Origin nnd History of the New England Company, London."

Numismatic, 4, St. Martin's-place, W.C., 7 p.m. Annual General Meeting.

FRIDAY, JUNE 20...United Service Institute, Whitehall-yard, 3 p.m. Colonel E. Maitland, "The Heavy Guns of 1884."

Philological, University College, W.C., 8 p.m. Mr. James Lecky, "Modern Irish."

Journal of the Society of Arts.

No. 1,648. Vol. XXXII.

FRIDAY, JUNE 20, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirtieth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 25th June, at 4 p.m.

(By order of the Council)

H. Trueman Wood,
Secretary.

CONVERSAZIONE.

A Conversazione will be held at the International Health Exhibition by the Council of the Society of Arts, in conjunction with the Executive Council of the Exhibition, on Wednesday evening, 9th of July.

The whole of the buildings will be open, and the gardens will be illuminpted.

Each member will receive tickets for himself and a lady. These will probably be issued in the latter part of next week.

MEDALS.

The Council have awarded the Society's Silver Medals to the following readers of papers during the Session, 1883-4:—

To The Most Hon. The Marquis of Lorne, K.T., for his paper on "Canada and its Products."

To Rev. J. A. Rivington, for his paper on a "New Process of Permanent Mural Painting, invented by Joseph Keim."

To C. V. Boys, for his paper on "Bicycles and Tricycles."

To Professor Fleeming Jenkin, F.R.S., for his paper on "Telpherage."

To I. Probert, for his paper on "Primary Batteries for Electric Lighting."

To H. H. Johnston, for his paper on "The Portuguese Colonies of West Africa."

To Professor Silvanus P. Thompson, for his paper on "Recent Progress in Dynamo-Electric Machinery."

To Edward C. Stanford, F.C.S., for his paper on "Economic Applications of Seaweed."

To W. Seton-Karr, for his paper on "The New Bengal Rent Bill."

To C. Purdon Clarke, C.I.E, for his paper on "Street Architecture in India."

Thanks were voted to the following members of Council for the papers read by them:—

To W. H. Preece, F.R.S., Vice-President of the Society, for his paper on "The Progress of Electric Lighting."

To B. W. Richardson, M.D., F.R.S., Vice-President of the Society, for his paper on "Vital Steps in Sanitary Progress."

To Col. Webber, R.E., C.B., Member of Council, for his paper on "Telegraph Tariffs."

To B. Francis Cobb, Vice-President of the Society, for his paper on "Borneo."

To J. M. Maclean, Member of Council, for his paper on "State Monopoly of Railways in India."

To W. G. Pedder, Member of Council, foi his paper on "The Existing Law of Landlord and Tenant in India."

PRACTICAL EXAMINATIONS IN MUSIC.

The Examinations for London were conducted last week at the Society's House, by W. Alexander Barrett, Mus. Bac. (Oxon), and occupied five days. The numbers showed a considerable increase over former years. 198 candidates presented themselves, many of them taking the vocal as well as the instrumental portion of the examination. Of these 179 passed and 19 failed. The number of practical examinations was 226, resulting in the award of 41 first class, and 160 second class certificates, with 25 failures. Of these entries 176 were for the piano, 10 for the organ, 2 for the violin, 1 for the harmonium, and 37 for singing. In addition to these, there were three examinations for Honours, two second class certificates being awarded in this division.

In addition to the above, two provincial examinations were held by the Society in May; one in Glasgow (75 candidates), and the other at Liverpool (29 candidates).

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1884.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1883	440	16	11			
Do. in hands of Secretary	16	13	7			
				457	10	6
,, Subscriptions received during the year from Members and Institutions in Union	6,284	0	0			
,, Life Compositions	556	10	0			
				6,840	10	0
,, Dividends and Interest				586	4	9
,, Ground Rents				180	0	0
,, Examination Fees				241	8	3
,, House and Office (receipts for gas, &c.)				43	19	6
,, Advertisements				1,124	13	3
,, Donation by the late Sir William Siemens towards cost of Conversazione				1,120	0	0
,, Amount received from W. Westgarth, Esq., for Prizes for Essays				1,200	0	0
,, Do. do. from J. S. Stacy, Esq., for Prize in connection with the Health Exhibition				20	0	0
,, Do. do. from Union Centrale des Arts Décoratifs, for expenses in promoting an Exhibition in Paris				40	0	0
,, Sales—						
Cantor Lectures	18	5	3			
Examination Papers		19	3			
Journal	139	4	3			
Public Health Conference Reports	4	8	8			
Spoiled Post-cards	2	18	5			
Transactions	2	12	6			
				68	8	4
				£12,022	14	7

Cr.

	£	s.	d.	£	s.	d.
By House and Premises:—						
Rent, Rates, and Taxes	347	12	0			
Insurance, Gas, Coal, House expenses, and expenses incidental to ordinary meetings	326	6	9			
Repairs and Alterations	102	17	10			
				776	16	7
,, Office:—						
Salaries and Wages	1,975	0	1			
Stationery, Office Printing, and Lithography	329	6	8			
Advertising	73	17	10			
Postage Stamps, Messengers' Fares, and Parcels	200	18	10			
				2,579	3	5
,, Library, Bookbinding, &c.				86	12	5
,, Conversazione				1,525	5	5
,, *Journal*, including Printing, Stamps, and Distribution				2,100	8	2
,, Advertisements (Agents and Printing)				524	13	4
,, Examinations				323	11	0
,, Medals:—						
Albert (Printing, &c.)	2	14	2			
Society's	22	5	0			
				24	19	2
,, Prizes (awards and expenses):—						
"Howard"	10	0	0			
"Owen Jones"	20	11	0			
"Mulready"	19	10	6			
"Shaw"	20	0	0			
"Swiney"	200	0	0			
"Westgarth"	9	2	11			
				279	4	5
,, Cantor Lectures				225	13	2
,, Juvenile Lectures				30	18	9
,, Sections:—						
Applied Chemistry and Physics	63	0	6			
Foreign and Colonial	61	8	0			
Indian	50	16	0			
				175	4	6
,, Memorial Tablets				7	3	0
,, Committees:—						
Collisions at Sea	25	3	8			
Fires in Theatres	16	1	0			
Patent Bill	4	6	3			
General expenses	18	1	11			
				63	12	10
,, Annuity to Mrs. Le Neve Foster				100	0	0
,, Investment of Life Compositions of the year in Reduced 3 per Cent. Stock	556	10	0			
Do., in Queensland Bonds, of balance due to Capital in repayment of sale of Stock in 1876	503	15	0			
Do. of accumulation of Interest added to "Aldred" Trust	43	19	2			
Do. do. "North London Exhibition" Trust	34	15	0			
				1,138	19	2
,, Deposit with Messrs. Coutts and Co.:—						
Amount placed in the Society's hands by W. Westgarth, Esq.	1,200	0	0			
Accumulation of Interest on Trust Funds	300	0	0			
				1,500	0	0
				11,462	5	4
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1884	537	1	2			
Do. in hands of Secretary	23	8	1			
				560	9	3
				£12,022	14	7

Liabilities.

	£	s.	d.	£	s.	d.
To Tradesmen's Bills	438	13	2			
,, Rates	52	1	8			
,, Examiners' Fees	81	18	0			
,, "Trevelyan" Prize	100	0	0			
,, "Westgarth" ,,	1,200	0	0			
,, "Stacy" ,,	20	0	0			
,, Sections:—Foreign and Colonial, Applied Chemistry, and Indian	185	0	0			
,, Prizes offered, and accumulations under Trusts	343	14	7			
,, Albert Medal, 1883	21	0	0			
,, Advertising for Union Centrale des Arts Décoratifs, Paris	40	0	0			
				2,482	7	5
Excess of Assets over Liabilities				10,099	8	10
				£12,581	16	3

Assets.

	£	s.	d.	£	s.	d.
By Society's Funds invested in—						
Reduced 3 per Cent. Stock, £5,995 1s. 2d., at par on 31st May, 1884, less £757 15s. 11d., reserved to meet Trusts Nos 6, 7, and 8, stated below	5,237	5	3			
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May, 1884	317	7	3			
£1,000 Queensland 4 per Cent. Bonds, worth on 31st May, 1884	1,007	10	0			
				6,562	2	6
,, Subscriptions of the year uncollected	705	12	0			
,, Arrears, estimated as recoverable	300	0	0			
				1,005	12	0
,, Property of the Society, including Barry's Pictures and Lease of House				2,000	0	0
,, Advertisements on the Books, due and in course of execution*				853	12	6
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1884				537	1	2
,, Ditto on Deposit				1,600	0	0
,, Ditto in hands of Secretary				23	8	1
				£12,581	16	3

* A portion of this sum is liable to charges for printing.

Investments Standing in the Name of the Society.

	£	s.	d.
Ground Rents on Tyssen-Amherst Estate	£4,590	0	0
Consols	425	8	9
New 3 per Cents	388	1	4
Reduced 3 per Cents	5,995	1	2
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150	0	0
Bombay and Baroda do. do.	2,450	0	0
Canada 4 per Cents	423	0	0
India 4 per Cents	105	18	7
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cents	1,000	0	0
Cash on deposit with Messrs. Coutts and Co.	1,600	0	0

Trust Funds included in the above.

		£	s.	d.	
1.	Dr. Swiney's Bequest	£4,500	0	0	Invested in ground-rents, and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiène Prize	133	6	8	,, ,, ,, Interest as a Money Prize.
4.	North London Exhibition Trust	192	2	1	,, ,, ,, ,, ,,
5.	Fothergill Trust	388	1	4	New 3 per Cents, chargeable with the Award of a Medal.
6.	J. Murray, in aid of a Building Fund	54	18	0	Reduced 3 per Cent. Stock. (Nos. 6–8)
7.	Subscriptions to an Endowment Fund	562	2	2	
8.	Dr. Aldred's Bequest	140	15	9	
9.	Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock.
10.	Dr. Cantor's Bequest	4,600	0	0	Bombay and Baroda and Oude and Rohilcund Railways 5 per Cent. Guaranteed Stock.
11.	Owen Jones Memorial Trust	423	0	0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12.	Mulready Trust	105	18	7	India 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock.
14.	"Trevelyan" Prize	100	0	0	On Deposit with Messrs. Coutts and Co. (Nos. 14–16)
15.	"Westgarth" Prizes	1,200	0	0	
16.	Accumulated Interest on Trust Funds	300	0	0	

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.

The Payments set forth above have been made by authority of the Council.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

Owen Roberts, W. R. Malcolm, } *Treasurers.*

J. Oldfield Chadwick, F.C.A., *Auditor.*

H. Trueman Wood, *Secretary.*

Society's House, Adelphi, 17th June, 1884.

Miscellaneous.

*NATIONAL HEALTH AND WORK.**

It was very difficult to select, from the vast number of subjects relating to health and to education, one of which I could fitly speak to-day. On general education I could not venture to speak; and, believing that I should have to address a large and various audience, I thought it would be best to choose a subject by which I might urge one of the chief objects of this Exhibition, and one which I know that you, sir, have always had in view, namely, that the public themselves should consider, much more than they do, the utility and the means of maintaining their own health. I have, therefore, chosen the relation between the national health and work; especially as it may be shown in a few of the many examples of the quantity of work which is lost to the nation, either through sickness or through deaths occurring before the close of what may fairly be reckoned as the working time of life. I think it may be made clear that this loss is so great, that the consideration of it should add largely to the motives by which all people may be urged to the remedy of whatever unwholesome conditions they may live in. It is a subject which is often in the minds of the real students of the public health, but the public itself is far too little occupied with it.

I shall speak only of national health. In consideration of his own self, a man may be deemed healthy who lives idle, comfortably and long; who enjoys every day of his life, and satisfies every natural appetite without consequent distress. And when such a one dies of old age, with a timely, uniform and painless decay of every part, he may be deemed to have been completely healthy. And yet it is possible that he may have enjoyed his own health in the midst of a poor, unhealthy, and unhappy nation, to which he has done no good whatever.

If we could find a nation composed of people such as this man, we might be bound to speak of them as healthy; but we should be right in calling the whole nation utterly unsound, and might safely prophesy its complete stagnation, or its qnick decline and fall.

It is not health such as this—idle, selfish, unproductive—that we want to promote either in the individual or in the multitude. Comfortable idleness, such as that of some vagrants and fine gentlemen, is a despicable result of good health; it is what no thorough man would ever wish for. In view of the national health and welfare, the pattern healthy man is one who lives long and vigorously; who in every part of his life, wherever and whatever it may be, does the largest amount of the best work that he can, and, when he dies, leaves healthy offspring. And we may regard that as the healthiest nation which produces, for the longest time, and in proportion to its population, the largest number of such men as this, and which, in proportion to its natural and accumulated resources, can show the largest amount and greatest variety of good work.

Here let me insert, as an interpretation clause, that in all this and what is to follow the word "man" means also "woman," and "he" means also "she;" and that when I speak of work, I mean not only manual or other muscular work, but work of whatever kind that can be regarded as a healthy part of the whole economy of the national life. And I shall take it for granted that a large portion of all national welfare is dependent on the work which the population can constantly be doing; or, if I may so express it, that the greater part of the national wealth is the income from the work which is the outcome of the national health.

It is a common expression that we do not know the value of a thing till we have lost it; and this may be applied to the losses of work which are due to losses of national health. There are very few cases in which these can be estimated with any appearance of accuracy; but I am helped to the best within our present reach by Mr. Sutton, the actuary to the Registry of Friendly Societies. In his office are the returns, for many years past, of the sickness and mortality among the members of a very large number of these societies; and, among other things, there is recorded the number of days which each member, when "off work" on account of sickness, receives money from his society. Hence Mr. Sutton can estimate, and this he has been so good as to do for me, the average number of days' sickness and consequent loss of work among several hundred thousands of the workmen and others who are members of these societies. From the entire mass of these returns, he deduces that the average number of days' sickness, per member per annum, is very

* Address delivered by Sir James Paget, Bart., F.R.S., at the International Health Exhibition, 17th June, 1884. H R.H. the Prince of Wales, K.G., in the chair.

nearly 1½ weeks; and this agrees, generally, with the estimates made in other societies by Mr. Neison and others. But the averages thus obtained include the cases of members of all ages, and among them many cases of chronic sickness and inability to work during old age. In order, therefore, to get a better idea of the actual annual loss of work through sickness, he has calculated the average annual number of days' sickness of each person during what may be deemed the normal working time of life; that is, between 15 and 65 years of age. This he has done among the members of the large group of friendly societies known as the Manchester Unity of Odd Fellows; and then, on the fair assumption that the rates of sickness of the whole population during the working years of life would not be far different, he has calculated the following tables, showing the average annual rates of sickness of each person enumerated in the Census of 1881 as living between the ages of 15 and 65.

Ages.	Number of males: Census of 1881 (England and Wales).	Weeks' sickness per annum, according to the experience of the Manchester Unity.	Average sickness per individual per annum (in weeks).
15—20	1,268,269	844,428	·666
20—25	1,112,354	820,183	·737
25—45	3,239,432	3,224,134	·995
45—65	1,755,819	4,803,760	2·736
All ages from 15—65	7,375,874	9,692,505	1·314

Ages.	Number of Females: Census of 1881.	Weeks' sickness per annum, according to the experience of the Manchester Unity.	Average sickness per individual per annum (in weeks).
15—20	1,278,963	851,701	·666
20—25	1,215,872	896,685	·737
25—45	3,494,782	3,476,146	·995
45—65	1,951,713	5,368,229	2·751
All ages from 15—65	7,941,330	10,592,761	1·334

Briefly, it appears from these tables that the average time of sickness among males during the working years is 1·314 weeks—that is, a small fraction more than nine days in each year—and that among females it is a small fraction more. The result is that among males there is a loss of 9,692,505 weeks' work in every year, and among females a loss of 10,592,761 weeks. Thus we may believe that our whole population between 15 and 65 years old do, in each year, 20,000,000 weeks' work less than they might do if it were not for sickness. The estimate is so large that it must, on first thoughts, seem improbable; but on fair consideration I believe it will not seem so. For the members of the Manchester Unity who are in the working time of life, the reckoning is certainly true, and it is founded on the experience of between 300,000 and 400,000 members. In respect of health they may represent the whole population, at least, as well as any group that could be taken. They are not very strictly selected—they are not picked lives; yet they are such as are able, when they are in health, to earn good wages or good salaries, and, as their prudence in joining this association shows, they are comparatively thrifty and careful persons. They do not, at all events, include many of the habitual drunkards, the cripples or utterly invalids, or those who, through natural feebleness or early disease, or mere profligacy, cannot earn enough to become members or maintain themself in membership. Neither do they include many of the insane, or imbecile and idiotic, of whom there are, in our population, nearly 70,000, doing no work, and losing not less than 3½ millions of weeks' work in the year.

It would be tedious to tell the grounds on which the estimate may be deemed too high, for just as many and as good could be told on which it might be deemed too low. And it is rather more than confirmed by some estimates of the annual sickness in other and very different groups of persons.

In the Army, at home, the average number of days' sickness in each year is, for each soldier, about 17; and, as the number of the troops in the United Kingdom is more than 80,000, we have here a loss of about 200,000 weeks' service in each year.

In the Navy, on the home stations, the average number of days' sickness in each year has been in the last five years for each man nearly 16; so that for the total of about 20,000 men there is a loss of 45,000 weeks' service in each year.

The amount of sickness in the services thus appears much higher than in the friendly societies. This is due, in great part, to the fact that a soldier or a sailor is often put off duty a day or two for much less illness than that for which a civilian would "go on his club." Still, the one estimate may confirm the other; for the sickness in the Army and Navy is that of picked men, who were selected for the services as being of sound constitution, and who are in what should be the best working years of life: and if it includes many cases of sickness for only a day or two, it excludes nearly all cases of more than a few months, such as make up a heavy proportion of the average sickness in the friendly societies and in the general population.

And I may add that the estimate from these societies, that nine days in the year may justly be thought a fair estimate of the working time lost by sickness, is confirmed by the records of sickness among the 10,000 members of the metropolitan police force; for among these, including cases of long illness such as are also in the societies, the average is more than nine days in the year.

I think, then, that we cannot escape from the reasons to believe that we lose in England and Wales, every year, in consequence of sickness, 20,000,000 of weeks' work; or, say, as much work as 20,000,000 of healthy people would do in a week.

The number is not easily grasped by the mind. It is equal to about 1-40th part of the work done in each year by the whole population between 15 and 65 years old. Or, try to think of it in money. Rather more than half of it is lost by those whom the Register-General names the domestic, the agricultural, and the industrial classes. These are more than 7,500,000 in number, and they lose about 11,000,000 of weeks; say, for easy reckoning, at £1 a week; and here is a loss of £11,000,000 sterling from what should be the annual wealth of the country. For the other classes, who are estimated as losing the other 9,000,000 weeks' work, it would be hard and unfair to make a guess in any known coin; for these include our great merchants, our judges and lawyers, and medical men, our statesmen and chief legislators; they include our poets and writers of all kinds, musicians, painters, and philosophers; and our Princes, who certainly do more for the wealth and welfare of the country than can be told in money.

Before I speak of any other losses of work or of wealth due to sickness, permit me, as in parenthesis, to point out to you how very imperfectly these losses are told, or even suggested by our bills of mortality. These, on which almost alone we have to rely for knowing the national health, these tell the losses of life, and more than misery enough they tell of; but to estimate rightly the misery of sickness, and the losses of all but life that are due to it, we need a far more complete record than these can give.

Take, for example, such a disease as typhoid fever—that which Mr. Huxley has rightly called the scourge and the disgrace of our country. It has of late destroyed, in England and Wales, among persons in the working time of life, nearly 4,000 in the year. Its mortality is about 15 per cent., so that if in any year 4,000 die of it, about 23,000 recover from it. Of these, the average length of illness is, on the authority of Dr. Broadbent, about ten weeks. Here, therefore, from one disease alone, and that preventible, we have an annual loss of 230,000 weeks' work, without reckoning what is lost with those who die. And the same may be said of nearly all the diseases that are most prominent in the bills of mortality. The record of deaths, sad as it is, tells but a small part of the losses of happiness and welfare that are due to sickness. It is as if in a great war we should have a regular return of the numbers killed, but none of the numbers wounded, though these, more than the killed, may determine the issue of the war.

Let me now tell of another loss of work and of money through sickness and early death. In all the estimates I have yet referred to, no account is taken of those who are ill or die before they are 15 years old. They are not reckoned as in the working-time of life, though in some classes many thousands of them are. [In the domestic, agricultural and industrial classes of the Registrar-General nearly half-a-million of them are included.] And yet the losses of work due to sickness among children must be very large. Consider the time which might be spent in good productive work, if it were not spent in taking care of them while they are ill. Consider, too, the number of those who, through disease in childhood, are made more susceptible of disease in later life, or are crippled, or in some way permanently damaged; such as those who become deaf in scarlet fever, or deformed in scrofula or rickets, or feeble and constantly invalid, so that they are never fit for more than half work, or for work which is only half well done. These losses cannot be counted, but they must be large;

and there are others more nearly within reckoning; the losses, namely, which are due to the deaths of those who die young. If they had lived to work, their earnings would have been more than sufficient to repay it; but they have died, and their cost is gone without return. The mortality of children under 15 in 1882 was nearly a quarter of a million; what have they cost? If you say only £8 a piece, there are more than £2,000,000 sterling thus lost every year. But they have cost much more than this, and much more still is lost by the loss of the work they might have lived to do.

It is, indeed, held, I believe, by some that these things should not be counted as losses; that we have a surplus of population, and that really the deaths of children, though they may be the subjects of a sentimental sorrow, cannot reasonably be regretted. I cannot bring myself to admit that such a thing should even be argued. I have lived long in the work of a profession which holds that wherever there is human life it must be preserved; made happy, if that can be; but, in any case, if possible, preserved; and no argument of expediency shall ever make me believe that this is wrong. Indeed, I am rather ashamed—even for the purpose I have in view—to use so low an argument as that of expediency in favour of the saving of health and of life. I am ashamed of making money appear as a motive for doing things for which sufficient motives might be found in charity and sympathy, and the happiness of using useful knowledge; but it seems certain that these are not yet enough for all that should be done for the promotion of the national health; therefore, it seems well to add to them any motives that are not dishonourable; and so I add this, that we lose largely not only in happiness but in wealth by the deaths of these poor children.

I will add only one more illustration of these losses, which is always suggested by looking at tables of mortatity. The deaths of persons between 25 and 45 years old, that is during what may be deemed the 20 best working years of life, are annually between 60,000 and 70,000; in 1882 they were 66,000. Think, now, of the work lost by these deaths; and of how much of it might have been saved by better sanitary provisions. If one looks at the causes of their deaths, it is certain that many might have been prevented, or, at least, deferred. Say that they might have lived an average of two years more; and we should have had in this year and last an increase of work equivalent to that of at least 6,000,000 weeks; as much, in other words, as 6,000,000 people could do in one week.

More instances of losses of work by sickness and premature death might easily be given, but not easily listened to in this huge hall. Let these suffice to show something of our enormous annual loss, not only of personal and domestic happiness—that is past imagining—but of national power and wealth. Surely we ought to strive more against it.

But, some may ask, can these things be prevented? are they not inevitable consequences of the manner of life in which we choose or are compelled to live? No; certainly they are not. No one who lives among the sick can doubt that a very large proportion of the sickness and the loss of work which he sees might have been prevented; or can doubt that, in every succeeding generation, a larger proportion still may be averted, if only all men will strive that it may be so.

Let me enumerate some of the chief sources of the waste as they appear to oneself in practice.

Of the infectious fevers, small-pox might be rendered nearly harmless by complete and careful vaccination. Typhus and typhoid, scarlet fever and measles might, with proper guards against infection, be confined within very narrow limits. So, probably, might whooping cough and diphtheria.

Of the special diseases of artisans there are very few of which the causes might not be almost wholly set aside. Of the accidents to which they are especially liable the greater part, by far, are due to carelessness.

Of the diseases due to bad food and mere filth; to intemperance; to immorality; in so far as these are self-induced, they might, by self-control and virtue, be excluded. And with these, scrofula, rickets, scurvy, and all the wide-spread defects related to them, these might be greatly diminished.

It can only be a guess, but I am sure it is not a reckless one, if I say, that of all the losses of work of which I have spoken, of all the millions of weeks sadly spent and sadly wasted, a fourth part might have been saved, and that, henceforth, if people, will have it so, a still larger proportion may be saved.

We may become the more sure of what may be done by looking at what has been done already. Let me show some of it; it will be a relief to see something of the brighter side of this picture.

In a remarkable paper lately read before the Statistical Society, Dr. Longstaff says:—"One of the most striking facts of the day, from the statistician's point of view, is the remarkably low death-rate that has prevailed in this country during the last eight years." In these years the annual death-rate has been less than in the previous eight years, in the proportion of two deaths to every 1,000 persons living. The average number of deaths has been 50,000 less in the last than in the previous eight years. Doubtless many things have contributed to this grand result, and it is not possible to say how much is due to each of them; but it would be unreasonable to doubt that the chief good influence has been in all the improved means for the care of health which recent years have produced. This is made nearly certain by the fact that the largest gains of life have been in the diminution of the deaths from fever, and of the deaths in children under 15 years old; for these are the very classes on which good sanitary measures would have most influence.

The annual number of deaths from typhus, typhoid, and the unnamed fevers, has been about 11,000 less than it was about twenty years ago. The annual number of deaths of children under 5 years old has been about 22,000 less than it was; and that of children between 5 and 15 has been upwards of 8,000 less.

These are large results, and though they tell only of deaths, yet they bear on the chief subject I have brought before you—the working power of the nation; for, however much we might assign to improved methods of medical treatment of fever, yet the diminished number of deaths means a very large diminution in the total number of cases. The deaths during the working years of life were 6,500 less; and, this being so, we may hold that, if the average mortality was, say, 25 per cent., the diminution in the total number of cases must have been at least 25,000; and if we may believe, as before, that each of these involved ten weeks of sickness, we have, in these fevers alone, a clear saving of 185,000 weeks' work in every year.

And so with the diminution of the mortality among children, there must have been a greater diminution in the number of costly and work-wasting illnesses, and a large saving of money that would otherwise have been sunk. And not only so: but many of the children saved in the last eight years will become bread-winners or care-keepers; and who can tell what some of them will become? or what the world would have lost if it had lost all of them.

Let me add only one more reckoning. In a paper last year, at the Statistical Society, Mr. Noel Humphreys showed "that if the English death-rate should continue at the low average of the five years 1876-80, the mean duration of male life in this country would be increased by two years, and that of female life by no less than 3·4 years as compared with the English life-table." And he showed further that "among males 70 per cent. and among females 65 per cent. of this increased life would be lived between the ages of 20 and 60 years, or during the most useful period."

I should like to be able to tell the value in working power of such an addition to our lives. It is equal to an addition of more than 4 per cent. to the annual value of all the industry, mental and material, of the country.

But some will say,—admitting that it is desirable, seeing how keen the struggle for maintenance already is, can more than this be done? and the answer may be and must be, much more. In this, as in every case of the kind, every fruit of knowledge brings us within reach of something better. While men are exercising the knowledge they possess, they may be always gaining more. This Exhibition has scores of things which are better helps to national health than those of the same kind which we had twenty years ago, and with which the gains already made were won. If I were not in near official relation with the jurors, I would name some of them: there are truly splendid works among them.

But do not let me seem to disparage the past in praising the present. It is difficult to speak with gratitude enough of what has been done, even though we may see, now, ways to the yet better.

Anyone who has studied the sources of disease during the last thirty years, can tell how and where it has been diminished. There is less from intemperance, less from immorality; we have better, cheaper, and more various food; far more and cheaper clothing; far more and healthier recreations. We have, on the whole, better houses, and better drains; better water and air; and better ways of using them. The care and skill with which the sick are treated in hospitals, infirmaries, and even in private houses, are far greater than they were; the improvement and extension of nursing are more than can be described; the care which the rich bestow on the poor, whom they visit in their own homes, is every day saving health and life; and, even more effectual than any of these, is the work done by the medical officers of health, and all the sanitary authorities now active and influential in every part of the kingdom.

Good as all this work has been, we may be sure it may become better. The forces which have impelled it may still be relied on. We need not fear that charity will become cool, or philanthropy inactive, or that the hatred of evil will become indifference. Science will not cease to search for knowledge, or to make it useful when she can ; we shall not see less than we do now, and here, of the good results of enterprise and rivalry, and of the sense of duty and the sorrow of shame that there should be evil in the land.

What more, then, it may be asked, is wanted? I answer, that which I have tried to stir; a larger and more practical recognition of the value and happiness of good national health ; a wider study and practice of all the methods of promoting it; or, at least, a more ready and liberal help to those who are striving to promote it. In one sentence, we want the complete fulfilment of the design of this Exhibition, with all the means towards health and knowledge that are shown in it, and with its handbooks, lectures, conferences, and the verdicts of its juries.

We want more ambition for health. I should like to see a personal ambition for renown in health as keen as is that for bravery, or for beauty, or for success in our athletic games and field-sports. I wish there were such an ambition for the most perfect national health, as there is for national renown for war, or in art or commerce. And let me end soon by briefly saying what I think such health should be.

I spoke of the pattern healthy man as one who can do his work vigorously wherever and whatever it may be. It is this union of strength with a comparative indifference to the external conditions of life, and a ready self-adjustment to their changes, which is a distinctive characteristic of the best health. He should not be deemed thoroughly healthy who is made better or worse, more or less fit for work, by every change of weather or of food; nor he who, in order that he may do his work, is bound to exact rules of living. It is good to observe rules, and to some they are absolutely necessary, but it is better to need none but those of moderation, and observing these, to be able and willing to live and work hard in the widest variations of food, air, clothing, and all the other sustenances of life.

And this, which is a sign of the best personal health, is essential to the best national health. For in a great nation, distributed among its people, there should be powers suited to the greatest possible variety of work. No form or depth of knowledge should be beyond the attainment of some among them; no art should be beyond its reach; it should be excellent in every form of work. And, that its various powers may have free exercise and influence in the world, it must have, besides, distributed among its people, abilities to live healthily wherever work must be or can be done.

Herein is the essential bond between health and education; herein is one of the motives for the combination of the two within the purpose of this Exhibition; I do not know whether health or knowledge contributes most to the prosperity of a nation; but no nation can prosper which does not equally promote both; they should be deemed twin forces, for either of them without the other has only half the power for good that it should have.

It is said, whether as fact or fable, that the pursuit of science and of all the higher learning followed on the first exercise of the humanity which spared the lives of sick and weakly children; for that these children being allowed to live, though unfit for war and self-maintenance, became thinkers and inventors. But learning is not now dependent on invalids; minds are not the better now for having to work in feeble bodies; each nation needs, for its full international influence, both health and knowledge, and such various and variable health, that there should be few places on earth or water in which some of its people cannot live, and multiply, and be prosperous.

If, therefore, we or any other people are to continue ambitious for the extension of that higher mental power of which we boast, or for the success of the bold spirit of enterprise with which we seek to replenish the earth and subdue it; if we desire that the lessons of Christianity and of true civilisation should be spread over the world, we must strive for an abundance of this national health—tough, pliant, and elastic—ready and fit for any good work anywhere.

INTERNATIONAL HEALTH EXHIBITION.

The joint Conference of the Society of Medical Officers of Health, the Sanitary Institute of Great Britain, and the Parkes Museum of Hygiene, noticed in last week's *Journal*, was continued during the whole of the week.

On Tuesday, 17th inst., the work of the International Juries was formally inaugurated by his Royal Highness the Prince of Wales, President of the Exhibition, in the Royal Albert Hall. After the delivery of an address by Sir James Paget, Bart., F.R.S. (see *ante*, p. 752), the foreign Commissioners, the chairmen of juries, and the foreign jurors were presented to the Prince by Lord Reay.

On Wednesday, 18th inst., a conference on "The Meat Supply of this Country," organised by the Central Chamber of Agriculture, was held.

General Notes.

TELPHERAGE.—The telpher line may be seen in action any day next week at Weston. This village is reached by a drive of five or six miles from Hitchin, or by a somewhat shorter drive from Stevenage. The telpher train will be kept running for the greater part of each day, and no notice need be given by intending visitors, but those who wish to be certain that the line is running on a particular day can make inquiries at 12, Fitzroy-square.

METRICAL CONGRESS.—The following contractions have been adopted by the International Metrical Congress at Paris, and are recommended for general use: — 1. Length — Kilomètre, *km*; mètre, *m*; decimètre, *dm*; centimètre, *cm*; millimètre, *mm*. 2. Surface—Square kilomètre, km^2; square mètre, m^2; square decimètre, dm^2; square centimètre, cm^2; square millimetre, mm^2; hectare, *ha*; are, *a*. 3. Cubic Measure—Cubic kilomètre, km^3; cubic mètre, m^3; cubic decimètre, dm^3; cubic centimètre, cm^3; cubic millimètre, mm^3. 4. Hollow Measure—Hectolitre, *hl*; litre, *l*; decilitre, *dl*; centilitre, *cl*. 5. Weight—Ton (1,000 kilogrammes), *t*; metric hundredweight (100 kilogrammes), *q*; kilogramme, *kg*; decagramme, *dkg*; gramme, *g*; decigramme, *dg*; centigramme, *cg*; milligramme, *mg*. Italic letters are used for these contractions, and no stop is to be used at the right of them. The contractions succeed the figures to which they refer, on the same line, and after the last decimal placed when figures are used which contain decimal fractions.

ARGENTINE EXHIBITION AT BREMEN.—This Exhibition, opened May 25, has been organised by the Bremen Geographical Society, with the assistance of the Argentine Government. It contains a complete representation of the natural products and manufactures of the great South American Republic, with which Germany has extensive commercial relations, both as regards imports and exports. A collection exhibited by Professor Brackebusch, of Cordoba, illustrates the considerable and but little developed mineral wealth of the mountainous regions. A systematic display is made of various kinds of hides and wool. In the agricultural division are numerous specimens of plants being used in dyeing, medicine, and industry. A full collection of woods represents the timber of the northern provinces. The life of the inhabitants of the Pampas and of the Indian tribes is illustrated by numerous implements, weapons, tissues, &c. In a separate department are works of literature and art bearing on the object of the Exhibition.

HEALTH EXHIBITION SEASON TICKETS.

The Executive Council of the International Health Exhibition have consented to allow members of the Society of Arts the privilege of purchasing season tickets for the Exhibition at half price (10s. 6d.) Each member can purchase a single ticket only on the reduced terms, and these tickets can only be obtained through the Secretary of the Society of Arts. For further particulars see notice in the *Journal* for May 2, p. 575.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 23...Geographical, University of London, Burlington-gardens, W., 8½ p.m. Rev. W. P. Johnson, "Seven Years' Travels in the Region East of Lake Nyassa."

TUESDAY, JUNE 24...Statistical, School of Mines, Jermyn-street, S.W., 4 p.m. Annual Meeting.
Anthropological, 3, Hanover-square, W., 8 p.m. 1. Prof. Flower, "The Size of the Teeth as a Character of Race." 2. Mr. A. O. Shrubsole, "Flint Implements found at Reading." 3. Dr. S. M. Curl, "Phœnician Intercourse with Polynesia." 4. Mr. M. J. Walhouse, "A Hindu Prophetess." 5. Mr. J E. Greenhill, "Exhibition of Palæolithic Implements recently found in the north-east of London."

WEDNESDAY, JUNE 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.
Geological, Burlington-house, W., 8 p.m. Papers will be read by Prof. Judd, Dr. Hinde, Prof. Rupert Jones, Mr. G. R. Vine, Mr. T. Roberts, Mr. A. W. Waters, Lieut.-Col. Godwin Austen, Capt. F. W. Hutton, Mr. Teall, Mr. Tomes, Dr. Forsyth Major, Dr. G. W. Parker.
United Service Inst., Whitehall-yard, S.W., 3 p m. Lieut.-Colonel Moody, "Recruiting for Her Majesty's Service."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, JUNE 26...Society for the Encouragement of Fine Arts, 9, Conduit-street, W. A Morning Meeting.
Antiquaries, Burlington-house, W., 8½ p.m.

FRIDAY, JUNE 27...United Service Institute, Whitehall-yard, 3 p.m. Lieut.-General Sir Henry Daly, "The Punjaub Frontier Force."
Inventors' Institute, Lonsdale-chambers. 27, Chancery-lane, W.C., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
New Shakspere, University College, W.C., 8 p.m. Annual Entertainment, Music and Recitations.

SATURDAY, JUNE 28...Physical, Science Schools, South Kensington, S.W., 3 p.m.
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, JUNE 27, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

A Conversazione will be held at the International Health Exhibition by the Council of the Society of Arts, in conjunction with the Executive Council of the Exhibition, on Wednesday evening, 9th of July.

The visitors will be received by his Grace the Duke of Buckingham and Chandos, K.G., Chairman of the Executive Council of the International Health Exhibition, and by Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council of the Society of Arts, near the principal entrance to the Exhibition in Exhibition-road. The reception will commence at 8.30 p.m.

The military bands of the following regiments will perform either in the buildings or in the gardens, according to the weather—the Grenadier Guards, the Coldstream Guards, the First Regiment of French Engineers (from Versailles), and the 7th German (Magdeburg) Cuirassiers. A vocal and instrumental concert, consisting of glees, &c., will also be given.

The gardens, as well as the Exhibition buildings, will be lighted by the electric light, and the gardens will also be illuminated with variegated lamps and Japanese lanterns.

The Exhibition will be closed on this evening to the general public, and there will be no admission by payment.

Each Member will receive tickets for himself and a lady. These will be issued early next week.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 25th instant, at four p.m., Sir FREDERICK ABEL, C.B., D.C.L , F.R.S., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society :—

Anderson, William Adam, 4, Gladstone - street, London-road, S.E.

Angell, A. Torrington, 18, Redcliffe-road, S.W.

Ashworth, Edward, J.P., Staghills, near Waterfoot, Lancashire.

Atchison, William, 24, Finsbury-circus, E.C.

Bate, Lieut. Charles McGuire, R.E., 128, Westmoreland-road, Elswick, Newcastle-on-Tyne.

Bedford, James, Woodhouse Cliff, Leeds.

Bide, Augustus, 26, North Audley-street, W.

Brooke, George Freeman, Leadenhall Market, E.C., and Rotherfield-hall, Sussex.

Buller, Miss Mary Alice, 7, Holland-villas-road, Kensington, W.

Bullman, Edward Kenyon, 8, New Cavendish-street, W.

Burroughs, Silas Manville, Snow-hill-buildings, Holborn-viaduct, E.C.

Cameron, Charles, LL.D., M.P., 80, St. George's-square, S.W.

Collins, Joseph Henry, F.G.S., 64, Bickerton-road, Highgate New-town, N.

Cranley-Boevey, Arthur William, M.A., Balliol College, Oxford.

Davids, Richard Gore Brabazon, Campinas Sao Paulo, Brazil.

De Salis, Rodolph Fane, B.A., 1, Westminster-chambers, S.W.

Dowling, James, Leadenhall-market, E.C., and the Hawthorns, Upton, E.

Down, Frederick Jonathan, 13, Victoria-road, Old Charlton.

Dyer, Henry James, 21, Wendell-road, Shepherd's-bush, W.

Fremersdorff, William Frederick, Roseneath-villa, Castle-road, Card ff.

Gadesden, James Philip, Long Ditton, Surrey.

Glanville, George, 106, The Grove, Camberwell, S.E.

Gordon, Colonel Edward Charles Acheson, R.E., Commandant's-house, Brompton, Chatham.

Goolden, Walter T., M.A., 28, Westbourne-park, W.
Hodgson, Christopher, 144, Blake-street, Barrow-in-Furness.
Holt, Thomas, Sydney, New South Wales, and Grosvenor-hotel, Belgravia, S.W.
Jeffreys, Edward H., 7, Queen Anne's-gate, S.W., and 5, Westminster-chambers, Victoria-street, S.W.
Kilburn, Charles Conning, 3, Cannon-place, Hampstead, N.W.
McGregor, Duncan, 45, Clyde-place, Glasgow.
Mason, Alfred Henry, 178, Mance-street, Montreal, Canada.
Parnell, George Thomas, Mortimer-house, 45, Mortimer-road, Kingsland, N.
Record, J. C., Prescott-house, Eaton-rise, Ealing, W.
Rudler, Frederick William, 6, Regent's-park-villas, N.W.
Sandford, Henry, 31, Ferndale-road, Clapham, S.W., and 36, King-street, E.C.
Talbot, Colonel Hon. Wellington Patrick M. C., 15, Cromwell-road, S.W.
Theobald, John Wilson, 1, Macaulay-road, Clapham-common, S.W.
Watson, John Cecil, The Rhyddings, Church, Accrington.
Wellcome, Henry S., Snow-hill-buildings, Holborn-viaduct, E.C.
Wells, J. B., Cambridge-wharf, Grosvenor-road, Pimlico, S.W.
West, Rev. William De Lancy, D.D., Royal Medical Benevolent College, Epsom.
Wilkins, Lieut.-General H. St. Clair, 7, Nevern-square, Earl's-court, S.W.
Wilson, William, 3, Newman's-court, Cornhill, E.C.

The CHAIRMAN nominated Mr. Henry Maudslay and Mr. Henry Liggins scrutineers, and declared the ballot open.

The SECRETARY then read the following—

REPORT OF THE COUNCIL.

I.—ORDINARY MEETINGS.

For the first time since the appointment of a Chairman of Council, the bye-law of the Society which provides that every Session should be opened by an address from the Chairman was not carried out. Sir William Siemens, who was Chairman of Council for the previous year, and had been elected to the office a second time, was, as the members will well remember, engaged in the preparation of his opening address when his sudden and lamented death occurred. When he was first attacked by his illness it was hoped that the delivery of the address, which was then half written, need only be postponed, and arrangements were made for supplying the place of the Chairman at the Opening Meeting; but the illness which it was thought might be temporary, ended fatally two days before the date of the Meeting, and it was felt that, under such circumstances, the only course to pursue was to abandon the idea of commencing the Session in the usual formal manner, and to hold no meeting on the Wednesday evening on which the business ought to have begun. The first actual meeting of the Society was therefore held on November 28, on which evening a paper was read by Mr. A. J. R. Trendell upon the Fisheries Exhibition then just closed. Mr. Trendell, it will be remembered, had acted as Literary Superintendent of that Exhibition.

Looking at the meetings as a whole, the same remark may be applied to them that was made in the Annual Report last year, for it will be noted that amongst those dealing with applications of science, the most numerous and some of the most interesting were those which dealt with one or other of the applications of electricity to practical uses. Taking these in the order in which they were read, we come first to a paper by Mr. A. Reckenzaun, on "Electrical Launches," which was read at the first meeting after Christmas. Mr. Reckenzaun gave an account of the manner in which storage batteries are applied for the purpose of propelling small vessels or launches, and described the most complete of these vessels, the one which had been made by the Electrical Power Storage Company for the Vienna Exhibition. It will be remembered that the earliest attempt in this direction was due to Mr. Reckenzaun, whose boat, the *Electricity*, made her first run on the Thames in 1882. About six weeks after the reading of this paper, Mr. W. H. Preece, to whom the Society is indebted for so many admirable lectures and papers, gave a comprehensive account of the progress of electric lighting. In this paper Mr Preece maintained that electric lighting was a practical success, though he was unable to express an opinion as to the economy of the light. In the discussion which followed, Mr. Preece's views were vigorously supported by Mr. Crompton, Mr. Hammond, and others. At this meeting some very ingenious fittings were shown, devised by Mr. Tayler Smith, for the purpose of enabling the lamps to be moved from room to room, and fitted in any place where they might be required for a time.

At the end of the Session a number of electrical papers came together, the last three ordinary meetings having, in fact, been devoted to them. On the 14th of May, Professor Fleeming Jenkin gave his first public account of the very beautiful system of electric railways he has devised under the name of "Telpherage." At last year's meeting of the British Association at Southport, Prof. Fleeming Jenkin described the principles on which he was working, but at the meeting here he was able to give the results of a year's practical trials on an experimental line, together with full details of the improved machinery he had had constructed for the purpose. So complete was the form in which the invention was presented to the meeting, that the many electrical engineers who were present found but little to criticise, and on the whole the meeting seemed to be of opinion that there was a useful future before this novel system of applying electricity to the purpose of transport. At the following meeting, Col. Webber, in his paper on "Telegraph Tariffs," advocated his proposal for delayed telegraph messages; that is to say, for two classes of messages, one at a higher rate and to be expedited as much as possible, the other at a cheaper rate, to be sent after the first class and at times when the wires would otherwise be out of employment. At the last meeting of the Session, Mr. Probert gave an account of the different primary batteries which it is proposed to use for electric lighting, and stated very clearly the advantages and disadvantages of such batteries. Mr. Probert's general account was supplemented by descriptions, from several inventors present, of their particular batteries.

The important question of sanitation, with which the Society has so frequently dealt in recent years, received due attenion at the ordinary meetings. Dr. Richardson treated generally the question of sanitary improvement, pointing to the directions in which he thought it was most important that the attention of the Society and other kindred organisations should be directed. Mr. Elijah Hoole, who had much practical experience in the construction of dwellings for the poorer classes, read a useful paper on "The Dwellings for the Poor in Large Towns." The meeting at which this paper was read had the advantage of being presided over by Cardinal Manning. Mr. Westgarth, whose very liberal offer of Prizes for Essays is referred to in another portion of this report, brought before the attention of the Society the extensive scheme he proposes for the improvement of communication in the City of London. Mr. Westgarth's views are such as to claim the sympathy of all sanitary reformers, but whether it will be possible to carry them into effect upon so large a scale as he proposes, is a matter which remains to be seen. Another paper, dealing not indeed with sanitary matters but with another question of very great importance, the London communication across the river from north to south, was that read by Mr. Redman, on "Thames Communications;" while another, dealing both with one of the chief of sanitary questions, the supply of water, and also with the important topic of communication, was General Rundall's on "Water Regulation." General Rundall's views on the construction of storage reservoirs for the prevention of floods were combated by some English engineers of wide experience, but were equally strongly supported by engineers who have had experience in India.

Among other papers of an important industrial character, as dealing with various applications of science to manufactures, may be mentioned Mr. Bruce Warren's on "Mineral Waters;" Dr. Forbes Watson's on "Rhea Fibre;" Mr. Thomas Fletcher's on "Coal Gas as a Labour-saving Agent in Mechanical Trades;" and Mr. Swinburn King's on "Internal Corrosion and Scale in Steam-boilers." The paper read just before Christmas by the Marquis of Lorne on "Canada and its Products," was one of considerable value, and gained additional importance from the authority with which Lord Lorne, who had just then returned from the Governor-Generalship of Canada, was able to put forward his views. Mr. Lant Carpenter, in his paper on "Science Teaching in Elementary Schools," dealt with a branch of education which has always attracted much interest amongst members of the Society. The Rev. J. S. Rivington gave an account of the very promising process for permanent mural painting invented by Keim, of Munich. Mr. G. P. Sanderson, whose practical knowledge of the elephant, acquired during the performance of his duties as superintendent of elephant-catching operations in Bengal, makes him one of the greatest authorities on the subject, gave an account of the means now in use for obtaining a proper supply of these useful animals in India. But one more paper remains to be mentioned, the one in which Mr. C. V. Boys dealt in a very able and scientific fashion with a subject which is now attracting great popular attention, the construction of bicycles and tricycles.

II.—Indian Section.

The six evenings allotted as usual to the Indian Section were satisfactorily filled up, the attendances on each occasion were good, and the discussions animated and interesting. The first paper in the Section this Session was by Mr. J. M. Maclean, who ably treated the subject of the "State Monopoly of Railways in India," a subject of growing importance with especial reference to the enormously increased exportation of wheat, and consequent necessity for increased facilities of transport to the coast. The second paper, by Mr. Seton-Karr, on the "New Bengal Rent Bill," treated the Bill not from any party view, but its scope and object were clearly explained with judicial impartiality, and the reasonableness and necessity for some such measure pointed out. The third paper was on the "Routes through Afghanistan," by Mr. Griffin W. Vyse, who having been employed in carrying out actual surveys on the Afghan frontiers, had exceptional knowledge of that little known country, and was able fairly to surprise his audience by his descriptions. The fourth paper was on "The Law of Landlord and Tenant in India," by Mr. W. G. Pedder, who gave it as a sort of complement to the able paper read last Session, on "The Historical Development of the Different Scttlement Systems of India." These two papers by Mr. Pedder, with the two by Mr. Seton-Karr, one this Session, and one last Session, on "Agriculture in Lower Bengal," contain an amount of information, in a very readable form, on the somewhat difficult subject of land tenure in India, which could not be attained elsewhere without considerable expenditure of time and trouble, and combine to constitute a really valuable manual on the subject. The fifth paper was a valuable statement of facts and opinions on the past and present condition of indigenous education in India, by Dr. Leitner, who, as Principal of the University of Lahore, and an accomplished Orientalist, was especially qualified to treat a question of such great importance to the present and rising generation of our Indian fellow subjects. The sixth paper was a most interesting descriptive account of "Street Architecture of India," by Mr. Purdon Clarke, who last Session gave us a similar account of the domestic architecture of India. This paper derived additional interest and attraction from the very beautiful illustrations by means of the oxy-hydrogen light provided by Mr. Clarke.

III.—Foreign and Colonial Section.

At the first meeting of the Foreign and Colonial Section, Mr. J. J. Colmer, the Secretary to the High Commissioner for Canada, took the opportunity of the approaching visit of the British Association for the Advancement of Science to the Dominion, to give an account of the present condition of the country as it will be presented to the notice of the members of the Association. The interest of this meeting was considerably increased by the presence in the chair of the Marquis of Lorne, the late Governor-General of the Dominion. At the next meeting Mr. H. H. Johnston contributed a sketch, drawn from personal acquaintance, of the Portuguese Colonies of South Africa. The third communication to the Section was a paper by Mr. Demetrius C. Boulger on "Chinese History," in which the pertinacity and enduring vitality of the race were insisted upon. Following this, Mr. B. Francis Cobb gave an interesting account of the Island of Borneo, which led to a discussion of the value of North Borneo as a possible trade depôt for the commerce passing between China and Australia. Next, Mr. Robert Capper, Lloyd's agent for the West Coast of Africa, based upon his personal experiences in the district an earnest advocacy of the employment of the water-ways of the Congo and Niger as entrances for the introduction of the civilising agencies of commerce into the densely peopled regions of Mid-Africa, a view in which he was supported by Commander Cameron, who maintained that these two rivers must ultimately become the great arteries of the country. The last meeting of the Section was occupied by a communication from Mr. W. H. Penning, late of H.M. Geological Survey in England, upon the present state and future prospects of the Transvaal Gold Fields, which Mr. Penning, from the evidence of personal investigation, finds to be of very high promise, even in comparison with the older, and more thoroughly tested, gold.yielding districts of Australia. This testimony was practically verified and enforced by the exhibition of gold nuggets, recently brought by Mr. Barrett from the De Kaap Mines, and weighing respectively eleven, fourteen, and thirty-two ounces.

IV.—Applied Chemistry and Physics Section.

The first meeting of this Section took place at the end of January, when Prof. Wanklyn read a paper on "The Manufacture of Gas from Limed Coal." In the next paper, Prof. Silvanus Thompson continued the subject he so ably brought before the Society in his recent course of Cantor Lectures, "Recent Progress in Dynamo-Electric Machinery." The following paper, by Dr. Percy Frankland, on "The Upper Thames as a Source of Water Supply," gave rise to considerable discussion. The adjourned discussion extended over two nights, and was taken part in by many authorities on the subject. Dr. Alder Wright, in his paper on "Cupro-Ammonium Solutions," gave a description of the manufacture of the material known as Willesden paper. Mr. Stanford's paper on "Economic Applications of Seaweed," gave an acount of the progress of researches which have been carried on by Mr. Stanford for the past twenty years, and the earlier stages of which were described in a paper read by him in 1862. The last paper read before this Section was by Dr. William Ramsay, and dealt with the recovery of waste products obtained in the treatment of wool.

V.—Cantor Lectures.

During the present Session there have been six courses of Cantor Lectures. In the first course, which was delivered before Christmas, and attracted much attention, Mr. Mattieu Williams gave a useful popular account of the scientific principles which are, or ought to be, considered in the various operations of cookery. In the first course after Christmas, Mr. Bolas, whose course delivered here six years ago, on "Photo-typography" has practically become the standard work on this subject, brought the information thereon up to date in a course of three lectures on "Recent Improvements in Photo-mechanical Printing Methods." A great advance has been made since Mr. Bolas's first course, many of the processes, then only immature, having been since completed and brought into practical use. Mr. Bolas was followed by Mr. R. W. Edis, who dealt with the sanitary construction of London houses in the same interesting way as he had dealt two years ago with their decoration and furniture. In the fourth course, Professor Chandler Roberts, the well-known chemist of the Mint, under the title of "The Alloys Used for Coining," gave a lucid account of the various metals employed for the purpose, of the way of dealing with them, and the arrangements for coining and for testing our coinage. The next course was by Mr. Norman Lockyer, on "New Optical Instruments and Arrangements." In the two lectures on this subject, Mr. Lockyer described the advance which has been made both in the construction and the fitting of astronomical telescopes, and of the progress which has been made in photographing celestral objects. Mr. Lockyer laid great stress upon the want of proper arrangements for the manufacture of optical glass, and expressed his hope that the Society of Arts would take action in the matter. The concluding course of the session was by Prof. W. N. Hartley on "Fermentation and Distillation," the scientific principles on which the various manufacturing proceses are based being very clearly and graphically described in a course of three lectures.

VI.—Juvenile Lectures.

The subject of the usual short course of Juvenile Lectures, delivered for the benefit of children of members during the Christmas holidays, was "Crystals and Crystallisation," the lecturer being Mr. J. M. Thomson, the lecturer on chemistry at King's College. The chief feature of Mr. Thomson's lectures was the very beautiful experiments in crystallisation with which he illustrated them, experiments which had never been shown before on so large a scale to an audience in London.

VII.—International Health Exhibition.

In closing the International Fisheries Exhibition in October last, H.R.H. the Prince of Wales announced that he proposed to hold in the buildings at South Kensington, during the next three years, the following International Exhibitions :—

1884. A Sanitary and Educational Exhibition, comprising Health as applied to Food and Drink, the Dwelling, and Dress ; also General and Technica Education.
1885. An Exhibition of Industrial Inventions, especially Labour-saving Machinery.
1886. An Indian and Colonial Exhibition.

This announcement was soon followed by the publication of the names of the Executive Council which his Royal Highness had appointed for the purpose of carrying into effect his intentions with regard to the first-named of these three Exhibitions, that devoted to Health and Education. An application to the Council of the Society, asking that the Exhibition Council and Committees might meet at the Society's House, met with ready assent, and the Council undertook to co-operate in any way which lay within their power with the Exhibition Executive. The Executive Council accordingly continued their meetings from the

7th November until the end of January, in the Society's house, when the progress of the arrangements rendered it necessary for the place of meeting to be transferred to the buildings at South Kensington. The numerous Special Committees which dealt with the different sections of the Exhibition, also held their meetings here till they too were obliged to migrate to the Exhibition itself.

The Council felt that in thus endeavouring to assist the Exhibition, they were acting in accordance with the traditions of the Society, which has been so long and so intimately associated with work of this sort, and that they were not only carrying out the intentions of H.R.H. their President, but also anticipating the wishes of the general body of members, who have for many years past assented to the employment of the Society's influence and of its funds in the advancement of Education and the promotion of Public Health.

The Society may fairly claim the credit of having taken a very leading part in drawing public attention to the unhealthy conditions of modern life, especially of modern town life; the Sanitary Conferences held by the Society, were, if not the cause, certainly the first indication, of a change in public sentiment as regards the needs of healthful life. To this change in public opinion, and to the attention thus drawn to sanitary matters, is due the very great improvements of a sanitary nature which have taken place during the past ten years; the latest and probably the most important outcome of the movement thus set on foot may be said to be the present Health Exhibition.

Nor is the other division of the Exhibition (Education) less closely connected with the Society. It is unnecessary to do more than refer to the Examinations which, established in 1856 almost as an experiment, to test the scheme of holding simultaneous local examinations from a single centre, still, despite the numerous rival agencies, hold a useful place in our educational system. Nor need more be said of the long-continued efforts of the Society on behalf of Technical Education, efforts which prepared the way for the important institution founded by the London City Companies, and now gradually getting into steady practical work. The only Educational Exhibition ever held in this country was that held in 1854 by the Society of Arts.

Seeing how closely akin to the objects of the Society were those for which the Exhibition was founded, the Council felt that whatever help they could render by placing at the disposal of its executive the resources and organisation of this Society, they were bound to afford. They also readily undertook to carry on a useful part of the work of the Exhibition by assuming the charge of the valuable series of hand-books issued under the direction of the Exhibition authorities. A list of these books has been given in the *Journal*, and it has been announced that their publication will be continued by the Society after the dissolution of the Exhibition Council. In recognition of the assistance rendered by the Society, the Executive Council of the Exhibition granted to members of the Society the privilege of purchasing season tickets at half prices. Of this privilege members have largely availed themselves, nearly 400 tickets having been sold.

VIII.—International Inventions Exhibition, 1885.

Carrying out the proposal of H.R.H. the Prince of Wales, the announcement has been made that it is intended to hold in the year 1885, an International Exhibition of Inventions, and of Musical Instruments. Division I. (Inventions) is to be devoted to illustrations of apparatus, appliances, processes, and products, invented or brought into use since 1862. Division II. (Music) will consist of examples of musical instruments of a date not earlier than the commencement of the present century, supplemented by historical collections of musical instruments and music, and of engravings and paintings illustrative of the history of music.

As was the case with the Health Exhibition, the Council have readily consented to render any assistance in their power, to promote the arrangements for carrying out this most interesting project. The Executive Council appointed by H.R.H. the Prince of Wales have already commenced their meetings here, under the presidency of Sir Frederick Bramwell, a late Chairman of Council of this Society, and so long as such accommodation is of service, the Council will continue to place the Society's committee rooms at their disposal.

IX.—International Health Exhibition Prizes.

Amongst the funds which had been left to the Society, at different times, for the purpose of providing premiums, the members will remember that there is included a sum of £100, presented to the Society by the late Sir

Walter Trevelyan for prizes. This sum has been frequently offered for a method of preserving fresh meat, that being an object in which it was known the donor was greatly interested. The prize, however, has never been awarded; but the fact that one of the groups of the present International Exhibition was specially devoted to food, seemed to the Committee to afford a good opportunity for renewing the offer in a somewhat different form. They, therefore, determined to offer five gold medals, or five sums of £20 each, for the best exhibit in each of certain classes of the Exhibition relating to food. They further considered that it would be consonant with the wishes of the donors for them to offer a gold medal, or money of equal value, under the North London Exhibition Trust, for the best set of specimens illustrating handicraft teaching in any school. The two medals which were not awarded last year under the John Stock and the Shaw trusts are now offered, the former for the best example of sanitary architectural construction, and the latter for the most deserving exhibit in the classes relating to Industrial Hygiene. Inasmuch as one of the special objects in the Fothergill trust was the prevention of fire, a subject included in one of the classes of the Exhibition, the Council thought it would be desirable to add an offer of two medals out of this fund, one in the class containing apparatus for the prevention of fire, and the other for the best exhibit in the lighting apparatus class. Announcements to this effect having being made, Lady Siemens expressed her wish to provide a prize of £20 which might bear the name of the late Sir William Siemens, and should be devoted to a subject in which he was interested, the best application of gas for heating and cooking in dwellings. A little later on, also, Mr. Stacy, a member of the Society, was good enough to place in the hands of the Council a similar sum, leaving to the Council to decide in what way the prize thus provided should be offered. Having regard to the character of the prizes which had already been announced, the Council determined to offer Mr. Stacy's prize for the best exhibit in that class of the Exhibition which deals with sanitary decoration. Full particulars of all these prizes have already appeared in the *Journal*.*

X.—Premiums.

In the last Report of the Council reference was made to the premiums which had been offered under the following trusts:—John Stock, Benjamin Shaw, Howard, Fothergill, and Mulready. The Council regret to have to report that the response to the offers they made has been far from satisfactory. Of the two gold medals offered under the Shaw trust, the Council were only able to award one, which was given to Mr. H. A. Fleuss, for his apparatus enabling persons to breathe in mines and other places filled with vitiated air or irrespirable gases. The medal offered under the Mulready trust was also awarded, the recipient being Mr. C. J. Adams; but nothing worthy reward was sent in for the prizes offered under the John Stock, the Howard, or the Fothergill trusts. That the offer of £100 under the Howard trust should not have attracted better essays than those which were sent in is, to the Council, a matter of some surprise as well as of regret; and they did not feel themselves justified in bestowing so large a sum upon any of the essays which were submitted.

XI.—Swiney Prize.

In January last the occasion for the award of this prize recurred, the 21st of that month having been the fortieth anniversary of the testator's death. As the award has to be made jointly by the Society of Arts and the College of Physicians (though the Society is sole trustee), it has been the practice of the adjudicators to give the prize alternately to general and to medical jurisprudence. On this occasion it was awarded to Professor Sheldon Amos, M.A., for his work entitled "A Systematic View of the Science of Jurisprudence." The award was made, as usual, on a recommendation from a joint Committee of the Society of Arts and the College of Physicians. By the terms of the testator's will the prize consists of a silver goblet of the value of £100, containing gold coin to the same amount. It has now been awarded eight times.*

XII.—Owen Jones' Prizes.

These prizes are provided by the interest on the sum of £400, presented to the Society of Arts by the Owen Jones Memorial Committee. They are awarded on the results of the annual competition of the Science and Art Department to students of the Schools of Art, who produce the best designs for household furni-

* See *Journal* for March 14, 1884.

* Fo a li o the recipients, see *Journal*, 7th September, 1883, p. 91

ture, &c., on the principles laid down by Owen Jones. Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.* A similar number of prizes will be offered for the coming year.

XIII.—Prize Essays.

By the liberality of Mr. William Westgarth, a member of the Society, the Council have had a sum of £1,200 placed at their disposal, to be awarded in prizes for essays on "Dwellings for the Poor," and on the "Reconstruction of Central London."

This amount, in accordance with Mr. Westgarth's wishes, will be divided into five prizes:—

A first prize of £250, for the best practical essay upon the re-housing of the poorer classes, and especially of the very poorest classes, of the metropolis.

A second prize of £500, for the best practical essay upon the whole subject of the sanitation, street re-alignment, and reconstruction of the central part of London.

Three prizes of £150 each:—1. For the best treatment of the engineering considerations. 2. For the best treatment of the architectural considerations. 3. For the best treatment of the sanitary considerations.

The essays in competition must be sent in to the Secretary not later than the 31st December in the present year. The precise conditions to be observed will be found in the *Journal*.†

The Council trust that this generous offer will meet with a fitting response, and that they may be able to award the prizes to essays worthy of it.

XIV.—Medals.

The Council have awarded ten medals for papers read at the ordinary meetings, and at the meetings of the three Sections. Of these five have been given for papers read at the Ordinary Meetings, one for a paper in the Foreign and Colonial Section, two for papers in the Section of Applied Chemistry and Physics, and two for papers in the Indian Section. Besides the papers thus marked, there have been several the merits of which, as they were the work of members of their own body, the Council are precluded from recognising otherwise than by a vote of thanks. These papers are "The Progress of Electric Lighting," by W. H. Preece; "Vital Steps in Sanitary Progress," by Dr. B. W. Richardson; "Telegraph Tariffs," by Colonel Webber; "Borneo," by Mr. B. Francis Cobb; "State Monopoly of Railways in India," by Mr. J. M. Maclean; and "The Existing Law of Landlord and Tenant in India," by Mr. W. G. Pedder. The following is the complete list of the awards:—

To The Most Hon. The Marquis of Lorne, K.T., for his paper on "Canada and its Products."

To Rev. J. A. Rivington, for his paper on a "New Process of Permanent Mural Painting, invented by Joseph Keim."

To C. V. Boys, for his paper on "Bicycles and Tricycles."

To Professor Fleeming Jenkin, F.R.S., for his paper on "Telpherage."

To I. Probert, for his paper on "Primary Batteries for Electric Lighting."

To H. H. Johnston, for his paper on "The Portuguese Colonies of West Africa."

To Professor Silvanus P. Thompson, for his paper on "Recent Progress in Dynamo-Electric Machinery."

To Edward C. C. Stanford, F.C.S., for his paper on "Economic Applications of Seaweed."

To W. Seton-Karr, for his paper on "The New Bengal Rent Bill."

To C. Purdon Clarke, C.I.E., for his paper on "Street Architecture in India."

XV.—Albert Medal.

The Albert Medal for the present year has been awarded to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communication of North America, and have thereby rendered valuable aid to the commerce of the world."

The works of Captain Eads are well known to members of his profession, not only in his own country but in this, as is shown by the fact that in response to the invitation sent out to various learned bodies, the Institution of Civil Engineers recommended Captain Eads. The works carried out by him for deepening and improving the south-western entrance of the Mississippi may be said to stand alone as regards the largeness of the scale on which they have been constructed. He is also the constructor of the celebrated bridge over the Mississippi at St. Louis, an arched bridge with a central span of 520 feet, and with side spans of 502 feet each, all formed of steel tubes. In making this award, the Council have been glad, not only to recognise the talents of one who is so

* See *Journal*, vol. xxxii., p. 905.

† See *Journal*, January 25th, 1884, p. 153.

near the head of his great profession, but also to do honour to a citizen of the United States.

XVI.—Howard Lectures.

Under the Will of Thomas Howard (1868) the Society holds a sum of £500 for the purpose of "presenting periodically a prize or medal to the author of a treatise on the properties of steam generally, or any of them particularly, as applied to motive power, or it may be of air or permanent gases, or vapours, or other agents so applied, or to the inventor of some new and valuable process relating thereto."

The offer made last Session under this trust, of a prize of £100 for an essay on the utilisation of electricity for motive power, not having produced anything considered worthy of so valuable a prize, the Council came to the conclusion that the best way of carrying into effect the wishes of the testator would be to arrange for the delivery under this trust of a series of lectures on some subject dealing with motive power, which might, after their delivery, form a text-book on the subject, and they are now glad to be able to announce to the members that Mr. Wm. Anderson, whose lecture on "The Generation of Steam, and the Thermodynamic Problems Involved" attracted so much attention when it was delivered before the Institution of Civil Engineers, has consented to give to the members of the Society, during the coming Session, a course of lectures on some subject coming within the terms of the trust. The great value of the Cantor Lectures, and the interest which has always been taken in them by members, make the Council feel sure that this addition to the Society's courses of lectures will be fully appreciated.

XVII.—Patent-law.

At the time of the publication of the last Annual Report of the Council, it was uncertain whether the Bill brought in by the Government for the reform of the Patent-law would pass into law. The history of the measure after that time is, of course, well known to those members who take an interest in patent-law reform; but, as a matter of record, it may be as well to state that the Bill was soon after taken up by the Grand Committee on Trade, and underwent at the hands of that Committee alterations of an important character. The Society's Committee, acting in concert with the Committee of the British Association, did their best to induce the Government to accept certain amendments which would have rendered the Bill more like that introduced by the Society of Arts, and would have got rid of the objections indicated by many of the speakers at the Society's meetings. The fact, however, that the Bill was carried through its concluding stages near the close of the Session, was urged by the President of the Board of Trade as a reason for not admitting amendments, on the ground that their acceptance would be likely to imperil the passing of the measure. Some few alterations however, were effected, but the Act, as it was passed, did not assume so satisfactory a form as the Council believes it might have taken, had the Government been able or willing to accept some of the alterations suggested to them. The Act, as the members are aware, came into operation at the beginning of the present year, and it may be fairly stated that so far as it has yet gone, it seems to have given great satisfaction to inventors generally. The number of applications have been far in excess of the estimate made by Mr. Chamberlain on the introduction of the Bill. During the first month there were 2,499, and up to the present time,* that is to say, for practically the first half of the year, the total is 9,207. For purposes of comparison, it may be mentioned that the greatest number in any previous year was that in 1882, namely, 6,241.

The Patent Committee of this Society was reappointed by the Council for the purpose of watching the progress of the Act, but it has not been necessary to call it together. The results of the Act cannot very fairly be estimated until it has had at least a year's working, and the time of trial has yet to come. The first six months of provisional protection under the new Act have not expired, and the publication of the specifications on which letters-patent have been granted is only commencing. A crucial test of the working of the new Act will be the result of the proceedings in opposition, disclaimer, and amendment. The manner in which the new office proves itself able to deal with these questions will be watched with the closest attention by all who take an interest in the matter; and on the success or failure to deal satisfactorily with these important questions depends the success or failure of the Act.

XVIII.—Collisions at Sea.

It was stated in the last Annual Report

* The numbers are really down to the 19th of this month.

that a Committee had been appointed by the Council to consider and report upon the question of the best means of preventing collisions at sea. Soon after its formation, the Committee found it would be better for them to restrict their labours to the question of collisions in fogs, and to this point therefore alone their attention has been directed. In answer to an invitation published in the *Journal*, a great number of suggestions were sent in by inventors as to the best means of preventing such collisions. Most of these suggestions dealt with methods of signalling. A synopsis of them all has been prepared, and, as already stated in the *Journal*, will be furnished to anybody applying for a copy. The Committee also took a good deal of evidence on the subject, and their chairman, Admiral Sir Alfred Ryder, to whom the Council are much indebted for the time and thought he devoted to the work of the Committee, prepared a report, which, after being presented to the Council, has been published in the Society's *Journal*.*

XIX.—Paris Exhibition of Art Industries.

The Paris Union Centrale des Arts Decoratifs have been engaged since the year 1880 in holding a series of Exhibitions of Art Industries. The chief object of the Union, which has the sanction and approval of the French Government, though it is not actually a Government Department, is to establish in Paris a museum similar in character to the South Kensington Museum in London. The President of the Union asked for the assistance of the Society in drawing the attention of English manufacturers to the Exhibition of the present year, which relates specially to industries connected with stone, wood, pottery, and glass. The Council felt they were promoting a useful work by rendering such aid as was in their power, and they have consequently done their best to make the aims and objects of the Exhibition known in this country. Some particulars with regard to the Exhibition have already appeared in the *Journal*, and further information can be obtained on application to the Secretary of the Society.

XX.—Examinations.

As no changes were made in the programme for the present year, there is not much which calls for special remark in the results of the examinations. There was a satisfactory increase in the number of candidates, 991 having presented themselves at 38 centres; whereas last year there were 808 candidates and 35 centres. Of these 991 candidates 785 passed and 206 failed. The number of papers worked was 1,058; of these 121 took first class certificates, 363 second class, and 348 third class, while to 226 papers no certificate was awarded. It is noticeable that of the 226 failures, no less than 110 were in Shorthand, a subject taken up by 234 candidates. It is evident that, when nearly 50 per cent. of the candidates fail, a large number must enter who have not sufficiently considered the nature of the examination or their own chances of passing. It will be well that in future years, candidates in this subject should not present themselves until they are satisfied that there is a fair probability of their attaining the standard of proficiency necessary to obtain a certificate. Teachers also of this subject might wisely exercise some discretion in recommending their pupils not to compete unless they are likely to pass. The subject of Book-keeping shows a large increase—233 against 141 last year, and of these only 28 papers failed to satisfy the examiner. In the following subjects, Commercial Geography and History, German, Italian, Spanish, and Sanitary Knowledge, no examination was held, as the requisite number of candidates (25) did not present themselves. As regards Sanitary Knowledge, this may be accounted for by the fact that the subject of Hygiene has been added to the Science and Art Department's list, and teachers are naturally induced by the payments on results to send their pupils in for the Government Examinations. It is intended to keep this subject on for one more year, but should it fail next year to attract a sufficient number, it will be discontinued. With regard to the other subjects, the Council would draw the attention of the Managers of Institutions and others interested in the Examinations to the neglect with which these important subjects are treated. The Council have decided not to make any alterations of importance in the programme for 1885, which will be issued very shortly.

XXI.—Practical Music Examinations.

The number of provincial centres at which the practical examinations in Music have been held this year has not increased, there being, as in previous years, only two such centres,

* See *Journal* for May 2nd, 1884.

Liverpool and Glasgow. At Liverpool 29 candidates presented themselves, all of whom passed; 21 first class certificates were awarded, and 13 second. At Glasgow 75 candidates entered, all of whom passed, taking 34 first class, and 45 second, with two second class honours. At London, there were 198 candidates, of whom 179 passed, taking 41 first class, and 160 second class certificates, with two second class honours. It should be stated that many of the candidates were examined both in the pianoforte and singing, and consequently the number of the certificates awarded does not agree with the total number of candidates passing. A comparison with previous years shows that though there is an increase in the number of candidates presenting themselves, there is a slight falling off in quality, the per-centage of first class certificates being smaller.

XXII.—Water Supply Conference.

In March last, the Council received an invitation from the Executive Council of the Health Exhibition, asking them to organise a Conference on the subject of Water Supply, to form one of the series of Conferences which it was proposed should be held at the Exhibition. The Council readily undertook to carry out this suggestion, and H.R.H. the President of the Society graciously consented, in answer to a request from the Council, to take the chair. The arrangements were interrupted by the sudden death of H.R.H. the Duke of Albany, and it became necessary to defer to a later period than was originally intended the date for holding the Conference. The Council, however, have continued the preparations, and they are happy to say they have received promises of papers from several well-known engineers and others. They hope that these preparations may soon be completed, and that they may be able to give due notice of the exact date on which the Conference will be held. They trust that it may prove no less successful than the one held in 1878, on the suggestion of H.R.H. the Prince of Wales, in the Society's own rooms.

XXIII.—List of Members.

There can be no better proof of the prosperity of the Society than is afforded by the fact that its numbers continue steadily to increase. The total number of life members, subscribing members, and institutions in union which subscribe to the Society from their own funds, is now 3,551, or 106 more than at the corresponding period last year, when the number was 3,445. During the year 1883-4, 262 members have been removed from the list by death or resignation. During the same period, 368 have been elected.

XXIV.—Conversazione.

Notice has already been given in the *Journal* that the Society's Conversazione, this year, will be held at the International Health Exhibition. The Council are glad that they have been able to arrange with the Executive Council of the Exhibition for the holding of a joint Conversazione, to which Members of the Society of Arts will, as usual, receive an invitation.

XXV.—Chairman of Council.

The death of Sir William Siemens, who had been re-elected Chairman by the Council at their first meeting after the Annual General Meeting, rendered it necessary to supply his place. The Council consequently elected Sir Frederick Abel, who has been an active member of their body almost continuously since 1868.

XXVI.—New Council.

Since the election of the Council, by the last annual general meeting, there have occurred several vacancies, which the Council, acting under the bye-laws, have filled up. The death of Mr. Wm. Spottiswoode took place on the very day of election last year. The Duke of Marlborough, who had been on the Council since 1881, died very soon after this; and Admiral Sir Alfred Ryder, who was elected on the Council last year, found himself unable to accept the nomination. The three vacancies thus formed were filled up during the year by the election of Admiral Sir Edward Inglefield, Mr. W. G. Pedder, and Colonel Webber. The lamented death of H.R.H. the Duke of Albany did not render it needful for the Council to elect another Vice-President, since his Royal Highness was nominated by H.R.H. the President of the Society.

The Vice-Presidents retiring this year from the Council, by reason of their seniority, in accordance with the bye-laws, are Sir Rutherford Alcock, Sir Frederick Bramwell, Sir Frederick Leighton, and Mr. W. H. Perkin. Sir Frederick Bramwell has been Vice-President since 1879, having previously served on the Council, and the other three gentlemen named, since 1880. The ordinary members of Council retiring are Mr. Henry Doulton, Admiral Sir Edward Inglefield, Mr. George Matthey, and Mr. Loftus Perkins. In place of these the Council now put forward for election, as Vice-Presidents, the Marquis of Hamilton, Sir James Paget, Lord Reay, and Mr. Matthey; as ordinary members of Council, Professor James Dewar, Mr. Brudenell Carter, Mr. Edward Birkbeck, and Colonel Donnelly.

XXVII.—Death of H.R.H. the Duke of Albany.

The Council deeply regret to have to place on record in their report the loss the Society has sustained by the death of H.R.H. the Duke of Albany, who, since 1879, had been a Vice-President of the Society of Arts. Immediately after the death of His Royal Highness, a special meeting of the Council was held, at which votes of condolence were passed with Her Majesty, with H.R.H. the Prince of Wales, and with H.R.H. the Duchess of Albany.

XXVIII.—Obituary.

The heavy losses which the Council have sustained by death have been referred to above. Besides H.R.H. the Duke of Albany, one of their Vice-Presidents, the Council have lost their Chairman, Sir William Siemens, the Duke of Marlborough, and Mr. William Spottiswoode, during the past year. They have also to note the deaths of Mr. Cromwell Varley, Lord Overstone, Dr. Hullah, for many years the Society's Examiner in Music, Dr. Goodford, the late Provost of Eton, and several other members, notices of whom have already appeared in the *Journal*.

XXIX.—Finance.

The members have had before them the annual Financial Statement published in last week's *Journal*, and there are a few items in it about which some words of explanation may, as usual, be desirable. On the debtor side of the account it may be noticed that the annual subscriptions received show an excess of £156 over last year, the total amount, £6,284, being considerably higher than that taken in any year since 1876. On the other hand, the life compositions, though up to the average of recent years, fall short of the large sum taken last year by £116. The other receipts of the Society do not differ greatly in amount from the corresponding items in recent years. There are, however, a few entries which appear on this side which considerably swell the total of receipts, though they do not form part of the Society's regular revenue. These are, the liberal contribution by the late Sir William Siemens towards the cost of last year's Conversazione (£1,120), the amount received from Mr. Westgarth for his prizes (£1,200), and two smaller sums of £20 and £40 each, one representing Mr. Stacy's prize, the other the amount which the Council have undertaken to expend for the Paris Union Centrale des Arts Decoratifs.

On the credit side of the account the items of ordinary expenditure do not seem to call for very much remark. Against the £1,500 expended on last year's Conversazione is, of course, to be set Sir William Siemens's contribution of £1,120, leaving a charge of £425 which was met by the Society. The principal item in the total of £279 expended on prizes consists of the Swiney Prize, £200. This charge, it will be remembered, recurs every five years. In addition to the life compositions invested as usual, the Council have been enabled to repay to capital a sum of £500, the balance of an amount sold out in 1876, and then applied for current expenses of the Society. The first portion of this money was repaid to capital account in the Session 1881-2. This sum, like the former one, has been invested in Queensland 4 per cent. Bonds. It has also been considered wise that the accumulations of interest on trust funds should be taken out of the current account, and for this reason a sum of £300, representing these accumulations, has been placed on deposit with Messrs. Coutts and Co. The amount of Mr. Westgarth's prizes has also been placed on deposit with the Society's bankers. A sum of about £80 has been invested on account of the Aldred trust and the North London Exhibition trust, in accordance with the resolution arrived at last year, that the amount accumulated under these trusts should be added to the principals. The reasons for this were given in last year's annual report. The last item, cash in hand, shows an increase of a little more than £100 on the amount at the commencement of the financial year.

Under the head of liabilities, it will be seen that the total liabilities are apparently considerably in excess of last year, being £2,482, as against £954. This is principally due to the one item of Mr. Westgarth's prizes, and is of course balanced by corresponding entries amongst the assets. In consequence of the investment referred to above, the Society's invested funds show a most satisfactory increase, being £1,060 more than last year. These investments now amount to £6,562, and are of course entirely independent of the invested funds chargeable with various trusts. The other assets, consisting of uncollected subscriptions, and the property of the Society, are estimated at their usual value. The financial statement closes with a list of the investments standing in the name of the Society, and of the trust funds included in them. On them it may be noted that the securities in which the Society's funds were in past years invested, now stand without exception very high. The property is, therefore, really very much more valuable than it appears on the face of the statement. The Council think that a careful examination of the statement will show that the Society's finances are in a thoroughly sound condition, and afford evidence of steadily increasing prosperity.

The CHAIRMAN, in moving the adoption of the report, remarked that the past year of the Society's existence had been not less active and useful than previous ones, and he congratulated members on the very satisfactory financial position of the Society. He referred to the great loss the Society had suffered by the death of Sir William Siemens, and to the invaluable aid which he had rendered as chairman of its Council.

Lord ALFRED CHURCHILL, who seconded the motion for the adoption of the report, remarked that although the funds were so highly satisfactory that some members seemed to think that the Society was too prosperous, they must bear in mind the time when the lease of the Society's house would fall in, so that they might be prepared to meet this contingency.

Mr. LIGGINS expressed his hope that the Committee on Collisions at Sea would not consider its labours at an end, in consequence of the report already given, which only dealt with one part of the subject. He urged the necessity of a clearer international understanding as to the meaning of the words "starboard" and "port," as used in steering a vessel. These terms were practically used in one sense by English seamen, and in another by the sailors of France, and certain other countries. This was a point to which the attention of the committee might well be devoted.

After some remarks from Mr. KLENCK on the financial statement, the report was adopted.

The ballot having remained open for one hour, and the scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.	Sir John Lubbock, Bart., M.P., F.R.S.
Sir George Birdwood, M.D., C.S.I.	*George Matthey, F.R.S.*
Andrew Cassels.	*Sir James Paget, Bart., D.C.L., LL.D., F.R.S.*
B. Francis Cobb.	W. H. Preece, F.R.S.
Edwin Chadwick, C.B.	Sir Robert Rawlinson, C.B.
Lord Alfred Churchill.	*Lord Reay.*
Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.	B. W. Richardson, M.A., M.D., F.R.S.
Captain Douglas Galton, C.B., F.R.S., D.C.L.	Lord Sudeley.
Earl Granville, K.G., F.R.S.	Sir Richard Temple, Bart., G.S.C.I., C.I.E., D.C.L.
Marquis of Hamilton.	Duke of Westminster, K.G.
Sir John Hawkshaw, F.R.S.	

ORDINARY MEMBERS OF COUNCIL.

Sir Frederick Abel, D.C.L., C.B., F.R.S.	*Colonel J. F. D. Donnelly, R.E.*
Edward Birkbeck, M.P.	Thomas Villiers Lister.
Alfred Carpmael	J. M. Maclean.
R. Brudenell Carter, F.R.C.S.	W. G. Pedder.
Thomas Russell Crampton.	R. E. Webster, Q.C.
Prof. James Dewar, M.A., F.R.S.	Colonel C. E. Webber, R.E., C.B.

TREASURERS.

W. H. Malcolm.	Owen Roberts, M.A., F.S.A.

SECRETARY.

H. Trueman Wood, M.A.

A vote of thanks to the Scrutineers, moved by the CHAIRMAN, was carried unanimously.

Mr. HYDE CLARKE proposed, and Mr. LIGGINS seconded, a vote of thanks to the President, Vice-Presidents, and members of Council for their services during the past year, which was carried unanimously.

Sir FREDERICK ABEL replied on behalf of the Council. He said that the Council were fully employed, but it was a gratification to them to find their labours appreciated by the members, and the Society in so prosperous a condition. He also remarked on the valuable aid they received from the Secretary.

Mr. LIGGINS proposed a vote of thanks to the Secretary, to the Editor of the *Journal*, and to the other officers of the Society, which was acknowledged by the SECRETARY.

The meeting concluded with a vote of thanks to the Chairman, moved by Lord ALFRED CHURCHILL.

Miscellaneous.

NOTES ON THE BUILDING EXHIBITION.

As the notes of last year relating to this Exhibition at the Agricultural-hall bore upon the outside of the house, those of this year deal principally with the interior and fittings. Wood-working has a special feature, many machines showing that great progress has lately been made in this direction.

F. W. Reynolds and Co. exhibited their "Queen" hand-power combined circular and band sawing machine, the table of which is perfectly clear on both sides for cross-cutting to any length, no obstruction being caused by the fly-wheel. The main features of the "Briton" combination band and circular sawing machine, for steam power, is the patent arrangement of countershaft for driving, whereby two separate motions are obtained from a single countershaft, the attendant being able to work instantly either the band saw or the circular saw. The "No. 3," improved planing and trying-up machine, with rising and falling tables, will take timber "out of winding" (as the joiners' call it), to a length of 7 feet, and, by means of the "fence," or guide, will square up timber accurately. The panel planer will plane any thickness, either hard or soft wood, up to 5 inches thick and 30 inches wide, without leaving any perceptible ridge or unevenness; and the "comprehensive" general joiner has been designed to do a large variety of work, while occupying only a small space.

Lewis and Lewis showed a hand-feed planing machine which, it is claimed, will "take out of winding" any kind of timber, however warped it may be, and reduce it to an even face more quickly than can be done in a trying-up machine. C. J. Boyce and Co. showed in action Olley's self-feeding saw-bench, the peculiarity of which is that the circular saw revolves in the contrary direction to that usually adopted, and thus cuts upwards instead of downwards, with a considerable reduction of friction, and, therefore, of the power required to drive. As the speed at which the saw is driven by hand is constant, the speed of the feed is altered according to the thickness of cut, thus equalising the strain at the handle. This company also showed in action an ingenious machine, invented by Mr. Tushaw, for punching holes in iron hoopings, for binding packing cases, and also a modification of the same machine, which serves not only to set large saws, but even to make them from the steel plate, by punching out the spaces between the teeth. J. T. Syer exhibited his convenient bench knives for joiners, and also a handy machine for cutting mitre-joints perfectly true.

There was more than one example of poultry houses and conservatories, especially designed and constructed so as to be easily removeable by the tenant at the expiration of his lease. There were also several examples of glazing without putty, the joints being at the same time perfectly good, in particular, a conservatory, erected by Messenger and Co., had a sheet of water constantly poured over it to show the tightness of the joints. In Samuel Deards' patent "Victoria dry glazing," the bar for holding the panes is composed of two zinc tubes combined, resembling the letter X, in which the glass is placed, and upon which a zinc cap is afterwards made to slide, all being held firmly to the rafter by one screw.

Several firms manufacture prismoidal and other glass blocks for being inserted into gratings, and thus allowing daylight to enter basements by refraction. Among them, Hayward Bros. and Eckstein had on view several examples of their "semi-prism reflecting lens" pavement light. T. Hyatt combines his prism and lens lights with silvered reflectors, so contrived that they direct the rays of light on to any part of the basement. In his "safe-walking surface" grating, the iron is completely hidden by a combination of glass and tiles, which produce a pleasing effect. The stand of Hamilton and Co. was fitted to represent a basement, arranged with their various lights and coal-hole plates, showing the quantity of daylight which they allow to enter.

There were two notable exhibitors of wall-papers, both plain and embossed, viz., Jeffrey and Co., and W. Woollams and Co., both of whom guarantee the absence of arsenic. There were also several examples of non-poisonous paints, in which the base is zinc instead of lead. Rendle Brothers gave practical demonstrations of the efficacity of their "electric" paint remover, which supersedes the use of a fire or hot iron for this purpose. While tin is successfully employed for lining lead pipes, wrought iron piping is, by Chedgey's process, lined with glass, so that water, or various acids and chemicals, passing through them, remain absolutely pure. The pumps of this exhibitor, with bored glass barrels, have the same advantage; while, owing to their transparency, the valves are exposed to view, so that anything going wrong with them is readily noticed.

Sanitary appliances formed a large class. The representatives of the late George Jennings exhibited a convenient appliance for City offices, consisting of a combined lavatory, slop sink, &c. The "concealed" lavatory, which takes up very little space, resembles an ordinary cupboard, while a similar contrivance for billiard-rooms is masked by a cue-rack. The one inconvenience of the "tip-up" basin, the chance of a portion of the waste water being projected upwards, is now obviated by the addition of a "splash rim" to the casing. The West Central Engineering Company have an arrangement of w.c., in which all the wood casing may be lifted up together, for facility of inspection and repair.

Stoves, ranges, and fireplaces, were well represented, not only in the expensive but also in the ordinary varieties. The principle of the gas-roasting appliances of James Slater and Co., which resemble large iron safes, is that the whole of the oven is surrounded by a stream of air, which is conveyed by passages in the top, sides, back and doors, to the burner pipe in the bottom of the oven, taking up in its passage all the heat that would otherwise be radiated to waste in the kitchen. The incoming and outgoing currents nearly balance each other, permiting of the retention of the hot air in the oven as soon as possible, and therefore of the extraction from it of the greatest amount of caloric. Their gas-heated circulating boiler has, with 1,800 cubic feet of Dawson's gas, equal to 900 cubic feet of coal gas, boiled 600 gallons of water. The gas-cooking stoves of H. and C. Davis are double-cased and surrounded by a non-conducting substance. An arrangement has been made whereby they may be obtained from the gas companies at quarterly rentals; and it is asserted that they will cook an ordinary dinner for ten persons at a cost in gas of $1\frac{1}{4}$d.

The bars of S. Deards' "Princess Louise" coil grate consist of wrought iron tubes, in which a current of water is heated for baths, warming greenhouses, and other purposes.

AMERICAN FOREST TREES.

The following particulars respecting West American forest trees are taken from a communication of Mr. Thomas Meehan to the *Gardeners' Chronicle*:—

In going westward from Lake Superior the arborescent vegetation ceases near Brainerd, the last trees being white pine, banks' pine, the larch, white birch, white maple, and aspen. Thence to the Rocky Mountains a continuous sheet of herbaceous vegetation covers the surface, and no trees are seen except cottonwoods (*Populus monilifera*) along the Missouri. The first ranges of the Rocky Mountains on this route along the Yellowstone River and in the Park are covered sparsely or densely with trees, the higher summits and ridges with *Pinus flexilis* (James), *Abies grandis*, and *Pseudo-Tsuga Douglasii* (Carr.); while the foot-hills, and in some cases the levels, are thickly set with *Pinus contorta* (Douglas), var. Murrayana (Watson). The latter is regarded by some as a distinct species *P. Murrayana* (Murr.), but is only an upland form, which is larger and more spreading. Both varieties, however, grow in proximity in many parts of Oregon and Northern California. In the lowlands of the Park are dense thickets of dwarf willow, and here and there a tree of *Populus augustifolia* (James), and *Pinus ponderosa* (Douglas).

Between the last ranges of the Rocky Mountains, near Pend'Oreille Lake, and the Cascades, the prevailing and almost the only tree is *Pinus ponderosa* (Douglas). It scarcely forms forests here, but is scattered over the country in considerable abundance, and attains a large size.

Passing the gorge of the Columbia, we come into the dense forests of the Pacific coast proper, where the number and magnitude of the trees is greater than I have seen in any eastern or even tropical region. The trees of several kinds here reach an altitude of 300 feet, and often stand so near together that all undergrowth is absent, and the horseman makes his way through them with difficulty. On the lowlands the Douglas spruce and the western arbor-vitæ are the most abundant. Locally, the hemlock is common, and along the rivers the north-western cottonwood (*Populus trichocarpa*), stands thick and attains a large size. Along the smaller streams, and in swampy places, the Oregon ash (*Fraxinus Oregana*, Nutt.) and the arborescent alder (*Alnus rhombifolia*, Nutt.) occur in considerable numbers, and attain about equal size—*i.e.*, a diameter of 1 foot, and a height of 50 or 60 feet. Scattered through this lowland forest are the two common maples of the west (*Acer macrophyllum*, Pursh, and *A. circinatum*, Pursh). Of these, the first grows sometimes to the height of 80 feet, with a diameter of trunk of 12 to 15 inches, and on young plants the leaves sometimes attain a breadth of a foot or more. The vine maple is a peculiar feature in the forests of the Lower Columbia, Puget Sound, Vancouver's Island. It never becomes more than 6 inches in diameter, and several trunks usually spring from the same root. These are very slender, droop, and frequently reaching the ground, take root at the summit. Where these interlacing trees are numerous, they form a thicket which is almost impenetrable.

Among the great conifers of the Pacific coast two of the most gigantic and valuable, the sugar pine, *Pinus Lambertiana* (Douglas), and the redwood, *Sequoia sempervirens* (Endl.), approach, and the first reaches the line of the N. P. Railroad, though their habitat is more southern, and both are important elements in the resources of the country from which it will derive much of its business. Of these the sugar pine—nearly related to the eastern white pine by habit, foliage, cones, and wood—is the monarch of the genus, frequently reaching a height of 300 feet, with a diameter of from 10 to 15 feet. This grows chiefly in the Sierra Nevada and Cascade Mountains throughout Oregon and California. The redwood is even larger. It is found only along the coast and about Port Orford forms forests, which surpass in the average dimensions of the trees any others I have seen. The lumber furnished by both these great trees is excellent; and, like the white pine of the East, they are suffering such wholesale destruction as promises soon to exhaust the supply they furnish. The next in intrinsic value as timber trees, and, from their abundance, having even greater economic importance, are the Douglas and Menzies spruces, the white fire, *Abies grandis* (Lindl.), and the western white cedar, *Thuia gigantea* (Nutt.). These form the basis of the lumber industry of the Puget Sound region, and supply all the great saw-mills, some of which cut 250,000 feet per day. The timber furnished by these trees is good, but the lumber is inferior.

With the array of magnificent conifers which flourish in the moist and equable climate of the North Pacific coast, the poverty of the angiospermous flora is in striking contrast. Two maples, two poplars—one on the high and other on low grounds—one ash, and one alder, have been enumerated. To these should be added two arborescent willows (*Salix lasiandra*, Benth., and *S. longifolia*, Muhl.), one oak of little value, and two other hard-wood trees and the list is complete.

In the open grounds of the Villamette Valley, Puget Sound, and Vancouver's Island, Garry's oak (*Quercus Garryana*, Dougl.) is not uncommon. It is usually of moderate size, and of a peculiar straggling and peculiar misshapen growth; occasionally, trees of three or four feet in diameter are met with, but the shape is so irregular, and the wood so brittle, that it has little value as a timber tree. In the forests of both Oregon and Washington Territory two trees are sometimes seen that are sure to attract the attention of the Eastern botanist. One of these, which grows on the higher grounds, is the Oregon Chinquapin (*Castanopsis Chrysophylla*), generally a shrub, but sometimes reaching an altitude of fifty or sixty feet, and conspicuous from the golden pubescence of the underside of the leaf. The other tree is the Madroña (*Arbutus Menziesii*, Pursh.). This is a small tree, but one much admired; the foliage is persistent and rich, the leaves oblong or lanceolate, with serrated edges, and the fruit, which grows in clusters, is red, and somewhat resembles that of the mountain ash, but is less abundant, and grows in more open panicles.

WATCHMAKING IN SWITZERLAND.

Some interesting information respecting this industry, one of the most important of Switzerland, has lately appeared in the report by her Majesty's Secretary of Legation, at Berne. From this it appears that the business of watchmaking dates back from the year 1587, taking its rise in Geneva, and gradually spreading north and east to the neighbouring cantons of Neuchâtel, Berne, and Vaud. Within a century from its introduction 100 master watchmakers are said to have been established in the city, the total annual turn out being 5,000 watches. In Neuchâtel the manufacture was introduced a century later, owing, it is said, to the importation of an English watch into a mountain hamlet, where a blacksmith examined it and succeeded in constructing one in imitation. As regards the Canton de Vaud, the Jura valleys of the Lac de Joux and Sainte Croix, have long been the head-quarters of the same industry, which has appeared to flourish more in the mountain region than in the plain. The same peculiarity is observable in the Canton of Berne, where the principal watchmaking centres, counting from the foot of the Jura, and ranging upwards, are Bienne, St. Imier, Franches Montagnes, Tramelan, &c. Further than Berne this particular trade does not appear to have established itself to any extent in any part of the confederation. There are, however, various isolated manufactories in other cantons as Fribourg, Soleure, Bâle, and Schaffhausen. The Cantonal Governments have accorded the watch manufacture a support by fostering various institutions created in its behalf. Foremost among these are the horological schools, of which the earliest was founded at Geneva, in 1824, and became, in 1843, a municipal institution, directed by a committee of watchmakers. At this school it is competent for a student in the craft to attend classes for practical instruction, as well as a special theoretical course lasting four years. The fee for Swiss pupils is five francs a month. In the Canton of Neuchâtel there existed, in 1872, three such schools; a fourth has since been established at Fleurier. The theoretical course here is of three years' duration. In the Canton of Berne there are two of these schools at St. Imier and at Bienne. Various societies have also been, from time to time, formed more or less in connection with watchmaking. Among these may be mentioned the "Section d'Horlogerie," of the Société des Arts, at Geneva, founded in 1870, with a monthly newspaper entitled the *Journal Suisse d'Horlogerie*. Another active society is the "Société Intercantonale des Industries du Jura," founded in 1876, having ten sections, and engaging in all manner of operations for the advancement of the watch trade generally. It is, however, to the public observatories of Switzerland, and in particular to those of Geneva and Neuchâtel, that the Swiss watchmaker is, above all things, indebted for the degree of precision to which his art has been enabled to attain. That at Geneva was built in 1773, and restored in 1829, since which special arrangements have been made in it for testing and regulating the chronometers brought for inspection. It communicates, by electricity, the exact time to all the principal factories in the city. The one at Neuchâtel, which was founded in 1858, similarly regulates the time for the chief watchmaking centres and telegraph offices in the canton, and even beyond. In both these observatories there is held a yearly competition of chronometers, with prizes offered either by the Society of Arts or by Government. There appears to be an absence of reliable statistical information on the subject of watchmaking in Switzerland, but from calculations which were made in 1866, as to the number of workmen employed and the watches turned out, it appeared that in the Canton of Neuchâtel there were 13,706 workmen, turning out yearly nearly 1,000,000 watches, valued at 50,000,000 francs; in the Jura Vaudois, 2,700 workmen; in the rest of this canton there were 5,000 workmen engaged in this manufacture and in that of musical boxes; in Berne, about 1,300 artificers, producing watches valued at 30,000,000 francs. At the present day, it is estimated that the total annual production of watches in Switzerland exceeds 1,600,000, with an aggregate value of 88,000,000 francs, the total number of workmen employed averaging 40,000. Dr. Adolph Hirsch, the director of the Neuchâtel Observatory, in his report on the watches of the Vienna Exhibition, gave it as his opinion that, "so far as regards watches, properly so called, Switzerland might be said to occupy the first rank among the nations, and even in respect of chronometers to be fully the equal of England." The total exportation of watches in 1882 was 154,500 kilogrammes, or 25,300 more than in 1881, while 46,400 kilogrammes were imported; the latter, however, were chiefly articles in the rough, intended to be finished and re-exported. Mr. Thornton, in conclusion, says that a novel kind of watch has been recently invented by M. Paul Kramer, at Neuchâtel, but owing to the defective state of the law in Switzerland, the inventor has been obliged to patent it in France. This watch is called *à aiguilles universelles*, and indicates simultaneously the times of different countries; one, for example, shows the different times for Paris, Suez, Bombay and Hué, another for New York and San Francisco. Any such watch might be constructed to suit the wishes of the purchaser. The hands pointing to these different hours are painted upon a small movable dial placed in the centre of the principal face of the watch. Mr. Thornton says:—"What is perhaps more generally needed than anything else for the recovery and maintenance of the old Swiss reputation for solid excellence in watchmaking, is the passing of a law for the protection of industrial inventions, models, and designs. Such a law was proposed eighteen months ago, but was, unfortunately, rejected by the popular vote for reasons entirely disconnected with its intrinsic merits or demerits; there is, however, little doubt that its more important provisions will, before long, re-appear in a similar measure, which will this time meet with a better fate."

THE WHEAT-FIELDS OF MEXICO.

It is stated, in a report recently issued by Mr. Joseph Nimms, Chief of the United States Bureau of Statistics, on the trade between Mexico and the United States, that Mexico, as a grain-field, is becoming large enough to affect the supply and consumption of the world, and to enter into serious competition with the United States and Russia; the two leading wheat-exporting countries.

The physical formation of Mexico is simply an extension southward of the great Colorado mountain base plateau. Wheat grows on the plateau of Mexico at from 6,000 to 9,000 feet above sea level, and between the 18th and 24th parallels of latitude. Corn grows everywhere, except on certain waste districts along the northern frontier. The wheat-growing area of Mexico really extends from Puebla nearly as far as Colima, about 500 miles east and west, and from Southern Michoacan to Zacatecas, about 400 miles north and south. This plateau is broken by mountain ranges into a number of rich districts specially adapted for the growing of wheat, namely the Lerma Valley, roughly 200 by 16 miles; the Bajis (Northern Michoacan, Jalesco, and Southern Guanajuato), 200 by 200 miles; Agnascalientes, 50 by 50 miles; the San Louis Potosi and Queretaro district 150 by 30 miles; thus making a total of 52,000 square miles. Of this immense field of rich and arable land one-third it is believed could be readily put into wheat cultivation, with due regard to other agricultural interests of the country.

Under the Mexican plan of cultivation, three crops are taken off the land every two years—one crop of wheat and two crops of corn. The average wheat yield of Mexico now does not exceed twenty bushels to the acre. Corn on irrigated lands averages about fifty, on dry land about thirty bushels to the acre. The mode of cultivation is similar to that practised by the Egyptians thousands of years ago. Wooden beam ploughs are used, with a small iron shoe, which scratches a furrow five inches broad, and about five inches deep; and it is said that five men are employed, and five yoke of oxen, to do the work which would in other countries be performed by one. The wheat grown is of the very finest quality. At the Centennial Exhibition at Philadelphia, in 1876, Mexico took the first prize for wheat. Threshing is done by driving horses round over a circular tile or stone floor, and winnowing is performed by men tossing the grain and chaff into the air with scoop shovels. Transportation from the field to the farmhouse or railway station is on ponderous two-wheeled ox carts. Apart from the 52,000 square miles spoken of above, which is the choice wheat-producing area, there is sufficient outlying wheat, barley, and corn land now under actual cultivation to supply the present population of Mexico, 10,000,000 persons. These persons are at present fed on grain grown in the immediate vicinity of their domiciles, there having been up to this time no machinery for the transportation of products from one part of the country to the other. Mexico is essentially a corn-fed nation, seven-eighths or more of the people living habitually on *tortillas*. If the wheat area were cultivated to its full capacity, namely, 17,333 square miles, or about the third of the 52,000 square miles, it would yield, under present conditions, twenty bushels of wheat and forty bushels of corn per acre, or an average of 110,000,000 bushels of wheat and 440,000,000 bushels of corn every year. This immense yield will be all available for a foreign market, as the outlying lands will always produce sufficient for the home consumption of Mexico, as they do at present. It is expected that by the end of 1884 Mexico will enjoy a perfect railway system, as there will be two trunk lines from the capital to the United States, having also good branch lines to the gulf ports of Vera Cruz, Tampico, Matamoros, and Corpus Christi. The land of Mexico is largely held in huge estates, for instance, the Bustamente extends over portions of three states, and the line of the National railway runs through it for fifty miles. These vast estates, with the fact that in the central part of Mexico at least they are of cleared land, will enable the wheat-growing area to be put rapidly under cultivation when once the railways open up a market for wheat. The Mexican wheat grower appears to enter the markets under peculiarly favourable conditions. He owns his own land in large tracts, he works it with the cheapest labour, and he is frequently a man of large funded capital. There is, however, one serious difficulty with which the wheat grower has to contend, namely, the system of State taxes which prevails all over the Republic. In some States the production of wheat is taxed, in others the importation of it into, or through their borders. This tax is uncertain, varies with the State, and is very burdensome. It is said to be almost impossible to codify or keep any account of these State imposts, which are levied without system, or on any system of political economy. It is computed, however, that they can be roughly estimated at one per cent. on the value of nearly everything grown or brought into the State.

NEW HAND-LOOM.

M. de Lagreré, a French consular representative in Russia, has forwarded to his Government an account of a new description of loom, which (according to a French contemporary) is likely to accomplish an important reform in the weaving industry; restoring to weavers that independence which had disappeared under existing conditions. This loom is considered to be the realisation of an idea often spoken of in the technical press, viz., the construction of machinery suitable for small manufacturers, and for hand-weavers, which would allow them to compete advantageously with the largest factories.

The new loom has the advantage of being worked by a pedal and bar, which are set in motion by the foot and hand of the weaver. The facility with which it is worked, allows of children and girls producing goods free from defects, without having any special knowledge of weaving. Thus it is said that young weavers of fifteen can make eleven yards of taffetas per day, without their strength being unduly taxed. When such looms are in a weaving-shed, one foreman can supervise the working of fifty looms, and this facility of supervision is also an important advantage in domestic weaving. Each loom occupies a space of about 16 square feet, and this new invention is considered to have solved the problem of an automatic loom, which can work at the varying degrees of speed applicable to different tissues.

This loom is said to be so light that the finest silk goods may be woven upon it without any fear of the warp-thread breaking; the weaver being, therefore, only obliged to stop when he weft has to be renewed. The loom is entirely constructed of cast-iron or steel, and can be used for several years without being repaired. The cost has been roughly estimated at £16. It is capable of being used for all descriptions of rich plain goods and armures, as well as wool and silk materials, cotton and silk Roubaix goods, batistes, &c., being, in fact, a universal loom.

AUSTRALIAN MALACHITE.

Hitherto the principal supply of this beautiful marble, which is largely used in Europe for mantelpieces, pedestals, and similar decorative purposes, has been obtained from Russia, but it is equally rich and abundant in New South Wales, where its colour ranges from pale emerald to deep green, the various layers often possessing different shades of colour, and forming a most beautiful and valuable stone for ornamental and inlaying purposes. Crystals are occasionally met with, and sometimes of large size; those from the Cobar Mines are particularly beautiful. The silky lustre is often very remarkable, the capillary crystals being sometimes several inches long, and compacted together into fibrous bundles. It is found in most of the upper workings of New South Wales copper mines, as in the Bathurst district with chlorite, vitreous, yellow, and other copper ores; at Cambalong earthy and fibrous malachite is associated with barytes or heavy spar, and with yellow and peacock ore; at Cobar, county Robinson, with steatite; Mitchell's Creek, Wellington, county Wellington, mixed with other surface ores, and often containing large quantities of gold and silver. Reedy Creek and Bingera, county Murchison; Icely, Yass, county King; Nymagee, county Mouramba; Buckinbah, county Gordon, in granite, with the sulphides of copper; at Lucknow, county Wellington; Gundagai, county Clarendon; Cow Flat and Milburn Creek, county Bathurst; Belara, county Phillip; Gordon Brook, county Richmond; Clarence River, county Clarence; Kaizer Mine, Mitchell's Creek, often containing beautiful specimens of coarse gold, and Peelwood, county Roxburgh; Wiseman's Creek and Oberon, county Westmoreland; Courntoundra Range, 60 miles from Wilcannia; Condobolin, county Gipps; between the Cotta and Queanbeyan Rivers; county Cowley; Mount Hope, county Blaxland. At Capabella, county Goulburn; Barraba, county Darling; Burraga, county Wellington; Silver Dale, near Bowning, county King; and Parkes, county Ashburnham, with cuprite, redruthite, and other copper minerals.

APPLICATION OF HOT SPRINGS TO CULTIVATION.

Signor Francesco Cirio, the exporter of early grown vegetables, &c., from Italy, who is also the lessee of the establishment of the baths of Acqui, has recently turned his attention to the utilisation of the heat derived from hot natural springs, for forcing melons and other market garden produce.

In the centre of the town of Acqui there is a fountain, supplied from a spring called "La Bollente," the temperature of hot water being 75° Cent. (167° Fahr.). This hot water is conducted in stone pipes to a small experimental garden belonging to Signor Cirio, on the outskirts of the town, and then by a suitable arrangement of sluices, is caused to flow in channels made in cement concrete and covered with stone slabs, under long lines of forcing frames about 4 feet in width; the slabs of stone being covered with from 10 to 12 inches in depth of rich vegetable soil, in which the melon plants are grown. The frames are precisely similar to those in use generally for hot-bed cultivation, and are covered with glass. Early last April an abundant crop of melons were ready for market. Tomatoes, asparagus, salad and other crops are being successfully grown, and it is probable that before long this system of cultivation will be carried on, on a large scale, in Acqui, as the "Bollente" springs supplies a far larger quantity of water than can be ever required for the use of the new bathing establishment now in construction, which water, at the present time, runs to waste.

The melons grown in this experimental garden are sent to Turin and Milan, and even to Paris, where, at the present time, they fetch high prices.

Notes on Books.

International Health Exhibition Handbooks. London. W. Clowes and Sons. 1884.

A list of the Handbooks on subjects cognate to the Exhibition, which the Executive Council propose to publish, has already been given in the *Journal.* Several of these have now been issued, and the following short notices relate to them:—

Health in the Village. By Henry W. Acland, C.B., F.R.S. Illustrated.

The author points out the conditions of village life unfavourable to health and well-doing, and then presents a broad view of the circumstances most favourable to the good order and happiness of a rural population. The book is divided under the headings—(1) The tale told; (2) The need stated; and (3) The lesson learnt. To these divisions is added a list of books on the subject treated of by Sir Henry Acland.

Healthy Nurseries and Bedrooms, including the Lying-in Room. By Mrs. Gladstone.

In this handbook, the wife of the Prime Minster treats first of the nursery in health, and the arrangements necessary to keep it healthy, and then deals with the special necessities of the sick-room.

Health in the Workshop. By James B. Lakeman, Senior Metropolitan Inspector of Factories, Home-office.

The subject is divided into the following sections:—1. Progress of factory legislation, from the first Act in 1802, to the last Act in 1883. 2. Accidents, their causes and extent. 3. Sanitation. 4. Ventilation.

Legal Obligations in respect to Dwellings of the Poor. By Harry Duff, M.A.; with a Preface by Arthur Cohen, Q.C., M.P.

Mr. Duff shows what has been done on this important subject, and analyses the various Acts of Parliament that have been passed for the removal and prevention of nuisances, and for the improvement of labourers' and artisans' lodging-houses. Mr. Cohen, in his preface, alludes to the necessity for the establishment of some central authority to be entrusted with the duty of seeing that the powers given by the various Acts are properly enforced.

Diet in Relation to Health and Work. By Alexander Wynter Blyth, M.R.C.S.

The general principles of diet are here enunciated, and an exposition is given of the composition and nutritive powers of the chief foods, a series of tables being added.

Water and Water Supplies, and Unfermented Beverages. By John Attfield, Ph.D., F.R.S.

Water as the basis of all beverages is treated very fully, both in respect to its source and its supply. Subsequent chapters are devoted to mineral waters and artificially aërated waters. Then follow water purification and analysis, and chapters on tea, coffee, cocoa, chocolate, milk, &c.

Fires and Fire Brigades. By Captain Eyre M. Shaw. Illustrated.

Captain Shaw has given in this handbook some account of the practice in various countries, and a large amount of information from his own experience of the best means of protection against fire.

"Our Duty" in Regard to Health. By G. V. Poore, M.D.

Dr. Poore shows what "our duty" is in regard to the arrangements of the house, both external and internal, to the proper supply of water, the importance of fresh air, and the need for seeing that it is not contaminated, to the right use of refuse, and lastly as to the treatment of the dead, and the best mode of burial.

Food and Cookery for Infants and Invalids. By Catherine Jane Wood, with an Introductory Chapter by W. B. Cheadle, M.D.

The authoress gives the principles upon which a rational diet for the young and the sick must be arranged, and shows how they can be carried out in practice. She also also adds a selection of recipes.

Ambulance Organisation, Equipment, and Transport. By Surgeon-Major G. J. H. Evatt, M.D. Illustrated.

The author states that this is intended as a primer to give the visitor to the Exhibition who is ignorant of ambulance aims and objects, a general idea of the work. He describes the ambulance arrangements of an army in the field, and describes the volunteer war aid given by knightly orders and Red Cross societies. All the various appliances in use are fully illustrated.

Dress and its Relation to Health and Climate. By E. W. Godwin, F.S.A. Illustrated.

Mr. Godwin treats his subject chronologically, and traces the changes in costume from the earliest times to the 19th century. He divides the dress of civilised nations into the two great classes of loose and tight, the former favoured in warm climates, and the latter in cold.

General Notes.

Amsterdam Exhibition.—The medals awarded to British exhibitors at the late International Exhibition at Amsterdam, will be presented by the Lord Mayor at the Mansion-house, on Monday, 30th inst., at 3 p.m.

King of the Belgians' Prize.—The prize of 25,000 francs, or £1,000, offered annually by the King of the Belgians for some work on social science or progress, is this year open for competition by natives of other countries besides Belgium. The subject selected is, "The best work setting forth the means to be employed, and the measures to be taken for popularising the study of geography, and for developing its teaching in educational establishments of various degrees." Works intended for competion must be addressed to the Minister of the Interior, Brussels, before the 1st January, 1885.

Garden Flowers of New South Wales.—The geranium is in New South Wales a very different plant from what is found in England, often attaining the size of a gooseberry bush, covered during eight months out of the twelve with a profusion of large blossoms. Violets do not, as commonly supposed, lose their fragrance on Australian soil, but thrive to an extent unknown in English gardens. Sweet-williams, convolvuluses, daisies, stocks, wall-flowers, and other common English flowering plants grow in a most luxuriant manner even in the poorest soil, while in some districts the rapidity with which the sweet-briar overruns the land causes it to be regarded as a noxious weed, to be extirpated at any cost. It is the same as the cactus, better known as the prickly pear. Although grown with much difficulty in English green-houses, it has thriven to such an extent in New South Wales that the Government have had to take steps for its eradication. Roses, lilies, camellias, &c., flourish everywhere, the most tender kinds being grown with the greatest ease.

Vegetable Products in Switzerland.—From a report of the Horticultural Department of the recent Zurich Exhibition, by M. E. Mertens, we learn that the approximate annual value of the horticultural products in Switzerland is as follows:—

	Francs.
In 1,002 hotels—Preserved fruits and vegetables	1,025,000
Fresh fruits and vegetables	1,200,000
In 606,723 private houses—Preserved fruits and vegetables	60,672,000
Stove plants, flowers, fruit trees, seeds, bulbs, &c.	30,386,000
	93,283,000
Less the excess of imports over exports	3,077,400
	90,205,600

Industrial Art Prizes at Ghent.—The Chambre Syndicale Provinciale des Arts Industriels of Ghent has arranged a series of competitions for designs and executed works, for prizes consisting of diplomas and medals, in addition to sums of money varying from £16 to £8. The cabinet work to be executed, in addition to the drawing one-tenth actual size, is an oak washstand, the cost of which is not to exceed £12 without the fittings; and the committee reserve the right of purchasing at that price all that are sent in. The designs are for a wrought-iron gate for square; a decorative panel; an oak confessional for church of 13th century; a woven woollen fabric with not more than six colours for upholstery; and a frontispiece for a work entitled "History of Art in the Flanders." Competitors must either be Belgians by birth, or must have lived three years consecutively in Belgium, and must give notice of competing before the 1st August, while the works must be sent in by the 10th October. The designs, &c., are to bear a symbol or motto, to be repeated on a sealed envelope containing the name and address. The designs and executed works will be exhibited in the Ghent University from the 19th to the 26th October next. Further information may be obtained from the Secretary, M. Emile Varenbergh, Ghent, Belgium.

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FRIDAY, JULY 4, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Council of the Society of Arts and the Executive Council of the Health Exhibition have arranged for a Conversazione to be held in the buildings of the International Health Exhibition, South Kensington, on Wednesday evening, the 9th July next.

The visitors will be received by His Grace the Duke of Buckingham and Chandos, K.G., Chairman of the Executive Council of the International Health Exhibition, and by Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council of the Society of Arts, near the principal entrance to the Exhibition in Exhibition-road. The reception will commence at 8.30 p.m. The gardens, as well as the Exhibition buildings, will be lighted by the electric light; the gardens will also be illuminated with variegated lamps and Japanese lanterns, and the fountains will be lighted by the electric light.

The following bands will perform, either in the buildings or in the gardens, according to the weather:—the Band of the Grenadier Guards; the Band of the Coldstream Guards; the Band of the First Regiment of the French Engineers, from Versailles; and the Band of the Seventh German (Magdebourg) Cuirassiers. A vocal and instrumental concert, consisting of glees, &c., by the Royal Criterion Hand-bell Ringers will be given.

Most of the exhibitors have undertaken to keep their stalls open, and those of them who have machinery in motion have agreed to keep it running. Refreshments, including tea, coffee, ices, fruit, &c., will be provided at the buffets in different parts of the building; and many of the exhibitors of articles of food have kindly consented to supply the same free of charge. No refreshments of any kind will be allowed to be sold.

The only entrance to the Exhibition will be that in the Exhibition-road.

There will be no arrangements for receiving hats, coats, cloaks, &c., as part of the entertainment will be in the gardens.

The Exhibition will be closed on this evening to the general public, and there will be no admission by payment, or by sesson tickets.

Each member will receive tickets for himself and a lady. They are now in course of issue.

Proceedings of the Society.

INDIAN SECTION.

Friday, May 30, 1884; Andrew Cassels, Vice-President of the Society, in the chair.

The paper read was—

STREET ARCHITECTURE OF INDIA.

By C. Purdon Clarke, C.I.E.,

Keeper of the Indian Collection, South Kensington Museum.

Introduction.

Whatever may have been the aspect of a Hindu town in that Golden Age when every action in life was regulated by the sacred Shastras, at the present time, with very few exceptions, the cities of India owe their plans to the same influences which have determined the growth of streets and the position of public offices in most of the towns of the world.

For the greater number, it is impossible to formulate a general plan owing to local peculiarities of site, but if classified under such heads as royal cities, holy cities, and commercial towns, a general description can be attempted. One of the exceptions to any such classification is the royal city of Jeypore, of which it is enough to say that, built in a very short space of time upon a level plain, it possesses the advantage — or what many would consider the disadvantage—of a regular plan, being a parallelogram divided longitudinally by a single wide street, and transversely by two, making the whole town six large blocks of buildings, of which one is entirely occupied by the palace.

Again, it is necessary to except the Presidency capitals, where, naturally, the foreign rule has asserted itself by the erection of large public buildings in a diversity of styles, and the interference with native custom by the introduction of building acts more or less vexatious, and, lastly, that crowning source of litigation and ugly building—"light and air" regulations.

Royal Cities.

The aspect of an Indian royal city, whether still a capital or fallen to the head-quarters of a collectorate, is not to be surpassed in picturesqueness by any other style in the world; the area restricted by embattled walls and bastions—a towering fortress, palace, often a town in itself, occupying a fair portion—being often the nucleus upon which the city grew. The gates mark the terminations of the principal streets which stretch out a rich succession of façades, the houses of officers of State, and the no less ostentatious shops of the well-to-do burghers and handicraftsmen. These streets are seldom regular in their line of frontage, even when bounded by the open drain which, running close under the shelf-like projection of the shop floors, is often buried where an arcaded canopy is added to the shelf, and the shop front encroaches on the road.

These shops, though separated by party-walls, and their line of frontage broken by irregular verandahs and awnings, yet mix and blend into a vista of rich profusion, where bright coloured stuffs succeed the splendour of the brass-worker's shop, again to be followed by the burnished metal and gaudy decoration of the cook or spice seller. The jewellers and money brokers may occupy a whole street, and their somewhat plain shops—white-walled, and white cotton-carpeted—assert a dignity which enhances even the apparent value of their wares.

The banking business is generally carried on in the upper part of the house, and in such cities as Delhi, Amritzar, Lashkar and many towns in the Bombay Presidency, the wealth of the owners has been lavished upon the façades, and, what is more than wealth, the individuality of owner and builder (for these people are, in a way, their own architects) has found expression, without that incongruity which, with us, generally results where an attempt is made to depart from the common-place lines dictated by ground landlords and speculating builders.

Off the main streets, and often approached by gate and archway, are the quarters of the various classes, casts and sects. These are small towns within themselves, and here the labyrinth seems to be the model upon which their streets, or rather alleys, were planned. The gates of their quarters in the Bombay cities show the necessity of such precautions in the Mahratta days, and their loop-holes, machicolations, ironbound doors, and surprise proof wickets, are significant of those good old stirring times. These gates are now fast disappearing in the towns under our rule, but the people still congregate in their several quarters, where the chiefs of each community vie with each other in the magnificent exteriors of their dwellings.

The royal city of Ahmedabad probably stands first among those Indian towns where civil architecture rivals that of the regal and ecclesiastical buildings, and has a still greater interest to us by still possessing the art in undiminished vigour.

The 16th century house front erected last year in the South Kensington Museum* (though to us a marvel of richness), is but a fair average example of an Ahmedabad merchant's dwelling. It belongs to a good period, and differs from the modern houses more in form than in excellence of design. There are still many of these balconied houses left, and all seem to owe the peculiarities of the upper stories to the absence of the deep open portico which, in the more recent buildings, stretches across the whole of the ground floor. Amongst these it is very difficult to distinguish between houses built ten years and those of fifty or sixty years since; and, perhaps, one of the best façades in Ahmedabad was erected during the great cotton times of the last American war. Under the Moguls, the officers of State generally held their courts in their town dwellings, and thus a number of minor palaces, thronged with suitors, uniformed attendants, and guards, marked important centres in the city, and changed the character of the scene; again to be changed when, passing on, the Hindu temple with busy worshippers, or the solemn court-yard of the Jumma mosque broke the line of shops and markets, and prepared the traveller for the greater glories of the palace.

The palace often contributes the least to the picturesqueness of the adjacent streets; generally occupying an exterior area, bounded by high walls unpierced by windows, the

* Now removed, and in course of re-erection in the India Museum, Exhibition-road, South Kensington.

effect is rather that of a prison or fortress, and it is only when one of the great gates is reached this impression is changed for another, when a row of shops is seen within, and a multitude of every-day people coming and going, apparently on their own business, again recalls the town gate. This last is not far from the actual fact, for the palace is a town with a full complement of purveyors and artificers, and a population which can only be reckoned by the thousand. By passing other gates, the more private precincts are reached, and having left the horses at the gate beyond which no one but royalty rides, and crossed another court on foot, at last the spot is reached where further progress can only be made in the company of a chamberlain.

Where the palaces are actually moated forts, like Agra, Delhi, and Lahore, they cannot be considered as influencing the architecture of the streets, especially when a difference of style is well marked. In the case of Jeypore, however, the palace and town (built together) seem to belong to each other, and one of my illustrations—"The Tower of the Winds"—is a remarkable and beautiful addition to a street which otherwise would have had all the attractiveness on one side.

Holy Cities.

The next type of town is the holy city, where rival temples dispute the offerings of pilgrims, and offer to the variously inclined security in the next world, or indulgences in the present. Benares, in the north, and Madura in the south, may be taken as good examples of this class. Here the enclosure walls and bastioned gates are wanting, and, though palaces have sprung up in various places, the towns preserve the peculiar character of their early days, when a newly canonised shrine, attracting a number of pilgrims, became surrounded with the huts where their wants were catered for.

It may be that the knowledge of the transitory state of mundane affairs has had a sobering effect upon the minds of the burghers and their builders, or that they are content to devote their spare wealth to the adornment of the temples, or to add to the jewellery and plate which are preserved in the holy treasuries for the service of their gods. Whatever may be the reason, the fact remains that the streets of the holy cities depend for their effect on the contents of the shops rather than on the shops themselves; and in the south, where the temple enclosures house not only the functionaries and their families, but the shops and families of those who sell food, spices, and the necessary articles for worship, it is only natural that the splendour of the town-bazaar suffers from this competition.

The number of people living in these places is enormous, and almost rivals the communities within the precincts of the royal palaces. As an example, the number of individuals said to live within the temple of Seringam, near Trichinopoly, is 3,000. Whilst noting the plainness of the streets in such a city as Benares, no injustice should be done to the wonderful pictures produced by the temples, which are of all sizes, from votive models, scarcely a yard high, to cathedral-like masses, many, fortunately, unenclosed, except where shops and other buildings have grown against them.

It is here that Hindu architecture is seen at its best, and perhaps owing to the sharp contrast between the exquisite finish of the elaborately unpractical but solid-looking angle of a temple porch or base jutting out from between low lintelled shops—some bright with whitewash, others smoke begrimed, all plain and business-like—such dignity is accorded to the portion which would be lost were the whole building seen clear of the surroundings.

The peculiar feature of these cities is the bathing ghaut on the river side, or the tank, which might sometimes be more properly termed a lake. These, the crowning works of the Hindu architect, though closely connected with almost every thought and action in their daily life, distinctly belong to the spiritual part of their existence; and, perhaps, it is for this reason, and because here the last rites are administered to their dead, that such splendid sites are almost unused for the erection of palaces or residences of the wealthy, except when intended for purposes connected with their religion.

Rich with closely packed temples, and the stepped ways thronged with innumerable people going and coming from the water, there is, however, a want of human interest in the scene; and the same feeling is experienced when a busy mart or dock is encountered in our own country, where the bustle and confusion of the people, each intent on his own business, the hard and unsympathetic look of the surroundings, and absolute want of the appearance of domesticity on all sides, makes the whole mechanical, and we wonder whether these moving units have homes like other human beings, or are puppets in a great show, moving only in obedience to some hidden force.

Commercial Cities.

The last class of city I have to describe is the least interesting as a general rule. Scattered about all over the country are towns which, owing to the ebb and flow of commerce, become for the time being commercial centres, or the depôts of produce of various sorts. Such cities spring into existence rapidly, and as soon fade out; whilst others have been leading marts since the beginning of history. Our railways have done much to confirm the stability of many of these, whilst others, left at a distance from the iron road, are ruined beyond hope.

Of new cities, I do not know of a better example than Beawar in Rajputana. It is difficult, on approaching the picturesque gateway and lofty crenulated walls, to realise that this town was built in a desert, and filled with one of the busiest populations in Rajputana in a few years; and it is still more surprising to find that the reverenced name of the founder is not that of a native warrior or saint, but of an English gentleman*; and the principal shrine where Hindu and Moslem leave votive lamps, the tomb of that officer's wife. Some of the commercial and royal cities still occupy the same sites after an existence of 2,000 years, whilst others have been constantly on the move, either in obedience to some physical change—such as river encroachment—or to such causes as the pride, intrigues, and family quarrels of those dynasties of rulers who founded the successive cities which culminated in the present Delhi, after leaving detached groups of ruins over an area of over 100 square miles. Others have disappeared, like Gaur in Bengal, which, during 300 years, retreated before the shifting bed of the river, and having moved back twenty-one miles, only forsook the contest when the commerce which the river brought found another channel and mart.

Of the class of towns represented by the important city of Nagpore in the Central Provinces, are several which show how much can be done in India when native talent and love of display are well directed. A few years since they were remarkable only for the plainness and dull monotony of their shops and dwellings, even though the possessors of some extensive sacred buildings. Then suddenly the native communities (encouraged by the chief English officials) began to build as only princes did in the ages passed by. Four of these towns owe much of their present splendour to the energy of a gentleman* who was successively the chief administrative officer in each. Beginning with the Ghaut at Mizapore, then the museum and many buildings, both public and private, at Muttra; and since, the the market places at Bulandshahr and Khonja, with numerous private houses which have sprung up through the emulation of the leaders in various sects and castes: all these improvements have been happily carried out in native style, and designed by good native workmen, the only European influence exercised being Mr. Growse's criticism on any proposed departure from the canons of good taste, which, from his knowledge of the modern Mogul style, he is able to give with authority. I wish particularly to instance these towns, as the work accomplished there within the last few years fully illustrates the latent power for true art work which exists in even the most unpromising of Indian towns, and which is so often wrongly developed or crushed out when Government or over-zealous but ignorant officials attempt to do something to revive the native arts of India.

I show a model of one of the most modest of the new Bulandshahr buildings, representing a row of shops built on one side of the market place, which replaced a row of single-storied buildings of the meanest description. I have here, also, a lithograph fac-simile copy of the working drawings which, made by Mircha Mistri, were submitted to the collector for approval before a start was made. Built with trust money of the Court of Wards, the building may be considered as erected under the same conditions as public buildings are generally; but, having personally examined the quality of the work, I can but express wonder at the organisation or control which restricted the finished cost to 8,700 rupees, or about £725 sterling. Another copy of a drawing by Yusuf Mistri, represents a façade, designed specially for erection in the Indian Section of the South Kensington Museum. The order given to the Mistri was that he should make a drawing of a house front to occupy a frontage of 25 ft. by a height of 35 ft., the cost of the building not to exceed 3,000 rupees, or £260. After some days the sketch was ready, but accompanied by a note stating that to keep within the sum, the width and height must be slightly reduced. This was

* Colonel Dixon.

* F. S. Growse, M.A., Oxon.; C.I.E.; Collector and Magistrate, Bulandshahr.

accepted, and the conditions have been faithfully adhered to. Respecting this Moghul art, it is strange how it has displaced the national column and lintel wooden style in parts of the country where the Hindus have held their own. The Meywar people, though ubiquitous, have their own city in the great Rajput desert, and it is from choice only that they did not follow the lines of Hindu construction and design, which even the Moslem conquerors of Ahmadabad adopted.

The power and adaptability of national Hindu architecture is shown in the old palace of Man Sing, in Gwalior fortress, but even there it is barbaric, and fails entirely in grace and refinement.

But in adopting the style of their Moslem rulers, they have in a way made it their own, and seldom in architecture can such a blending of different forms be found as in the Seth's house in Ajmere, of which I have a few illustrations. It is not that stone replacing wood in Central India has led the merchant classes to adopt the construction and ornament of the Agra and Delhi palaces, for the same people, when in the Punjab, in places where stone is rare and wood plentiful, copy in the lighter material the lithic forms of cusped arch and hollow cornice, but with such due regard to the quality of the material used, and with such admirable taste and knowledge in proportioning the members, that wood seems to dispute the parentage of this art with stone.

As most of my illustrations are taken from this class of design, I may be permitted to direct your attention to the vast area of the world's surface which has been embellished with buildings in the Saracenic style, of which the Mogul is a branch, differing from others only in the details of ornamentation and such changes of plan as are necessitated by the different conditions of living in India. Whether developed in Byzantium, or invented later in Persia (for it is no descendant of the architecture of the Arsaces or Chosroes), Saracenic art possessed a strong individual character, and, even when in Eastern Bengal the general form of the buildings became that of the haystack-topped native houses, with eaves bending under the weight of covering, the similarity of expression was sufficiently retained to allow of comparison with the work of the Moors in the far west. This likeness is the more marked in the Deccan, where the lighter features of the Mogul work in the north disappears, and the stone work approaching the lines of Persian ecclesiastical art, leaves a stucco covered class of buildings like the great archways at Hyderabad, with very little surface ornament but the strongly marked forms so characteristic of Morocco and the cities on the north-west African coast.

My illustrations begin with a street scene in Jeypore (Plate I.), where the remarkable building, which occupies nearly the whole extent of the picture, bears the name of "The Tower of the Winds." It is placed at one angle of the great palace, and almost entirely constructed of stone, has open lattice work in its multitude of projecting windows, affording, in the interior, the combined open air and shade so necessary in such a climate. The shops on either side are built against the palace wall, and where they and other buildings occur, the monotony is relieved. Similar shops extend along the whole front of the palace, which, except at the large gates, would otherwise present a frontage of bare walls, of great height.

The second view (Plate II.) is of another street corner in the same city, and illustrates a peculiarity of Jeypore which is not always detected by admiring visitors. Owing to the short space of time allowed by Jai Sing for the building of the city, it was only possible to run up the façades of many houses in the principal streets. This, in some cases, led to a style of building beyond the means or requirements of the owners, soon resulting in a stoppage of the internal works, or their completion on a somewhat reduced scale, often without reference to the lines of the front.

The next (Plate III.) will be recognised by all who know the Bombay Presidency. It is a house in one of the inner streets where the commercial classes dwell. Although from Ahmedabad, it may be taken as a representation of the older style of house in other towns on the northern Malabar coast.

Plate IV. shows a row of such dwellings, but much more modern, some of them being only ten years built; whilst the fifth illustration will appeal to all lovers of the picturesque, and stand as a protest against fussy and interfering laws which, by docking the projecting upper stories and roof, and widening the roads, would destroy the grateful shade which, even to natives, alone makes life bearable in hot countries. The house blocking the end of the street possibly commits every crime forbidden by the Building Act, but at the same time it protects the street from the glare, and to some extent the noise of the market place beyond;

and although it is bound to go down, sooner or later, before the fiat of some collector (upon town improvement bent), we may wish it to stand long enough to convince the unthinking that, whilst wide streets are essential as the main thoroughfares of commerce, the same rule can be relaxed when private dwellings and retail bazaars are being planned in a tropical climate.

Another offender against our rules and regulations is the next view (Plate VI.)—a shop within the Lahore gates; and this illustrates one of the advantages enjoyed under the old unwritten laws of the country. The owner of a small corner plot, just 8 ft. wide by 13 ft. deep, runs up as tall a house as such a base will carry, without any regard to the surrounding buildings, and having the road on two sides, his floors are balconied out so that his open terrace at the top attains a respectable area. No one on the opposite sides of the two streets is ever likely to complain, as this block affords shelter from the sun during some part of the day; and his immediate neighbour, should he wish to go as high, or project as far, or to block up any windows overlooking his ground, would have full liberty to do so at any time, no length of enjoyment being accepted as a plea for the right of view across another man's land by which he would be prevented from building thereon when he desired to.

Plate VII. shows the window of a mezzanine floor over a shop in Lahore, and shows the richness attained in ordinary carpenter's work in that city. This is also illustrated in the next view, (Plate VIII.) where the upper window of wood recalls the Mushrabeyeh windows of Cairo. The triple casements beneath are in wood, but the piers, with their pilasters and foliated arches, are in cut brickwork, coated with stucco. These are flanked by two small niches for lamps on illumination days; and two oriel windows for use in the cool of the evening.

The general view (Plate IX.) of one of the principal streets in Lahore will afford a good idea of the result of leaving people, unfettered by rules and regulations, to build as they like, but subject of course to those laws which good neighbourship and fellow feeling dictate; and although no two keep exactly to the same frontage or horizontal parallels of floor, window, or cornice, it must be admitted that this wholly irregular street can compare favourably with many of our own in this great city, where these niceties have been attended to.

The next two represent a brick street in Delhi. The first (Plate X.), the entrance from a court, and the next (Plate XI.) a *cul-de-sac* leading from it; both are rich in the projecting balconies, which Government is striving to curtail, and, with us, the bridge which here joins the houses of two brothers would represent a correspondence with the Board of Works horrible to contemplate.

Plate XI. can scarcely be classed under street architecture. It was a very old courtyard behind some very modern shops, and used as a store for Manchester goods. The original façade had been demolished or built up, so I secured this note of all that remains of what was once a very important building.

Leaving these old-established cities for one of the mushroom class, the three following views of Lashkar or New Gwalior show the Moghul style adopted by an essentially Hindu people, even though their ruler set an example by going off in another direction, and employing an Italian to design and build the palace. It is not necessary for me to say how that palace compares with the ordinary shops and dwellings of Lashkar, for few would congratulate the Maharajah upon the wisdom of his choice of style.

The last (Plate XVI.), and perhaps the best, represents a portion of the Seths or bankers' house at Ajmere, and there is little in the royal palaces of India to compare with this mansion for graceful richness and delicate treatment. In this no assistance was rendered by the material, which is a stone so coarse that whitewash has been liberally used to make a surface.

Conclusion.

In conclusion, I beg to add a few remarks upon our influence on the future of Indian street architecture, and having instanced several towns where the imperial style of Delhi has been used (without any attempt to blend it with our own) by the executive, I consider it unfair to leave without notice of the remarkable series of buildings designed and erected by the architect* to the Madras Presidency. These are happily not confined to that portion of India, and the opportunity afforded to Mr. Chisholm by the commission for the Baroda buildings has been well utilised. With great courage, the leading characteristics of Hindu and Moslem architecture have been worked into the construction of these buildings, and if ever an eclectic style based on sound principles becomes

* R. F. Chisholm, F.R.I.B.A.

adopted by Hindu and Moslem as the one national style, it will be to such work as Mr. Chisholm's that the first steps will be attributed.

[A series of illustrations to this paper, taken from the original photographs, is given in a separate sheet as a supplement to this number of the *Journal*.]

DISCUSSION.

Mr. MARTIN WOOD, after alluding to the melancholy news announced in the morning papers of the death of one who was familiar with the subject they were discussing (Sir Bartle Frere), said, with regard to what Mr. Purdon Clarke had remarked respecting Mr. Chisholm, that he (Mr. Wood) remembered when Lord Napier of Ettrick delivered an elaborate lecture on the architecture of India, he vindicated—it might be said finally established—Mr. Chisholm's position as an architect. With regard to building regulations, and their interference with the picturesque and convenient styles of building in India, he might mention that, in 1866 or 1867, when the draft of a Building Act was put before the new Corporation of Bombay, it was found to be an exact counterpart of the Building Act of the City of London, and anything more absurd than that could not be imagined. There was no doubt that domestic buildings in India would have to be erected more in accordance with the requirements of modern times; but many difficult problems had been carried out in that country, and they need not despair of ultimately arriving at a successful issue with regard to this one. He would like to add that he felt sure everyone present was grateful to Mr. Clarke for the treat which the splendid views displayed had afforded them.

Mr. FITZGERALD inquired if Mr. Clarke could tell them at what period the Saracenic style of architecture was introduced into India, and whether or not it was introduced through Persia.

Mr. CLARKE said that the best authorities differed on the point. Saracenic art could be traced as far back as the 12th century, in the Pathan buildings of Northern India. It was introduced through Persia, but did not originate there.

In reply to a further question by Mr. FITZGERALD as to whether it was possible to trace the differences between Indian and Saracenic architecture, and whether there were courtyards to the private houses in India as at Damascus,

Mr. PURDON CLARKE said that 2,000 years ago the courtyard was a common feature in many countries, and from the Roman remains which had been found in England, there was no doubt that they were very general even in this country. He did not know whether the courtyard was a more general feature at Damascus than in Spain. He remembered comparing the two places, and he noticed that whereas at Damascus small houses were built which could not afford the luxury of a courtyard, the houses in Spain must be very small indeed to be without a patio.

Mr. FITZGERALD said that in Hindoo China there were enormous buildings, and inquired if they were of the Saracenic type.

Mr. PURDON CLARKE said that he did not know the Burmese side at all, and could give no information on the subject; they had models of temples and public buildings in the India Museum, but not of private houses.

General ST. CLAIR WILKINS, R.E., said that one of the finest buildings, as everyone knew, was the Taj Mahal, at Agra; and he should like to know if Mr. Clarke could tell who was the architect of that building. The objection which had been put forward against the adoption of the indigenous architecture of India, was the enormous cost of construction, supposing buildings were made of stone. Most of the modern buildings in the style were, he believed, of stucco, which was not a material approved of by architects.

Mr. CLARKE replied that the Taj Mahal was partly due to the king, who was assisted, no doubt, by both Italians and Frenchmen, but he thought it was a mistake to give too much of the credit to Europeans. The question as to who was the architect was almost answered when they looked at other buildings of the same class. There were an immense number of them. The central dome, flanked by four towers, was common all over Asia. There was very little originality in the Taj Mahal, and though no doubt it was the finest building of its class, the form was invented several hundred years before its erection; just in the same way as Sir Cristopher Wren was credited with the design of St. Paul's Cathedral, whereas St. Peter's, at Rome, was built by Michael Angelo long before it. He thought that it would be best to foster the style of architecture peculiar to the country. In the north of India there were very few stucco buildings, it was more in the south that that material was used; but what was often mistaken for stucco was the thick coating of whitewash which was placed on stone buildings. From Agra and Delhi, and up some distance, the houses were nearly all built of stone, and the slender columns and slight lattices, which seemed to be made of wood from their lightness, were really made of the same stone, obtained from the quarries near Agra.

General ST. CLAIR WILKINS said that in the public buildings erected in India it would be almost impossible to adopt the Hindoo Saracenic style of architecture, owing to the immense cost of carving the ornamental work of that style in stone, that was supposing the buildings were to be built of stone. In a great part of India there was no stone at all, and in some districts, very little stone indeed which was at all workable, and many of the buildings now erected were of necessity built of basaltic stone, which was inconceivably hard, and which would not be looked at in England. There was in India an ancient city which he ventured to assert would be better known in the future than it had been in the past, and that was the city of Bejapoor. It was to some extent known, owing to the magnificent work which had been produced by Mr. Ferguson and Colonel Taylor, but that work was very difficult to obtain. He had endeavoured to procure it, and found that £30 was the price for which he might become the owner of a copy. It was a work limited in its publication to so few copies that scarcely any one possessed it. This city was founded in the 15th century, and although till lately in a deserted state, steps were being taken to resuscitate it, the British Government having resolved that it was now to be the centre and the capital of the country, as it was in ancient days; and they might hope that some of its most beautiful ruins would be preserved from the decay into which they had fallen. He had charge of this city for some time, and endeavoured to stop the decay which was overtaking the magnificent buildings there, but he found it was almost a hopeless task. The buildings were being destroyed by trees growing out of the tops of the domes, and indeed, out of almost every crevice, tearing the buildings to pieces. There was a dome in that city which covered, he believed, more ground than any other similar building in the world. It was built as a tomb, and the dome was the most wonderful thing he had ever seen. It was constructed of very large bricks, and was ten feet in thickness, and rather flat, but it had not a single buttress, being entirely supported by its pendentives hanging inside, constructed in the most scientific manner. A great deal was being said just now about local self-government in India, but he imagined it was not altogether an unalloyed blessing to the people. There was a certain rajah who, in the time of the mutinies, was unfortunate enough to make a mistake and cut the head off the political resident, and was hanged. He had no heirs, and his palace became a public building, which he (General Wilkins) used occasionally to visit, in order to admire the beautiful pictures with which the walls were decorated. Local self-government was introduced into the country, and on the next occasion of his visit to the palace he looked in vain for the pictures—they were nowhere to be found; and on making inquiry, he found that the local municipal engineer thought the house required a cleaning, and he had had the whole of them whitewashed over. The speaker thought that it would be a great misfortune if the English Building Acts were introduced into cities like Bombay. They had all seen and admired the views which had been placed before them, showing the projecting balconies and the windows which, though very small, were very beautiful, and he certainly thought it would be a thousand pities if the native talent were interfered with by any attempt to draw hard and fast lines as laid down in the Building Acts. Of course, in London, they were obliged to obey the Building Act, but he thought that with regard to India, the case was altogether different.

Mr. R. PHENE SPIERS said that he possessed no practical knowledge on the subject of street architecture in India, what he did know being derived principally from photographs. As to the question of the time of the introduction of the Saracenic style of architecture into India, he thought it would be better if all those styles which had been practised by the races who embraced the Mohammedan religion were called the Mohammedan styles, because it would be much better for the purpose of explaining the peculiar features. The peculiarity of the Mohammedan style was that it changed to a certain extent, so far as the form of building went, according to the place where the buildings were erected. For instance, Mohammedan style in Constantinople was different in its main forms to that at Cairo, and that at Cairo was different to that found in Spain, the fact being that in each country which was converted by the Mohammedans the buildings in them were adopted by them, and they made certain modifications and introduced such details as their own style required. They were all no doubt aware that one of the first rules and regulations of the Mohammedan style was that no human form, or even vegetable form, should be employed in ornamentation; and they would see at once what an immense range of ornamental detail that must have knocked off from the architectural styles, and how those who had to design the buildings found themselves curtailed in their powers of producing beautiful forms such as had existed previously in those countries which were taken possession of by the Mohammedans. It was, therefore, necessary to find other forms which would give that richness in ornamentation which the Oriental mind especially always desired, and the only way of getting out of this difficulty would seem to have been either to adopt for the surface of the buildings, or for windows, a series of geometrical patterns and beautiful designs; or, for features which required more development, or more relief, they played with what were called constructural features. The earliest type of the stalactite style was found to consist of very few features. It was necessary to place a circular dome over a square form, and then to have four angles to cover over; the Byzantine form was to cover it over with the pendant, a portion of the sphere being intersected by four vertical planes touching one another, and also a horizontal one. In buildings of large dimensions the Mohammedans found that it was very difficult to use the spherical form, and so they sub-divided it. The Saracenic style seemed to have been originated with Persia; at least that country seemed to have been the great centre from which all Oriental art spread in every direction. Of course, it was just possible that someone who knew India better might point out features in the buildings of that country which were of earlier date than those of Persia. With regard to the very important question as to the Buildings Act, he would observe that as to London, one of its objects was to prevent the spreading of fire, and he thought that was one of the first problems which would have to be solved with regard to India. The projecting balconies were, no doubt, beautiful, and if they were built of stone there would perhaps be little danger, but if they were of wood, it was evident that they must be most dangerous in case of fire. They knew perfectly well that whenever a fire occurred, for instance in Constantinople, it burnt down an enormous number of houses, and there was no possibility of stopping it, owing to the amount of wood which was used in the erection of houses. If London of to-day were built in the same way as the old street, which they could see at the International Health Exhibition, he was afraid that one of the fires which occurred now and then would consume it as it did in 1666; and he thought, therefore, that it was necessary that some rules and regulations should be laid down for the construction of buildings, as well in India as in this country. There was no doubt that in India, with the immense heat, there was a necessity for covering over the streets to a certain extent, but he thought some other means ought to be found for doing this by the architects in India There were various buildings in Kensington, designed by Mr. Norman Shaw and others, which with their projections and bow windows, seemed entirely forbidden by the Building Act, but it would be found on inquiry that these projections were made of cement and fire-proof material, and consequently were within the Act. If, therefore, the balconies of the houses in India could be made of stone, or brick and stucco, he thought it would be infinitely better that they should be allowed to exist, and no doubt the Building Act might be so framed as to allow of this. He thought that General Wilkins had made a great mistake in saying that stucco was a material which was not accepted by architects. As far as he (Mr. Spiers) could see, all those buildings (such magnificent illustrations of which had been given) could be constructed in brick, and covered in stucco, and no one would have a word to say against them. The Mohammedan style was a style which suited stucco, and no one could raise any objection to its use, because it was only objectionable when it was used to imitate a material which it really was not.

Mr. CLARKE, in reply, said that with regard to the cost of these buildings in India, though apparently an extravagant style, he was surprised to find, on working it out, that the sum expended in erecting one of these houses was much less than the cost of the plain buildings which were being put up. As to the Mohammedan style, although they wisely adapted themselves to the requirements of the different countries, it would be found that they everywhere introduced two forms in their sacred buildings. They always used a dome of some sort, flat in some countries and high-pointed in others, and secondly, the minarets, in some cases placed close to the dome, and in others, following the style of the courtyard at Mecca, at the angles. The Mohammedan mosques were all, more or less, copies of mosques at Mecca or Medina. As to stalactite vaulting it was an art of the past in India, but it was of every day use in Persia. As a rule, very ordinary Persian houses possessed this feature. One did not walk directly into the house, but passed through a vestibule, and turned a corner. This vestibule started in a square form, and then intersecting arches cut the angles off, and these angles were filled with stalactite. In that case they were ornamentation, rarely they were part of the actual construction. With regard to fires in wooden cities, the people in India had got on without our rules and regulations for centuries, and fires were almost unknown, but in London they were of almost daily occurrence, even with the Building Act in operation. He had seen all the great cities built by the Mohammedans in Egypt, India, Syria, and Spain, and he had never seen a burnt house, although he did not mean to say they had no fires. In Persia he was foolish enough to propose to bring out a fire-engine, and was laughed at during the remainder of his stay there. He thought the people, knowing the danger, were very careful, and the fact of their being without matches would, perhaps, in some way account for their immunity from fires; but, perhaps, now that the Germans were importing large quantities of matches, fires would be of more frequent occurrence. In answer to a remark by Mr. Fitzgerald as to the cost of ornamentation, the lecturer said that in England, where generally one man built a house and another was forced to live in it, a little money was certainly saved in making a plain building; but in that case a good deal more was spent in gilt mouldings, wall-papers, and so on, to make it passable. In England the architect made expensive drawings which were not always understood by workmen, but in India, when a man was going to build a house, he sent for a clever builder, and the builder, after ascertaining the size of the house required, set about building it, and the ornamentation was done naturally and as a matter of course. That was the reason why it was not costly. But the moment a native builder was dictated to on the subject of ornamentation, he began to spend a great deal of money, and especially if requested to copy on the front of a house some inappropriate ornament from a neighbouring temple.

The CHAIRMAN proposed a vote of thanks to Mr. Purdon Clarke for his able paper, which was carried unanimously.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The following Conferences have been held and lectures given at the Exhibition since those mentioned in the *Journal* for June 20th :—

On Tuesday, June 24th, a lecture on "The History of English Dress" was delivered by the Hon. Lewis S. Wingfield, George Augustus Sala in the chair; and a lecture on "Healthy Houses" was given by T. Pridgin Teale, F.R.C.S., Captain Douglas Galton, F.R.C.S., in the chair.

On Wednesday, June 25th, a second lecture on "Parasites of Meat and Food" was delivered by Dr. F. Spencer Cobbald, F.R.S., the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.S., in the chair.

On Thursday, June 26th, a lecture was delivered by Surgeon-Major Evatt, M.D., A.M.D., on "Ambulance Organisation in Peace and War," Sir William MacCormac, F.R.C.S., in the chair.

On Friday, June 27th, a conference on Sanitary Legislation was held by the Social Science Association; Sir Richard Temple, G.C.S.I., in the chair; also a lecture on "Anglo-Saxon Dress, Food, and Houses" was given by J. Frederick Hodgetts.

On Monday, June 30th, a lecture on "Domestic Poisons" was delivered by Henry Carr.

A conference of "The Association for the Oral Instruction of the Deaf and Dumb" was held the same day.

On Tuesday, July 1st, a lecture on "The Digestive Ferments and Chemical Processes of Digestion" was delivered by Prof. Arthur Gamgee, M.D., F.R.S., Professor Huxley, P.R.S , in the chair.

On Thursday, July 3rd, a lecture on "The Chemistry of Bread Making" was delivered by Prof. Charles Graham, D.Sc., Prof. Odling, M.B., F.R.S., in the chair; and a lecture on "Reform in Poor Relief" was given by Dr. Gibert, of Havre, Samuel Morley, M.P., in the chair.

CITY AND GUILDS OF LONDON INSTITUTE.

The new Central Buildings of the City and Guilds of London Institute for the Advancement of Technical Education, in Exhibition-road, were formally opened on Wednesday afternoon, 25th ult., by H.R.H. the Prince of Wales, President of the Institute. His Royal Highness, who was attended by Colonel Teesdale, V.C., was received by the Lord Chancellor, Sir Frederick Bramwell, and Sir Sydney Waterlow, M.P., Vice-Presidents of the Institute; Mr. John Watney and Mr. Owen Roberts, Hon. Secretaries, and Mr. Philip Magnus, Director and Secretary; Lord Carlingford, President, and the Right Hon. A. J. Mundella, M.P., Vice-President of the Committee of Council on Education; and, as representing the Council of the International Health Exhibition, by Sir James Paget, F.R.S., Vice-Chairman of the Executive Council, the Marquis of Hamilton, Lord Reay, Sir Philip Cunliffe-Owen, Mr. Birkbeck, M.P., and others.

The LORD CHANCELLOR said:—May it please your Royal Highness, I have to thank your Royal Highness, on behalf of the Council and of the Governors of the City and Guilds of London Institute, for having graciously consented to open this Central Institution, thereby showing your continued interest in the success of the great educational work which the Corporation and the principal Guilds of London have combined to promote. It is now very nearly three years since your Royal Highness, in July, 1881, accompanied on that occasion by her Royal Highness the Princess of Wales, set the first column on which this building rests, and we are glad to be able to state that, under the able superintendence of Mr. Alfred Waterhouse, the architect, the work has been satisfactorily executed within the time originally intended. It is estimated that the building, when fully equipped, will have cost nearly £100,000, and the Council confidently trust that the balance still needed for its completion will be supplied by the liberality of the City Guilds, on which they have hitherto so hopefully and so exclusively relied. Pending the completion of the fittings, your Royal Highness, as President of the International Health Exhibition, will be gratified to learn that the Council of this Institute have been able to lend a portion of this building, for the exhibition therein of educational and school appliances, to the Executive Council of the Health Exhibition, who, in compliance with our request, have courteously postponed the opening of that interesting section of their Exhibition until to-day. During the last three years, the progress of the work initiated by the City Guilds has been most gratifying. The Finsbury Technical College, the foundation of which was laid in May, 1881, by the late Duke of Albany, whose loss we, in common with all classes of her Majesty's subjects, deplore as a national calamity, was opened in February, 1883. It is now in full working order, affording a sound and complete technical education to youths from middle-class schools who are preparing to enter industrial careers at a comparatively early age, as well as to large numbers of artisans engaged in various trades. At South London, our Applied Art School is filled with students who are being trained as wood engravers, and as designers for different branches of industry. The affiliated classes in the provinces, in connection with our technological examinations, have increased in number far more rapidly than could have been anticipated, and have developed, in many cases, into excellent technical schools. In 1881, when I had the pleasure of addressing your Royal Highness on the ground on which we are now standing, I stated that the number of candidates for the technological examinations was 1,563, as compared with 816 in the previous year, and I am now able to state that the number recently examined was 3,628, as compared with 2,322 in 1883. A great impulse was undoubtedly afforded to the establishment of technical schools in this country by the appointment, in 1881, of a Royal Commission, presided over by Mr. Bernhard Samuelson, M.P., to inquire into the facilities for technical instruction enjoyed by the industrial classes abroad, and to compare them with the opportunities enjoyed by similar classes at home. After a laborious investigation, occupying nearly three years, in the course of which they visited all the principal technical schools in Central Europe and in the United Kingdom, the Commissioners presented to her Majesty a report, in which they were able to show that, owing greatly to the action of the Science and Art Department and of the City and Guilds of London Institute, the opportunities afforded to workmen and to foremen in this country to obtain, by means of evening classes, sound technical instruction, compared favourably with those enjoyed by the same classes abroad; and it is gratifying to learn from them that no organisation like that of the Science and Art Department, or of the City and Guilds of London Institute, exists in any Continental country, and that the absence of any such organisations has been lamented by many competent persons with whom they came in contact. It is, however, in the appreciation of, and in the facilities for, higher technical instruction that we in this country are most deficient, and it is to supply the want that this central institution has been established. This college has been established to meet a two-fold want. It is intended to give that higher instruction of which the leaders of our industries stand so much in need; and also, and principally, to train teachers for the several technical schools and classes which, owing greatly to the encouragement afforded by this institute, now constitute an important feature in our educational system.

The Prince of Wales, in reply, said:—My Lord Chancellor, my Lords, and Gentlemen,—I have listened with attention to your address, and I assure you it gives me great pleasure to be able to preside at the opening of this important institution, the first pillar of which, in company with her Royal Highness the Princess of Wales, I set nearly three years ago. I thank you for your very feeling reference to the severe loss which the Queen, and each member of her Majesty's family, has sustained by the untimely death of my late brother. His interest in every movement calculated to humanise and to elevate the people of this country will, I am quite sure, cause his loss to be felt far beyond the circle of his immediate friends. I have been gratified that the City and the Livery Companies of London have so generously responded to the letter which, as President of the Institute, I addressed some few months since to the Lord Mayor and to the Worshipful Masters of the Livery Companies of London. This institute, which owes its origin to the liberality of the City and of the Guilds of London, is an illustration of the excellent work that may be done by united action, which could not possibly be accomplished by individual efforts. Conformably with the traditions of these ancient guilds, there is, perhaps, no purpose to which they could more appropriately devote their surplus funds, and none which would be of more practical advantage to the country at large than the promotion of technical education. As president of the International Health Exhibition, I am glad that the Council of this Institute have been able to place at the disposal of the Council of the Health Exhibition a portion of this building for the exhibition of apparatus and appliances used in technical and other schools. It now only remains for me to declare the Central Institution of the City Guilds of London Institute to be open, aud to express the warmest hope that the important educational work to be carried on in this great national school of technical science and art will help to promote the development of our leading industries, and that the City and Guilds of London, which have so liberally subscribed funds for the erection and equipment of this institution, will maintain it with efficiency, and will at the same time continue their support to all other parts of the institute's operations.

The Company was then addressed by Lord Carlingford, Mr. Mundella, M.P., and the Lord Mayor, after which the gentlemen connected with the institute, and the architect (Mr. Waterhouse) were presented to His Royal Highness.

AGRICULTURE IN PARAGUAY.

Consul Baker, of Buenos Ayres, states that one of the most valuable crops of Paraguay is tobacco; in 1829, its production amounted to only 2,675,000 lbs., while in 1860, the crop amounted to 15,000,000 lbs.; but the war with the allies almost ruined this source of wealth. It has, however, somewhat recovered its importance, the exports alone last year amounting to 8,975,000 lbs. A large proportion of the crop is annually worked up into cigars, a branch of industry which is almost entirely in the hands of the women. The tobacco planted in Paraguay originally came from Havana, with the exception of a particular kind which is called in Paraguay, blue tobacco, *peti-hoby*, the origin of which is unknown. The favourite leaf is a yellow tobacco, *peti-para*, grown chiefly in Villa Rica, which possesses about 6 per cent. of nicotine. Sugar-cane is another of the important agricultural products of the country—a plantation of which sometimes lasts, without any care or necessity of replanting, for ten or twelve years. It is estimated that one acre of the cane will produce about 250 gallons of molasses. Rice also is extensively cultivated, and also Indian corn. Coffee is largely grown, and is regarded by some as the crop of the future. The crop which is most esteemed by the Paraguayans is the mandioca, it being with them an article of prime necessity, taking the place of wheat-flour in the family household; the tuber is also used as a vegetable. The quantity of land now under cultivation is very small compared with the amount before the war with the allies, the great scarcity of labourers in the country very seriously retarding the development of the agricultural interests. At the present time there are 450,650 acres of land under cultivation, of which 210,000 are under corn, and 126,000 under mandioca. In Paraguay the cotton plant grows spontaneously, growing very rapidly, and lasting for ten or twelve years. The orange groves are scattered indiscriminately all over the country, the plantations attaining an immense growth, and the forests are everywhere full of the orange trees from the casual dropping of the seed. The fruit has come to be not only an almost indispensable article of food, but its annual exports exceeds 10,000,000 of oranges, chiefly destined for Buenos Ayres and Montevideo. The most important production of the country is stated to be Paraguayan tea, or *yerba maté*, which in former years, by its preparation for market and exportation, yielded the greater portion of the national revenue. The exportation of this article has increased from 4,000,000 lbs. in 1861 to 11,375,000 lbs. in 1882.

General Notes.

Industrial Statistics of France.—According to a return issued by the French Minister of Commerce, the working population of France is distributed among the various branches of industry as follows:—

	Hands.
Collieries (342)	106,415
Peat works (1,035)	27,977
Iron mines (353)	8,468
Other metalliferous mines (60)	4,422
Iron works (359)	57,000
China and earthenware factories (412)	18,708
Glass houses (162)	23,421
Paper-mills and cardboard factories (536)	32,655
Gas works (619)	10,575
Candle manufactories (157)	8,603
Soap works (339)	3,509
Sugar works (512)	63,526
Textile factories (5,024)	353,383

Production of Zinc.—The following quantities (in tons) of zinc were produced between 1880 and 1883, inclusive:—

	1880.	1881.	1882.	1883.
The Rhine district and Belgium	98,830	110,989	119,193	123,891
Silesia	64,459	66,497	68,811	70,405
Great Britain	22,000	24,419	25 581	27,661
France and Spain	15,000	18,358	18,075	14 671
Poland	4,000	4,000	4,100	3,783
Austria	2,520	2 520	3,199	2,879
United States	23,239	30,000	33,765	32,790
Totals	230,048	256,783	272,724	276,080

Utilisation of Maize Husks.—The husks of maize, or Indian corn, after the grain has been extracted, serve only for manure, or, in some cases, as fuel for portable engines for agricultural purposes. But they contain starch, albumen, and other substances capable of being turned to account, and even afford an alcohol which is at least equal to potato spirit, leaving a pulp suitable for the food of various animals. Herr Holl, of Worms, has invented a process for utilising these husks, by which he exposes the husks for an hour or an hour and a-half to the action of steam, at a pressure of 35 to 45 lb. per square inch, in order to reduce them to powder, and thus open the starch cells, when distillation is proceeded with in the ordinary manner.

Royal Colonial Institute.—1. The Council of this Institute offer prizes of £20, £15, £10, and £5, respectively for the four best essays or papers on "The Dominion of Canada: its History and Present Position, Geographical, Political, and Commercial." This may include the colony of Newfoundland. 2. The prize of £20 is open to persons being members of any University in the United Kingdom, and who shall not, at the time fixed for sending in the essays, have been members for more than three years. 3. The prizes of £15, £10, and £5 are open to pupils of any school in the United Kingdom, who do not exceed the age of eighteen years at the time fixed for sending in the essays. 4. The competition is open to both sexes. 5. Certificates will be awarded to the prize winners, and to such other competitors as may appear deserving. 6. The length of the papers to be from thirty to fifty pages of post quarto of twenty lines to the page, written on one side of the paper only, with an inch and a half margin on the lefthand side. 7. The papers must be delivered at the Rooms of the Institute, No. 15, Strand, not later than 5 p.m. on the 10th November, 1884. 8. Not more than three papers to be sent in by any school. 9. Each envelope to be marked on the lefthand upper corner "Essay Competition," "University," or "School," as the case may be, and addressed to "The Secretary, Royal Colonial Institute, 15, Strand, London, W.C." Further particulars respecting the regulations for the prizes can be obtained from the Secretary.

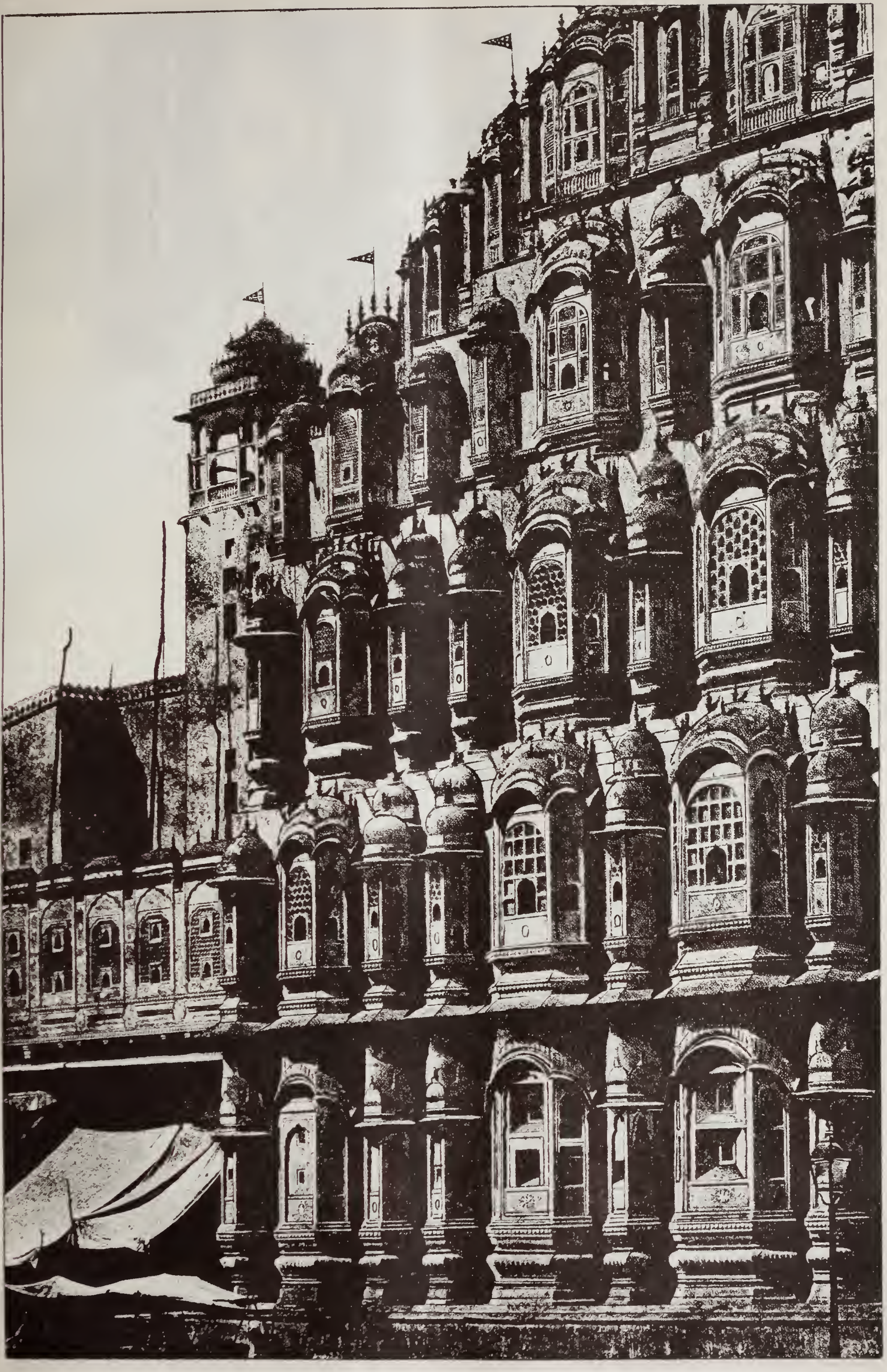

PLATE 1.

JEYPORE PALACE. THE TOWER OF THE WINDS.

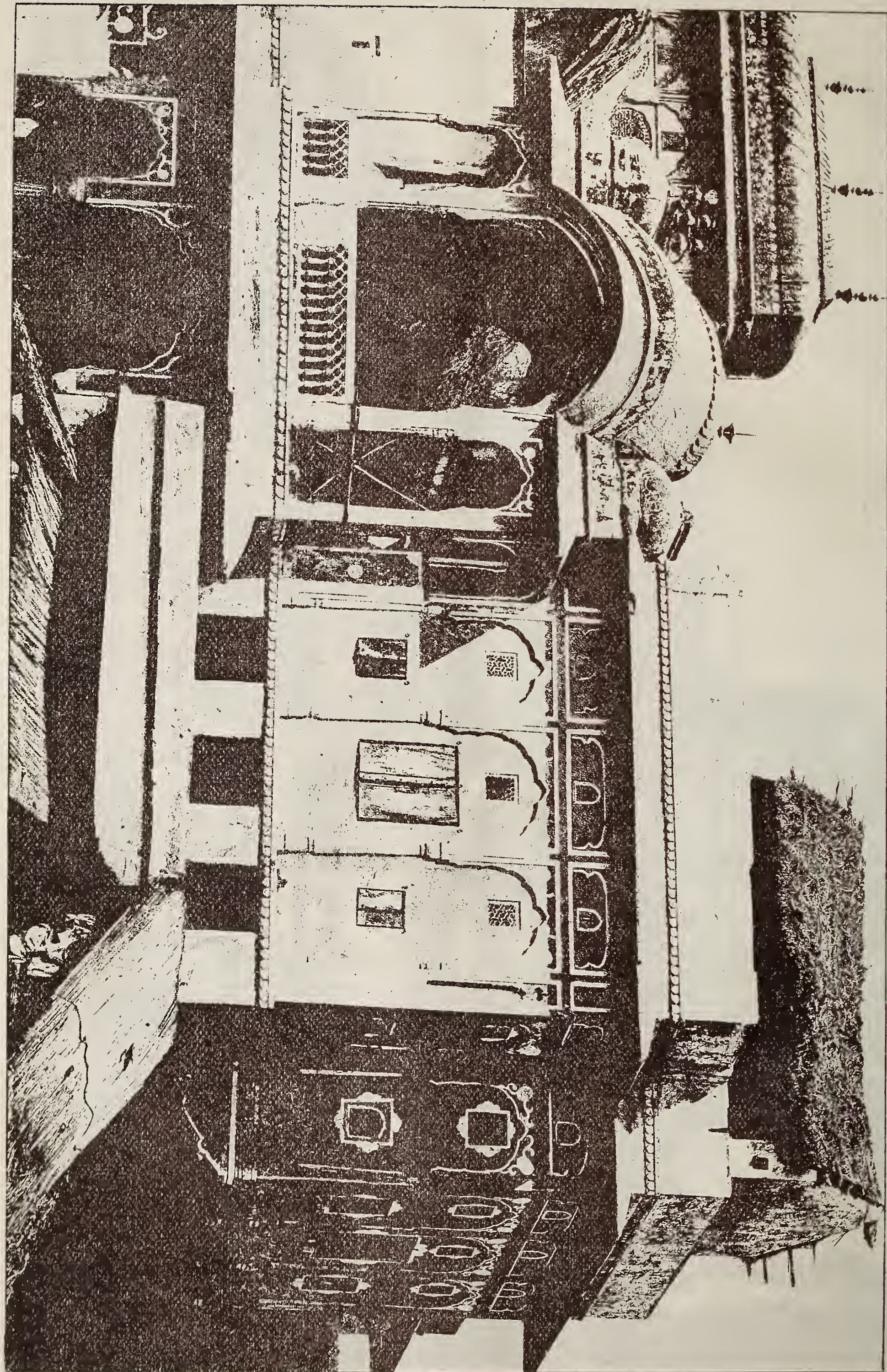

PLATE 2.
A STREET CORNER IN JEYPORE.

PLATE 3.
FRONT OF A MERCHANT'S HOUSE, AHMEDABAD.

PLATE 4.

A ROW OF HINDU HOUSES, AHMEDABAD.

PLATE 5.
A STREET CORNER, AHMEDABAD.

PLATE 6.

A CORNER HOUSE WITHIN THE GATES, LAHORE.

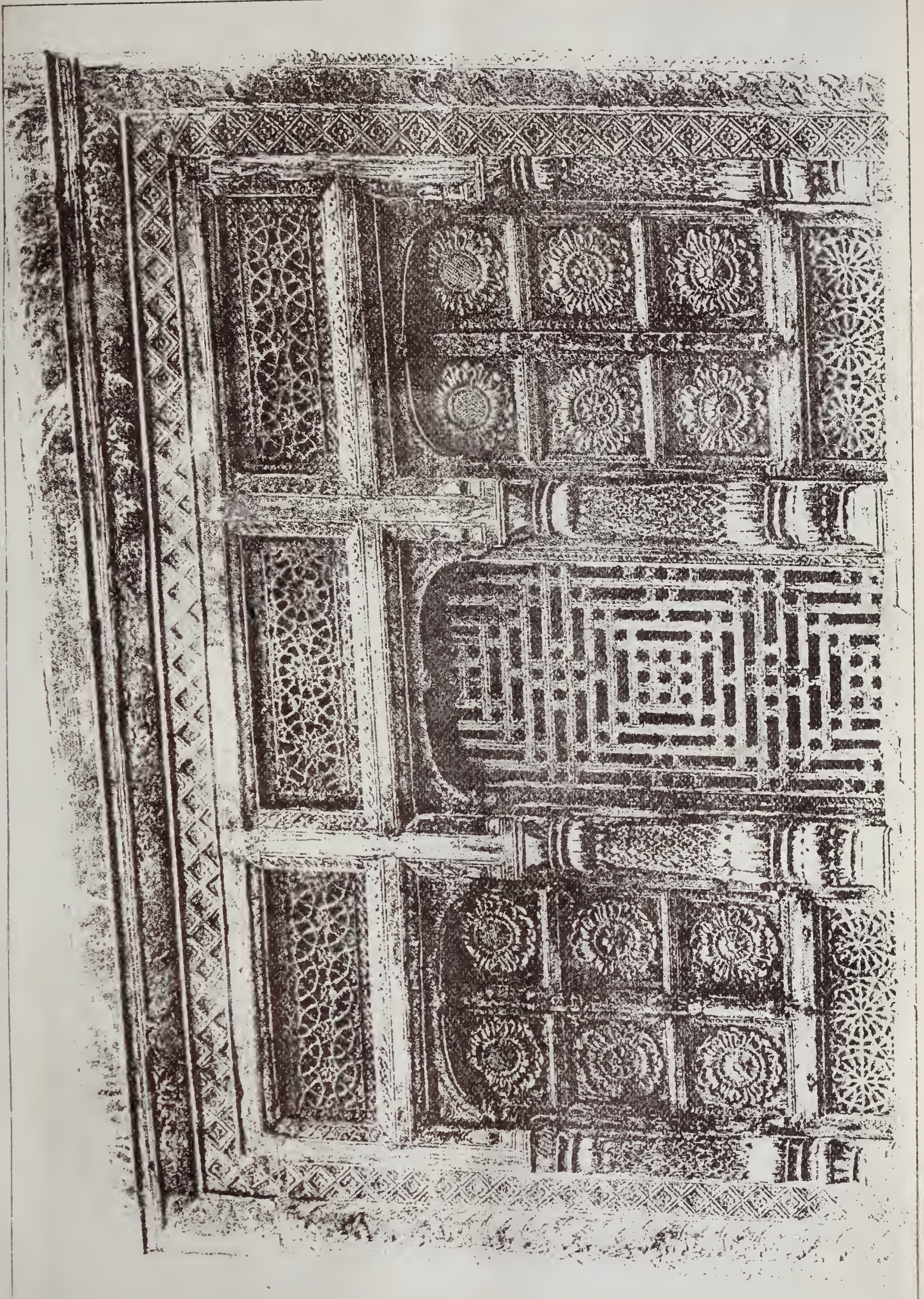

PLATE 7.

UPPER PORTION OF A SHOP FRONT LAHORE.

PLATE 8.

A STREET SCENE, LAHORE.

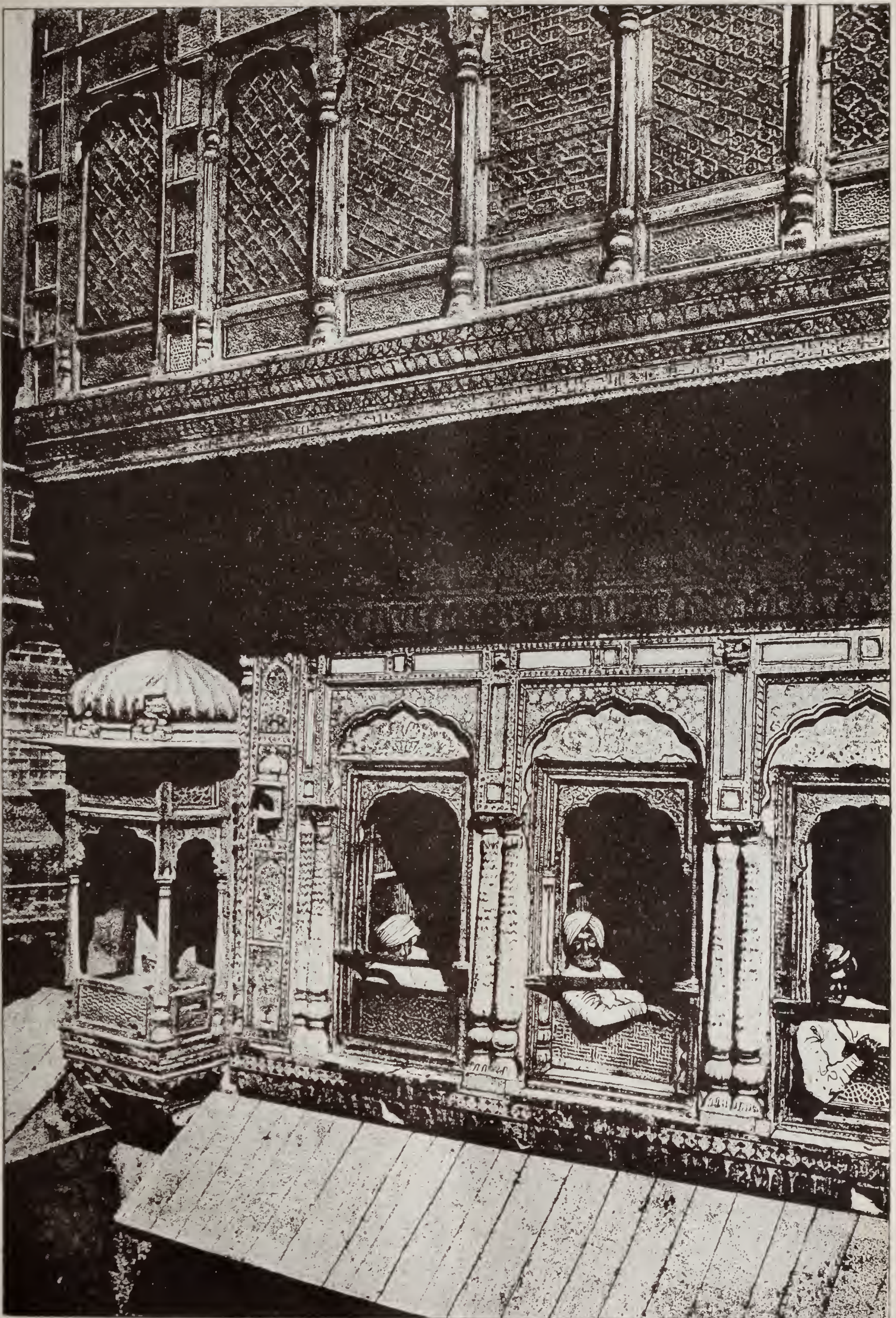

PLATE 9.

A MERCHANT'S DWELLING OVER A SHOP, AMRITZAR.

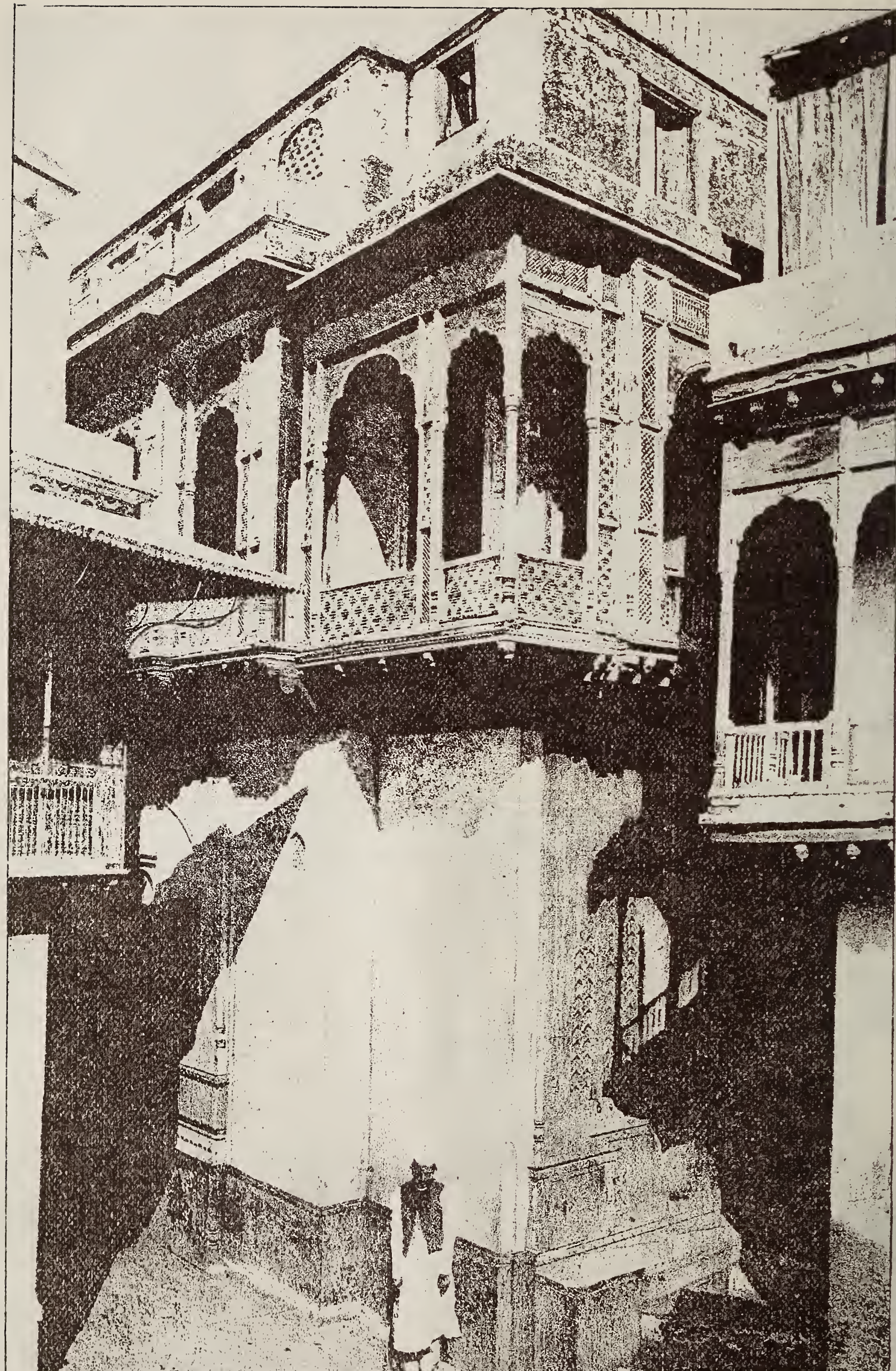

PLATE 10.
A STREET CORNER, DELHI.

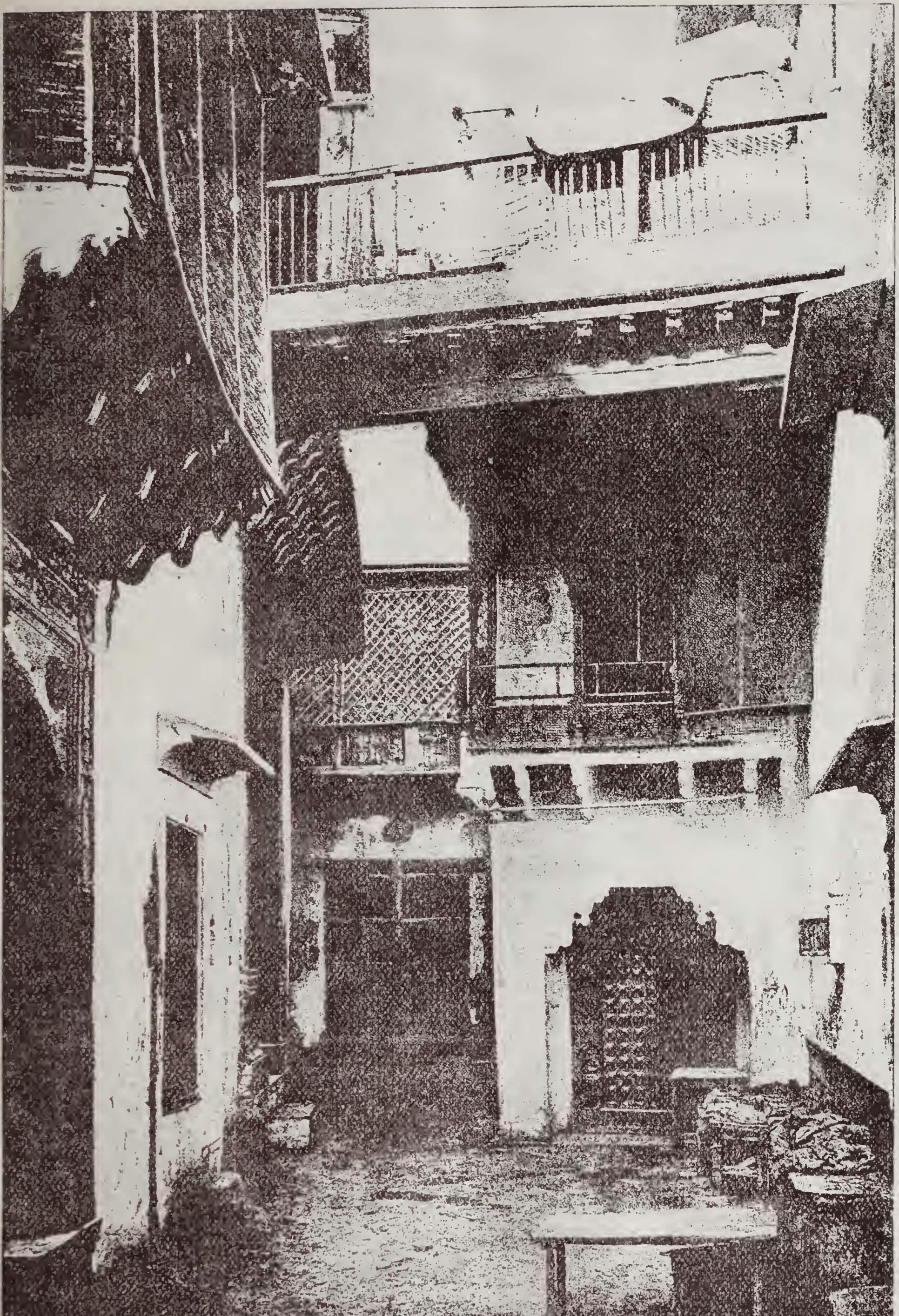

PLATE 11.
A BACK STREET, DELHI.

PLATE 12.
INTERIOR OF A COURT-YARD BEHIND SOME MODERN SHOPS, DELHI.

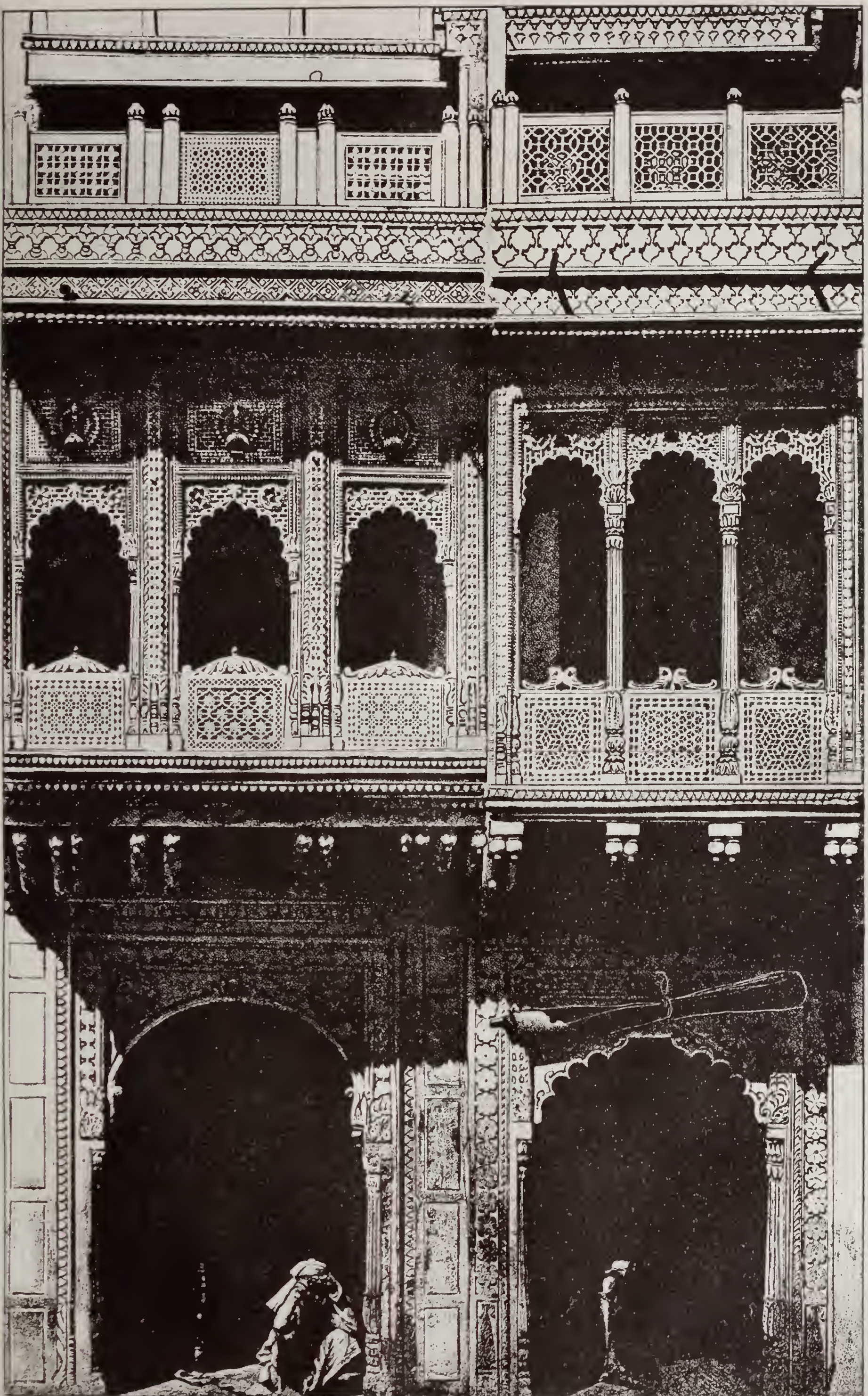

PLATE 13.

SHOPS IN THE PRINCIPAL STREET, LASHKAR GWALIOR.

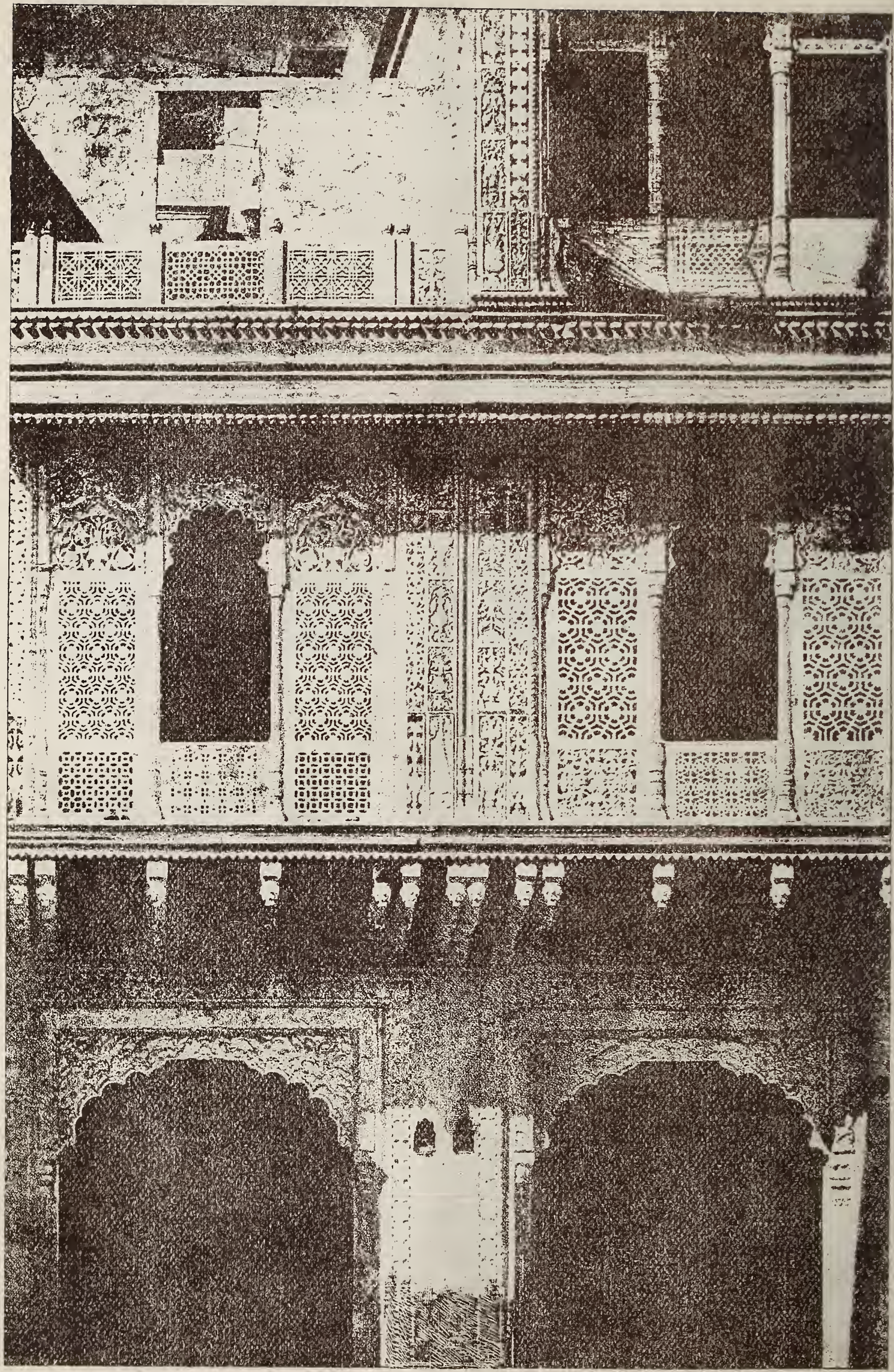

PLATE 14.

SHOPS IN THE PRINCIPAL STREET, LASHKAR GWALIOR.

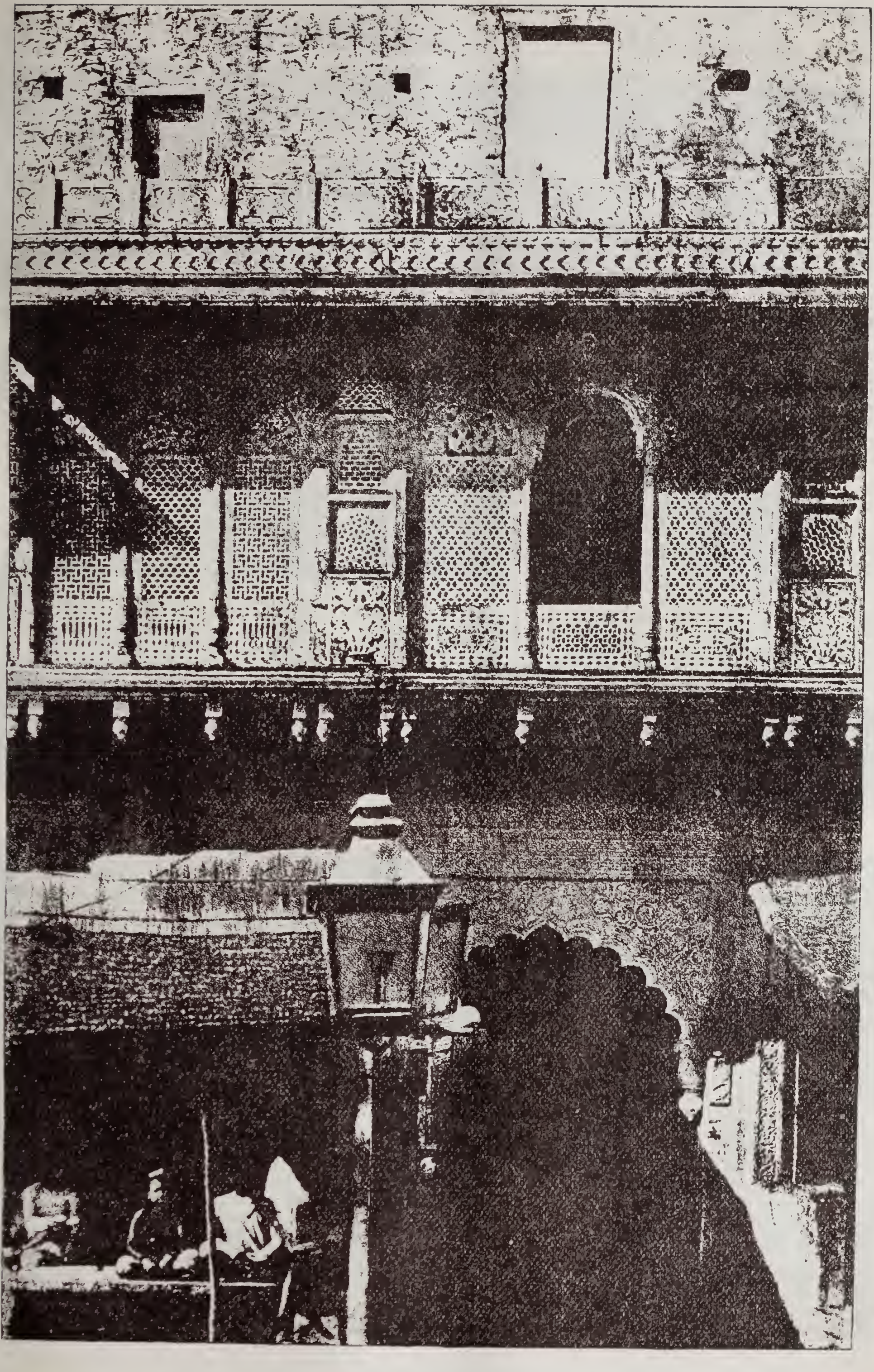

PLATE 15.
SHOPS IN THE PRINCIPAL STREET, LASHKAR GWALIOR.

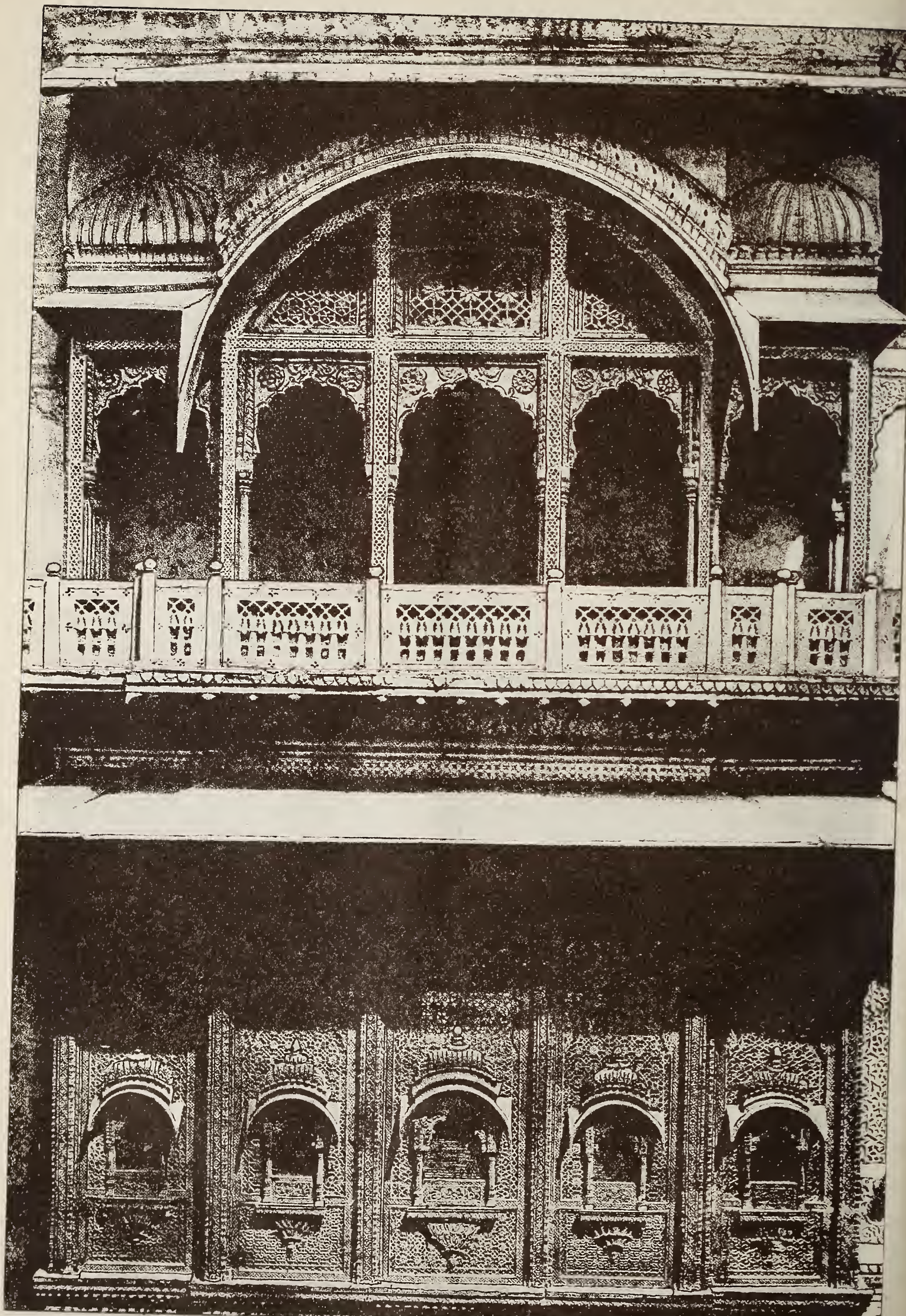

PLATE 16.

PORTION OF THE FRONT OF THE SETHS HOUSE, AJMERE RAJPUTANA.

Journal of the Society of Arts.

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FRIDAY, JULY 11, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, 7th inst., at their first meeting, the Council elected Sir Frederick Abel, C.B., D.C.L., F.R.S., as Chairman for the ensuing year. The various committees were also re-appointed.

NEW MEMBER OF COUNCIL.

The vacancy on the Council, caused by the inability of Colonel Donnelly to attend, has been filled up by the Council, in accordance with the bye-laws, by the election of Sir Frederick Bramwell, F.R.S.

CONFERENCE ON WATER SUPPLY.

The Conference on Water Supply, to be held at the International Health Exhibition, by the Society of Arts, is fixed for Thursday, July 24th, and Friday, July 25th. The meetings will take place each day at 3 p.m. Further particulars will be duly announced.

Proceedings of the Society.

CONVERSAZIONE.

The Conversazione given by the Council of the Society of Arts and the Executive Council of the Health Exhibition was held in the buildings of the International Health Exhibition, South Kensington, on Wednesday evening, the 9th of July.

The reception was held near the principal entrance by his Grace the Duke of Buckingham and Chandos, K.G., Chairman of the Executive Council of the International Health Exhibition, and by Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council of the Society of Arts, assisted by the following members of the respective councils:—The Lord Mayor, Mr. Alfred Carpmael, Mr. Cassels, Mr. E. Chadwick, C.B., Mr. B. F. Cobb, Mr. T. R. Crampton, Sir Philip Cunliffe-Owen, K.C.M.G., Sir Joseph Fayrer, Captain Douglas Galton, C.B., Ernest Hart, Mr. T. V. Lister, Mr. J. M. Maclean, Mr. G. Matthey, F.R.S., Sir James Paget, Bart., Dr. Poore, Mr. W. G. Pedder, Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., Owen Roberts, Sir John Rose, Lord Sudeley, Colonel Webber, R.E.

The Exhibition buildings were lighted by the electric lights; the gardens were also illuminated with variegated lamps and Japanese lanterns, and the fountains were lighted by the electric light.

The band of the Seventh German (Magdeburg) Cuirassiers, Conductor Herr Wilhelm Gruenert, performed in the Vestibule near the entrance.

The band of the Coldstream Guards, conducted by Mr. C. Thomas, performed in the Central Avenue.

The band of the First Regiment of the French Engineers (Genie de Versailles), conductor, Mons. Gustav Wettge, performed in the Eastern Kiosk.

The band of the Grenadier Guards, conducted by Mr. Dan Godfrey, performed in the Western Kiosk.

The Chinese band performed in the gardens by the Chinese Court.

A vocal and instrumental concert, consisting of glees, &c., was given by the Royal Criterion Handbell Ringers, under the direction of Mr. Harry Tipper, in the Old London street.

The number of ladies and gentlemen present at the Conversazione was 14,080. Among these were:—His Excellency the Chinese Ambassador, the Marchioness Tseng, and Lady Blossom Tseng, Count D. de Bylandt, Count Vitzthum, Baron A. de Stoeckl, the Rajah of Sarawak, the Maori King, Earl of Belmore, Earl of Bradford, Earl Brownlow, Duke of Buccleuch, Earl Cairns, Marquis of Carmarthen, Viscount Castlereagh, Lord Cremorne, Earl of Darnley, Earl Ducie, Earl of Dysart, Earl of Gosford, Lord Hastings, Earl of Ilchester, Earl of Kenmare, Earl of Longford, Earl of Mayo, Earl Fortescue, Lord Norreys, Marquis of Ormond, Viscount Portman, Viscount Powerscourt, Earl of Powis, Earl of Mount Edgcumbe, Earl of Normanton, Marquis of Northampton, Lord Northwick, Earl of Onslow, Earl of Romney, Earl of Rosse, Duke of Sutherland, Lord Tewkesbury, Lord Tennyson, Lord Thurlow, Lord Vaux of Harrowden, Lord Coleridge, Lord Justice Cotton, Sir James Hannen, Lord Ormathwaite, Mr. Justice Giffard, Mr. Baron Huddleston, Mr. Justice Denman, Mr. Justice Manisty, Mr. Justice Pearson, Mr. Justice Pollock, Count Münster, Count A. E. Gleichen, Right Hon. John Bright, Right Hon. H. C. E. Childers, Right Hon. C. P. Villiers, Right Hon. Joseph Chamberlain, Right Hon. T. Dyke Acland, Bishop of Lichfield, Bishop of Manchester, Bishop of Maritzburg, Dean of Westminster, Dean of Hereford, Dean of Lincoln, Lord Edward Churchill, Lord Esmé Gordon, Lord Douglas Gordon, Lord Charles Montague, Lord Clarence Paget, Lord John Scott, Lord William Seymour, Colonel Richardson Gardner, M.P., Mr. Hastings, M.P., Mr. George Howard, M.P., Mr. T. R. Hill, M.P., Mr. Andrew Grant, M.P., Mr. Justin McCarthy, M.P., Colonel Makins, M.P., Mr. Nevil Maskelyne, M.P., Mr. Southeron Estcourt, M.P., Mr. W. H. Willy, M.P., Sir Henry Acland, Sir Henry Barkly, Sir James Bazalgette, Sir Robert Bazley, Sir Michael Hicks Beech, Sir Risden Bennett, Sir F. Bolton, Sir William Bowman, Sir C. T. Bright, Sir George Campbell, Sir Robert Carden, Sir Orfeur Cavenagh, Sir William Charley, Sir Andrew Clarke, Sir W. J. Codrington, Sir Daniel Cooper, Sir E. Du Cane, Sir W. Hart Dyke, Sir Howard Elphinstone, Sir Frederick Evans, Sir Douglas Forsyth, Sir W. A. Fraser, Sir Alexander Galt, Sir Frederick Goldsmid, Sir Julian Goldsmid, Sir J. P. Grant, Sir William Gregory, Sir Lepel Griffin, Sir George Grove, Sir William Gull, Sir E. B. Hamley, Sir Charles Hartley, Sir J. C. D. Hay, Sir Bridges Henniker, Sir J. McGarell Hogg, Sir Joseph Hooker, Sir William Humphrey, Sir Selwyn Ibbetson, Sir E. Inglefield, Sir P. G. Julyan, Sir Astley Cooper Key, Sir W. Owen Lanyon, Sir John Lawes, Sir E. A. H. Lachmere, Sir Henry Lefroy, Sir R. R. W. Lingen, Sir Joseph Lister, Sir Leopold McClintock, Sir George Macfarren, Sir Henry Maine, Sir T. Erskine May, Sir Julian Pauncefote, Sir Lewis Pelly, Sir Dighton Probyn, Sir Henry Rawlinson, Sir Edward Reed, Sir Saul Samuel, Sir Bernhard Samuelson, Sir Alfred Slade, Sir John Strachey, Sir Edward Sullivan, Sir John Swinburne, Sir H. Hussey Vivian, Sir Edward Watkin, Sir R. Wallace, Sir Spencer Wells, Sir Sydney Waterlow, Sir Allen Young, Messrs. J. E. Boehm, P. H. Calderon, Vicat Cole, C. W. Cope, Lowes Dickenson, Frank Dicksee, C. L. Eastlake, L. Fildes, Frith, Carl Haag, F. Holl, J. C. Horsley, J. E. Hodgson, Holman Hunt, E. Long, McWhirter, W. Orchardson, E. J. Poynter, Val Prinsep, G. Richmond, Lumb Stocks, Waterhouse, J. Abernethy, Ayrton, George Bullen, Hyde Clarke, R. B. Clifton, Crookes, Boyd Dawkins, Doulton, A. Geikie, Hales, Hawkesley, Jeaffreson, J. Knowles, H. Labouchere, Ray Lankester, Norman Lockyer, Oliver Lodge, J. Marshall, H. Maudslay, Max Müller, Mylne, Nasmyth, James Payn, Prestwich, Redgrave, Herbert Spencer, L. de Rothschild, Sylvester, J. L. Toole, Hon. Lewis Wingfield, Doctors Cobbold, Diamond, Gamgee, Gladstone, Günther, Mann, J. H. Murray, Stainer, Voelcker, Rev. H. R. Haweis, Rev. A. H. Sayce, General Pitt Rivers, Admiral Mayne, Captain Shaw, Captain Cameron.

Miscellaneous.

SULPHUR: ITS OCCURRENCE AND EXTRACTION.

By C. G. Warnford Lock.

The following notes relate exclusively to native sulphur (brimstone). Though the amount of sulphur annually mined in the form of sulphides of various metals (*e.g.*, iron and copper pyrites, galena, blende, &c.), probably far exceeds that obtained in the uncombined state, still, the separation of the sulphur in an inoxidised condition from such compounds is never attempted, for the simple reasons that, in the processes for extracting the several metals from their ores, the first step necessary is the elimination of the combined sulphur, which is most easily effected by a roasting or oxidising operation, whereby the sulphur is at once converted into sulphurous acid, itself a valuable commodity, and, moreover, capable of being readily oxidised one step further to form sulphuric acid, the chief purpose for which sulphur is consumed.

Occurrence.

It will be most convenient to discuss the occurrence of sulphur deposits under geographical headings, leaving geological differences to be noted as they are met with.

Austro-Hungary.—There are two mines of sulphur worked in this empire, one not far from Cracow, and the other at Radoboi in Croatia; both deposits are of considerable extent, but the annual yield is insignificant. The whole district around Mount Büdös, in Transylvania, is rich in sulphur. The deposits are situated at the south and west of the mountain, the principal localities being Kis Soosmezö, Vontala feje Bálványos, and a little above the châlet Gál András; some thirty or more diggings have been undertaken in a circuit of eighteen miles, but the area covered by the deposits is more than three times this size. The sulphur occurs in unequal strata one to nine inches thick, beneath one to three feet of mould. The soil is everywhere saturated with sulphur, and in this permeated earth pieces of the pure mineral are found. The whole is the result of living solfataric action, and the accumulation will continue to grow as long as that action survives. Samples of the impregnated earth, taken over an area of 16,000,000 square fathoms, yielded from 41 to 64 per cent. of sulphur. Allowing for interruptions in the deposits, and taking these at an average thickness of three inches instead of nine, Boner estimates that 200 lb. of sulphur might be obtained from each square fathom, assuming 50 per cent. of sulphur in the deposit; continuing the calculation, he thinks, the district should afford over 700,000 tons. He reckons the probable cost at £10 per ton, including carriage from Büdös to Kronstadt; this, he says, is less than the prices paid in the places where it is produced in Poland, Slavonia, and Bohemia. The total sulphur output of the Austrian empire, in 1863, was 1,754 tons, at an average rate of £12 15s. per ton. The imports are about 5,000 tons per annum.

Banda Islands.—Large quantities of sulphur are found in and about the crater of Gunong Api, and attempts have been made to collect it for exportation. It is said, however, that the labour of ascending the mountain is too great to render the speculation profitable.

China.—Sulphur is one of the most important products of Formosa. When taken from the mine, the ore is boiled in iron pans till it assumes a treacly consistence. This is constantly stirred till every impurity is separated from the sulphur, which is then ladled out into wooden tubs, shaped like sugar-loaves. In these it is left to cool, and the conical cakes are freed from the tubs by the simple process of knocking out the bottoms of the latter.

Sulphur is procurable in saleable quantities from the mountains around Ta-chien-la, in Western China; the inhabitants of the ravines may often be seen engaged in the manufacture of matches of the Guy Fawkes pattern, which they split from a pine plank, with a spokeshave, and tip with sulphur. During his penniless residence at Na-erh-pa, Baber generally used these sulphur chips to procure a flame.

France.—Near the hamlet of Tappets, about three miles north-east of Apt, in the department of Vaucluse, is a bed of sulphur ore yielding about 20 to 25 per cent. It consists of a sulphur-impregnated marly limestone, and accompanies the lignite beds of the tertiary system. The deposit is neither very extensive, nor very thick.

Iceland.—The sulphur deposits of Krisuvík, in the south of Iceland, were the subject of a paper by C. W. Vincent, published in the *Journal* of Jan. 17, 1873 (No. 1,052, vol. xxi., pp. 137-144); and those situated in the north of the island were described by me in the *Journal* for April 30, 1880 (No. 1,432, vol. xxviii. pp. 508-9). The interested reader may refer to these for details; it will suffice here to give a general idea of the deposits as a whole. They belong to the recent solfataric group, and, though often compared with the Sicilian mines, bear very little analogy to them. The sulphur occurs in a fine state, intimately associated with earthy impurities, as a superficial layer of no great depth, but having recuperative powers that render them practically inexhaustible. They are now the property of an English company, and give promise of being worked to advantage in the future.

India.—The sulphur deposits of India, according to Professor V. Ball,* are unimportant, and inconveniently situated. Near a village called Sura-Sany-Yanam, between the mouths of the Godaveri in Madras, small heaps of sulphur are occasionally collected in the dried-up margin of a tidal swamp, where the mineral appears to result from a deoxidisation of gypsum by contact with organic matter. Another trifling deposit is reported to occur at Ghizri Bandar, near Karachi. A considerable mine, worked by adits and chambers, exists at Sunnee in Cutchi, Balochistan, and affords the chief supply for Candahar; petroleum is said to be mixed with the refuse of the workings to produce an inferior quality of sulphur, while the pure sulphur is boiled in oil to prepare it in the form of commercial brimstone. This practice recalls the method adopted in Iceland about 300 years ago, when the crude ore was boiled in train oil, to effect separation of the dross. Sulphur is obtained in some abundance from near a hot spring called Pir Zinda, in the Soree Pass of the Suleiman Hills, Afghanistan. The native Kusranis and Bozdars treat the crude ore, consisting of amorphous gypsum traversed by streaks of sulphur, by distilling it in a retort improvised out of two gharas, one on the fire and the other inverted as a condenser. A "vast quantity" of sulphur is said to occur at Hazara, North Afghanistan. On the southern flanks of the Gunjully Hills, in the Kohat district of the Punjab, a large amount of sulphur is constantly being deposited as a result of the decomposition of pyritiferous alum shales. As much as 1,000 tons a year is said to have been gathered. At Luni-ki-Kussi, on the west side of the Indus, sulphur is obtained by roasting the loose earth. The sulphur mines at Nakband (Kushalgarh), on the Indus, eight miles from the mouth of the Kohat, are 30 to 40 feet deep, and have yielded largely, the ore being sublimed as in

* "Economic Geology of India."

Balochistan. Other localities mentioned as affording sulphur in the Punjab are Gumbat and near Panoba, four miles from Shadipur, on the Indus; Jaba, fourteen miles from Kalabagh, in the Bannu district; and Jeura, near Simla. None of these seem to possess any industrial importance.

The sulphur at Puga, in Kashmir, occurs massive, and as a lining in the clefts and fissures of a sort of quartz schist, often accompanied by gypsum. The process of formation seems to be still at work, judging by hotsprings in the neighbourhood. The deposits are worked by pits about 8 feet deep, and adits of the same length; but the production is small. A trifling quantity of sulphur is deposited by hotsprings in the beds of the Ramgunga and Garjia rivers, in the Kumaun district of the north-west provinces; and a considerable amount is found in the galleries of the lead mines at Meywar, on the Tons river, in the Jaunsar district. Little is known of the Nepalese sulphur mines. In Upper Burma the chief localities are Mooda Myo, Tsein Goon, Kyoukhoo, Bawyine, Dybayen Myo, Pagan Myo, Toogthoo Einlay, and Bhamo district. The dormant volcano of Barren Island affords small quantities of sulphur, the result of solfataric action.

Italy.—The sulphur deposits of the Romagna are situated in the Miocene lacustrine formation, and lie amid the sub-apennine hills. The mines worked in the province of Forli, by the Cesena Sulphur Company, cover an area of about 260 square kilometres. Their average annual production for the seven years, 1873-79, was 27,780 tons. The cost of extraction, refining, and royalties come to about £4 per ton, according to Consul Colnaghi. The mineral is worked by blasting, each miner having to bore three holes in six hours, when all are fired simultaneously. At Pergola, some 60 kilometres distant from Ancona, is a sulphur mine worked by a German Company, which shipped 90 tons of refined sulphur to England in 1880. In Central Italy, near Bologna, a vein is worked which extends over 15 miles in length. The ore is poor, and has to be raised from a considerable depth.

Japan.—Sulphur is said to be abundant in the island of Yezo.

Philippines.—A good deal of sulphur is collected at Camiguin.

Sicily.—Some notes on the sulphur mines of Sicily has appeared in the *Journal* (see Feb. 17, 1882). They may be supplemented by the following. At the end of the Middle Miocene period, the sulphur-bearing area was raised, and lakes were formed in which occurred the deposition of the sulphur rock and its accompanying gypsum, tripoli, and silicious limestone. The sulphur rock is composed of sulphur and marly limestone, the sulphur being sometimes disseminated through the limestone, and at others forming thin alternate layers with it. These sulphur-bearing seams are often separated by layers of black marl, 20 inches to 6 feet thick, some seams attaining thickness of 28 feet. The total aggregate thickness of the sulphur seams reaches 100 feet in one case, but the average total is 10 to 12 feet only. All the seams are decomposed at their outcrop, and show only an accumulation of whitish friable earth, called *briscale* by the miners, and mainly composed of gypsum. This has resulted from the oxidation of the sulphur to sulphuric acid by atmospheric agency, the acid in turn attacking the lime carbonate, and forming sulphate (gypsum). The most plausible supposition as to the origin of the sulphur seams would appear to be that the lakes received streams of water containing calcium sulphide in solution, this calcium sulphide probably resulting from a reduction of the masses of calcium sulphate (gypsum) by the action of volcanic heat. Gradual decomposition of the calcium sulphide in the presence of water would finally result in a deposition of sulphur and of lime carbonate, in the relative proportions of 24 and 76 per cent. As a matter of fact, much of the Sicilian ore actually has this per-centage composition. Whatever the process has been, it is no longer in activity, and there is no growth nor renewal of the beds, in this respect differing essentially from recent deposits due to "living" solfataric action.

Almost all the Sicilian ore is carried to the surface on boys' backs, consequently it does not pay to work below about 400 feet, as it then becomes necessary to employ hauling machinery. Hence the deposits lying below that horizon are hardly touched, and as many of the beds are nearly vertical, and do not diminish in yield as they descend, the still untouched resources must be very great. Various estimates have been made as to the period for which the supply will last at the present rate of consumption; these range from 50 to 200 years. There are said to be about 250 mines in the island, and no less than 4,367 *calcaroni* were reported in operation 15 years ago. The average yield is stated not to exceed 14 per cent.

Spain.—In the province of Murcia, and at other places, the existence of fine beds of sulphur has been ascertained. One is worked by an English association, the Hellin Sulphur Company. The quality is very good.

Suez.—A sulphur deposit exists at Djemsa, in a perfectly rainless desert on the African coast, very near the sea, and constituting a hill 600 feet high, whose sides are blasted down as in quarrying stone. Some 200 Arabs, employed under French engineers, succeeded in mining ten tons a day. A similar deposit occurs at Ranga, 500 miles from Suez, also near the coast of the African continent, which differs only in being buried under other strata, so that mining is necessary.

Sunda Islands.—The Gunong Jollo, or sulphur mountain, lies south west of the village Prado, and south east of Dompo. The sulphur is dug from three places in an old crater now in the solfataric stage of its existence. Each spot is 100 to 120 roods long, and 50 to 60 broad. The sulphur collects between masses of white stone (perhaps decomposed trachyte), and sometimes covers a space of one to three roods square. On the liquid and warm sulphur a hard crust forms, two inches thick. Digging is only carried on at morning and evening, the heat being too great at mid-day. Round holes are made, eight to nine feet apart, two feet deep, and with an outlet from above of one foot, and from below of three or four feet. Sulphur is also found in the solfatara of Gunong Prewa, but in trifling quantity. A great deal exists on the sides of Tambora.

Tripoli possesses a sulphur deposit important both for extent and richness, but it is not worked.

Turkey.—Native sulphur is found in some quantity adjacent to the lead lodes at Devrent (Derbend), near Alashehr, Salyklœ, and Nymphi. A sulphur mine exists two days' ride from Arta, and four from Butrinto, Albania. Some Italians are said to have secured a concession of a "basalt vein containing sulphur" near the Dardanelles. This has a very doubtful look, and if the mine alluded to be the same as the one I examined in 1873, the formation is the exact counterpart of that met with in Sicily, and the neighbouring basalt has nothing to do with the sulphur. This mine exists at a place known as Komarla, and the mineral affords about 40 per cent. of sulphur. A similar mine occurs at Alahtan, about six hours from Kassaba.

United States.—Sulphur is found native in Nevada, California, Utah, Virginia, Louisiana, and other States, occurring in beds of considerable bulk in Unitah county, Wyoming, near Evanstown, where it is said to be quite pure; also in some quantity in the Yellowstone Park, Montana, and in various localities in New Mexico. It is only worked to any extent in Nevada and California, and even there not on a large scale, the total production in 1880 being stated at under 600 tons. Locally produced sulphur cannot compete in price with imported Sicilian, on account of the cost of land transport; it is, moreover, found to be often contaminated with arsenic, which greatly reduces its market value and limits its application. At the most important mine, called the Rabbit Hole, in Humboldt county, Nevada, the sulphur occurs as an impregnation in a white volcanic tuff or breccia, of Miocene age. The deposit is worked by regular mining, and the mineral, containing 15 to 40 per cent. of sulphur, is dealt with by the steam process, the production being sometimes six tons a day. At the Pluton mines, California, the sulphur is found as a crystalline body scattered through a confused mass of decomposed rocks, and intimately associated with cinnabar, apparently occupying an ancient crater. The mineral is removed altogether, and the sulphur is either recovered by steam process, or, if both sulphur and cinnabar are in paying quantities, the mass is put into a mercury distilling furnace, and the sulphur is separated from the mercury by passing superheated steam into a chamber situated in front of the mercury-condensing chamber.

Extraction.

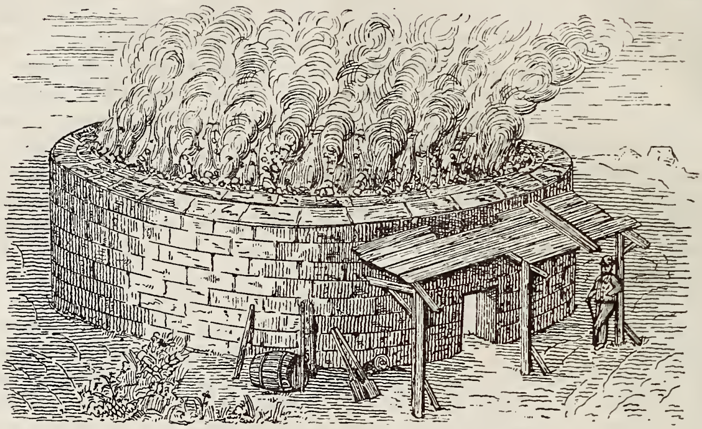
Sulphur is extracted from the earthy materials with which it is intimately associated in nature, by the following several means:—(1) Dry heat (roasting the ore in mass); (2) wet heat (melting out by the aid of aqueous solutions of salts, the salts being added to heighten the boiling point); (3) superheated steam; (4) chemical solvents. The great bulk of all the sulphur produced is extracted by apparatus belonging to the first class, and including the *calcarelle*, *calcarone*, and *doppione*.

Calcarelle.—The earliest system adopted in Sicily was the *calcarelle*. This consisted simply of a stack of ore, 6 to 15 feet square, built in a ditch 3 or 4 inches deep, and whose floor was beaten hard and sloped to a single point, permitting the molten sulphur to flow out by an opening termed the *morto*. In building the stack, care was taken to put the largest pieces of ore at the bottom, selecting lumps of gradually diminishing size as the top was approached. The mass was ignited at the summit. The construction of the stack usually occupied two days; on the third day the sulphur escaped by the *morto*, and on the fourth the *calcarelle* was pulled down. The air necessary for the combustion of a portion of the sulphur (to afford the heat required to smelt the remainder), was freely admitted at all sides; only the mineral in the centre of the heap was heated without actual contact with the air, so that its sulphur was melted out instead of being burned (oxidised). Consequently about 6,700 lb. of sulphur mineral were needed to afford 385 lb. of sulphur, or a yield of 5·7 per cent.; as the ore contained 35 per cent. of sulphur, the consumption of sulphur as fuel was 1,960 lb., in order to extract 385 lb. In addition, the immense volumes of sulphurous acid emitted from the stack caused a terrible destruction of the agricultural crops in the neighbourhood.

Calcarone.—Nearly all the sulphur prepared in Sicily is now extracted by the *calcarone* (or *calcherone*, as it may also be spelled). This, as is shown in Figs. 1 and 2 (p. 796), is formed by building a circular stone wall on an inclined sole. In front is the *morto* or outlet, having a height of 4 to 6 feet, and a width of 2 feet; over it is erected a wooden shelter for the workman in charge. *Calcaroni* may contain from 200 to 400 *casse* (each *casse* being equivalent to about 6 tons, and giving 12 to 16 cwt. of sulphur). The durability of the *calcarone* is governed by the care exercised in its construction; ten years is not an unusual period. The charging of the *calcarone* is a matter of primary importance, as on it depends the yield of sulphur. The largest pieces of ore are selected for the first layer, leaving interstices between them; the size of the lumps gradually diminishes as the height increases, care being taken to form the walls of the *morto* with calcareous stones, so as to ensure a passage being maintained for the escape of the liquefied sulphur. In adding the finest portions on the top, narrow channels, about two feet apart, are left for the draught to carry the heat down. The whole is covered with a layer of the refuse from previous operations. This layer is more or less thick, according to the state of the weather, because the *calcarone* being built in the open air, variations of temperature and wind influence the progress of the operation; consequently means have to be adopted to prevent an undue access of air rendering the combustion too rapid. For instance, during a sirocco (local hot wind) there is danger of the sulphur contained in the ore lying at the side facing the wind being completely converted into sulphurous acid, and thus lost. The employment of a roofed shed would prevent much of the waste occasioned by climatic causes.

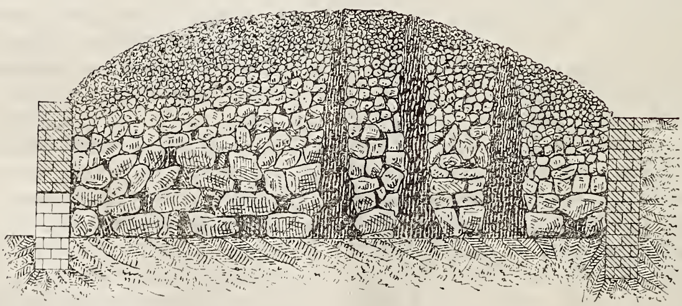
When the charging is completed, the *morto* is closed by a stone slab, and fire is communicated to the mass by means of little bunches of dried herbs, dipped in sulphur, which are thrust into the vertical channels before mentioned. Some six or eight days afterwards, a hole is pierced in the top of the *morto*,

FIG. 1.



by means of an iron rod; later, a second hole is made near the floor. By these two openings the sulphur escapes, and is collected in wooden buckets (*gravite*), shaped like a truncated cone, and holding about one hundredweight of sulphur. These buckets cost over 2s., and serve only for three or four castings without wanting repairs. The outflow of sulphur lasts for a fortnight or a month. Commonly, the *calcarone* is left to itself when once the mass has been ignited, but then the loss of sulphur is much more serious. To ensure good results many precautions have to be observed, mainly connected with the nice adjustment of the draught, so as to effect the maximum degree of fusion with a minimum of oxidation. When the operation is conducted during winter, the product is less abundant, and of inferior

FIG. 2.

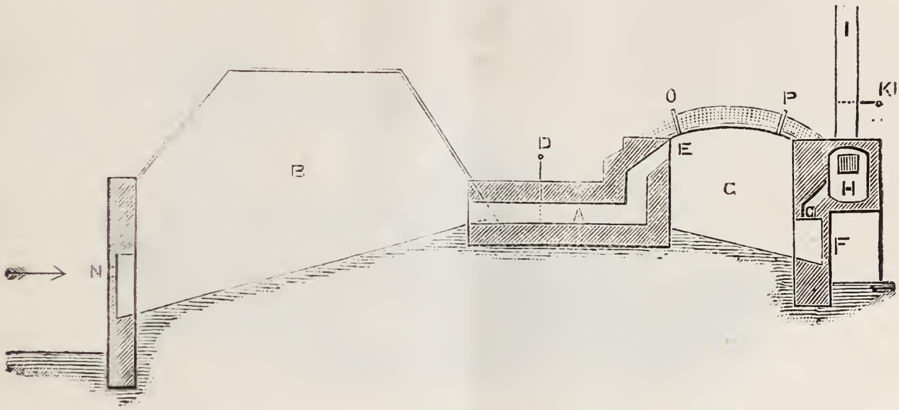


quality. After the charge is exhausted, a new one cannot be introduced till the mass has cooled down, occupying a period of ten days to a month, according to the size of the *calcarone*. The discharging has to be done slowly and cautiously, on account of the sulphurous fumes liberated. The consumption of sulphur (as fuel) in the heating is about 50 per cent. of the total amount contained in the ore. Thus, to obtain one ton of sulphur, there is consumed as fuel about another ton, worth, say, £5, and performing a duty which could be much more satisfactorily accomplished by two hundredweight of coal, costing, perhaps, 5s.

Calcarone, Foster's Improved.—A great improvement in the Sicilian *calcarone* has been introduced by P. Le Neve Foster, and worked with good results, showing an increase of yield of 30 per cent. above the ordinary plan. According to his description, the waste heat from an ordinary *calcarone*, after all the sulphur has been run off, is utilised to heat to the required temperature the charge of ore placed in his kiln, and as soon as the moisture has been driven off and the heat is great enough, the charge is fired from the top. The combustion, fed with hot air containing some sulphurous acid gas, is very slow, hence the loss of sulphur by burning is less than when, as in the ordinary *calcarone*, the ore has to be heated entirely by the combustion of the sulphur. The apparatus (shown in Fig. 3,* prepared from a drawing kindly furnished me by the inventor) consists essentially of three parts—(1) the flue, or conductor of heat; (2) the kiln, in which the ore is treated; (3) the chamber for the condensation of the sulphur that is volatilised during the fusion, and in which it is collected.

The kiln may be of any suitable form to contain two charges of ore, but a rectangular chamber is found to be most convenient, with floor sloping towards the front. The chamber consists of four walls, preferably not covered with an arch, as affording greater facility for charging and discharging. The kiln communicates, by means of a flue, A, with the back of an ordinary *calcarone*, B, which furnishes the heat necessary for melting the sulphur from the ore contained in the kiln, C. The upper portion of the *calcarone* should be covered with a layer of *genese* (spent ore), so as to prevent the dispersion of heat by any other channel than that offered by the flue, A, which is provided with a damper, D, so as to regulate the admission of heated air by openings, E, at the upper back part of the kiln. A rectangular opening, F, is left in the front wall of the kiln, from which the melted sulphur is run. This opening, if of sufficient size, may serve for discharging the spent ore at the termination of the fusion. From the upper part of the opening, and also in the front wall,

Fig. 3.



slightly above the level of the floor, flues, G, communicate with a horizontal passage, H, which is made large enough to serve as a condensation chamber, on the walls of which the sublimed sulphur collects. At one end of the chamber is a vertical chimney, I, provided with a damper, K.

The kiln is charged in the usual way by placing the large pieces of ore on the floor in such a manner as to leave passages for the flow of the liquid sulphur; the small pieces are next filled in, and the finer ore at the top. A few blocks of rough stone, or burnt ore, are placed at the opening in front in such a way as to leave a vacant place for the melted sulphur to collect before being run off. When charged, the ore is covered with bricks laid flat, and on these is put a layer of *genese*, well rammed and wetted, so as to form a nearly impermeable coating, with a slight slope towards the walls, in order that the rain water may run off. The opening, F, in the front wall should be closed with a thin wall of plaster of Paris The ore in the kiln, which is now ready for fusion, is put in communication with the spent *calcarone*, B, by opening the damper, D, and at the same a small hole, N, is made in the wall that closes the opening in front, from which the melted sulphur has been run off from the *calcarone*, B. The current of air entering by the hole, N, and passing through the incandescent mass of ore, is thus heated, and enters the kiln by the flue, N, at a sufficient temperature. In this manner the heated mass of spent ore in the *calcarone* becomes a regenerator of heat, to be utilised in the kiln for the fusion of the sulphur that it contains. In the upper covering, two or more tubes, O P, are placed, and serve not only for observing the internal temperature by a thermometer, but also for firing the mass.

The combustion of the sulphur supplied with hot air, mixed with a considerable proportion of sulphurous acid gas, proceeds slowly in the upper part of the kiln, and the liquid sulphur dropping to the floor,

* This block is kindly lent by the Editor of the *English Mechanic*.

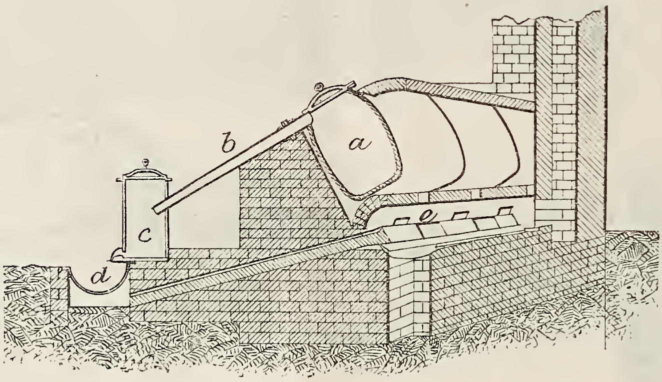
over the already heated ore, cannot solidify and choke the passages, and so prevent the circulation of the heated air and products of combustion of the sulphur to the chimney; in this manner the operation proceeds with regularity. The success of the kiln is principally due to the manner in which it is heated from the top and back towards the front and bottom, mitating, to a certain degree, the manner in which the heating of an ordinary *calcarone* proceeds, with this difference, that the heat is better utilised in the kiln, and, therefore, with less consumption of sulphur as fuel.

When the wall that closes the front opening, F, begins to heat, and the kiln is ready for running, a small hole is made with a pointed instrument, so as to allow the melted sulphur to flow off into wooden moulds. The horizontal flue or condensing chamber, H, should have a sloping floor, and when the temperature in it reaches the melting point of sulphur, the flowers that have been deposited on the sides are liquefied, and run off. Towards the end of the operation it will be found prudent to close all the dampers as well as the hole, N, to prevent the overheating of the kiln, in which case the sulphur would become thick, and difficult to run off, and the yield would consequently be lessened.

The first cost of the structure is slight, as the materials necessary are usually at hand. The yield too is much increased; but on the other hand the extra cost in charging, discharging, and attendance, as compared with the ordinary *calcarone*, make a large hole in the increased returns.

Doppione.—It will require little reflection to see that only a small quantity of the finely pulverised mineral, necessarily produced in the operations of mining and breaking down the ore, could be dealt with in the *calcarone;* consequently for a long time the bulk of this portion of the ore was simply thrown away, though it often assayed 70 per cent. of sulphur. The *doppione* was one of the earliest successful structures designed to remedy this state of things. As shown in Fig. 4, it consists of a set (generally six) of

Fig. 4.



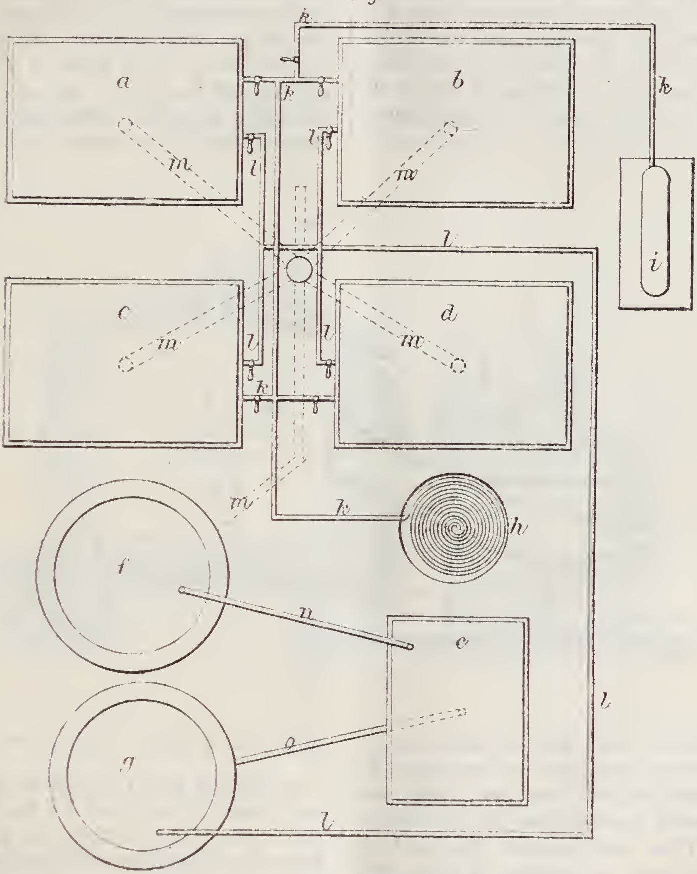
cast-iron pots, holding about 30 to 40 gallons each, arranged in a gallery furnace *e*, so as to be completely enveloped by the heated vapours from a fire beneath. Each pot, *a*, communicates by a long arm, *b*, with a cooling condenser, *c*, for the distilled sulphur, placed outside the furnace. The apparatus is generally employed on rich material, or on that obtained from the *calcaroni;* but it is also applicable to ores which are too poor to burn in the *calcaroni*, though the profit in that case must be small. The heat generated in the *doppione* is likely to encourage chemical action between the sulphur and any lime carbonate that may chance to be present in the mineral, creating a further loss of sulphur. The pots are charged and discharged by opening the lids, which are kept luted during the distillation. The volatilised sulphur is conducted by the cast-iron tub, *b*, into the receptacle, *c*, over which a small current of cold water constantly flows, reducing the sulphur to a fluid condition; it then escapes into the dish, *d*, beneath, whence it can be ladled into the moulds. The pots last for about 300 working days, and the furnace serves about the same time with a couple of repairings. The workman is expected to turn out 100 lb. of clean sulphur from every 109 lb. of *calcarone* sulphur.

Calcium chloride.—The principle underlying the use of calcium chloride is that, while raising the boiling point of water to about 239° F. (115° C.), the melting point of sulphur, it is cheap and inert in the presence of sulphur. The water to be used in the melting process is charged with 66 per cent. of the calcium chloride, and heated to boiling, in which state it is run into the vessel containing the sulphur to be melted. No doubt the sulphur is efficiently melted, but the very slight difference in specific gravity between the sulphur and the associated impurities from which it had been melted out practically precludes any real separation taking place. Consequently the process is virtually a failure, as I am assured by those who have worked it.

Steam.—At the Rabbit Hole mines, Humboldt county, Nevada, advantage is taken of the liquidity of sulphur at 232° F. (111° C.), to use steam at 60 to 70 lb. pressure for melting the sulphur out of the gangue. The apparatus employed consists of a cylindrical iron vessel, about 10½ ft. high, divided into an upper and a lower compartment, by means of a horizontal sheet iron diaphragm perforated with ¼-in. holes. As soon as the upper compartment is charged with ore (about 2 tons), steam is introduced for about half-an-hour, and the sulphur, liquefied by the heat, flows down through the diaphragm into the lower compartment, kept at the proper heat by injection of steam, and escapes by an outlet, opened at intervals into a receptacle placed outside. When water commences to flow out with the sulphur, steam is injected at full pressure for a few minutes, to clear out as much as will come, and the solid residue is afterwards removed through a door above the diaphragm. Each charge requires about three hours for its treatment. The process is adapted to ores which, for poverty and other reasons, cannot be economically worked by *calcaroni*, or other recognised methods.

Carbon Bisulphide.—Whilst hot water and steam have no solvent action upon sulphur, but merely

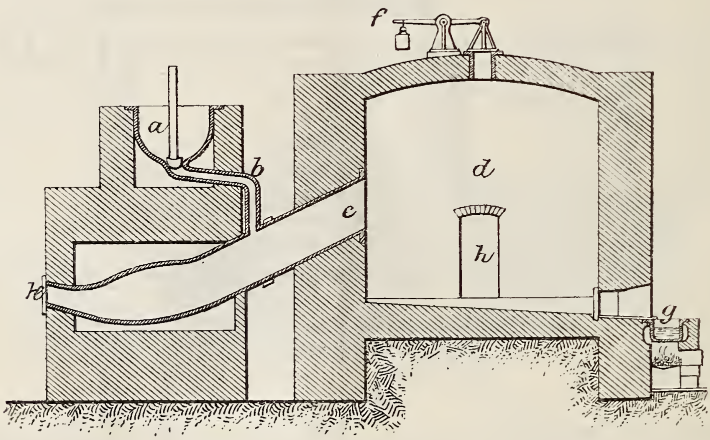
FIG. 5.



change it from a solid to a liquid state by the action of their heat, carbon bisulphide actually dissolves the sulphur and re-deposits it by evaporation. The plant necessary for carrying out this process is shown in Fig 5. It is designed of dimensions suitable for dealing with 20 tons of raw sulphur mineral per diem, yielding 50 per cent. of pure sulphur. The four extracting pans, *a*, *b*, *c*, *d*, have each a capacity of 5 tons, and are made of ⅜-in. wrought iron plate; they measure 6 ft. long, 4 ft. wide, and 4 ft. deep internally; and are fitted with a perforated bottom diaphragm, with connecting pipes, *m*, leading to the underground solution tank, *f*, with another set of pipes, *k*, for admitting steam from the boiler, *i*, and with a third set of pipes, *l*, communicating with the store tank, *g*. The still, *e*, is a steam jacketed "wrought jacket" pan, 6 ft. long, 4 ft. wide, and 4 ft. deep, with cast iron ("loam casting") oval-shaped bottom and ends, ½ in. thick, and provided with a dome-shaped lid, having an inlet pipe, *n*, and outlet pipe, *o*; its capacity is 3 tons. The store tank, *g*, measures 10 ft. in diameter, by 7 ft. deep, has a capacity of 10 tons, and is constructed of ½ in. wrought iron plates. The worm, *h*, is a coil of 2 in. pipe. The boiler, *i*, is of 20 horse-power nominal, and must be placed where it will be impossible for bisulphide vapours to find their way to the fire-hole. Force pumps are required to pump the bisulphide from the store tank, *g*, into the extracting vats, *a*, *b*, *c*, *d*, previously charged with the sulphur mineral. When the sulphur has been completely dissolved, the solution is run into the tank, *f*, and thence pumped into the still, *e*, where by the application of steam in the jacket, the bisulphide is evaporated, and passes into the store tank, *g*, for future use, while the sulphur forms a deposit in the still, and is collected therefrom. When the extracting pans have been emptied of solution, steam is let in so as to force any remaining bisulphide vapours into the worm for condensation and recovery, thus avoiding waste of bisulphide and consequent risk of fire and explosion by ignition of its dangerous vapours. The bisulphide is allowed to remain all night in contact with the charge. The diaphragm at the bottom of each extracting vat may advantageously be covered with bagging cloth to filter flocculent matters from the bisulphide.

Making Roll and Flowers of Brimstone.—For the preparation of "roll" and "flowers of" brimstone, the crude sulphur has to be again subjected to heat. The fusing apparatus, Fig. 6, generally consists of two cast-iron cylinders, *c*, measuring 3 ft. long, by 1 ft. in diameter, closed at one end by a door, *e*, and prolonged into a tube at the other, which leads into a brickwork condensing chamber, *d*. The retort, heated by a fire made immediately beneath, is completely surrounded by flues traversed by the heated vapours, which latter, before escaping to the chimney, heat a little pot, *a*, placed above the retort, and in direct communication with it by means of the pipe, *b*. Into the pot, *a*, is introduced the sulphur intended for distillation. It is raised to a temperature of 257° to 302° F. (125° to 150° C.), at which point the sulphur fuses, and flows, drop by drop, into the retort *c*, where it is vapourised, and whence it passes

Fig. 6.



into the chamber, *d*. The floor of this chamber is an inclined plane, converging to an aperture, *g*, by which the liquid sulphur flows out, while the "flowered" portion attaches itself to the walls of the chamber. These two forms (the liquid and the flowered) possess the same degree of purity, and their molecular difference depends only upon the varying grades of temperature under whose influence they are produced. An operation lasts about four hours. The door, *e*, facilitates the removal of spent refuse from the retort; the damper, *f*, regulates the draught and temperature in the chamber, *d*; and the door, *h*, gives access to the interior of the chamber, for the purpose of collecting the flowers of brimstone from the walls. The liquid sulphur, escaping at *g*, flows into a little pan, gently heated by a separate fire, and is thence ladled into wooden moulds suspended in a bath of cold water, to form the so-called "roll" or "stick" brimstone.

SCHOOL BOARD DRILL COMPETITION.

The Annual Drill Competition of Schools, under the London School Board, for the Challenge Banner given by the Society of Arts, took place on Saturday, July 5th, in Hyde-park, near Prince's-gate, in the presence of H.R.H. the Princess Louise, and the Marquis of Lorne, who acted as judge. Amongst the company present were the Duke of Buckingham and Chandos (chairman of the Executive Council of the International Health Exhibition), Mr. E. N. Buxton (chairman of the Board), Lord Reay, Lord Alfred S. Churchill, Captain Douglas Galton, C.B., F.R.S., Members of Council, and Mr. H. Trueman Wood, secretary of the Society of Arts, Sir Ughtred Kay-Shuttleworth, and Mr. S. Morley. The eleven schools represented were the Jessop-road, Brixton; Fairance-street, Limehouse; Harper-street, New Kent-road; Berwick-street, Soho; Lyndhurst-grove, Peckham; Bellenden-road, Peckham; Olga-street, Bethnal-green; Mina-road, Old Kent-road; Burrage-grove, Plumstead; Waterloo-street, Hammersmith; and the Gideon-road, Battersea. Each company was under the command of the masters of the respective schools, and the whole under that of Sergeant-Major Sheffield, drill instructor to the Board, while the music was supplied by the band of boys belonging to the training ship *Shaftesbury*. The drill commenced by the boys marching past in column, and then going through a serious of extension and flexion motions, after which each company was independently drilled. The whole of the boys, headed by the band, by invitation of the Executive Council of the Health Exhibition, marched to the Albert-hall, there to hear the award and witness the presentation of the banner by the Princess. Arrived in the hall, the Marquis of Lorne addressed the boys, and expressed the pleasure he and the Princess had felt in witnessing their proficiency in drill, which had been so good throughout that he had some difficulty in deciding which was the best company. The issue lay between the Gideon-street School (which held the banner for the past year) and the Berwick-street School; but a slight superiority in some of the minor evolutions had decided him and the committee to award the banner to the latter school. Two lads of the successful company then marched on to the platform and received the banner from the Princess, amid loud cheers. Mr. E. N. Buxton then thanked the Marquis and the Princess for their kindness in being present on the occasion, and added, as enhancing the value of their victory, that the winning boys laboured under the disadvantage of having no playground in which to drill at their school. The Marquis said the Princess wished to express the great importance she attached to physical exercise for boys and girls, and especially recommended the Swedish system for the latter as being particularly good. Besides its importance to health, drill, in a national sense, was by no means useless, as it made an excellent nursery both for our regular and auxiliary armies. The proceedings closed with three cheers for the Commissioners of the Health Exhibition, who had thrown it open to the boys for the remainder of the day.

PATENT-OFFICE REPORT.

The "First Report of the Comptroller-General of Patents, &c.," has just been printed, and is about to be issued to members of Parliament. By the Act of last year, the Comptroller is directed to submit to Parliament, before the 1st of June in every year, a report on the previous year; but inasmuch as the Act only came into force on the 1st of January, the only material available had to be sought in the first four months of the present year, and it is with that period that the document before us deals.

Under the Commissioners of Patents, whose rule was abolished by the Act, the practice was to report in August, by which time (the six months provisional protection of the applications sent in at the end of the previous year having expired) it was possible to give a twelvemonths' statistics in full, but the reason for this delay was not appreciated by the Grand Committee on Trade last year, and the earlier date was substituted.

The report, as far as it goes, seems satisfactory. It is obvious that it cannot go very far, since it only deals with a very short period during which there was little to do but receive the large number of applications attracted by the reduced cost of a patent under the new Act. That the office succeeded in dealing satisfactorily with the very large amount of work suddenly thrown upon it, is greatly to its credit. How sudden the pressure was, is shown by the fact that there were in January 2,499 applications, whereas the usual monthly average of recent years was about 500; and not only was the number increased fivefold, but the work in each case was much heavier. The provisional specifications were not merely pigeon-holed, as of old; they were all examined, and in a number of instances amendments were introduced at the suggestion of the examiners. As many as 2,484 communications of this nature were made by the Patent-office to applicants during the four months, the total number of applications being 7,060. Of the general character of the applications, the Comptroller does not express any opinion, but it may be remembered that a short time back it was officially stated that they were not apparently inferior to the average of former years. That 72 per cent. still pass through agents' hands, shows that the apprehensions of the patent agents of loss to their business from the passing of the Act were not well founded, but it is certainly remarkable that no larger proportion of inventors have availed themselves of the facilities thought to be offered for the obtaining of cheap patents directly from the office.

Of the 7,060 applications only 689 were accompanied by complete specifications, a proportion which seems to have surprised the Comptroller. As was pointed out in the *Times* last December, when the new patent rules were first issued, the drawback of immediate publication renders this method of proceeding less desirable than that by means of a provisional specification.

As the time has not yet arrived for the later stages of patents applied for during 1884, little appears about them in the report, reference being only made to some few which passed rapidly to the final proceedings, the applicants not having availed themselves of the full limit of time allowed. Nor have the cases been numerous in which existing patents have been affected by the new Act, since only a few applications for amendment of specifications have been received. It is, therefore, too soon to form any opinion as to the manner in which this part of the Act will work, or whether the plan of making the Comptroller sit as a sort of judge of first instance will answer.

The preparations for an illustrated journal of patented inventions are going on. The Comptroller has, as we anticipated last December, found that the descriptions given by inventors prove unsatisfactory, and announces that official descriptions will be prepared for the journal. It is stated that a few applicants have refused to furnish drawings for the journal, but no hint is given as to the fate awaiting these recalcitrant inventors.

An announcement is made that the indexes and abridgments published by the office are to be improved and completed. For a good many years a special staff has been engaged in preparing a full index of the "old law" specifications (from 1617 to 1852), and this is nearly completed. It is understood, though the report does not say so, that the completion of this work has been delayed in consequence of the special staff being employed in examining applications, and since the interest of the index is now almost wholly historical, the delay is, perhaps, no great matter. It is now intended to do what might well have been done before—to deal with the last 12 years or so (1870-1883) first, and work backwards to the historical periods. The subject-matter indexes are to be revised and consolidated, and the classified abridgments of specifications to be completed down to the end of last year. These are now sadly behindhand, none of the series going beyond 1876 and a large number stopping at 1866.

So far as can be judged from the financial statements appended, the office is working at a profit, notwithstanding the large reductions in fees; but the *data* for an accurate estimate are not given.

As regards designs and trade-marks, the alterations introduced by the Act appear, in the opinion of the Comptroller, to be working well; they are not of a very important character.—*The Times*.

OYSTER PRODUCTION AT ARCACHON.

The production of oysters in the Bay of Arcachon near Bordeaux, has, according to Consul Ward, become of late years a very important and lucrative branch of industry for the inhabitants, as well as the originators of the new method of breeding, which latter has had the result that the number of oysters now annually produced at Arcachon is greater than at any other place in Europe. During the year 1883, the number of oysters measuring at least 5 centimetres, or 1·95 inches in length and breadth, which were exported, is estimated to have reached about 173,000,000. The greater proportion of these were two or three years old, and were sold as "table" oysters, the remainder, though not inferior in size, were only one year and a-half old, and were forced by a peculiar process. This consists in placing the young oysters into so-called ambulances, that is, boxes with wooden sides and tops and bottoms, covered with galvanised wire, the boxes being fixed about a quarter of a yard above the ground. The oysters placed in these boxes grow about twice as rapidly as others which are merely placed in the beds. The chief reasons of the success of the Arcachon oyster beds are, on the one hand, the favourable condition of the water, which does not leave the beds dry for more than three hours at each tide, and thus causes the oysters to grow rapidly; and, on the other hand, the composition of the soil, a sort of blue clay, which is sufficiently hard to prevent the oysters from sinking down too deeply. The prolific production is also considered to be owing to the arrangement of tiles in the water along the sides of the oyster beds, the tiles having been previously dipped in a solution of lime; about 10,000 tiles are sufficient for a bed three acres in size, and after a short time from 50 to 1,200 oysters will collect upon each of the tiles. In consequence of the great productiveness of the Arcachon oyster beds, the French Government has lately prohibited oysters measuring less than 5 centimetres in length to be taken out of the bay for sale. The present price of oysters at Arcachon is considerably lower than 15 years ago, when only a few hundred thousand were exported annually; at the present date, oysters measuring over 7 centimetres fetch from 55 to 58 francs per 1,000, compared with 120 francs in 1870.

General Notes.

RAILWAYS BETWEEN FRANCE AND SPAIN.—According to the *Zeitschrift für Transportwesen und Strassenbau*, there are now three railways in contemplation, intended to augment the imperfect traffic facilities at present available between France and Spain, and regarding which Commissions appointed by the two countries will shortly make official reports. One line is intended to run from Pamplona in a north-easterly direction through the Roncal valley towards the French departments of Hautes Pyrenées and Haute Garonne. At the other end of the mountain chain there is intended to be a line built (without State help) from Lerida to the French departments of Ariège and Pyrenées Orientales, passing either through Arran or the more easterly valley of Noguera Pallares. The third project is favoured by the inhabitants of Arragon, and is a prolongation of the railway from Madrid to Saragossa and Huesca. At the Somport pass there will be a tunnel four miles in length, and the communication with the French railway system will be effected near Oloron on the Midi line. The French government has shown itself opposed to this last-named scheme, and even the Spanish government has manifested a preference for the Lerida-Arran line. Nevertheless, the works commenced in 1882 have so far been steadily proceeded with.

* Class 16. *Docks and Harbours.*—Models, plans, and designs for docks, harbours, piers, breakwaters, &c.; submarine constructions; diving apparatus; dredging machines; pile-drivers, screw piles; coffer-dams; graving docks, "patent" slips, caissons, pontoons, floating docks, hydraulic apparatus for working dock-gates, &c., gridirons. Buoys.

* ,, 17. *Lighthouses.*—Methods of construction; appliances used in lighthouses and in lightships, fixed and flashing light apparatus, lamps, sound signalling apparatus.

* ,, 18. *Rivers and Canals.*—Conservation and improvement of rivers; construction of canals; locks, lifts and inclines, weirs.

* ,, 19. *Water Supply and Sewerage.*—Methods of collecting, pumping, storing, filtering, and distributing water; appliances for detecting and preventing waste of water, water-meters; water fittings, filters; sewers, sewage disposal and utilisation.

,, 20. *Reclamation, Irrigation and Drainage of Land.*—Drainage (natural and artificial) of low-lying districts; embanking and warping land; irrigation works.

,, 21. *Testing Apparatus.*—Apparatus and instruments used in testing iron. stone, brick, concrete, cement, &c.

,, 22. *Military Engineering and Fortification.*—Military topography.

* ,, 23. *Materials used in Building.*—Bricks and tiles, machines for making them; concrete, artificial stone, cement, materials and appliances used in their production; asphalt; roofing felt, and other roofing materials; columns, girders, and other applications of metal in building; applications of terra cotta to buildings; preservative and fire-resisting materials, paints, &c., for application to stone, wood, iron, &c., methods of applying the same.

* ,, 24. *Building Construction.*—Models and plans showing methods of construction; non-combustible constructions; labour saving and other machines and appliances used in building, scaffolds, elevators; fittings and appliances used in buildings, shutters, blinds, lifts, bells, speaking-tubes, &c.

* ,, 25. *Heating, Ventilation, House-drainage, &c.*—Sanitary appliances; ventilators; cowls for chimneys, chimney-sweeping apparatus; apparatus for heating by steam, water, air, &c.; means of cooling air.

Group IV.—PRIME MOVERS, AND MEANS OF DISTRIBUTING THEIR POWER.

(For distribution of power by water, *see also* Group xi.; by electricity, *see* Group xiii.)

Class 26. *Steam-engines and Boilers.*—Stationary, portable, marine, locomotive; fireless locomotives; methods and means of preventing corrosion and incrustation; methods and appliances for preventing explosions, and for testing boilers; fire-grates, fire-feeders, smoke-consuming appliances; valves and valve gear, steam joints, governors, injectors, pumps; bearings, lubricators, anti-friction metals; indicators, gauges, manometers, tachometers, dynamometers.

,, 27. *Gas and Air-engines, &c.*—Gas-engines, hot-air engines, petroleum-engines, air-compressors, compressed air-engines; ammonia-engines, vapour-engines; accessories for the above.

,, 28. *Means of Utilising Natural Forces.*—Turbines, water-wheels, tide-mills; means of utilising wave-power; hydraulic rams, water-pressure engines; windmills, solar engines.

,, 29. *Means of Transmitting Power.*—Driving bands, shafts, pulleys, gearing, clutches, distribution of power by water or by air.

Group V.—RAILWAY PLANT.

(For construction of railways and tramways, *see* Group iii.; for locomotives, *see* Group iv.; for common road locomotives, *see* Group vi.; for signals *see also* Group xiii.)

Class 30. *Rolling Stock (excepting Locomotives)* —Carriages, trucks, waggons, vans; wheels, tyres, axles, springs, bearings, buffers, couplings.

„ 31. *Fixed and other Appliances.*—Switches, signals, crossings, turntables, switch-locks, communication with trains and in trains, water cranes and other modes of tender supply.

„ 32. *Brakes, Hand and Automatic.*—Screw, chain, compressed air, vacuum, steam, electrical.

„ 33. *Tramways.*—Rolling and fixed plant.

„ 34. *Atmospheric Railways, Portable Railways, &c.*—Rope railways, pneumatic dispatch.

Group VI.—COMMON ROAD CARRIAGES, &c.

(For farm wagons, &c., *see* Group i.)

Class 35. *Carriages for Common Roads.*—Steam, &c., carriages; pleasure and travelling carriages; cabs, omnibuses; hearses; trucks; carts; bath chairs; perambulators; ambulance carriages; machinery used in carriage, &c., construction; indicators; carriage lamps; carriage furniture and fittings; methods and means of propulsion.

„ 36. *Bicycles and Tricycles.*—" Cycles " of every description, and fittings for the same.

„ 37. *Saddlery and Harness.*—Horse clothing; whips; spurs; means and methods of breaking-in horses; disengaging runaway horses.

„ 38. *Farriery.*—Veterinary apparatus and material; medicines for horses, cattle, &c.; horse-shoes, machinery for making horse-shoes and horse-nails; methods of roughing horses; horse-clippers; grooming apparatus.

Group VII.—NAVAL ARCHITECTURE.

(For floating docks, and dredging apparatus, *see* Group iii.; for engines and marine engines, *see* Group iv.; for nautical instruments, *see* Group xxvii.)

*Class 39. *Ship and Boat Building.*—Construction and materials; sheathing, armour plating, launching; cleaning ships' bottoms, preventing fouling; raising sunken vessels, leak-stoppers, life-boats, life-rafts and fittings, life-saving apparatus; light-ships; submarine boats, torpedo boats; loading and discharging cargo.

* „ 40. *Ships' Fittings.*—Masts, sails, rigging, &c.; materials for sails, wire-rigging, self-reefing sails, use of steam power for working sails, anchors and chain cables, means for weighing anchor, steam winches, capstans, lowering ships' boats; pumping and ventilating arrangements.

„ 41. *Marine Propulsion (including Steering).* — Screw propellers, paddles, hydraulic propellers, river and canal propulsion, chain towing, hand, steam, and hydraulic steering gear.

Group VIII.—AERONAUTICS.

(For observing instruments, *see* Group xxviii.; for apparatus for balloon photography, *see* Group xxix.)

Class 42. *Balloons.*—Materials for balloons; methods of constructing and inflating; manufacture and transport of gas for the purpose; fittings; military and captive balloons; balloon equipment for field and siege purposes; fire-balloons; parachutes.

„ 43. *Aeronautic Apparatus.*—Flying machines; propelling and steering apparatus for such machines.

Group IX.—MANUFACTURE OF TEXTILE FABRICS.

(For dyes, mordants, &c., *see* Group xiv.)

Class 44. *Treating Raw Material.* — Cotton—picking, ginning, seed-cleaning, baleing, pressing, opening. Flax, jute, rheea, &c.—retting and its substitutes, breaking, scutching, heckling. Wool—clipping, sorting, washing, drying, heckling. Silk-rearing and feeding of silk-worms, reeling, winding, loading, conditioning.

" 45. *Preparing for Spinning.*—Combing and carding fibrous materials; manufacture of combs and cards.

" 46. *Spinning.*—Drawing, slubbing, roving, spinning, twisting, doubling, throwing, spooling, reeling, balling, &c. Making sewing and darning thread; reels, cops, and cop tubes.

" 47. *Preparing for Weaving.*—Sizing, warping, beaming, &c., yarns.

" 48. *Weaving.*—Weaving plain, figured, damask, and double fabrics, weaving carpets, velvets, and other pile and terry fabrics; weaving ribbons, tapes, &c., hose for water, sacks, sailcloth, hair; jacquards and apparatus for making jacquard cards, electrical and other substitutes; temples, pickers, including pneumatic and other modes of "handing" shuttles; harness, healds, and reeds, weft and other stoppers.

" 49. *Rug and Mat Making.*—Cocoa-nut and other fibre.

" 50. *Lace-making, &c.*—Manufacture of lace, knitted fabrics, hosiery, &c., net and meshed fabrics, nets, fringes, chenille, braid and plaited fabrics, elastic fabrics.

" 51. *Dressing and Finishing.*—Drying, stretching, ageing, dressing, finishing, singeing, shearing, folding, fulling, calendering, measuring, packing, and otherwise preparing for market.

" 52. *Felt-making.*—Manufacture of felted fabrics.

" 53. *Bleaching and Tissue Printing.*—Machines and appliances used in bleaching, dyeing, and printing fibres, yarns, and fabrics; mixtures used in bleaching and washing; dyeing patterns; resist and discharge printing; printing rollers and blocks. Dyeing materials and colours; thickeners.

" 54. *Rope-making.*—Manufacture of twine, cord, rope, safety fuses; materials used in the manufacture.

" 55. *Utilisation of Second-hand Materials and Waste Products.*—Mungo, shoddy, tow, oakum, waste silk, waste cotton.

Group X.—MACHINE TOOLS AND MACHINERY.

(For steam-hammers and forging machinery used in iron and steel making, *see* Group ii.; for machines for making horse-shoes and horse-nails, *see also* Group vi.)

Class 56. *Metal Working Machines.*—Lathes; planers; machines for punching, shearing, sawing, drilling, boring, slotting, shaping, milling, wheel-cutting, screw-cutting, rolling and bending, corrugating, stamping, coining, pressing, riveting, forging; emery wheels, grinding machines, rivet, nail, bolt, and screw-making machinery.

" 57. *Wood-working Machinery.*—Lathes (including lathes for ornamental turning), machines for sawing, planing, moulding, mortising, carving, veneering, cask-making. wheel-making, cork-cutting, &c.

" 58. *Stone-working Machinery.*—Machines for sawing, planing, turning, dressing, polishing, grinding, breaking and crushing stone and slate.;

Group XI.—HYDRAULIC MACHINES, PRESSES, MACHINES FOR RAISING HEAVY WEIGHTS, WEIGHING, &c.

(For hay and straw elevators, *see* Group i.; for elevators used in building, *see* Group iii.; for hydraulic rams, *see* Group iv.; for grain elevators, *see* Group xvii.; for chemical, &c., balances, *see* Group xxviii.)

Class 59. *Pumps, hand, steam, rotary, centrifugal.*—Ships' pumps, pumps for corrosive fluids; hydropults; syphons; methods of raising water; methods of obtaining, distributing, and equalising hydraulic power; accumulators.

* ,, 60. *Fire-engines.*—Fire-extinguishing apparatus; automatic apparatus for indicating and extinguishing fires; fire-escapes, ladders, fire-hose, accessory fittings and appliances; hydrants.

,, 61. *Cranes and other Lifting Apparatus.*—Hand, steam, and hydraulic cranes; travellers; elevators, jacks, capstans, windlasses, crabs, hoists, blocks, pulleys, derricks.

,, 62. *Hydraulic and other Presses.*

,, 63. *Weighing Machines (for commercial purposes).*—Steel-yards, platform weighing machines; commercial balances, scales, weights, &c., registering weighing machines, spring balances.

Group XII.—ELEMENTS OF MACHINES.

Class 64. *Mechanical Movements.*

,, 65. *Separate parts of Machines.*

Group XIII.—ELECTRICITY.

(For railway signals, *see* Group v.; for photometers, *see* Groups xv. and xxviii.; for scientific apparatus used in electrical research, *see* Group xxviii.)

Class 66. *Generators.*—Dynamos, primary and secondary batteries, thermo-electric batteries.

,, 67. *Conductors.*—Submarine cables and apparatus for laying them; aerial wires and underground cables; insulators and poles; insulating and coating materials; joints and connections; underground conduits; pipes, tubes, troughs, &c., electric light leads.

,, 68. *Testing and Measuring Apparatus.*—Galvanometers, magnetometers, dynamometers, volt-meters, current-meters, methods of testing.

,, 69. *Telegraphic and Telephonic Apparatus.*—Needle instruments, A.B.C. instruments, Morse instruments, type-printers, relays, duplex and quadruplex apparatus, keys, recording instruments, automatic transmitters, electric bells, indicators, telephones, microphones, lightning protectors.

,, 70. *Electric Lighting Apparatus.*—Lamps, resistance coils, cut-outs, safety catches, switches. Fittings for glow and other lamps.

,, 71. *Electro-metallurgy and Electro-chemistry.*—Methods of depositing and coating various metals. Electrotyping, galvano-plasty. Vats, cleaning and polishing apparatus, materials, tools, and appliances.

,, 72. *Distribution and Utilisation of Power.*—Electric railways, electric motors, electrically driven boats, tricycles, and other conveyances, systems of distribution.

,, 73. *Electric Signalling.*—Fire and burglar alarms, railway, ship, and time signals, water level and wind indicators, tell-tales, electric clocks, chronoscopes, &c.

CLASS 74. *Lightning conductors.*

" 75. *Electro-medical apparatus.*

" 76. *Electrolytic methods for extracting and purifying metals.*—Copper, zinc, lead, iron, refining the precious metals.

" 77. *Electro-Thermic Apparatus.*—Electrical apparatus for war, mining, blasting and other purposes.

GROUP XIV.—APPARATUS, PROCESSES, AND APPLIANCES CONNECTED WITH APPLIED CHEMISTRY AND PHYSICS.

(For chemical apparatus used in scientific research, *see* Group xxviii.)

CLASS 78. *Inorganic Products, and means used in obtaining them.*—Sulphuric and other acids, alkalies and ammonia, bleaching agents, dyes and dye-stuffs, salts, whitelead, pigments, and other paints, phosphorus, lucifer matches, disinfectants.

" 79. *Organic and Synthetical Products, and means used in obtaining them.*—Coal tar products, oils, soaps, and detergents, lubricating agents, candles, perfumery, paraffin, varnishes, manures.

" 80. *Apparatus and Appliances for Compressing and Liquefying Gases, and applications thereof.*

GROUP XV.—GAS AND OTHER ILLUMINANTS.

(For electric lighting, *see* Group xiii.; for gas-stoves, *see* Group xvi.; for photometrical apparatus, *see also* Group xxviii.)

CLASS 81. *Coal Gas.*—Manufacture, purification, storage, and distribution of gas; treatment of residues.

" 82. *Water Gas, Oil Gas, Carburetting Air, &c.*

" 83. *Tests and Photometrical Apparatus.*—Chemical tests; standards of light; measurement of light.

" 84. *Burners, and means of Utilising and Applying Gas.*—Gas fittings; burners for illuminating gas; devices for imparting luminosity to flame; gas-meters; methods of lighting gas; methods of increasing illuminating power of gas.

" 85. *Mineral and other Oils.*—Methods of obtaining; distilling and refining; testing.

" 86. *Candles, &c.*—Candles of wax, tallow, sperm, paraffin, &c.; night-lights, appliances used in the manufacture.

" 87. *Lamps for Oil and Spirits, Holders for Candles, &c.*

GROUP XVI.—FUEL, FURNACES, &c.

(For coke ovens and metallurgical furnaces, *see* Group ii.; for glass, &c., furnaces, *see* Group xxiii.)

CLASS 88. *Manufacture of Fuel.*—Materials and processes for the manufacture of artificial fuel; preparation and use of liquid fuel; preparation of peat; charcoal burning.

" 89. *Furnaces for Manufacturing Purposes.*—Furnaces for burning solid, pulverised, liquid and gaseous fuel.

* " 90. *Stoves for Coal, for Gas, for Oil, &c.*—Cooking stoves and kitchen ranges; domestic fire-places; gas cookers; gas burners for heating and cooking; petroleum and other stoves for heating and cooking.

Group XVII.—FOOD, COOKERY AND STIMULANTS.

(For the cooking of cattle food, *see* Group i.)

Class 91. *Machinery for Treating Grain and Flour.*—Machines for preparing and grinding corn and dressing flour, and other mill machinery; mill-stone dressers, roll turners, and similar machines; machines for milling and polishing rice; grain elevators; apparatus for drying grain; granary fittings.

* " 92. *Manufacturing Articles of Food.*—Apparatus for manufacturing and refining sugar; confectioners' machinery; machines and appliances for preparing mustard, spice, pepper, &c.; manufacture of salt.

* " 93. *Preserving Food.*—Methods, materials, and processes for preserving animal and vegetable food, machines for producing cold.

* " 94. *Bread and Biscuit Making.*—Kneading machines, biscuit and bread-making machines, ovens; processes for making bread.

* " 95. *Cooking Apparatus.*—Culinary utensils, chopping and mincing machines, apparatus for paring and slicing fruit and vegetables, cleaning fruit, washing and cleaning vegetables.

" 96. *Brewing, Distilling, and Wine-making.*—Machines and appliances connected with the manufacture and use of alcoholic drinks.

* " 97. *Manufacture of Aërated Waters.*—Machinery, materials, &c., used for the purpose. Stoppers and other appliances.

* " 98. *Infusions.*—Apparatus, &c., used in the preparation and use of tea, coffee, chocolate, &c.

* " 99. *Tobacco.*—Machinery, appliances, and processes for treating and using tobacco.

Group XVIII.—CLOTHING.

(For textile machinery, *see* Group ix.; for jewellery, &c., *see* Group xix.; for waterproof clothing *see* Group xxi.)

* Class 100. *Fabrics.*—Specimens of new materials, or materials recently applied to the manufacture of clothing.

* " 101. *Articles of Clothing.*—Specimens of clothing of novel construction.

* " 102. *Machinery and Apparatus.*—Machinery, &c., used in the production of articles of dress, sewing machines, knitting machines, machinery for the manufacture of boots, hats, gloves, &c., needles, and machinery employed in making them.

* " 103. *Cleaning Clothing.*—Washing and wringing machines, mangling, &c., machines; boot-cleaning machines; machines and processes for cleaning other articles of clothing.

* " 104. *Dress Fastenings, &c.*—Buttons, pins, hooks and eyes, machinery employed in their manufacture.

Group XIX.—JEWELLERY.

Class 105. *Jewellery and Personal Ornaments.*—Materials, apparatus for manufacture, &c.

Group XX.—LEATHER, &c.

(For saddlery, *see* Group vi.; for boots and shoes, *see* Group xviii.)

Class 106. *Manufacture of Leather.*—Materials, processes and appliances for cleaning, curing, preserving, unhairing, drying, tanning, dyeing, splitting, dressing, and otherwise preparing skins and hides. Specimens of leather prepared by new processes. Manufacture of parchment.

„ 107. *Treatment and Application of Leather (exclusive of saddlery and of boots and shoes).*—Methods of ornamenting, painting, polishing, staining, waterproofing, &c., leather.

„ 108. *Artificial Leather.*—Imitation leather, waterproof canvas, and tarpaulin.

Group XXI.—INDIA-RUBBER AND GUTTA-PERCHA, &c.

(For use of gutta-percha, &c., in electrical insulation, *see* Group xiii.; for artificial leather, *see* Group xx.; for kamptulicon, *see* Group xxi.)

Class 109. *Machinery for treating India-Rubber and Gutta-Percha.*—Washing machines, rasps, masticators, mixing machines, vulcanisers, spreading machines, thread-making machines, wire-covering machines; machines for manufacturing rubber goods, pressers, moulds, &c.; appliances for stereotyping in rubber.

„ 110. *Applications of India-Rubber and Gutta-Percha.*—Waterproof goods; elastic webbing; articles of unvulcanised and vulcanised rubber and gutta-percha, and fabrics prepared therewith; ebonite, vulcanite, and articles made therefrom; complex or insertion goods; kamptulicon, &c.; cements; grinding wheels; bottle-stoppers; printing rollers.

„ 111. *Substitutes for India-Rubber and Gutta-Percha, materials used in their treatment, &c.*—Natural substances available as substitutes; artificial substitutes; combinations of rubber or gutta-percha with other materials; rubber, &c., from new sources of supply; pigments, solvents, &c., used in the manufacture; celluloid and other preparations of nitrated cellulose.

Group XXII.—FURNITURE AND ACCESSORIES—FANCY GOODS.

(For bronzes and alloys, *see* Group ii.; for household fixtures, *see also* Group iii.; for manufacture of carpets, *see* Group ix.; for rug and mat making, *see also* Group ix.; for glass and china, *see* Group xxiii.; for paper hangings, *see* Group xxvi.)

* Class 112. *Furniture and Upholstery.*—Articles of furniture; machinery and processes used in their production; frames for pictures and mirrors; safes.

* „ 113. *Floor-coverings and wall-coverings (other than paper-hangings).*—Oilcloth; linoleum, kamptulicon; mats and matting; material, appliances, and processes used in their manufacture.

„ 114. *Artistic and ornamental metal work.*—Goldsmiths' and silversmiths' work; electro-plate; ornamental bronzes; appliances used in the manufacture.

„ 115. *Trunks, portmanteaux, &c.*—Dressing bags, cases, ivory horn and bone goods; travelling equipments.

„ 116. *Basket-work.*—Appliances for use in the manufacture.

„ 117. *Brushes.*—Materials; machines and appliances used in the manufacture; methods of brush-making.

„ 118. *Umbrellas, Parasols, and Walking Sticks.*—Machinery, &c., used in their manufacture.

Group XXIII.—POTTERY AND GLASS.

(For optical glass, *see* Group xxviii. : for glass apparatus, *see* Group xxviii.)

Class 119. *Kilns and Furnaces.*
,, 120. *Bricks, Tiles, Earthenware, &c.*—Terra cotta; architectural pottery; fire-clay goods; crucibles; drain-pipes; chemical and similar stoneware; materials, machinery, and apparatus.
,, 121. *Porcelain, Majolica, and Artistic Pottery.*—Biscuit ware, faience; Parian; materials, machinery, and apparatus.
,, 122. *Crown, Sheet, and Plate Glass.*—Window glass, mirrors, stained glass; glass mosaic; materials, machinery, and apparatus.
,, 123. *Bottles, Table Glass, Toughened Glass, &c.*—Materials, machinery, and apparatus.

Group. XXIV.—CUTLERY, IRONMONGERY, &c.

(For nail and screw-making machinery, *see* Section x.)

Class 124. *Cutlery and Tools.*—Engineers', carpenters', joiners' &c., tools.
,, 125. *Surgical Instruments and Appliances.*—
,, 126. *Files and Rasps.*—File-cutting machines.
,, 127. *Hardware.*—Hollow ware; ornamental castings; locks and bolts.
,, 128. *Screws, Nails, &c.*—Spikes, hinges; furniture fittings.

Group XXV.—FIRE-ARMS, MILITARY WEAPONS, AND EQUIPMENT; EXPLOSIVES.*

(For fortification, *see* Group iii.; for torpedo boats, *see* Group vii.; for special articles mentioned under "military equipment" *see also* respective classes.)

Class 129. *Ordnance.*—Heavy guns and means of working them; carriages and accessories; naval, siege, field, and mountain guns; machine guns; mitrailleuses; shells, and apparatus for their manufacture; apparatus used in testing, in measuring velocity, pressures, recoil, &c.
,, 130. *Fuses, Detonators.*—Appliances for firing guns, and for exploding shells, signal lights, war and signal rockets, life-saving rockets.
,, 131. *Guns, Rifles, Pistols.*—Military and sporting guns and rifles; revolvers; magazine guns; harpoon guns; air guns; machinery used in the manufacture of small arms; proving apparatus; targets.
,, 132. *Swords, Bayonets, Sappers' Tools, &c.*—Entrenching tools; shields; lances; dirks;
,, 133. *Gunpowder and Ammunition.*—Explosives generally, and apparatus used in their manufacture and testing; cartridges; cartridge cases.
,, 134. *Torpedoes.*—Submarine and subterranean torpedoes and mines, methods of laying, firing, and removing the same; naval torpedoes, means of carrying, projecting and firing the same.
,, 135. *Telemeters.*—Range-finders for artillery and submarine mine service.
,, 136. *Military Equipment.*—Photographic, telegraphic, pontoon, mining, signalling, hospital equipment; transport service.

* Explosive substances will under no circumstances be admitted. They must be represented by dummies or models.

Group XXVI.—PAPER, PRINTING, BOOKBINDING, STATIONERY, &c.

(For applications of photography to printing, *see also* Group xxix.)

Class 137. *Machines and Processes for the Manufacture of Paper, Paste-board and Papier-Mâché.*—Materials; manufacture of "half-stuff"; washing, beating, and bleaching engines; agitators, strainers, moulds; methods, &c., of glazing and planishing; methods of treating waste paper; appliances, &c., for treating and moulding papier-mâché; manufacture of artificial parchment; recovery of waste products, and preventing the pollution of streams.

" 138. *Machines, &c., for Cutting, Folding, and Ornamenting Paper.*—Stamping; embossing; envelope and bag making; manufacture of playing cards; chromo-lithography; paper box machines; marbling; perforating; ruling; waterproofing; enamelling.

" 139. *Paper-hangings.*—Printing machines; apparatus for engraving printing rollers; materials; tests for injurious materials.

" 140. *Letter-press and other Printing.*—Printing machines and presses; glazing and hot-pressing apparatus; apparatus, &c., for type-founding; lithographic machinery, materials, &c.; stereotyping apparatus, &c.; methods of anastatic printing; process blocks from autographic drawings; wood blocks; engraving machines; machines for cutting wood letter; type-setting machines, numbering machines, printers' furniture and locking-up appliances; production of printing surfaces; methods of printing cheques, bank-notes, &c.

" 141. *Bookbinding, Manufacture of Portfolios, &c., Applications of Papier-Mâché.*—Materials; bookbinding machines, wire-stitching machines, cutting presses, rounding machines, backing machines, arming presses; account books, desks, cases, &c., for stationery, &c.; purses.

" 142. *Artists' Implements and Materials.*—Pencils, brushes, colours and varnishes, easels, crayons, palettes, palette knives, drawing boards, drawing instruments, pencil sharpeners.

" 143. *Writing Materials and Appliances.*—Type-writers; manifold writers; copying presses and processes; processes for multiplying copies of MS.; pens; ink; penholders; inkstands; sealing-wax; stationery.

Group XXVII.—CLOCKS, WATCHES, AND OTHER TIME-KEEPERS.

(For electrical clocks, *see also* Group xiii.)

Class 144. *Clocks.*—Timepieces and other domestic clocks; regulators and astronomical clocks; watchman's, calendar, turret, electrical and pneumatic clocks; hour-glasses, sun-dials, water-clocks.

" 145. *Time Signals, &c.*—Methods of controlling and synchronising clocks; apparatus for the distribution and signalling of time; also for the determination of time by astronomical observations.

" 146. *Watches and Chronometers.*—Examples illustrative of stages of manufacture and of the different types of watches and of chronometers; keyless, chronograph, repeating, calendar, and other forms of watches.

" 147. *Tools, &c.*—Lathes and mandrils; wheel-cutting engines; machine tools for producing the several parts of watches on the "interchangeable" system; various hand-tools used in the manufacture and repair of clocks and watches; gauges and templates; appliances used in case-making.

Group XXVIII.—PHILOSOPHICAL INSTRUMENTS AND APPARATUS.

(For testing machinery, *see* Group iii.; for commercial weighing apparatus, *see* Group xi.; for practical applications of electrical apparatus, *see* Group xiii; for industrial applications of chemistry, *see* Group xiv.)

Class 148. *Optical.*—Lenses, prisms, telescopes, microscopes and accessories, spectroscopes, polariscopes, polarimeters, stereoscopes, photographic lenses, spectacles, eye-glasses, optical glass.

„ 149. *Astronomical.*—Telescopes (astronomical), transit instruments, equatorials, mural circles, driving clocks, siderostats, heliostats, altazimuths, methods of fitting observatories and mounting instruments.

„ 150. *Physical.*—Acoustic apparatus, tuning forks, sirens, phonautographs, phonographs; apparatus connected with molecular physics, air-pumps, manometers, radiometers; apparatus for measuring, &c., heat, thermometers, pyrometers, calorimeters; photometers; kinematic, static and dynamical apparatus, mechanics.

„ 151. *Electrical.*—Friction and induction machines, batteries and other sources of electricity, Leyden jars, condensers, electroscopes, electrometers, galvanometers, voltameters, dynamometers, magnetometers, rheostats, resistances, electrical units, induction coils, thermopiles, vacuum tubes.

„ 1 *Chemical.*—Thermometers, hydrometers, pyrometers, furnaces, blowpipe apparatus, assaying apparatus, apparatus for organic and inorganic analysis, for gas analysis, and for volumetric analysis, laboratory fittings and apparatus generally, balances, reagents.

„ 153. *Mathematical.*—Calculating machines, indicating and registering apparatus, pedometers, counting machines, slide rules, planimeters, drawing instruments, ellipsographs, straight-edges, gauges, surface planes, dividing engines, pantographs, eidographs.

* „ 154. *Meteorological.*—Barometers, thermometers, rain gauges, manometers, hygrometers, aneroids, anemometers, ozonometers, storm-signalling apparatus.

„ 155. *Geographical.*—Surveying apparatus, theodolites, chains, levels; underground surveying apparatus; apparatus for hydrographic surveying, and for marine investigations and observations; hypsometrical instruments, tide gauges; seismographical apparatus; projections, maps, charts, models, and globes.

* „ 156. *Nautical.*—Sextants, quadrants, sounding apparatus, logs, compasses.

„ 157. *Weighing and Measuring.*—Weights, scales, balances; measures of length, graduated scales, verniers, steel tapes; measures of capacity; instruments for angular measurement, clinometers, goniometers.

„ 158. *Biological.*—Apparatus for anatomical research; physiological apparatus; apparatus for collecting and preserving natural history specimens.

Group XXIX.—PHOTOGRAPHY.

(For applications of photography to printing, *see also* Group xxvi.; for photographic lenses, *see* Group xxviii.)

Class 159. *Processes and their results.*—Methods of gelatino-bromide plate-making, apparatus for making emulsion, apparatus for separating the sensitive constituent, coating, drying and packing machines; emulsion and other processes; printing processes, silver, carbon, Woodbury-type, platinotype, gelatino-bromide, collodio-chloride of silver, &c., apparatus for washing, &c., prints and negatives; methods for making photographic lantern slides.

CLASS 160. *Apparatus (excluding lenses).*—Cameras, shutters, changing-boxes, slides, tents, lamps; apparatus for making enlargements and for micro-photography.

" 161. *Application of Photography to various purposes, Typography, Ceramics, Relief-moulds, &c.*—Method of producing printing surfaces; photographic enamels, photographic printing on pottery; photographic reliefs. Use of photography in self-recording apparatus, in scientific observations, &c.

GROUP XXX.—EDUCATIONAL APPARATUS.

* CLASS 162. *Models and Apparatus.*—Appliances used in primary, scientific, technical, and artistic instruction.

GROUP XXXI.—TOYS, SPORTS, &c.

(For sporting guns, *see* Group xxv.)

CLASS 163. *Toys, Games, and Exercises.*—Outdoor games; gymnastic apparatus; skates, artificial skating surfaces; indoor games; billiard tables.

* " 164. *Field Sports.*—Apparatus used in hunting, fishing, shooting, &c.; traps for animals, birds, vermin, &c.

" 165. *Scenic and Dramatic Effects.*—Theatrical fittings and apparatus; optical (magic) lanterns and apparatus for illuminating them.

DIVISION II.—MUSIC.

GROUP XXXII.—INSTRUMENTS AND APPLIANCES CONSTRUCTED OR IN USE SINCE 1800.

CLASS 166. *Organs.*—Details of construction; machines for blowing, hydraulic or otherwise; details of mechanism and the construction of pipes; pneumatic apparatus for keyboards and couplers, electric appliances, designs for organs, designs for organ-cases.

" 167. *Harmoniums.*—American organ, vocalions, concertinas, accordions, varieties of reeds and air-channels, details of construction.

" 168. *Wind Orchestral Instruments.*—(*a*) Wood; (*b*) Brass.

" 169. *Pianofortes* (Grand, square, and upright).—Models of framings, castings, models of actions, pedal appliances, mechanical devices for tuning and transposing, wire and other material used in construction, designs for cases.

" 170. *Violins, and instruments of the Violin family; also Bows, strings;* and inventions connected with these instruments.

" 171. *Harps.*

" 172. *Automatic and Barrel Instruments.*

,, 173. *Drums, Cymbals, and other instruments of percussion.*
,, 174. *Bells and Carillons.*
,, 175. *National Instruments of all countries not ordinarily used in orchestras.*
,, 176. *Sirens, Tuning Forks, Pitch Pipes, Tonometers,* and appliances for the determination of pitch.
,, 177. *Miscellaneous Musical Appliances.*—Metronomes, desks, seats, appliances for forming the hand ; instruments for recording improvisation.

Group XXXIII.—MUSIC, ENGRAVING, AND PRINTING.

Class 178. *Printed and Engraved Music; and Machines and Appliances for its production.*

Group XXXIV.—HISTORIC COLLECTIONS.

Class 179. *Musical Instruments and Appliances.*
,, 180. *Pictures, Engravings, and Drawings of Musical Subjects.*

INTERNATIONAL INVENTIONS EXHIBITION, 1885.

CLASSIFICATION.

(UNDER REVISION).

NOTE.

The heads given below are not intended to be exhaustive, but are rather to be regarded as indicative of the proposed scope of each class.

Only under exceptional circumstances can applications be entertained for space for objects which have been shown in the Smoke Abatement Exhibition, 1881*; the Fisheries Exhibition,* 1883*; or the Exhibition of Health and Education,* 1884*; or for Agricultural Implements. The space allotted to those Classes marked with an asterisk, will therefore be very limited.*

DIVISION I.—APPARATUS, APPLIANCES, PROCESSES, AND PRODUCTS, INVENTED OR BROUGHT INTO USE SINCE 1862.

Group I.—AGRICULTURE, HORTICULTURE, AND ARBORICULTURE.

(For land drainage, reclamation, &c., *see* Group iii.; for agricultural engines, *see* Group iv.; for manure *see* Group xiv.; for milling machinery, *see* Group xvii.)

* Class 1. *Field Implements.*—Ploughs, drain-ploughs, cultivators, steam-diggers, harrows, drills, haymakers, horse-hoes, rakes, reapers, mowers, binders, anchors and rope porters, wagons, wagon-harness.

* ,, 2. *Barn and Farm-yard Implements.*—Thrashing machines, screens, winnowers, corn-cleaning machines, hay and straw elevators, hay and straw and fresh fodder compressors, turnip-cutters, chaff-cutters, grist mills, horse-gear, crop dryers.

* ,, 3. *Dairy and Poultry-Farm Appliances.*—Milking appliances, cream-separators, churns, cheese-making apparatus, apparatus for manufacturing butterine, incubators.

* ,, 4. *Agricultural Construction.*—Models, plans and designs for farm buildings, oast houses, siloes, rickstands, &c.

* ,, 5. *Cattle Food.*—Materials, processes, apparatus, seed mills, cake crushers, boilers, steamers and cooking apparatus; feeding appliances.

,, 6. *Horticultural Apparatus.*—Hot-houses, frames, greenhouses, orchard houses, graperies, boiler and heating apparatus, lawn mowers, watering apparatus, tools and implements, pots and plant boxes, garden wire work, chairs, &c., plant labels.

,, 7. *Arboriculture.*—Apparatus, &c., used in forestry; methods and material for the preservation from decay of trees and timber.

Group II.—MINING AND METALLURGY.

(For stone-working machinery and testing machines, *see* Group x.; for metal-working machinery, *see* Group x.; for slate sawing and dressing machines, *see also* Group x.; for electrolytic methods extracting, &c., metals, *see* Group xiii.; for furnaces in general, *see* Group xvi.; for manufacture of fuel, *see also* Group xvi.; for explosives, *see also* Group xxv.; for mine-surveying apparatus, *see also* Group xxviii.)

Class 8. *Machinery and Appliances used in Mines and Quarries.*—Prospecting searching, boring, shaft sinking, exploring, working, hauling, pumping, winding, hoisting; man engines, safety catches, safety hooks, hydraulic mining; tools, drills, cutters, getters, breakers, air compressors; blasting substitutes for explosives. Ventilating, lighting. Aids to respiration in mines. Life-saving appliances. Washing and dressing coal and other minerals, crushers, pulverisers, disintegrators, stamps, screens, riddles, separators, classifyers, jiggers, buddles, precipitators, sawing-machines. Utilisation of waste.

„ 9. *Production and Manufacture of Iron and Steel.*—Coke ovens, blast and other furnaces; Bessemer plant, Siemens plant, other processes for making iron and steel; blast engines; hot-blast stoves; steam and other hammers; rolling machines, hydraulic and other forging machines, squeezers and other shingling apparatus; production and use of malleable cast iron; wire-making apparatus; manufacture of tin plate, utilisation of gases and of slag; alloys and artificial compounds of iron with non-metallic elements.

„ 10. *Forging and Foundry Work.*—Cupolas, air furnaces, pot furnaces; moulding machines, plate-moulding; forges, forging machines; blowers, bellows, fans.

„ 11. *Metallurgy of Metals other than Iron, with the exception of the precious metals. Alloys.*—Furnaces and appliances used in the dry and wet methods of extracting and purifying copper; extraction of lead; metallurgy of zinc, tin, nickel, cobalt, bismuth, antimony, arsenic, mercury, aluminium; manufacture of sheet lead, lead pipe, Muntz's metal, sheet zinc, copper and brass tubes; bronzes, German silver and other nickel alloys; wires of copper and its alloys.

„ 12. *Metallurgy of the precious metals, Gold, Silver, and Platinum.*—Furnaces and appliances used in the dry and wet methods of extracting the precious metals; desilverisation of lead; amalgamation in all its forms, refining gold and silver; purification, melting and working of platinum and its alloys.

Group III.—ENGINEERING CONSTRUCTION AND ARCHITECTURE.

(For railway plant, *see* Group v.; for launching ships, *see* Group vii.; for surveying instruments, *see* Group xxviii.)

Class 13. *Roads.*—Methods and materials for constructing and paving roads; cleansing roads and pavements; road-sweeping machines; rollers; apparatus for the removal of mud, snow, &c.; water-carts and other means of watering.

„ 14. *Railways and Tramways.*—Construction; excavators and appliances used for earth-work and tunnelling. Permanent way; rails, chairs, sleepers.

„ 15. *Bridges and Viaducts.*—Models, plans, and designs for arched, girder, suspension, trestle, and other bridges; apparatus used in construction.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

THE ALBERT MEDAL.

The Council of the Society of Arts attended on the 16th inst., at Marlborough-house, when his Royal Highness the Prince of Wales presented to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., the Albert Medal awarded to him in 1883, "for the eminent services which, as a botanist and scientific traveller, and a Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce, by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire," and to Captain James Buchanan Eads, the distinguished American engineer, the Albert Medal for the present year, awarded to him "for his works, which have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

The members of Council present were Sir Frederick Abel, C.B., F.R.S., chairman, Sir George Birdwood, Sir Frederick Bramwell, Mr. Brudenell Carter, Mr. Andrew Cassels, Mr. Edwin Chadwick, C.B., Mr. T. R. Crampton, Professor Dewar, F.R.S., Capt. Douglas Galton, F.R.S., Sir John Lubbock, Bart., F.R.S., Mr. J. M. Maclean, Mr. W. G. Pedder, Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., Lord Reay, Mr. Owen Roberts, Lord Sudeley, Sir Richard Temple, Bart., G.C.S.I., Colonel Webber, C.B., with Mr. H. Trueman Wood, secretary, and Mr. H. B. Wheatley, assistant secretary.

WATER SUPPLY CONFERENCE.

The Conference on Water Supply by the Society of Arts, will be held at the Health Exhibition on the 24th and 25th inst. The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m. The proceedings will be opened on Thursday, at 11, by the Chairman. The papers and discussions will be arranged under the following heads:—1. Sources of Supply. 2. Quality of Water; Filtration and Softening. 3. Methods of Distribution; modes of giving pressure; house fittings; discovery and prevention of waste, &c., &c. The proceedings will be continued on Friday, and, if necessary, on Saturday. The readers of papers will be restricted to twenty-five minutes. Speakers will be restricted to ten minutes. The papers to be read will, in most instances, be printed and distributed in the room. Members desiring to attend the Conference will be furnished with tickets admitting to the Exhibition and to the Conference-room, on application to the Secretary of the Society of Arts, John-street, Adelphi.

INTERNATIONAL EXHIBITION OF INVENTIONS, 1885.

A supplement issued with the present number of the *Journal*, gives the full text of the Classification for the International Exhibition of Inventions to be held next year at South Kensington. As already announced, the Exhibition will consist of two Divisions, the first to consist of apparatus, appliances, processes, or products, invented or brought into use since 1862, and the second of examples of musical instruments of a date not earlier than the commencement of the present century. Division II. will also comprise machinery, apparatus, and appliances connected with music, and, in addition, historical collections of musical instruments, and paintings and engravings representing musical subjects.

The Executive Council, of which Sir Frederick Bramwell is chairman, have issued a series of regulations indicating the scope of the Exhibition, and the limitations which have been considered necessary in order to confine it within the available space. It is announced that the space devoted to those subjects which may be considered to have been sufficiently illustrated in recent exhibitions will be limited, and regulations have also been made as to the admission of large machines, or of models illustrating their working.

Applications from intending exhibitors are to be made not later than the 15th of September, and it is promised that the allotment of space will be completed by the beginning of December.

For further information, copies of the regulations, prospectuses, forms, &c., application should be made to the Secretary of the Exhibition, Mr. Edward Cunliffe-Owen, at the Exhibition-offices, South Kensington.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS USED FOR COINAGE.

By W. Chandler Roberts, F.R.S.
Chemist of the Royal Mint; Professor of Metallurgy, Royal School of Mines.

Lecture I.—Delivered Monday, Mar. 17, 1884.

At a very critical period of the history of the alloys used for coinage, one of the earliest of the English political economists, William Stafford, dedicated a little work to Queen Elizabeth, in which, under the form of a dialogue sustained by a knight, a doctor, and a merchant, he shows a keen appreciation of the conditions which a metallic currency has to meet.

The doctor complains of the base alloys circulated as coin in the previous reign, to which the knight (who tells us incidentally that he "was once in Parliament") replies:—"Forsooth, and such a dullard am I indeed, yt I cannot perceave what hinderance it should be to the realm to have this metal more than that for our coyne, seeing the coyne is but a token to goe from man to man when it is stricken with the prince's seale. . . . If ye prayse the gold for his weight and pliableness, led [lead] doth excel it in these pointes; if ye commend his colour, silver bye many men's judgement passeth him." The doctor then enters on an eloquent defence of the use of the precious metals for coinage, and sets forth what he calls "a briefe conceipte of English pollicye with regard to currency."*

* London, 1581.

At the present day, preference for one metal more than another, or for the simultaneous use of two metals, as standards of value, is widely and forcibly expressed; but although it is generally known that neither sovereigns nor shillings are made of pure gold or pure silver, few people have very definite ideas as to the composition of the alloys which are employed in coinage, and still fewer are aware that the amount of base metal added to the precious one is guarded with the most rigorous care. As showing the national importance of the subject, it may be mentioned that between 700 and 800 tons of the alloy of gold and copper constitute the gold coinage of this country.

There is a great difficulty in tracing, chronologically and in detail, the history of the mechanical side of the art of coining, because its progress has been by no means continuous. Certain types of machines have survived persistently in some countries, and have been abandoned in others often to be again introduced with or without modification. A good illustration of this difficulty is presented by the fact that the method of coinage practised in this country under the Plantagenet kings is still met with in native mints in India; and, conversely, a machine—the *mouton*—used for striking coins in France and Italy, and abandoned in the 13th century, is now employed in Birmingham, and in the Mint of this country, in the preparation of medal clasps. Again, the screw-press, invented in the 14th century, and long used for coining, is employed for striking medals in all mints in almost its primitive form; while a machine the action of which depends on a very different principle, is as universally adopted for striking coins.

It is safe, however, to conclude that while in civilised countries, at least since the 13th century, the designs of coins have always fairly represented the general artistic culture of the periods at which they were struck, the appliances used in their manufacture have, at times, been distinctly behind the mechanical science of their days, as indicated in other technical arts. For the last fifty years, until the year 1882, the Mint in this country presented a striking example of this, as its machinery was admitted to be antiquated, while the general progress of mechanical science, during the same period, was probably greater than at any other time.

Further, there can be no doubt that, viewed from a modern standpoint, there have been periods during which the work of the metallurgist—in the purification of precious metals, in alloying them, and in verifying their "standards"—has been greatly in advance of that of the artist who engraved the dies, or of the mechanician who struck the coins.

The historian of the coinage of Great Britain begins his great work* by stating that "in the most early stage of society, when the wants of man were confined to the absolute necessaries of life, barter may be sufficient for every purpose of exchange. But this is a point at which society cannot long remain fixed; and the first step towards civilisation introduces a train of wants that will require a more perfect medium of commerce; something which, by general consent, shall be received at a determinate value, in exchange for all other things." The problem is, however, by no means a simple one, and it is usual, in even the most elementary works, to give examples of articles, such as fruits, shells, and skins, which have been used in abortive attempts to find this common medium of exchange, under the adverse circumstances of imperfect civilisation.

M. Boucher de Perthes held that prehistoric stone implements were among the earliest mediums of exchange, a suggestion which Jevons considers not improbable. Metallic implements certainly would meet many of the necessary conditions of money. Even with regard to metals, I may remind you that Artemus Ward felt he must refuse the coffin-plates† and door-knockers offered him for admission to his lecture, for, although these were metallic, fairly portable, and may even have borne engraved devices, they did not meet the necessary condition of being universally acceptable.

The circulation of gold and silver by weight approached nearest to the convenience of coins; but even this method was open to the objection that the masses of metal bore no external evidence of their value, and, therefore, much time had to be devoted to weighing or assaying them, and these difficulties were not removed until coined money was devised, the stamp being an authoritative indication of its weight, standard, and value.

The commodity for exchange must be in such general use as to ensure the certainty of its being readily acceptable, and further, as Nicolas Oresme pointed out in the 14th century, it must be of value, *materia preciosa et cara*;* or as a later writer, Rice Vaughan, said in 1675, money should be made of a material which is not too common, "something not easy to be consumed with use, or spoiled for want of use." Further, it must be portable.† "I confesse" (said William Stafford), "precious stones do excell siluer, or yet golde as in value or lightness of carriage, but then, they may not be deuided without injury, nor yet put agayne together after they be once deuided." ‡

* "Annals of the Coinage," by the Rev. Rogers Ruding. 3rd edition, 1840.

† "Travels." English ed., p. 98.

The quality of being easily divided is very important. "The tailor," says Jevons, as we are reminded in several treatises on political economy, "may have a coat ready to exchange, but it much exceeds the value of the bread which he wishes to get from the baker. He cannot cut the coat up without destroying the value of his handiwork."

That is no reason, however, why articles of clothing most needed should not be represented by metallic symbols, as was actually done in a very early form of Chinese money, which was not struck but cast. These curious coins are said to go back four thousand one hundred years, and to have been made certainly in the time of Yaou B.C., 3256.§ The coin from the Mint collection (of which a drawing was provided), represents a Chinese shirt, and, in fact, pieces of cloth, or these metallic equivalents, were used, as Sir John Lubbock has pointed out, "in some measure, as a standard of value, almost as grey shirting is even now."||

Lenormant, speaking of Roman coins, considers that casting did not precede striking, and, quoting Mommsen, he points out that the Romans adopted the method of casting for the sake of cheapness and speed.¶ Information respecting the details of the method of casting will be found in papers published in the *Numismatic Chronicle*, from which it appears that, "under the reigns of the Cæsars, Constans, and Constantius, there were cast, in a mint established at Bibé, large quantities of money with the stamp of the emperors who had reigned from Caracalla to

* "Traictie des Monnoies, de Nichole Oresme," abou 1370; reprinted with elaborate notes, by M. L. Wolowski. Paris: 1864.

† "Discourse of Coins and Coinage," by Rice Vaughan, Esq., p. 2. 1675.

‡ "A brief conceipte of English Policy," p. 29. London: 1581.

§ Trans. China Branch of the Royal Asiatic Society, Part II., 1848-50, p. 1.

|| *Nineteenth Century*, No. 33, p. 789, November, 1879.

¶ Lenormant, "La Monnaie dans l'antiquité," Paris 1878, t. 1., p. 274.

Postumus, and that this manufactory did not belong to forgers, but was for the imperial money, copper money being struck with the die of the reigning emperors, and the silver money of the ancient Cæsars, still more adulterated than the original pieces, being reproduced by founding."*

With reference to the casting of money, I may add that, until the close of the 15th century, the beautiful medals, such as those of Giulio Romano, were all cast in fine sand moulds, and not struck, and that the use of cast money was revived in Europe in the year 1791, when a coinage of bell metal was cast in France under the the following circumstances:—In that year the bells of certain churches, which had been suppressed by order of the National Assembly, were ordered to be converted into coin. M. l'Abbé Rochon suggested that these should be cast in sand and not struck, and he pointed out, in an official report, that a "skillful moulder could easily cast 2,400 pieces in a day.† M. Dumas states that this bell metal was of two kinds; one variety, containing 20 to 22 per cent. of white metals, was cast directly into coins in sand moulds; and the other, containing only 10 to 12 per cent. of metals other than copper, was cast into strips of metal of the right thickness for cutting into discs without rolling. Over 19,000,000 francs' worth of these bell metal coins were subsequently converted into the bronze coins now circulating in France.‡

The early Greek coins, from an artistic point of view, present but little evidence of mechanical skill other than that involved in engraving the dies; but I purpose, before dealing with the alloys used for coinage, to trace the gradual development of the mechanical processes of coining from these earliest types until the introduction of the machinery now in use. It will not be necessary to deal with the existing appliances, as they have recently been fully described,§ and because they can be seen in operation at any time in the Mint. I shall, however, subsequently allude to the balances by which the weight and fineness of the coins is ascertained.

To return to the older methods. Nuggets, either of electrum or gold, presented a more or less convenient shape for direct conversion of coin, but if the precious metal had first to be melted as a preliminary stage of its conversion, then some kind of moulding was necessary. In the early days, a globular forms seem to have been given to the precious metal, by allowing it to fall in a molten state, through orifices so as to produce globular shot. These were placed on an anvil, and received a blow which served to flatten them, and at the same time to impress a device from an engraved die on their surface. Unstruck globules of the kind described have been found, lying with finished coin, at Reculver, in Kent.

As soon as the stamping of irregularly shaped portions of metal gave place to coins of rough, but more or less regular form, certain mechanical devices had to be adopted. First, the portion of metal to be converted into coin had to be fashioned by moulding into shape either a disc or a hemispherical mass. When the latter form was adopted, the device appeared on one side in high relief, and on the other in low relief. In either case the metal was probably cast into a shape approximating to that of the finished coin, and the more prominent features of the relief were given to the disc by casting. The early dies were made of an alloy of copper and tin. Such alloys are capable of being made of great hardness, but there is abundant evidence to show that the blanks were often, if not always, struck hot; and mechanically speaking, coinage must have been a very imperfect art before the art of hardening steel was well understood.

The Roman dies were shaped liked a sugar-loaf, and the flat bases bearing the engraved devices were of the diameter of the pieces to be struck. Both the obverse and reverse dies were sunk in metallic cylinders, the diameters of which were considerably larger than the dies. The lower cylinder bore a kind of rim which did not in any way restrain the lateral spreading of the metal to be struck, but prevented its ejection if the blow was incorrectly imparted to the upper die.

We owe descriptions of these very early methods of coining to M. l'Abbé Barthelemy,* a well-known antiquary of the last century, and to M. Mongez†, who repeated what were believed to be the ancient methods of producing dies and striking coins, and showed that the entire process might be performed with great rapidity.

It is probable that the use of cast globules of metal was followed by that of cast cylindrical rods of approximately the diameter of the

* *Numismatic Chronicle*, p. 147, *et seq.*, vol i, 1838-9.

† "Apperçu Presenté au Comité des Monnoies," p. 17.

‡ Dumas, "Notes sur l'emission en France des monnaies decimales de bronze," Paris, 1868, p. 11.

§ "Ency. Brit." 9th Ed., Article Mint, 1883.

* Mém: de l'Académiè des Inscriptions, t. xxiii, and xxiv.

† *Ibid*, nouv. sér., t. ix, p. 208.

coins; pieces cut transversely from these cylinders would, of course, be circular, and could be easily adjusted in weight. There is no reason to believe that this method long survived in the English Mints, but it is still practised in India, into which country it was probably introduced previous to its invasion by the Greeks. The beautiful coins of the Emperor Akbar were struck by this method*. That it is still retained in India is shown by the following description of the process, as conducted at the Cabul Mint.† "Silver, refined by cupellation, is melted with an equal amount of English rupees, and the mixture is ladled by hand into moulds, which give it the shape of flattened bars, twelve inches long. These bars are taken to a shed to be annealed by hammering, and given the form of slender round rods. These rods are drawn through a perforated iron plate, to give them a uniform circumference, after which they are cut by a chisel into short lengths or slices, of a size requisite to form the future rupee, each of which slices is carefully weighed. Those which are too light have a fragment of metal inserted in a notch, which is then closed up by hammering. The pieces are gently heated, and hammered into round blanks, which are pickled in a boiling solution of apricot juice and salt, then struck by the blow of a hammer from engraved dies."

The coins of Edward I. of England were produced by a similar process, but in this case the bars were probably square,‡ and the square fragments cut off were forged round with the tongs and hammer before being struck. This process was used from time to time in England, up to as late a period as 1561.

The primitive method of preparing "blanks" for coinage survived in Germany, even to the middle of the 18th century, and is thus described by Jars,§ who saw it in operation in the mint at Zellerfeld, in the Hartz, and I quote his description because the method of conducting the preliminary casting of the bars for coinage is interesting, as it differs essentially from the methods then in use elsewhere which involved casting the bars in moulds of sand or of iron.

"All the silver produced by the Communion district, even that from Upper Hartz, is brought to Zellerfeld to be converted into coins. An old coining method has been preserved in that town. The silver, after being melted in a crucible, is poured on a band (made of a kind of 'duck' or cross-woven tissue) fixed at each end, on a kind of bow, which can be stretched at will by means of a screw and nut. The tension of the stuff, and the mode of its attachment, form a rim on each side. The bands are more or less wide, according to the size of the coins; but only ingots destined to make coins from the smallest size, up to florin pieces, are poured on it; the two-florin pieces are cast in sand. Care is taken that all the ingots should be much narrower, and therefore thicker than the coins. A workman holds this kind of bow above a small vessel filled with water, in which he dips the band, whilst another workman pours on it the silver, the tissue being still damp. The former agitates it gently before the metal is set, in order that it should be equally spread in all directions. Afterwards, he dips the metal into the water, and causes it to drop to the bottom of the vessel, otherwise it would burn the band. Fresh silver is poured, and the operation is continued in the same manner." A variety of commercial copper, which was formerly highly esteemed, was cast in canvas furrows or moulds, under water, much in the way Jars describes in the case of the silver bars or ingots.

The cast metal is then cut into square pieces, and these are rounded into blanks by the hammer, and the coinage is effected by the obsolete hammer method already described.

After the abandonment of the method involving the use of cylindrical rods, the early coins that were prepared by purely mechanical means as distinguished from casting coins were cut into discs from sheets or strips of either pure metals or alloys, by means of shears. The metal or alloy was beaten into a sheet or strip by means of the hammer, as is shown in a well-known engraving of the 14th century; the method was retained in France as late even as the year 1553, when the system of rolling the metal into sheets, attributed to Antoine Brucher, was introduced.* The invention of rolls was, however, much more ancient, and although they do not appear to have been previously used in minting, they were probably employed in very early times for laminating metals and alloys; but little is known as to the exact forms given to rolls used in mints before the introduction of Briot's machines into the Scotch Mint. These, however, are described by Sir James Hope, in 1639, as being

* Figured Eighth Annual Report of the Mint, 1877.

† Abridged from an account given in the *Times*, Sept. 10th, 1880.

‡ Red-book of the Exchequer, quoted by Leake, p. 76.

§ "Voyages Metallurgiques," t. 3, p. 252. Paris, 1781.

* Dumas, loc. cit., p. 29.

"rollers of yrne for drawing of mettels into length and thinness, standing in the turneing loome,"* and in a marginal note he shows that they were of this form, Fig. 1. Horse-power

FIG. 1

was used for driving the rolls from a very early date, and it is perhaps worth noting that, in 1661, King Charles II. gave authority for the gold bars to be removed from the mint in the Tower to an adjacent building at St. Katherine's, in order that the "plates might be passed" through rolls attached to a water-mill.† With regard to the dimensions of the rolls, it may safely be stated that they were much smaller than those now in use.

Boizard describes the laminating mill used in the Paris Mint in 1692,‡ as consisting of two cylinders about four inches in diameter, keyed on to a driving rod of square iron, and turned by the wheels of a mill driven by horses, and he adds that the distance between the rolls could be adjusted by nuts and screws.

Probably but little change was made for a century after the above was written, for a description by Mr. Alchorne,§ Assay Master of the Mint in this country, in the reign o King George III., shows the general arrangement of the rolling-room in the Paris Mint towards the end of the last century, and incidentally indicates the nature of the London rolling mill. He says, "the bars are brought to a proper thickness by being passed several times between steel rollers, as in England. The rollers are turned by millwork, with horses as in London; viz., one large pair of rollers in the centre, and four smaller pairs at the four corners, if they may be called so. The central rollers are turned by the axes of secondary wheels, as in England; the rest by other wheels which are turned by these secondaries. The middle rollers both turn on the same level, so that the bars pass between them in a perpendicular direction, the other rollers turn one above the other as in England, so that the bars pass between them horizontally. The central rollers are considerably stronger and larger than the rest, and these are used for bringing the bars to a moderate thickness; after which they are properly reduced by the smaller rolls. The same mills are employed for both gold and silver, and four sets of them are placed in one range. Each set is worked by four horses, when the five pairs of rollers are used at the same time, and thus sixteen horses may work together under the same roof." I will only add that in the Mint, as re-organised in 1882, there are twelve pairs of rolls, the diameters of which vary from ten to fourteen inches, and that these are driven by an engine of sixty nominal horse-power.

It will be evident that the weight of the finished coin depends upon the thickness of the fillets; and to show how accurately the rolling must be performed in modern mints, it may be pointed out that, in the case of the half-sovereign, a variation of $\frac{1}{20000}$th of an inch above or below the accurate thickness, or a range of $\frac{1}{10000}$th of an inch, throws the coin out of the limits of weight within which its issue to the public could be permitted.

We may now pass to the preparation of the discs or blanks, and it is certain that whether the sheets of metal were prepared by hammering or by rolling, discs were originally cut from them by means of shears.

Lenormant,* quoting Hennin, considers that there is evidence of the use of circular cutters in early Egyptian times, but the adoption, in more modern times, of a cutter producing circular discs has been attributed to Aubin Olivier, who effected considerable improvements in the Paris Mint in 1553. Recent investigations have shown that the origin of the disc cutter was somewhat earlier, as its use was undoubtedly suggested by Leonardo da Vinci, the grandeur of whose genius has long been recognised, and the recent publication of whose literary works† has placed at our disposal a store of facts from which an estimate may be formed of his labours in specific branches of science. He is supposed to have designed the coins of Louis XII., King of France and Duke of Milan‡ in the time of Pope Leo X. He must, as Dr. Richter shows, have spent at least a year (1513-15) in the Roman Mint, where he cannot fail to have been struck with the crude ap-

* "Hopetown Papers," quoted by R. W. Cochran-Patrick "Records of the Coinage of Scotland," vol. 1., p. lix. 1876."

† Mint Record Book, vol. 4, p. 26.

‡ "Traité des Monnoyes, 1692," p. 133.

§ MS. in Mint library, "Observations on the Coins and Coinage of France and Flanders."

* "La Monnaie dans l'antiquité," t. i., p. 264. Paris: 1878.

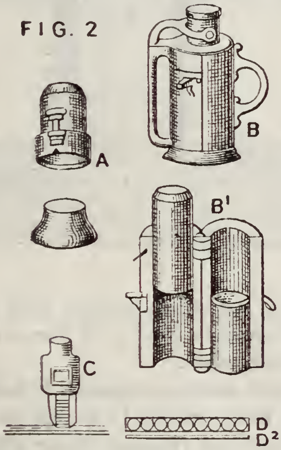
† "The Literary Works of Leonardo da Vinci," compiled from his original manuscripts by Dr. Jean Paul Richter. London: 1883.

‡ "Art Applied to Industry." By W. Burges (1865). p. 68.

pliances and methods of coinage then in use. In a note-book that can be proved to have been used in Rome, he says:—"All coins which do not have the rim complete are not to be accepted as good; and to secure the perfection of their rim it is requisite that, in the first place, all the coins should be a perfect circle; and to do this, a coin must, before all, be made perfect in weight, size, and thickness. Therefore, have several plates of metal made of the same size and thickness, all drawn through the same guage so as to come out in strips, and out of these strips you will stamp the coins [*i.e.*, cut the blanks] quite round as sieves are made for sorting chestnuts; and these coins [*i.e.* blanks] can then be stamped. The hollow of the die [cutter] must be uniformly wider than the lower, but imperceptibly. This cuts the coins perfectly round, and of the exact thickness and weight, and saves the man who cuts and weighs, and the man who makes the coins round. Hence it [the blank] passes only through the hands of the guager and the stamper, and the coins are very superior." *

The appliances devised by Da Vinci are shown in Fig. 2, and it is hardly necessary to

FIG. 2



A, collar and dies; B, pair of dies in collar; B¹, the same, open; C, cutter; DD, strip of metal after removal of discs by the cutter, C.

point out what a great advance upon the methods in use in the 16th century they indicated.

Fortunately, his countryman and contemporary, Biringuccio, the author of almost the earliest elaborate treatise on metallurgy we possess, devoted a chapter of his work to "a discourse, and advice on working a mint properly and profitably."† He distinctly says that the alloy of precious metals is to be cast, beaten out with the hammer, cut in square pieces and rounded.

Da Vinci's instrument for cutting blanks differed from that devised, or at least adopted, by Briot, and figured in a rough marginal sketch appended to Sir James Hope's account of the "Fyneing of Metalles," written in 1639.* It consisted of a vertical screw, worked by a lever, and terminating in a solid cylindrical cutter, which forced its way through the sheet or strip of metal, driving the blank before it, instead of allowing the latter to pass up into the interior of the hollow cutter as in Da Vinci's machine. It in no way differed from the cutter actually used in the Mint within the Tower of London, until its removal to the present site on Tower-hill; one of these old cutters is now before you.

The "blanks" may next be struck directly into coins, or they may just have their edges turned up by a special machine or marked with letters, lines, or geometrical devices. The earliest coins that have such marked edges are those with serrated edges called by Tacitus, *nummi serrati*, represented, among the specimens shown, by a silver coin of the Roman Republic which somewhat resembles, as regards its edge, a coarsely cut watch wheel.

M. Castaing was probably the inventor of the machine for edge-marking. It consisted of two strips of steel bearing letters or an engraved device, which were placed horizontally and parallel to each other at a distance somewhat less than the diameter of the blank One of the strips could be moved backwards and forwards by a rack and pinion, and when the blank was squeezed and rolled edgewise between the plates, the device was transferred to its edges. The instrument appears to have been in use in France in 1685.† The methods of imparting an impression to the edge of a coin, as part of the operation of striking in the coining press, will be noticed subsequently.

The operation of annealing the metal, either during the lamination or before the blanks are struck, is probably extremely ancient. "Blanching" also, or removing the alloying metal by the aid of dilute acid from the surface of the coins, has long been practised. The new money in the 18th year of Edward I. was "made white and refulgent by nealing or boiling," and the process remains in use until the present day.

* Richter, vol. ii., par. 726, p. 18.

† De la Pirotechnia, p. 132, Venice, 1540, or French translation, Rouen, 1627, p. 197.

* Hopetown papers.

† Boizard, "Traité des Monnoyes," p. 142.

The next process to be considered is that by which the disc has an impression imparted to it, and is thus actually converted into coin. I have already referred to the use of the hammer, and will now only add that the prejudice or interest of the craftsmen called moneyers delayed its entire abandonment in this country until the year 1662, although, as we shall see, better methods were well known more than a century earlier than this date.

The hammer was succeeded by a block of stone or metal, which, guided between two rods, fell vertically on the upper die, between which and a fixed lower die the disc was placed. The great antiquity of this appliance is referred to in a letter from M. L'Abbé Barthélemy, to M. Rochon, by whom it is quoted.*

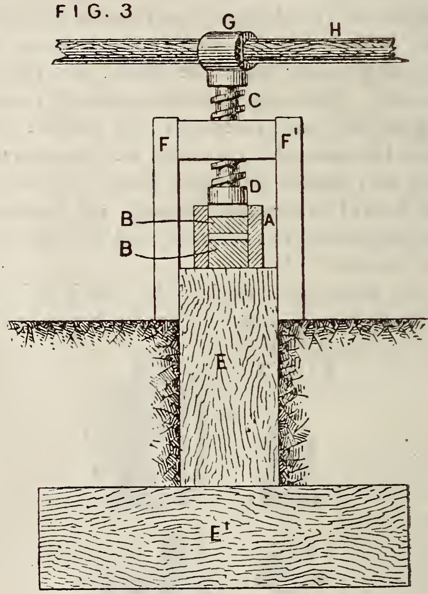
It is still extensively employed in the manufacture of buttons, and is used in the Royal Mint for making medal clasps. There is no evidence, as far as I am aware, that it was ever used in this country for striking coins, but it seems to have been employed for this purpose for a short period on the Continent.

The date of the invention of the screw-press is uncertain. It consisted of an iron frame, like an inverted U, in the bend of which a powerful screw fitted. The upper end of the screw was fixed to a cross arm furnished at its extremities, with heavy masses of metal; the lower end of the screw carried the upper die, the lower die being fixed in the bed of the machine.

Ruding,† quoting Le Blanc, says that the screw-press was introduced into this country in 1561, apparently by a Frenchman named Eloye Mestrell. It met with much opposition from the corporation of moneyers, and in 1572 Sir Richard Martyn, then Warden of the Mint, reported that, after repeated trials, it had been found defective. I am not aware that the exact form of Mestrell's press is known, but it cannot have differed much from the one in Italy at the same period, which is minutely described by Benvenuto Cellini,‡ who engraved coins for Pope Clement VII., and was perfectly familiar with this method of coining which he describes as *coniar a vite* in his treatise.§

A receptacle of iron (*staffa*, A, Fig. 3) is made of the size before mentioned (four fingers wide, two thick, and half a *bracchia* long), but so much longer as to admit, beside the dies (*tasselli*, B B'), on which is the intaglio of the medal, the female screw of bronze, which is forced into it on the male screw of iron (*mastio*). This *mastio* is in fact what is actually called the screw, the female being called *chiocciola*, D. The screw should be three fingers thick, and the worms of it should be made square, as they have more strength than those made in the old way. The *staffa* must be open at the top, and, since the dies will be placed in it, and between the dies the metal that is to be stamped, it is necessary that the size of the *chiocciola* is such that it does not move in the *staffa*. As the dies

FIG. 3



have to be somewhat smaller they are firmly fixed with wedges (*biette*) of iron, so that they do not move at all.

A beam of wood is prepared, E, two *bracchia* long, or more, which is buried so that only half a *bracchia* remains above ground, and that is planed smooth, the lower end is attached to a thick piece of timber, two *bracchia* long. In the upper end of the beam the *staffa* is placed in a notch into which it fits exactly.

Then certain wings (*aliette*, F F) are made of strong iron, which support the beam in which the screw is placed, so that it does not yield. The top of the screw is flattened (*stiacciata*), and in this flattened part is placed a great iron ring, G, having two ends which are open and fitted to a long pole (*corrente*, H) the length of which must not be less than six

* "Essai sur les Monnoies," p. 30. Paris, 17[illegible].

† Lansdowne MS. No. 5, cited by Ruding, vol. 1, p. 34[illegible].

‡ "Il Fiorino d'oro," p. 265. (Firenze, 1738.)

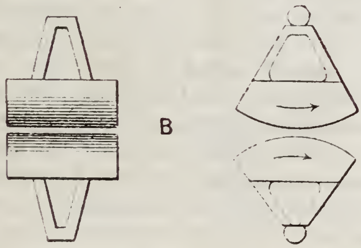
§ "Trattato dell' Oroficeria in Fiorenza, 1568," chap. x., p. 77. Ed. of 1731.

bracchia, and then the stamps and metal being dexterously kept straight, the medal is brought to perfection by the aid of four men.

The next invention of importance seems to have been made by Nicholas Briot, to whom reference has already been made. He proposed to substitute for the screw-press a machine invented or probably only improved by him, which consisted of two semi-cylinders, each bearing an engraved device, the distance between them being so adjusted as to admit of an oval blank, the minor axis of which being inserted between the cylinders, received the impression when the cylinders were moved on their axes through part of a revolution. The disc was, at the same time, extended laterally by the pressure, so that the oval disc became circular. This explains the description given by Sir James Hope, of Briot's machinery, which was actually used in the Scotch Mint in 1639. He says, the blanks that "wer cutt ovall did receave their impression successivlie, by the quhilk they were forced to the bread (broad) and so wer maid round....... The forme of thair stamp is the portione or sectione of a cylinder engraven on both syds,* and he fortunately gives a rough marginal sketch, reproduced in Fig. 4, which makes

FIG. 4

A B



A. Front view of the engraved cylinder. B. End View

the general nature of the appliance evident. He specially says "that the stamp [or die] of those that wer cut round was flat, and impress thairupon by one force lyke to the cutting out press, which in principle exactly resembled a screw coining press."

There has been much misconception as to the nature of Briot's machinery, and Rochon expresses surprise† at the absence of any allusion to the screw-press, in M. Poullain's description of the procès verbal of the trial of machinery, made in Paris, in 1617; but as the machine invented and claimed by Briot, coined by a squeeze and not by a blow, it is evident that it is quite distinct from the screw-press.

Dumas describes a similar machine in use at Geneva, in 1840, which consisted of two rolls, moving continuously, each roll being provided with four dies, capable of adjustment, so as to make each die on the upper roll correspond precisely with one on the lower roll. This arrangement enabled round blanks to be used instead of the oval blanks employed by Briot.

Briot's machinery does not appear to have had either a long or a widely extended use. It was soon abandoned in this country, and the method of striking by the hammer was resumed, and ultimately an improved form of screw-press was adopted.

I have dwelt on these appliances of Briot, because the lever-coining presses which have been definitively adopted in the newly organised Mint present some analogies to the above types; that is to say, they impart the impression by a squeeze, and against a definite resistance. Their analogy to Briot's machine will be made clear later on. But to return to the historical sequence. The hammer was still retained for coining in the Mint at the Tower of London, but the question of the adoption of the screw-press by the moneyers appears to have been revived in 1649, when the Council of State had it represented to them that the coins of the Government might be more perfectly and beautifully done, and made equal to any coins in Europe. It was proposed to send to France for Peter Blondeau, who had invented and improved a machine and method for making all coins "with the most beautiful polish and equality on the edge, or with any proper inscription or graining." He came on the 3rd of September, and although a committee of the Mint reported in favour of his method of coining, the Company of Moneyers, who appear to have boasted of the success of their predecessors in opposing the introduction of the mill and screw-press in Queen Elizabeth's reign,* prevented the introduction of the machinery, and consequently he did not produce pattern pieces until 1653.

Early in the reign of Charles II. the consideration of the question was resumed, and Mr. Pepys states, in his diary under the year 1660-61, February 18th, that he "met with Mr. Slingsby, Master of the Mint, who showed me the stamps for the King's coyne, which is

* Hopetown papers, 19th January, 1639, quoted by Mr. R. W. Cochran-Patrick, "Records of the Coinage of Scotland," vol. i., p. lx. 1876.

† Rochon, "Essai sur les Monnoies," pp. 62 et 89. Paris: 1792.

* "Simon's Medals," by Virtue, p. 23, 1780.

strange to see how good they are on the stamp, and bad on the money for lack of skill to make them. But, he says, Blondeau will shortly come over, and then we shall have it better, and the best in the world," and a year later, March 9th, 1662-3, he says, "Mr. Slingsby showed me examples of all the new pieces, both of gold and silver, that were made for the King by Blondeau's way."

It is certain that Blondeau did not invent, but only improved the method of coining by the screw-press, and I believe his improvements related chiefly to a method for "rounding the pieces before they are sized, and in marking the edges of the moneys with letters and grainings," which he undertook to reveal to the King. Special stress is laid on the engines wherewith the rims were marked, "which might be kept secret among few men."*

I cannot find that there is any record in the Paris Mint of Blondeau's employment there, and the only reference to his invention in the mint records of this country refers to the "collars" or perforated discs of metal surrounding the "blank" while it was struck into a coin.† There is, however, in the British Museum a MS., believed to be in Blondeau's hand, in which he claims his process "as a new invention, to make a handsomer coyne, than can be found in all the world besides, viz., that shall not only be stamped on both flat sides, but shall even be marked with letters on the thickness of the brim."‡ The letters were raised.

The press Blondeau used was, I believe, the ordinary screw-press, and I suppose that the presses drawn in Akerman's well-known plate of the coining-room of the Mint in the Tower, published in 1803,§ if not actually the same machines, were similar to those erected in 1661-2, by Sir William Parkhurst and Sir Anthony St. Leger, wardens of the Mint, at a cost of £1,400.||

Each press is served by four men, who set the cross-arm attached to the screw in motion by the aid of subsidiary jointed levers, which evidently allowed a certain amount of "play." Jars states¶ that the "balanciers" used in the Cremnitz Mint, one hundred years ago, required eight men at each press, when two florin pieces were struck, and as the men worked for only a quarter of a hour at a time, they had to be replaced by another set of eight men, making in all sixteen men to each press.

The blanks seem to be placed between the dies by the hand of an attendant, but a system of mechanical "laying on," as it is called, had been suggested in 1727, by M. du Buisson;* and in 1807, Phillipe Gengembre† devised and introduced a simple and ingenious "layer on" which permitted blanks to be struck surrounded by a plain perforated disc of metal called the "collar," the removal of the finished coin and its replacement by a fresh blank, being performed automatically.

The screw-press of Boulton marks a great advance in mint machinery for the "cutting-out," and coining presses continued to be worked by manual labour until he claimed the "application of motive power to stamping and coining" in 1790, when a patent‡ was granted to him "for certain new methods of applying the powers of water mills, cattle mills, and steam-engines, either simply or combined with the pressure of the atmosphere" for the purpose of coining. He employed a screw-press in which the blow is imparted by the intervention of a vacuum chamber; that is, instead of workmen operating directly on cross arms, a lever at right angles to the screw is connected with a piston of a chamber rendered vacuous during the upward motion of the screw, which is effected, not by manual labour, but by a projection on a revolving wheel or, in later forms, by a lever. When the screw has been raised to the utmost limit of its path it is released, and the pressure of the atmosphere on the upper part of the vacuum chamber forces it down, and brings down the screw which bears the upper die.§

This press was finally abandoned in the re-organisation of the Mint machinery, effected in 1882, when the lever-press invented by Uhlhorn in 1829 was adopted. Some of these lever-presses had been in use in the Mint since 1872. A sketch of the portion of the lever machine (Fig. 5, p. 813) which bears the dies will be all that is necessary to make clear the principle by which it works. The blanks are placed at B, between the dies, D D, and the pressure is imparted by the toggle joint, E, and bent lever,

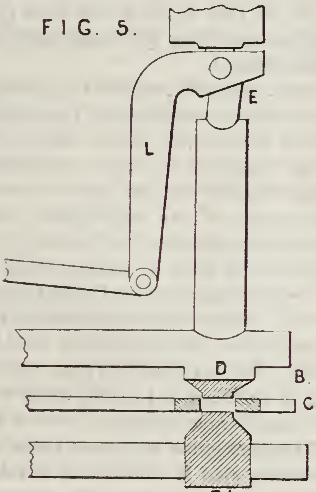
* Virtue's "Works of Simon," 2nd edit., 1780, p. 23.
† "Mint Records," vol. i, p. 144.
‡ *Numismatic Chronicle*, vol. i., 1838-9, p. 168.
§ "Microcosm of London," vol. ii., p. 202.
|| "Ruding," vol. ii., p. 7.
¶ Jars, "Voyages Metallurgiques," t. iii., p. 248, 1781.

* "Machines et Inventions approuvées par l'Academie," t. v., quoted by Rochon, p. 102, who fully describes the important details of the coining press.
† Dumas loc. eit., p. 20.
‡ Patent, No 1,757, A.D. 1790.
§ This press is fully described in the eighth edition Ency. Britt., vol. ii., p. 92.

L, and not by the partial revolution of a cylinder, as in Briot's machine. The edges of the coin may, at the same time, be marked with lines, or with a device, by means of a collar in the plate, C.

It is strange that the method of striking in a collar was not adopted earlier. The earliest reference I have been able to find, to a coin marked with letters on the edge, is a gold piece of Henry II. of France, dated 1555,* but the drawings of Leonardo da Vinci, published by Dr. Richter, clearly show that Da Vinci suggested the use not only of a collar fitting tightly round the blank, but of one capable of being divided into two portions, upon which a device might have been engraved, although he does not appear to have used such an engraved collar.

FIG. 5.



Simon's celebrated "petition crown," which bore an elaborate inscription on its edge, was probably not struck in a segmental collar, but in a plain one, the device being engraved on a steel spring, which was coiled inside the collar. A very slight pressure would remove the coin from the collar, and then the elasticity of the spring would remove it from the coin.

In conclusion, I would offer a few remarks with reference to the artistic side of the subject, in which the Society has always taken the deepest interest.

With regard to the substitution of the screw-press for the hammer in coining, M. Lenormant observes, "mais l'art y a perdu, comme il perd presque toujours à l'emploi des machines," and this is the complaint of a distinguished school in this country, whose view is probably based on the undoubted inferiority of modern work. But did art lose by the introduction of machinery? Such was not the opinion of Cellini, who advocated the use of the screw-press, nor of Da Vinci, who insisted that the discs should be cut with mathematical accuracy, and struck so as to ensure their being circular. It is not a little remarkable that the artists of the mints, the engravers, appear to have been the very people to urge the adoption of mechanical improvements. For instance, Nicholas Briot, "graver general of the monies," an excellent artist, quitted France in disgust because the introduction of his machinery was so bitterly opposed in that country. Jean Varin, Briot's successor in France, secured the definitive adoption of the screw-press in 1645, and Simon, Briot's pupil, and the greatest engraver England has ever had, aided Blondeau, who effected the great changes in the appliances of the Mint in the reign of Charles II., by secretly engraving the dies for him.

Speaking with no claims to artistic culture, I would venture to submit that no hand-struck Greek coins can be finer, as works of art, than certain machine-struck Renaissance coins, with designs in low relief, examples of which are now before you. The dies for striking them were either drawn or engraved by Francia, Da Vinci, Cellini, Hameranus, and Simon,* and the coins were struck from carefully rounded blanks. All these coins are surely marked by what Mr. Ruskin has called the "sign of the highest art," which "parts voluntarily with its greatness ...... so to exalt and set forth its theme that you may be fain to see the theme instead of it."† But in order to meet your obvious objection that these artistic questions are not in the province of the metallurgist, permit me to appeal to the words of Biringuccio, who, in 1540, in his advice to a Mint Master, reminded him that if he coined strictly according to the letter of the law, he would make but very small profits; if, on the other hand, he introduced too much base metal into the alloys, the execrations of the people would follow; but he specially urges that a good workman should

* Rochon *loc. cit.*, p. 101.

* The coins by Hameranus and Simon, to which special reference was made, were of Pope Inocent XII., whose name is familiar to English readers from Mr. Browning's poem, "The Ring and the Book," and the "Petition Crown" of Charles II.

† Aratra pentelici, p. 121. 1872.

be secured to engrave the dies, in order, as William Morris has said, that the people may have pleasure in things they must perforce u e.

Miscellaneous.

SUGAR.

By G. Buchanan.

The sugar crop or supply of the world is estimated at five millions of tons. Of this quantity one million tons may be put down to India and China. The cane is grown throughout India, and a small enhancement of value in the export market is soon followed by a large accession of sugar in the bazaar. The export from India is stated in the Statistical Abstract to be 644,531 cwts. But of the real production of the one or the other country very little is known. Omitting them from the calculation, the supply would be four million tons. It consists of cane and beet sugar in nearly equal parts, the figures for the year 1882 being:—

Cane sugar	2,060,565 tons.
Beet sugar	1,860,994 ,,

This equality of production is, however, not owing to a like degree of saccharine or sugar bearing capacity in the two plants, but to the more successful extraction of the sugar they contain in the manufacture of the beet than the cane. Were the modes of treatment of equal skill and efficacy in both cases, beet sugar, there cannot be much doubt, would have to take a lower position in the category, notwithstanding the fiscal support accorded to it in the country of its growth. Without the premium on export to stimulate its manufacture, a sustaining power could hardly have been found for the large production in the part retained for home consumption. Beet sugar, until of late years, could not, except in the form of refined sugar, bear comparison with sugar from the cane. The raw beet sugar is from the disagreeable smell and taste of the molasses, unfit for consumption as human food. By skilful treatment, a nearly pure white grainy sugar is now produced without the refiner's aid, but no grocery sugar made of beet can without offence come near the cane muscavado or v.p. crystals. In chemical composition, beet sugar is considered to be identical with cane. Whether it is so in the use also is doubtful. It is supposed to be deficient in sweetening power. And yet raw beet is largely imported for our refiners, and is preferred, perhaps, to the low classes of raw cane for its better preparation, as it is known much less crystallisable sugar can be obtained from beet than from cane of a similar analysis. The consumer may, consequently, be somewhat inconvenienced in pocket, and there being no way of telling one sugar from the other over the shop counter, it would be only fair towards him if a label of distinction were introduced. Analytical figures show that, in moisture and ash, no difference to speak of exists between the kinds of highly refined sugar, whether beet or cane. But they also show the unrefined white beet sugar to be as pure, although to smell and taste it is foul with the "hogo" of the beet that clings to it. If chemistry cannot find out the difference of odour, neither can it of sweetness. This is, perhaps, a matter of taste only, and the common notion that beet is inferior to cane may be justified by fact. It is well known that all the first-class jam makers and manufacturers of British wines will not use sugar made from beet, however beautiful it may look, or however cheap it may be. And it is to the beet in the sugar of the shops, it is said, that is often owing in home-made preserves the disappointment of the cook's expectation of a good jelly. If the difference of sweetness should be 10 per cent. less in the beet, it is an indirect taxing of the cane to allow beet sugar to be sold as one and the same thing with cane sugar, and ought to be discontinued.

The crude materials possessed by the sugar maker in the cane are acknowledged to be superior to those he finds in the beet, or in any other of the plants from which supplies of sugar are obtained. The advantage claimed for the beet is that the pulp, after exhaustion of the sugary juice, furnishes the cultivator with a valuable food for cattle. And it is this contributive force in stock feeding that to the farmer forms perhaps the chief object in growing the sugar-beet. Unless meat production went along with sugar production, the latter alone would be barely profitable. But as regards the cane, there is—to say nothing of the tops and leaves, which would make good ensilage like the beet tops—a set-off to the spent pulp of the beet in the megass or refuse of the cane after crushing, that is quite equal in value to wood for fuel to the manufacturer. The megass, too, if it could be returned unburnt to the land, would supply the cultivator with the natural fertiliser for his plants. The produce of a crop of sugar-beets in Germany is not more than ten tons of washed and topped roots per acre, whilst in India the native farmers are said to get twelve or thirteen tons of cut canes per acre. In Jamaica the yield is supposed to be from seventeen to twenty tons, and in Demerara twenty-five to thirty tons per acre. In France, where the beet is cultivated less for the sugar it affords, and more for the advantage of the pulp to the farmer, much larger crops are grown than in Germany, from twenty to thirty tons per acre being a common yield. But the bigger beets have inferior saccharine matter, and the deficiency of richness is not compensated for by the greater quantity produced, as the adverse chemical salts and other bodies inimical to sugar crystallisation increase also, not only in proportion to the sugar, but even to the gross weight. In quality, the juice of the cane is both purer and richer than the juice of beets. Weight for weight, the former has almost double the amount of sugar that the latter possesses; and taken when the cane is fully matured, the juice is said to be almost a pure syrup, and more free from contamination with uncrystallisable forms of sugar than beet juice. By analysis, the ripe cane is shown to contain from 13 to 22 per cent., with a mean of 18 per cent., of sugar. The beet contains from 5 to 10 and 11 per cent. of sugar, with a mean of 7½ per cent. In Germany, where the roots are taxed on the weight without reference to excess in the relative amount of sugar in them, the proportion has, with high cultivation, risen to 13·75, and even a per-centage of 18 appears to have been reached; but this may be looked upon as a maximum of the laboratory difficult of attainment, and in practice not more than 13 per cent. of sugar should be reckoned upon as the average in good years. The cane is also a more favourable crop to cultivate than the beet, giving less trouble, requiring less labour, and suffering less from vicissitudes of the weather. The cane roots send up a succession of young shoots, or rattoons as they are called, for three and four or more years; whilst for the beet, an annual tilling and sowing of the land is necessary; and the rattoons, taking into account the shorter time of growth, may be considered to yield as abundantly as the plant canes. The great draw-back in cane cultivation is that seed time and harvest fall together, causing the pressure of work to be doubly heavy in the season.

Where the cane is seen to be apparently inferior to the beet is in the course of extracting the juice. The sugar-beet contains from 94 to 96 per cent. of juice, and all of it, with the exception of 5 or 6 per cent., can be extracted. From the cane, on the other hand, only 60 per cent. is obtained of the 88 to 90 per cent. of juice that it contains. The new and enlarged mills, with rollers of greater length and diameter, will procure a yield of from 65 to 70 per cent., but the common run of mills do not get more than 45 to 50 per cent. of the weight of the cane in juice. This resistance to a fuller surrender of the juice is sought to be overcome by using more powerful machinery on the same principle, and as much as 80 per cent. of juice is said to have been expressed in experimental trials. But that this extra yield should be secured in the crushing of a whole crop of canes is scarcely to be expected. And beyond a certain point the excessive power employed would not be paid for by the increased quantity of juice, or the quality of what is got. The juice drawn from the lighter and less complete crushing of the cane is known, by the experience of the old cattle mills, to be the best. That which comes away, under more forcible pressure, may have a greater density, but it is the objectionable salts, albumen, and fragmentary fibre of the cane which increase in it, and not the sugar. Besides pressure is practically inoperative to squeeze out of the crushed body of the cane the juice that it holds hygroscopically, or retains by absorption. And it is only the wealthy owners of estates who can bear the cost of these big mills. No inconsiderable portion of the sugar must, therefore, continue to be lost, and the full profit of the manufacture fail to be got, unless a change can be made in the mode of treatment, and some improved method, such as would extract the saccharine matter from the cane as effectually as is done in the beet, be adopted. In the beet-sugar manufacture, which began upon the plan used with the cane, the old mode of extracting the juice by pressure has in Germany, nearly, if not altogether, given way to the diffusion process, with its auxiliary methods for saving the sugar in the molasses. And in France, where roller and hydraulic presses are still generally employed for the convenience of the farmers, who require to have the compressed pulp returned to them, and get back from the best mills as much as 20 per cent. in weight of the beet roots supplied, that is from 5 to 6 per cent. of solid residue, holding 14 to 15 per cent. of juice diluted with 18 per cent. of water, many of the large factories have begun to substitute diffusion for pressure. That the diffusion process can be applied successfully to the cane has been also demonstrated. By its use at the Aska works in Ganjam, India, 87½ per cent. of the 90 per cent. of juice in the cane has been abstracted, and, according to a published return, an average yield of 83½ per cent. was obtained from the crops worked off in the three years ending in 1870. In Guadeloupe the almost absolute exhaustion of the cane juice was effected by it; and in Louisiana, by the competitive trials of pressure and diffusion made in 1874, a surplus was shown in favour of diffusion over mill of from 40 to 43 per cent., obtained at a cost of but 1·30 $ more per 1,000 lbs. of sugar and molasses. But whether diffusion is in ordinary practice the process most suited for economic use in cane-sugar making, and would be as fully applicable to the cane as other processes, remains still to be determined. In growth and structure the cane is dissimilar to the beet. The one has a long slender stalk above ground, formed of strong parallel fibres, and divided by knots every few inches apart. The other has a short stem distended under ground, made of vascular pulp, and with a long tap root. And as they differ in substance, the tendency of the sugar and water to pass through the walls of the closed cell until equalised by transference, which is the condition of diffusion, will vary in some degree. But the position of the sugar cells in the cane, the largest number being found about the softer parts in the middle, should make it easier to displace the sugar by diffusion than to expel it by pressure through the rind. Defective, however, as the ordinary machinery for extracting the cane juice confessedly is, this is not the only or chief difficulty in the way of an extended sugar production. A greater obstacle is perhaps the want of time and labour in harvest. The canes, of which the gross quantity is enormous when compared in bulk with other crops, have to be cut, carried, and converted into sugar within the short space of three or four months. In manufacturing beet sugar, on the contrary, the period of working can be extended over a longer time, and the roots kept for later use, or till germination begins in spring, by storing them in pits. And it were a thing much to be desired, if the means of relief could likewise be found for the cane-sugar maker.

Great interest is shown in discussions upon the beet-sugar bounties, which are an evil, regarded from the refiners' point of view, that is not unmixed with good to the people of this country, but indifference appears to be profound on the subject of cane sngar. And yet it is indisputable that we, with our tropical possessions, are as distinctly a cane-growing people, as on the Continent they are beet growers. We are concerned not so much with how they manage things in France and Germany, as with what we can do to double and treble the produce of our own sugar-fields. The consumption of sugar per head of the population of these islands has more than doubled in the last quarter of a century. And were it not for the largely increased supply of beet, the price also would have been very appreciably affected. The relief of their wants received from the cane by those who take sugar has been small in comparison to that given by the beet. On a decennial estimate, the cane contributes only an additional amount of 277,958 tons, against an increased yearly quantity of 987,994 tons furnished by the beet. The relative figures for the two periods are—cane sugar, 1872, 1,782,607 tons; 1882, 2,060,565 tons; beet sugar, 1872, 873,000, tons; 1882, 1,860,994 tons. The cane is thus seen to be no longer the most important factor in the sugar market; and the superiority of the beet in this respect is further shown by the crop of the following year, 1883, with its enormous yield of 2,146,534 tons of sugar. No wonder, then, if exaggerated ideas of its potentiality in the future should be conceived, and the beet be looked upon as king, going on ruling, and to rule the markets. The legitimate claim, however, of the cane to the first place in the market of this country will very generally be admitted. But its restoration can only be brought about by producing good and cheap sugar more abundantly. And how is this to be done? It is an important question, in endeavouring to deal with which it may be allowable to make one or two suggestions. To say we are not justified in trying experiments, and must let improvement wait upon success, is to wait behind. As a good field for action, therefore, take Jamaica. It is easy of access, and its natural advantages of soil, water, and climate enable it to compete with other sugar-growing countries. The island has, unfortunately, suffered a long period of decadency, since the time of emancipation, and of the Act of 1846, equalising the duties on free and slave-labour sugar. But the official returns show that there was no decrease in the value of the staple and other products during the ten years ending in 1880. And if the year 1881 was a bad year, from blight and other causes, the year 1882 was a "bumper," and the exports of sugar, regard being had to the increased size of the hogshead, were the largest of any year since 1847—signs that present a good augury for the future. There is evidence, too, that the black and coloured population, already numbering more than half a million, are becoming sensible of new wants, and feeling a desire even for luxuries. The continual extension of provision grounds must cease to be profitable, or to provide a lazy subsistence, and the Negro, if he would have the means for an enlarged expenditure, will be compelled to prosecute the cultivation of the old commercial products of the country that are in repute abroad. Labourers for sugar estates are said to be scarce in some districts, but are commonly to be hired at from 5s. 3d. to 8s. 9d. per week of five days, the people not caring, or being pushed by want, to turn out on Saturday. And hundreds of men have left the island for Colon, engaged to work on the Panama Canal for wages of ten cents per hour; a strong proof that employment is not plentiful, and of a willingness to seek it under the attraction of good pay. Much land is lying waste and unproductive in both public and private ownership. The area under cultivation, including pasture, is 554,162 acres, out of which the average acreage under cane for five years, ending 1881, was only 43,999 acres. Of that vacant cultivable land a part might be very well applied to the growth of canes, and by the introduction of the East India system of farming, turned to good account. In India the ryot, as the peasant farmer is called, has usually in his holding a small patch of sugar cane growing with his other crops. The produce he makes into goor, or raw concrete sugar, and sells to the refiner, who turns it into clean white sugar for consumption. And experience shows that the ryot, giving his immediate care and attention to the work, and aided by wife and children, does better and more economically than a factory or sugar works, dependent on hired labour, and having the supervision of an extended area, can manage to do. The ryot has his plough, bullocks, rude crushing mill, and boiling pans, and when in want of money can, on the security of his interest in the land, obtain advances from the native banker. The adoption in Jamaica of this system is, however, not advisable in its entirety, but only so much of it as relates to the culture of the land, which, by the consension of opinion in India, is best left in native hands. The negro is not so inferior in capacity to the ryot that he could not, if put in the way and helped in the beginning, farm his small holding as efficiently, and secure in a market for his canes, do it successfully. The small agriculturists in Jamaica, making their couple of casks of sugar yearly, of whom there were 5,615 in 1871, though reduced in number to 4,700 in 1880, witness to this. But their example in being sugar makers is to be followed rather in the avoidance. With the cropping of the canes the proper work of the agriculturist ceases. The extraction of the sugar in them requires skill of another kind, and separate machinery; a fact that seems naturally to indicate a division of labour between the planter and the sugar maker, as there is between the paddy grower and the rice miller. Supposing, then, an estate, with 300 acres of suitable land, to be laid out in plots of convenient size for cultivation by a family, say 5, 10, or 15 acres, and let to the occupants at a fair rent on a fixed settlement, either perpetual or subject to revision after a period of years, there would be on the average 30 families, and counting the usual five in a family, a population of 150 attached to the land; a number that should afford more than a sufficiency of labour for its proper cultivation, since from two to three labourers are enough to plant from 8 to 10 acres; and if it were made a firm stipulation of the tenancy that three-fourths of the holding should be kept in cane-bearing, the sugar-works would only have to provide a supply of labour, required concurrently with the machinery, to convert the canes into concrete sugar for refining. In these small holdings there might, at first, be little room for any but the commonest implements of husbandry, yet opportunity would come to introduce carrying and other labour-saving machinery in aid of the manual labour of the occupiers. Formerly land, mill, and people, made one machine, but the people have since become a part detached; and if a well ordered land and sugar company could be framed on these or similar lines, the moneyed man might reasonably hope to find profit in aiding the readjustment of the mechanism for its new work. The numerous little sugar estates that are in Jamaica, would naturally group around and co-operate with diffusion works placed conveniently near them. On some of these estates cattle mills are still in use; on others, where water or steam is the power employed, the ordinary roller presses are wanting in capacity. For these small properties to incur the expense of new or enlarged machinery, in order to obtain better results in sugar making, would be economically less to their advantage than to spend the money in improved and useful agricultural instruments. And to raise the per-centage of sugar in the juice would be more for the common good than if they were to increase the per-centage of juice expressed. A successful grower of canes might, by selling to the adjoining diffusion works, lay his account to reap all the farming profit, and by taking a prospective interest in the sugar made, participate in the profit of manufacture also.

As regards keeping the canes for later use, when cropped, there are two things to be noted; the great liability of the juice, as an aqueous solution of sugar, to ferment on exposure to the air, and the influence of heat to turn it sour. The tendency of all vegetables upon reaching maturity is to fade and spoil. Sound ripe canes, however, deteriorate but little if the skin is unbroken, and the sugar cells are not ruptured. The juice is produced separately in each joint, and the plant ripens from the bottom upwards. Cut canes have been known to keep for days without harm, and even with positive advantage, the ripening of the top joints continuing to form sugar. Fermentation is said only to take place in a solution of sugar and water when sufficiently dilute, with less than four parts water to one part sugar it takes place imperfectly, if at all. As, therefore, the proportion of 18 sugar to 90 juice is just 1 to 4, the natural drying up of the cut canes should help to preserve them. In these circumstances it might be possible, if there was available space, to stack and keep the upper part of the stalk, whilst using the lower part that has ripened, and thus to lengthen out the time for working in the sugar-house. The means employed to lower the temperature and prevent the heating of hay in the rick, would probably answer with the cane, and by facilitating evaporation accelerate the reduction of the water in the juice to a safe point. Were the experiment successful, and the practice of storing canes to come into use, sugar works would be able to maintain a permanent gang of skilled workmen, and to carry on operations with a smaller outlay for machinery. But the drier the canes became, the less amenable they would be to pressure, and for the liberation of the juice it might be needful to have recourse to a solvent like the water of diffusion or maceration.

These processes, maceration and diffusion, are the opposites of one another. Diffusion is applied to, and acts upon, the close cell of the plant; maceration on the open cell. And the advantage is with diffusion, which, applied to the beet, has surpassed maceration in success. By crushing the canes, the cell walls are burst open, and with the admission of the air to the juice, fermentation begins. The juice gets also mixed with bits of broken fibre, mucilage, and other parts of the substance of the cane, which are washed out with it in the act of maceration. Impurities are left behind, or not meddled with in the course of diffusion, as in slicing the canes a certain number only of the cells are cut open. The cells appear to act as clarifiers, the sugar passing through the cell wall, to change places with the water outside, whilst the albumen remains inert. The diffusion process, as improved by Julius Robert, dates from 1864-5, and was first applied to the cane at the Aska works, in the year 1866. From the reports of good success in the use of it by this company, its introduction into Louisiana followed in 1873. Twenty years before, in 1845, in Guadeloupe, attention had been directed to a plan of putting sliced canes, in baskets, into copper vessels with water. But nowhere in the British possessions, excepting at Aska, does there appear to have been any endeavour made to prove the capabilities of the system for working up our cane crops. In Louisiana, an apparatus used before for beet was brought over from Europe and set up; on trial, however, it was found to be unfitted for manipulating sugar cane, and two new and complete machines were constructed for use, on separate plantations. Upon one of them, where the common kettles, or open pans, used for making brown sugar, were employed, the diffusion juice failed to granulate so readily as the juice from the mill. On the other plantation, where an exact test was made between the mill, an ordinary three roller mill, and diffusion, a vacuum pan being in use, the result demonstrated a considerable gain by the diffusion process. Disagreements, however, arose between the parties concerned in the affair, which prevented further experiments from taking place. The next year, the two diffusion machines were removed and set up on another plantation, and canes were purchased for working. But the season was most unfavourable, the canes did not ripen well, the transport arrangements were bad, there was no pecuniary benefit, and thus the enterprise failed. The apparatus was worked two or three years after this by the people who bought it, but only on a small scale, and finally they took it down, and re-erected the mill. With more judicious management, it is very possible the process might have been made a success, as the gain in saccharine matter was great. At Aska, also, the working of the diffusion process was said not to have been continued, a sure sign it was no success. But so far is this from being the fact, that the process is still in successful practice, and has been, yearly for seventeen years. At the works they now cut up during the season, 1,000 tons of canes a week, and are so satisfied with the results, that they have ordered out a complete apparatus of the newest construction.

(*To be continued.*)

MAORI LAW.

Consul Griffin, of Auckland, in a report on the history of New Zealand, says that the Maori or native population, according to the census of April, 1881, was 44,097, and it has not increased since then. The males numbered 24,368, and the females 19,729. The disproportion of sexes is cited as a proof that the race is not a productive one; in fact, the native races appear to be dying out all through the islands of the South Pacific Ocean, and in some they have disappeared altogether. When Captain Cook first visited New Zealand, he estimated the population of the Maories at 400,000. Captain Hobson, in 1840, fixed the number at 200,000; while Sir George Grey in 1849 thought they were fewer than 120,000. From these figures it will be seen that the race has steadily declined. The pure Maories are believed to be of Malayan origin, and there is a tradition that their ancestors landed in New Zealand in fourteen canoes from Hawaiki, probably the island of Savaii in the Samoan or Navigator's group. The natives of the South Pacific islands have little or no knowledge of the laws and principles of human life. They almost invariably build their residences in low, miserable, and unhealthy situations, and it is chiefly for this reason that consumption, scrofula, and rheumatism make fearful ravages among them. The Maori language is a peculiar one, and is wholly unlike any language in Europe. It consists of fourteen letters—*a*, *e*, *h*, *i*, *k*, *m*, *n*, *o*, *p*, *r*, *t*, *u*, *w*, *ng*. *A* is pronounced as in *fall* and *flat*, *e* as *a* in *acorn*, *n* as *na*, *t* as *ta*, *ng* as *nga*. The words are seldom composed of more than two or three syllables, and the accent is on the penultimate. Distinctions of gender are seldom recognised. Dr. Maunsell, who has devoted much study to the origin and construction of the Maori language, is of opinion that its forms of prepositions are more extensive than those of the Hebrew or English, or, indeed, any other ancient or modern language. The Maories are slow to adopt the habits and customs of the Europeans, but they endeavour to blend them with their own, with the result that the distinctive features of neither race are preserved. In the King country, a modified form of the ancient Maori laws of *tapu* and *muru* still exist. The law of *tapu* was everywhere acknowledged, and the word itself doubtless means sacred. According to the law of *tapu*, certain persons and things were always sacred. The bodies of chiefs and priests, and everything connected with their dignity and honour were held sacred, and the chiefs and priests had the power of imposing the *tapu* on others, and they had also the right to remove it. The first potato dug was tapued, the sticks on which the memorial records were kept are tapued, and the Maories even *tapu* their food. Certain chiefs are not allowed to touch food with their fingers, and unless fed by others, they have to eat like dogs Various methods are employed to remove the *tapu*, one of which consists of throwing leaves into the air, and jumping after them. The law is now generally admitted to be a religious observance established for government and political purposes. Rivers were tapued until the fishing was ended; and cultivations were tapued until the planting was done. If a drop of blood of a high chief fell on anything, it was tapued, that is it was unlawful to touch it. Consul Griffin says that it is extremely difficult to thoroughly understand many of the more important principles of that branch of Maori jurisprudence, the law of *muru*. This law is so broad and general in its application that no human being, whatever may be his rank or condition in life, is exempt from its benefits or penalties; but, in order to understand the practical working of the law, it must be borne in mind that the Maories are communists in theory and practice. They do not think it right for one person to own more property than another; in fact, property changes hands so often that a man cannot tell a week or a month beforehand who will be the owner of his canoe, blanket, or mat, or even the house in which he lives. The great principle is to keep property in circulation—the oftener it changes hands the better. A man's relatives have the first claim, and his friends and neighbours the next; no one, however, would presume to assert a claim to the property of another, except in accordance with the strictest principles of the law of *muru*, which alone can determine the right of ownership. Should a great misfortune overtake a man, such as the death of a favourite child, his relatives are allowed to dispossess him of all his goods, and, if need be, of the house in which he lives. He must pay a penalty for his misfortunes; but, strictly speaking, he does not regard the loss of his earthly possessions as a misfortune, but looks upon it as a great honour and a great blessing. He is considered to be favoured both by gods and men. If everything he possessed is taken from him, he is treated with the most profound respect, and becomes a man of great importance in the community in which he lives. If a man's wife or child should be burned to death, and the accident prove unavoidable, everything is taken from him, his goods, his food, clothing, spears, mats, boats, in fact all his earthly possessions, and in order to favour him still further, he is severely beaten with clubs, and usually left on the ground in a bruised and bleeding condition. It is, however, against the law of *muru* to kill him. He is duly warned of the process of the law, and a messenger is despatched to inform him of the approach of the law officers. He is expected to defend himself with a spear or club until overpowered, but it is against the law for him to strike the officers too hard. As soon as the first blood is drawn he must stop, but sometimes a very stubborn resistance is made, and the fight is carried on in earnest. Though the victim knows that he is doomed, he does not wish it otherwise, for to be victorious would be against the law of *muru*.

IMPROVEMENTS OF THE ROMAN CAMPAGNA.

Her Majesty's Vice-Consul at Rome says that the sanitary amelioration of the Campagna was determined upon and decreed by a law passed on the 11th December, 1878. It was ordered as a work of public utility that the marshes and ponds existing in the Campagna, should be drained, and in addition, the collecting of the springs and the regulating of the soil by means of a complete canal system of all the waters, comprising the under-ground waters. By virtue of a law recently passed, the work is to commence by improving, agriculturally, a zone of ground within a radius of about six miles from the centre of Rome. The total area of the Agro Romano is 525,316 acres; that included in the circle of six English miles is about the seventh part of this surface, or 77,647 acres, which are subdivided thus:—Town, 3,546 acres; rivers, 1,043; vineyards, gardens, parks, or villas, and intermingled roads and streams, 18,611. The remaining 54,447 acres are now used for pasture, wood, and quadrennial sowing, and to that surface is specially applied the agricultural amelioration which becomes obligatory on all the landowners. The Italian Government desire to attain their object without infringing on the rights of property, and they express their intention of leaving to proprietors a certain liberty in the choice of the works to be executed, and of the cultivation best adapted to the soil. The proprietors are invited to present a report in which should be indicated the agricultural improvements which they intend carrying out on their own account, and which should specify the quality and extent of the proposed cultivation of trees, plants, and herbs, and the roads and buildings for workmen and horses. A special agricultural commission will examine and modify these propositions, and will decide for those proprietors who have made no proposals which are the best improvements to adopt, and the estimated time and expense. In case the improvements are not effected, the Government will have the right of expropriating and at once occupying the land, with indemnity according to the general law on expropriation, and will have power to let the land on lease or to alienate it; and the obligation to execute the improvements will, in this case, devolve upon the tenant or purchaser, under pain of the devolution of the land. Those who construct any buildings in any part of the Campagna within or beyond the zone formed by the circle of six English miles, will enjoy exemption from taxation for ten years, and the increase of income which will be obtained by the agricultural improvements of the land comprised in the zone will be exempt from land tax for twenty years; and equal exemption will be conceded to the proprietors of the Campagna anywhere beyond the zone, if they execute at their own expense the agricultural improvements. Vice-Consul Franz says that "the future will show if these means are sufficient to execute the enterprise, which, in the opinion of the Government, has become a national obligation, to endeavour to deliver the capital from the tyranny which the *malaria* and the deserted country exert round Rome, and in changing the Agro Romano into a fertile and flourishing region."

MANUFACTURE OF GLASS BEADS.

The above manufacture includes turned massive beads, pressed, drawn, and blown descriptions. The first named kind was first manufactured in Venice, and about 200 years ago was introduced into the Fichtelgebirge district of Bavaria. At first the beads for rosaries were the principal articles made, and they are still produced in Bavaria, whence they are exported in quantities to Spain, Portugal, &c. The manufacture is, however, less important than formerly. As an illustration of the scale of production, it is remarked that a workman can make of some kinds of beads as many as 36,000 per day.

In contrast to the heavier Bavarian descriptions, come the Venetian productions. These are mostly beads for embroidery. The process of manufacture a curious one. The glass is drawn into thin tubes and then cut up. The beads are afterwards placed in heated drums, where the sharp corners are rounded off. After being rubbed in chalk and charcoal, they are strung together. In Bohemia a kind of bead for trimming is made in a similar manner.

In making the blown, or so-called lamp beads, a bellows is employed, with which a paraffin or gas flame is brought to a blowpipe flame. In this process, as carried out in Venice and Thuringia, drawings are made on the glass balls or beads with pointed implements made of glass, and these designs are burnt in by the flame. The deadening process so extensively employed is both chemical and mechanical in its character. In the chemical operation, hydrofluoric acid is used, by means of which the surface of the glass is removed. There was formerly another process used in France which was a secret. A German workman, however, found it out by accident. This is the sand process, which is now used in Thuringia for the operation of deadening.

The manufacture of pressed beads is effected by pincers, of suitable form. The glass is heated on a moderate fire and brought into the mould. In this manner beads and buttons are produced in very effective styles, both plain and coloured. Of course the beads have to pass many times through the workman's hands before completion. To this branch belong the amulets, which are sent to the Gold Coast, and are used in various sizes according to the rank of the wearer. Originally these amulets were made of agate, but as this substance is eight or ten times dearer than glass, the latter material has been adopted.

The Central German Society of Industrial Art has lately been giving attention to this subject, on which a lecture was delivered by Herr Bettmann, of Frankfort, himself a manufacturer of the articles in question.

General Notes.

Coal in France.—The two coal-fields of the North of France yielded 10,051,461 metric tons or tonnes in 1883, as contrasted with 9,594,942 tons in 1882, or an increase of 4·7 in 1883 over 1882. Nearly the whole of this increase is due to the output in the Pas-de-Calais, which was 423,625 tons more in 1883 than in 1882.

Antwerp International Exhibition, 1885.—The Lords of the Committee of Council on Education have received, through her Majesty's Secretary of State for Foreign Affairs, a communication from the Belgian Minister at this Court, stating that the Executive Committee of the Antwerp Exhibition have decided to fix the 1st August, 1884, as the limit of time for receiving applications for admission to that Exhibition.

Industrial Statistics of Germany. — In June, 1882, the population of Germany amounted to 27,287,860, of which 11,712,485 may be regarded as the bread winners. The latter are divisible into the six classes following :—

	Men.	Women.
1. Agriculture, the rearing of animals, gardening, forestry, hunting, and fishing	3,462,268	1,230,080
2. Mines, works, and construction	3,065,218	585,408
3. Trade and commerce ..	766,127	145,579
4. Work for salaries and daily wages..........	160,640	118,283
5. The church, law, army, and liberal professions	526,549	60,661
6. Undeclared	352,431	353,064
	8,333,233	2,493,075

Among the 11,712,485 bread-winners, 1,788,679 engage in 1,916,035 subsidiary occupations, in addition to which, 399,244 of those returned as devoting themselves to household cares are also engaged in subsidiary occupations.

Briar-root Pipes.—The following note on the so-called briar-root pipes is from a report on the trade and commerce of Leghorn, quoted in the *Gardeners' Chronicle* :—An interesting industry has been started here within the last three years by a Frenchman from Carcasonne, for the export of material for the manufacture of wooden pipes. Similar works are also to be found at Sienna and Grosseto. Selected roots of the Heath (*Erica arborea*)—preference being given to the male variety—are collected on the hills of the Maremma, where the plant grows luxuriantly and attains a great size. When brought to the factory, the roots are cleared of earth, and any decayed parts are cut away. They are then shaped into blocks of various dimensions with a circular saw set in motion by a small steam-engine. Great dexterity is necessary at this stage in cutting the wood to the best advantage, and it is only after a long apprenticeship that a workman is thoroughly efficient. The blocks are then placed in a vat, and subjected to a gentle simmering for a space of twelve hours. During this process they acquire the rich yellowish-brown hue for which the best pipes are noted, and are then in a condition to receive the final turning and boring, but this is not done here. The rough blocks are packed in sacks containing 40 to 100 dozen each, and sent abroad, principally to France (St. Cloud), where they are finished into the famous G. B. D., or "Pipes de Bruyère," known to smokers in England under the name of "Briar-root pipes." The production of this article is considerable, four hands turning out about sixty sacks per month. Consignments are also made to England and Germany, but at present the demand is said to be rather slack.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MINERS' SAFETY LAMP.

The adjudicators for the prize of £500, offered by Mr. Ellis Lever for a new Safety Lamp, have now reported. They are Mr. Thomas Burt, M.P., nominated by the Central Board of the Miners' National Union; Prof. Grylls Adams, by the Council of the Royal Society; Sir Frederick Abel, by the Council of the Society of Arts; and Prof. Sylvanus Thompson, by Mr. Lever.

The following is the report:—

Ellis Lever Competition.

Report of Adjudicators.

The adjudicators had to examine 108 lamps; of these 4 were electric lamps, and 104 oil lamps, of which a few were designed to burn mineral oils.

With respect to the electric lamps, there was not one which fulfilled, or approached fulfilment of, the conditions of the award.

All the lamps which fulfilled the preliminary requirements were submitted to a series of experiments of progressively increasing severity. These experiments, based upon the experience gained by the Royal Commission, and by experiments instituted by other bodies in this country, were calculated to fulfil even exceptional conditions to which lamps may be exposed in actual practice. While there was a considerable number of lamps which behaved satisfactorily under the normal conditions existing in mine workings, the number was reduced to very few as the extreme tests were reached. Of these there is no one lamp that perfectly fulfils the whole of the conditions enumerated in No. 2, and the adjudicators are consequently unable to make the award to any one of the lamps submitted.

Among the best there are two which the adjudicators regard as deserving of special mention, viz., the Marsaut lamp, with three gauzes, which most nearly fulfilled the conditions; and the lamp of Mr. William Morgan, of Pontypridd, South Wales, which presents several good features of marked originality.

Thos. Burt.
F. A. Abel.
W. Grylls Adams.
Silvanus P. Thompson.

The following are the the conditions of the prize, which were announced in March, 1883:—

1. The five hundred pounds to be invested in the names of three trustees, one of whom shall be Mr. Thomas Burt, M.P., the other two to be chosen by the Central Board of the Miners' National Union.

2. The lamp to be a perfectly self-contained electric lamp, or other lamp, which the working miners can conveniently carry from place to place in the mine, which will continue to give a useful amount of light for not less than twelve hours, and which will not cause an explosion of gas under any circumstances at all likely to represent conditions which may occur in actual practice.

3. The efficiency of the lamps put in for competition, to be submitted to five gentlemen, composed as follows:—Three scientists to be named hereafter, one to be selected by Mr. Lever, one by the Council of the Royal Society, and one by the Council of the Society of Arts, one person representing the Mining Engineers, chosen by themselves, and one person representing the workmen, chosen by the Central Board of the Miners' National Union.

4. The adjudicators to meet in London after the allowed time for sending lamps for competition has elapsed.

5. The prize will not be awarded to any lamp now in use.

6. Not drawings or specifications, but lamps in a condition fit to be tested, must be sent for examination by the adjudicators.

7. The lamps must be sent to No. 2, Victoria-street, Westminster, London. No lamp to be sent in before the 1st of December, or none later than the 31st of December, 1883.

8. If a lamp meeting the requirements herein stated has not then been invented, the five hundred pounds to revert back to Mr. Ellis Lever.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS USED FOR COINAGE.

By W. Chandler Roberts, F.R.S.

Chemist of the Royal Mint; Professor of Metallurgy, Royal School of Mines.

Lecture II.—Delivered March 24th, 1884.

The meaning of the word alloy, in mint language, is different from that ordinarily accepted in scientific phraseology, as it is applied to the base metal added to a more precious one, and not to the mass, which may be either molten or solidified, of the mixed metals. This use of the word has been fostered by the way in which it has, from time to time, been employed in ordinances that have regulated the composition of the coin, and in the indentures made between the Sovereign and the Master of the Mint. It has also been perpetuated by the first schedule of the Coinage Act 1870, the legislative enactment which guides the currency at the present time. The earliest of these ordinances extant, that given by King Edward I. to Gregorie Rokesley, prescribes, that a pound of silver money shall contain "11 ounces, 2 easterlings (dwts.), and 1 farthing of silver, and the other 17 pence 3 farthings to be 'lay,'* that is, 'alloy.'" Biringuccio used the word with perfect accuracy in the 16th century. "I have told you," he says,† speaking of the gold alloys, "that an alloy only signifies an intimate association (*damicabile amicitia*) of one metal and another." The author of an interesting little work, entitled "A Touchstone for Gold and Silver Wares,"‡ usually employs the word in the Mint sense, as when he says, "Silver having too little alloy would be too soft, so too much alloy would make it brittle like brass;" but Cramer,§ a later writer, is scientifically accurate in calling a mixture of gold with silver a "white alloy." With regard to the derivation of the word, it may be sufficient to point out that the old French *alei* was retained in the Norman as *alai* or *allai*, whence our word allay. Through the erroneous fancy that the French *aloi* was equivalent to *à loi* (to law) the word, meaning originally simple "combination union," came to be used specially of the mixing baser metal with gold and silver in coin, so as to bring it to the recognised standard, and hence of the standard itself.‖ The French word comes from *alleium* or *alaium*, the original being probably *ad-ligo* (alligo), to bind to. Used in the Mint sense, the relation of the word "lay" or "allay" to the Teutonic *linderen*, to lessen, as pointed out by Sir John Pettus¶ is suggestive, as it is in the sense of a precious metal "lessened" in value, that "alloy" is retained in the Mint at the present day; but I may be permitted to repeat that this is an inaccurate use of the word, and that a sovereign should be viewed as a coined disc of an alloy of gold and copper, the union of the two metals constituting the alloy. The word sterling, again, deserves a brief notice, and I will only quote Stow,* as his explanation, adopted by later writers, is probably the correct one. He says, "but the money of England was called of the workers thereof, and so the Easterling pence took their name of the Easterlings, which did first make this money in England in the reign of Henry II., and thus I set it down according to my reading in Antiquitie of money matters, omitting the imaginations of late writers, of whom some have said Easterling money to take that name of a starre stamped on the border or ring of the penie: other some, of a bird called a stare or starling stamped on the circumference, and others (more unlikely) of being coined at Stiruelin or Starling, a towne in Scotland." Lowndes adopts this "Easterling" view of the origin of the word sterling,† and supports it by reference to a very old treatise "entered at large in the Red-book of the Exchequer, in the time of King Edward III," and he considers that the words "sterling" and "standard" are synonymous. Similar arguments are adduced at great length, with abundant references to authorities, in Hearne's "Curious Discourses."‡ The word sterling was, however, probably used to distinguish a definite alloy of silver and copper from certain other alloys containing less of the precious metal.

Throughout these lectures the words "standard fineness," indicates the amount of "fine" or pure metal present in any given alloy, and the degree of fineness will be expressed decimally, pure gold or pure silver being considered to be 1,000.

The reasons for the use of alloys, in preference to pure metals, are somewhat complex. In early states of civilisation coins are generally made of more or less pure metal, but a nation does not advance far in its history before the very important fact is recognised that alloys are more durable than pure metals, and that their substitution for pure gold or silver affords

* Ruding, vol. i., p. 192.
† Original Edition, p. 73. 1540.
‡ Second Edition, p. 8. 1679.
§ "Elements of the Art of Assaying Metals," by J. A. Cramer, M.D. Second Edition, p. 118. London: 1764.
‖ A New English Dictionary, edited by J. A. H. Murray, Clarendon Press, 1884.
¶ "Fleta Minor," Essay explaining Metallic words, see "Allay" in the appendix. London: 1683.

* "A Survey of London," by John Stow, p. 52, 1603.
† "Essay on the Amendment of the Silver Coins," p. 16, London, 1695.
‡ Edition of 1771, vol. i, p. 10 and 13, and vol. ii, pp. 315 and 379.

a notable source of revenue. In cases where the coinage is in any degree international, the adoption of a low standard by one nation has to be followed by its neighbouring nations, in order to prevent loss, and to facilitate commerce by avoiding the necessity for tedious calculations as to the rate at which coins may circulate in the respective countries. It is still possible, though not to the same extent, to make profits in the way indicated by Sir John Pettus, who, writing in the 17th century, observes, "it is good for a traveller to be skilful in different alloys, whereby, as a friend of mine told me, that he carried out £100 with him, and by his art of exchange in countries where alloys differed, he bore his charge of travel, and brought his stock home again."* A well-known modern instance of such a system is presented by the action of the first Europeans trading with Japan in virtue of the Treaty of 1858, who, availing themselves of the fact that the gold coins of that country were current at considerably less than their true value in silver, bought the gold kobangs then in circulation for about one-third of their actual value, and realised large profits.

The actual melting of the precious and base metal is effected in small furnaces with natural draught, and the crucibles employed are usually made of a mixture of graphite and fireclay. The capacity of the crucibles is very varied; those used in this country for melting gold hold about 1,200 ounces, and the crucibles for melting silver 4,000 ounces. Gaseous fuel is sometimes, though rarely, employed in mints, and I only know of one mint in which metal is melted on the open bed of a reverberatory furnace, and then of course the alloy to be formed is only bronze. The use of such furnaces would present some advantages, but as a considerable amount of metal would be, temporarily at least, hidden in the more or less leaky furnace bed, it becomes absolutely necessary to employ crucibles for melting the precious metals.

With regard to the choice of the base metal to be added to the precious, many conditions have to be taken into consideration. The resulting alloy must be of good colour, must be ductile, and must not exhibit any traces of brittleness. In the case of gold, silver forms a very ductile alloy, but then, as we have seen, it sensibly lowers the colour of the gold. Copper, on the other hand, heightens the tint, and has the advantage of yielding a durable as well as ductile alloy. A triple alloy of gold, silver, and copper may be made of delicate tints, but a triple alloy is difficult to assay, and it is undesirable to complicate the accounts of a mint by the use of two precious metals and a base one in the same alloy, therefore a single base metal, copper, is now almost universally used.

It has long been known that the union of two or more metals produces a result which often differs more in physical properties from either of its constituents than they do from each other. Copper and tin, for instance, alloyed in definite proportions, yield alloys of a wide range of properties, and there is hardly any fact more remarkable in the whole range of metallurgy than the enormous influence exerted on a large mass of metal by a small quantity of another metal or metalloid.

From the Mint point of view, the properties which it is most desirable to secure are—1. Ductility; 2. Durability; 3. Uniformity of composition.

In addition to these, the alloy is expected to be sonorous, that is, the coin struck from it must have the true "ring;" and, finally, it must possess exactly the degree of viscosity which will enable it to flow, under pressure, into all the fine lines of an engraved die, while at the same time the metal must have sufficient rigidity to retain its impression when submitted to rough usage. This question of the flow of metals has been beautifully worked out by M. Tresca,* who has shown that when metals and alloys are submitted to compression, they so closely resemble fluids in their behaviour, that the shape they will assume can be deduced by calculation. In coining a disc of metal, the engraved work of the die forms a series of channels designed to facilitate the flow of the metal of which the coin or medal consists, and to guide it in the required directions. In the compression of a "blank" between dies, the portions not to be brought into relief by the action of the press are reduced in thickness for the benefit of the neighbouring raised portions, the metal literally flowing from the level parts to the reliefs.

I once heard Mr. Ruskin say in a lecture:—"You stamp the effigy of a cow on a pat of butter, why don't you stamp the bee on the honey?" Simply because one is much more viscous than the other, and will not retain a shape given to it; and from the coining point of view this is precisely true of lead, which

* Fleta Minor, Appendix, word, "Money."

* Paper read before the Society of Mechanical Engineers of Paris; translated, *Journal of Franklin Inst*, Philadelphia, 1878, vol. lxxvi., pp. 263-326.

rapidly becomes defaced by only a moderate amount of wear, and in a less degree of pure gold. It is absolutely necessary to add some other metal which will form a more or less rigid alloy.

With regard to the sonorous property of the alloys used for coining, if two rods, one of pure silver, and the other of the alloy of silver and copper, known as standard silver, be hung close together, one will ring loudly when struck, while the other gives a comparatively indistinct sound. The best indication, however, of the total difference between the molecular grouping of a pure metal and an alloy, is afforded by their electrical behaviour.

It will, I trust, be evident that the base metal added to gold or silver may be regarded from two distinct points of view; either as a useful constituent of the coin, which enables it to resist wear and hinders the obliteration of its impression, or, if coins containing base metal are made current at more than their intrinsic value, as a source of gain to the rulers of a country. With regard to the actual standards of fineness which have, from time to time, been employed, it may be pointed out that, in the numismatic history of the world, endless combinations of precious and base metal have been represented. Pure gold and silver have been used, either singly, or alloyed with each other, or alloyed with copper, the latter metal, in turn, being sometimes employed with only infinitesimal additions of precious metal.

The alloys actually used for coinage at the present time are not numerous, and it may be well to begin the consideration of such as are specially important by tracing the steps which led to their adoption.

In the case of both the gold and silver currency of this country, the adjustment of the relative proportions of the precious and the base metals was undoubtedly guided by the particular systems of weights used. To take the silver coinage first, the fineness of alloys of this metal has from very early times been computed by divisions of the troy pound, which weight is still retained in weiging gold and silver. The Commissioners appointed in 1868 to inquire into the conditions of the Exchequer standards, state that "the troy pound is said to have been derived from the Roman weight of 5759·2 grains, the 125th part of the large Alexandrian talent, this weight, like the troy pound, having been divided by the Romans into twelve ounces;" and they add, "the troy weight is universally allowed to have been in general use from the time of King Edward I. The most ancient system of weights in this kingdom was that of the moneyer's pound, or the money pound of the Anglo-Saxons, which continued in use for some centuries after the Conquest, being then known as the Tower pound, or sometimes the goldsmith's pound. It contained twelve ounces of 450 grains each, or 5,400 grains, and this weight of silver was a pound sterling. The Tower pound was abolished in 1527 by a statute of King Henry VIII, which first established troy weight as the only legal weight for gold and silver. . . . From that time to the present our system of coinage has been based on the troy weight."* The computation of the standard fineness of alloys of gold is based on the singular "carat" system of weights, the origin of which is popularly believed to have been derived from the weight of an oriental plant-seed. Mr. H. J. Chaney, who is entrusted with the duties of the office of Warden of Standards, informs me that "its history is not easily traced, but that the origin of the carat is doubtless Grecian. The *ceratium* was a small Greek weight."† It is uncertain whether the use of the carat came to us through the Arabian alchemists, or through the Roman mints, and the exhaustive inquiries of Vasquez Queipo do not throw much light upon the point; but with regard to the supposed derivation of the weight from the seed or bean, Mr. Chaney thinks "it is more probable that the Greek *Keration*, and the Arab *Kyrat* were applied to the beans or seeds by the native merchants, who made them serve provisionally as weights.

It has been necessary to offer the foregoing explanations, because the expression of the varying standards of fineness, either in the "carat and grain" system or in the "ounces, pennyweights, and grains" of the troy system, is somewhat obscure to those who are not familiar with their use; and although the decimal system will be adopted for the purposes of this lecture, it will be difficult to avoid references to the older methods of computation.

In 1790, Mirabeau, in an elaborate memoir submitted to the National Assembly in France,‡ urged that the decimal system should be applied to the coinage, and, as will be shown subsequently, his views were adopted in 1794.

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* Third Report of Commissioners. Parliamentary Paper, c. 30, p. iii., 1870.

† Quoted by Mr. Chaney, in a letter to me, from "Lucae Paeti de Mensuris et Ponderibus," Venetiis, 1573, p. 88.

‡ "Collection complette des Travaux de M. Mirabeau l'ainé à l'Assemblée Nationale," Paris, 1792.

The use of this system spread rapidly over the Continent, but the computation of the fineness of gold alloys by the system of carats and grains survived in the English Mint until 1882, when the decimal system was introduced.*

With these remarks we may proceed to the consideration of the alloys used for coinage in early times.

It may be convenient to begin the history of the alloys used for coinage with the employment of the natural alloy of gold and silver, to which the ancients gave the name of electrum, native gold being always associated with silver, which is sometimes present in sufficient quantity to sensibly lower the colour of the more precious metal, and to cause the gold tint to disappear almost entirely when it exceeds one-third part of the mass.

Dr. Schliemann describes† three pale yellow rod-like bars, each 4·33 inches long, provided with fifty to sixty equi-distant horizontal incisions, at right angles to the length of the rods, which probably indicated their value, and facilitated their sub-division into definite portions. Dr. Schliemann kindly permitted me to analyse a small portion of one of these rods. which was found to contain 651 parts of gold, and 334 parts of silver in 1000 parts, and small quantities of copper and lead.

In a dissertation on the Homeric talent, Dr. F. Hultsch states that it weighed 16.8 grammes, or a little above ½ oz. troy, and was the prototype of the oldest gold stater, coined in the beginning of the 7th century B.C., at Phocea, and other cities of Asia Minor.‡ I have already referred to the coined nuggets of electrum which may have been adopted for purposes of currency long before the use of coined money; but, as M. Lenormant points out,§ in the series of coins of the kings of Lydia, gold and electrum were coined simultaneously, as distinct metals, having distinct monetary values.

The numerous analyses made by Dr. Rauch‖ and others have placed at our disposal much accurate information as to the standard fineness of the alloys used for coinage in Greek and Roman times. M. Lenormant,¶ who devotes a considerable portion of his elaborate work to the consideration of this subject, observes "that in the Hellenic world the coins of gold and silver were remarkably pure, the gold coins sometimes contained only three parts of silver in the 1,000, which represented the highest degree of purity attainable by the method of refining then in use.* In the coins of Darius a little base metal was intentionally introduced, but its amount did not exceed 30 parts in the 1,000, and, speaking generally, the Grecian silver coins contained considerably less base metal than coins issued in modern times. The standard of the tetradrachms of Athens, at the best period, varied from 983 to 986, while those of the second series fell only as low as 966, and these contained 2 parts of gold in the 1,000, as well as the 32 parts of copper. A series of Greek coins struck in Italy and Sicily in the 6th century before the Christian era, vary in fineness from 910 to 980. At the end of the coinage at Tarentium, the standard was sensibly lowered, for a didrachma assayed by Dr. Rauch was found to have only the fineness 880, but M. Lenormant observes that, in the entire series of Asiatic coins before the conquests of Alexander, there is no essential change in the standard of silver, which is uniformly high, although instances are met with of coins of as low a standard as 709. With regard to Roman money, I will only quote Lenormant's statement that the gold of the Republic was always pure, and that Imperial gold coins, until the time of Vespasian, were of excellent quality, although their standard was slightly reduced, that is, from pure gold to standard 991. After the time of this emperor, the standard appears to fallen to 938, and subsequently, about the time of Septimus Severus, it fell much lower. In the year 265 A.D. the gold coins were struck in a base alloy, containing—

827·3	of copper.
159·4	„ silver.
13·3	„ gold.
1000·0	

The silver of the Republic was always excellent, varying, according to Darcet, from 993 to 995, but under Imperial rule its debasement appears to have been rapidly effected, especially from the time of Nero until the 3rd century, when the silver became mere *billon*, containing—

820	of copper.
160	„ lead and tin.
20	„ silver.
1000	

* 13th Annual Report of the Deputy Master of the Mint, 1882, p. 46.

† "Ilios," p. 496. London, 1880.

‡ "Griechische und Römische Metrologie." Berlin, 1882. Quoted by Dr. Schliemann, "Troja," p. 113. London, 1884.

§ "La Monnaie dans l'Antiquité." Paris, 1878, t. i., p. 194.

‖ Zeitschrift für Numismatik. Band 1, p. 36, 1873.

¶ Op. cit. t. 1, p. 187, *et seq.*

* This was the cementation process described by Geber in the 8th century, of which a full account is given b Biringuccio, original edition, p.72 (1540).

From the time of Diocletian, when the coinage of silver was resumed, it was of excellent quality. A series of Roman coins of the first three centuries, found at Baden Baden in 1828, was analysed by Dr. Walchner of Carlsruhe, whose results may be briefly stated as follows. A coin of Heliogabalus proved to be the lowest standard (505), while one of Antoninus Pius, which contained 913 parts of silver, was the highest, coins of Commodus, Domitian, Hadrian, and Trajan varying from standard 797 to 890.* It may be added that there was a coin of the Triumvir Antoninus† (B.C. 31) which had almost the same composition as British silver coin, as it contained—

925	of silver.
71	,, copper.
2	,, lead.
1	,, gold.
999	

Time will not permit me to trace the varying changes in the fineness of coins issued in the barbaric times which followed the overthrow of the Roman Empire. Judging from their appearance, the coins present endless variations of standard. In view, however, of the special interest connected with the early British series, I may point out that Mr. John Evans‡ has clearly traced the design they bear to the stater of Philip of Macedon, who struck the coin in question of gold of a high degree of purity. In view of this lecture, I have assayed an early British gold coin, believed to have been struck at a period ranging from 50 to 60 B.C.§ Its design well exhibits the characteristic evidences of its descent, and it proved to contain—

403·5	of gold.
400·2	,, silver.
196·3	,, copper (by difference).
1000·0	

The next historical point is presented by the early Saxon sceattæ, a single specimen of which, assayed by me, proved to contain 558 of silver, 12 of gold.

I have also assayed a silver coin of Burgred King of Mercia, 852-874, A.D., which proved to be of so low a standard as 331·6; and one of Ethelred (978-1016 A.D.), which contained 918·1 of silver, and a little gold, while a coin of Canute (1016 to 1035 A.D.) was of standard 931. Two coins of King Edward the Confessor, one of them kindly given me by Mr. John Evans, for the purpose of assay, proved to be of standard 943·2, and 940·4, both coins containing, in addition to the silver, nearly 2 parts of gold in 1000.

With these slender links, I must pass to the series of coins which began with the Norman conquest, observing, however, that a further connection between the Roman, mediæval, and modern series is maintained by at least two coins, which were so widely circulated, that they may almost claim to have afforded an international currency. These coins are the "bezant" of Constantinople, and the "florin" of Florence, which we know to have been of nearly pure gold.

"The gold bezants of the Greek Empire, and the gold coins struck during the 9th and 10th centuries by Arabic princes, in Sicily, were probably used, more or less, in mercantile transactions all over Europe, and are found occasionally in this country, but they had no legal currency here, and were probably accepted merely as bullion. In the middle of the 13th century, however, a native gold coinage was almost simultaneously adopted by the European nations. The first gold florin was issued by the Republic of Florence, in 1252. Louis IX. introduced gold coins into France, and the Emperor Frederick II. into his kingdom of Naples, and at the same time the same innovation took place in England."*

In the accompanying diagram (p. 841), the dates of issue, and the standards of fineness of the gold and silver coins of this country have been taken as co-ordinates, the points being mainly plotted from the tables given by Ruding.† Taking the gold coinages first, it will be seen that the line begins at the year 1257, the 41st year of King Henry III., who made a penny of the finest gold, which weighed two sterlings. This, as Ruding points out, is remarkable as the first coinage of gold in the kingdom, and it is extraordinary that it took place at the height of the king's distress for want of money. The next step of importance was taken in 1343, when King Edward III. coined, or projected a coinage of the standard 994·8 [23 carats, $3\frac{1}{2}$ grains, and $\frac{1}{2}$ grain of alloy], which was referred to by later writers as the "old sterling" or "right standard" of

* Quoted by Dr. Percy, "Metallurgy of Gold and Silver," part i, p. 169, 1880.

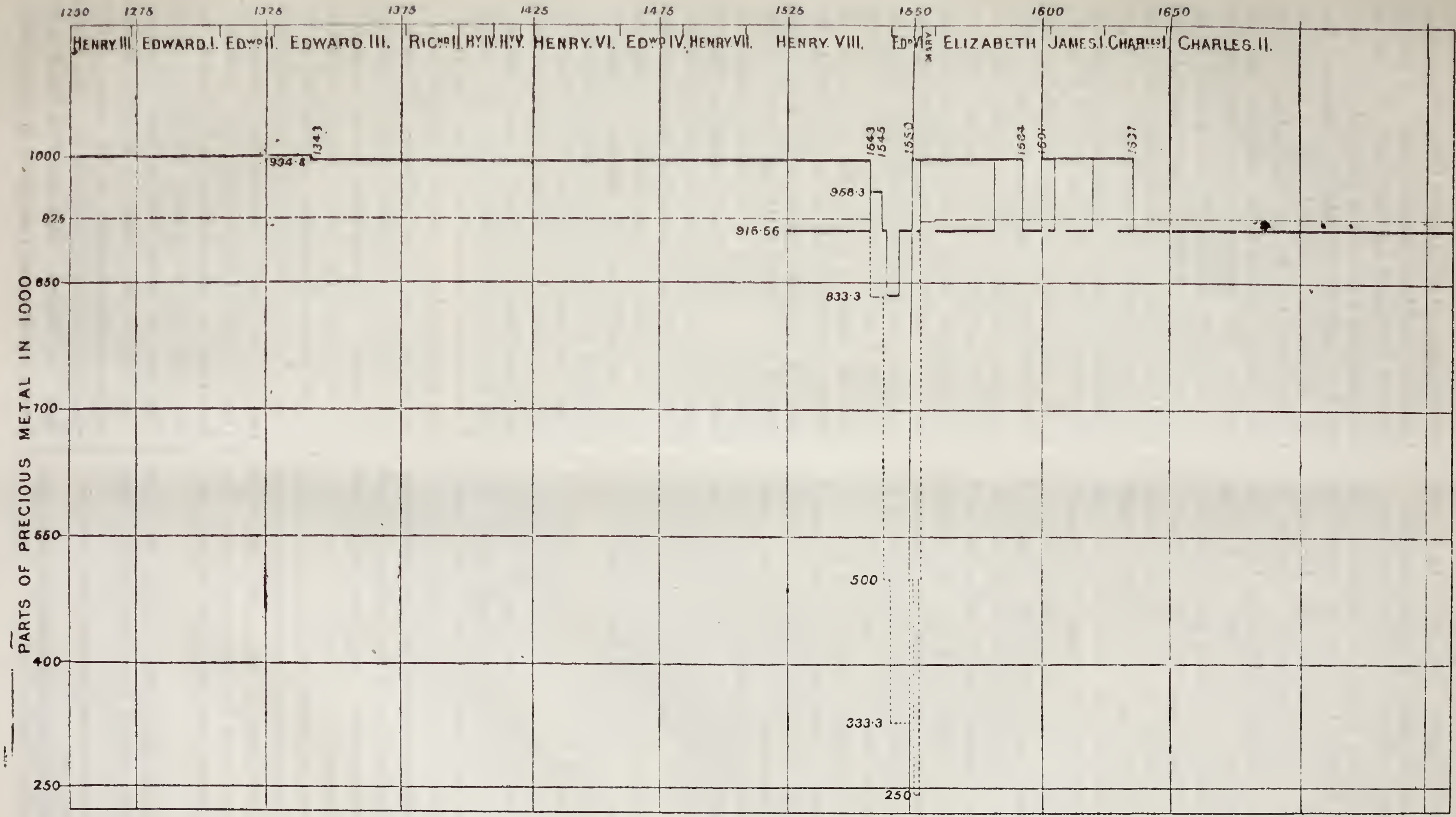
† "Die Metallurgie Metallverarbeitung," Prof. A. Ledebur, p. 86 1882.

‡ "The Coins of the Ancient Britons," p. 23. London, 1864.

§ This coin is similar in design to that figured Plate C, No. 8 of the above work.

* "The Gold Coins of England," by R. L. Kenyon, p. 14., 1884.

† "Annals of the Coinage," vol. i., p. 10.



The gold coinages are represented by a thick line, thus:— ————. The silver by a dotted one ············. Changes of standard are indicated by a thin continuous line in the case of gold, and by a thin dotted line in the case of silver. The scale is doubled at the critical period between the years 1525-50. There has been no change in the standard of gold since the year 1660, or in the standard of silver since the reign of Queen Elizabeth.

England, and Lowndes, quoting the Red-book of the Exchequer, says, that the ½ grain of alloy might be either of silver or copper.* Although these were not, as Stow considered, "the first coining of gold in England," the coins of Edward III. were of remarkable beauty, and it was asserted that they were struck from gold prepared by occult aid, by the well-known alchemist, Raymond Lully, who had a laboratory in the Tower of London. There are, however, chronological difficulties in the way of this explanation of the origin of the precious metal. As the diagram shows, no further change was made in the standard fineness of the gold coin until the year 1526, when King Henry VIII. reduced the standard to 916·66 [22 carats], the professed object of the reduction being to prevent the exportation of the coin to Flanders. The further debasement of the standard, which was effected in 1543-4, was preceded by a kind of scientific research, as the King ordered the Officers of the Mint to prepare, whenever they should be so directed by the Privy Council, alloys to the value of one pound in weight, of such fineness as should be devised by the said Council, in order that the general nature of alloys, similar to those used in foreign realms, might the sooner come to his Majesty's knowledge. The standard 916·66 [or 22 carats fine] (which is the standard of the alloy used at the present day for the gold coinage of this country) was again issued in 1544. By a subsequent indenture, dated 1545, the gold was brought down to 833·4 [20 carats fine.]

King Edward VI. improved the fineness of the gold currency in 1549, and in 1552 an indenture was made authorising the coinage of gold both of the old standards 994·8, and of the standard 916·6̇. Queen Mary issued coins of fineness 994·8 [23 carats 3½ grs.] Queen Elizabeth struck coins of both standards. As the diagram shows, the coinage of gold of the "old standard" 994·8 was abandoned in the 12th year of King Charles I., and since that time the standard 916·6̇ [22 carats fine], has alone been issued. Coins made of the old standard previously to that period continued to be current until the year 1732, when they were withdrawn from circulation by proclamation.†

The vicissitudes through which the silver coinage has passed have been greater than those that have affected gold. I have selected a few examples of coins issued before the Roman Conquest, and have assayed them. A coin of Burgred contained only 302 parts of silver in the thousand, while one of Ethelred was 918·4, and was probably intended to represent the old standard of England, 925. A coin of Canute proved to be of standard 931, which was clearly intended to represent the old standard. Two separate coins of King Edward the Confessor, assayed by me, proved to be 941, which is "better" than standard; but Mr. John Evans, who kindly gave me one of the coins, considers that this slight superiority to standard is due to the fact of copper having been removed from the surfaces of the coins by the operation of cleaning to which they had been submitted. Anglo-Saxon and Anglo-Norman coins are believed to have been of the "old standard," 925, and a coin of William the Conqueror which I assayed, proved to be 922·8. In England, this old standard appears to have remained unchanged until the 34th year of King Henry VIII., when, as the diagram shows, a great fall took place. It will be seen that a still more rapid fall in the standard fineness ensued in the rest of the reign of King Henry VIII, and in the reign of Edward VI. It fell to its lowest point in the fourth year of the latter monarch, when the pound of silver contained only three ounces of fine silver, and nine ounces of base metal, that is, the standard, expressed decimally, was only 250. Strangely enough, this base coinage was projected with a view to secure by the transaction the sum of £160,000, to be devoted to the restoration of the standard generally. Half this sum appears to have been actually obtained. As a step to the withdrawal of the base money, it was almost universally decried, that is, the coin which had been current at rates far above its intrinsic value, was officially reduced to a value nearly corresponding with its standard of fineness. Dreadful distress was caused to the people, and the saddest pictures are drawn of the financial condition of England at the time. In 1552, the standard was restored to nearly its original richness, as coins containing 11 oz., 1 dwt. of pure metal, and 19 dwts. of base metal, or standard 921, were issued, and this alloy was maintained by Queen Mary. The diagram shows how far Queen Elizabeth contributed to the restoration and maintenance of the standard fineness of the coin. A proclamation, dated September 27, 1560, stated that "her Majesty, who, since she came to the throne, never gained anything by the coinage,

* "Lowndes, Essay for the Amendment of the Silver Coin," p. 18. London: 1695.

† Lord Liverpool's letter to the King, p. 32. Edition published by the Bank of England, 1880.

nor yet ever coined any manner of base monies, for this realm, had begun a coinage of fine money in the Tower of London." Notwithstanding the Queen's efforts to restore the coinage in England, the coins circulated in Ireland were deplorably low, as the pound only contained 2 ozs., 18 dwts. of fine silver, and 9 ozs., 2 dwts. of copper (that is the standard was only 250). Well might that shrewd economist, William Stafford,* remind her Majesty that, "though gold and silver be the mettals comonly wherin the coyne is stryken to be the tokens for exchange of things between man and man, yet it is the wares necessary for man's use, that are exchanged in deede under the outward name of the coyne;" or, in other words, by diminishing the value of coin, its purchasing power is diminished.

The restoration of the standard of the silver, begun in the reign of King Edward VI., was, however, completed by Queen Elizabeth, and it has not been since debased.

Before leaving this part of the subject, it may be well to offer a few remarks on the debasement of coinage generally. The famous antiquary, Sir Robert Cotton, in a well-known speech made before the Privy Council in the reign of Charles II., observes, "what renown is left to Edward I. in amending the standard, both in purity and weight, ... must strike as a blemish upon princes that do the contrary. When Henry VIII. had gained us much of power and glory abroad, and of love and obedience at home, as ever any, he suffered shipwrack of all upon this rock." And he elsewhere points out "that every man will rate his commodity in sale, not according to the accompt of pence or pounds, but to the weight of pure silver contained in the current money."

With reference to the apparent motives for the debasement of the currency, Lord Liverpool observes that "these motives were, first, a desire of augmenting the royal revenue, and, second, principles of mistaken policy," supported by "an idea that they should thereby prevent the coin from being exported," and he adds, "but this idea has been fully exploded since the principles of commerce and foreign exchanges have been well understood." † It may be pointed out that the exact standard fineness of the alloy used is a matter of but small importance, and that a coin poor in precious metal is not really "debased," if it is not made current at a rate below its intrinsic value.

* "A Brief Conceipt of English Policie," p. 29. London, 1581.

† Op. cit., p. 123.

One other method of debasing the coinage remains to be noticed, which was, so far as I know, confined to Roman times. It consists in the issue of pieces of copper, iron, lead, or tin, plated with a thin layer of silver, or more rarely gold. The workmanship of such coins exhibited much skill and care, and they appear to have been issued simultaneously with coins of full value, often with a view to defray the cost of the coinage of the good pieces. An elaborate literature has been devoted to them, which has been well condensed by M. Lenormant.*

The issue of coins of base metal by King James II., for use in Ireland, can hardly be called a depreciation of the standard, as in many cases they contained no silver at all, but were made from old guns, bells, kitchen utensils, "and the refuse of metals molten down together, and valued, by the workmen in the Mint, at no more that three or four pence the pound weight; but when coined into sixpenny, shilling, or half-crown pieces, and made current by arbitrary power, it passed at the rate of five pounds sterling the pound weight, or eleven thousand two hundred pounds the ton, when at the real value, namely, fourpence the pound weight, the compound metal was not worth more than thirty-seven pounds, six and eightpence the ton."†

I have thus attempted to trace the history of the gold alloy of standard fineness $916\cdot\dot{6}$, and the silver one of 925, the alloys used in this country for the gold and silver currency, and as the gold represents a large proportion of the coinage of the world, it may fairly claim to be the most important gold alloy in existence. England is not the only country in which it is retained; the explanation of its existence in other countries is found in the fact that standard $916\cdot\dot{6}$ is the metric equivalent of 22 carat gold, and, as the carat system has been in use from early times, it is natural that many nations should have originally adopted the convenient proportion presented by $\frac{22}{24}$, or $\frac{11}{12}$, which this alloy represents, and it has, accordingly, held its own in British India, Russia, the Turkish Empire, Portugal, Persia, and with a slight variation in Brazil.

As it will not be possible to examine the history of the alloys at length, attention must

* Op. cit., t. i., p. 221, *et seq.*

† King's state of the Protestants in Ireland, quoted in an essay on Irish coins by James Simon, F.R.S., p. 62, Dublin, 1749.

be limited to the more important ones, of which the alloy containing 900 parts of gold in the 1,000 parts demands special notice.

The coins in circulation in France from the beginning of the 17th to the end of the 18th century varied in fineness from 900 to 982; for instance, the louis d'or of King Louis XIII. were 22 carats fine, the ecus d'or of Louis XIV. were 23 carats, while the lys d'or of the same monarch were 23 carats and one-fourth of a grain.*

When, however, the decimal system of weights and measures was fairly established, coins were issued in conformity with it. The law of the 28th Thermidor, An. III. (1796), fixed the franc as the monetary unit, and enacted that the standard fineness of the silver coins should be 900, the weights as well as the fineness of the coins being strictly in accordance with the decimal system, although round numbers were not secured in the respective weights of the coin. Eight years later, the law of the 7th Germinal, An. XI. (28th March, 1803), prescribed the coinage of gold pieces of 20 francs, the standard of which was also 900. A subsequent law, the result of the recommendations of a committee appointed by the French Senate, directed, on the 25th of May, 1864, that pieces of 50 and 20 centimes should be of standard 835; and on the 14th of July, 1866, the standard of fineness of pieces of one and two francs was also reduced to 835.† By the Monetary Convention of the 23rd December, 1865, concluded between France, Belgium, Italy, and Switzerland, the standards of fineness above described were adhered to. Several other countries, notably Roumania, Servia, Greece, Scandinavia, and most of republics of South America, have partially adopted the same monetary system. In Germany, in virtue of the laws of the 4th of December, 1871, and the 9th of July, 1873, the standard fineness of both gold and silver has been fixed at 900. In the United States of America the use of the alloy 900 fine has been confirmed, for both gold and silver, by the Coinage Act of the 12th of February, 1873. It will be evident, from the foregoing remarks, that the two really important alloys used for coinage of gold have respectively the standard fineness 916·6 and 900, while for silver coins the standard 900 is now more widely used than any other, England alone employing 925, which still maintains the connection with Saxon coins.

In concluding this portion of the subject, it will be sufficient to examine briefly a few other standards of fineness, which either may be actually struck at the present time, or the circulation of which is permitted by the legal enactments of certain countries.* First, as regards gold, the richest gold alloy which survives to the present day would appear to be the gold ducat of the Austro-Hungarian Empire, which, in accordance with the laws of the 24th December, 1867, and the 9th of March, 1870, contain no less than 986 parts of fine gold in 1,000. The issue of gold ducats of fineness 983 is permitted in the Netherlands, by laws of 26th November, 1847, and 6th June, 1875. The poorest gold alloy in circulation appears to be that employed for certain Egyptian coins, the standard of which is only 875, and the same standard is also used for gold coins in Mexico, and in the Philippine Islands.

In the case of silver, the variations are greater. Since 1868, Austro-Hungary has issued kreutzers which contain, respectively, 400 and 500 parts of fine silver in 1,000. The 10 öre piece of Norway also contained only 400 parts of fine silver. The standard of the silver coins of Brazil is 917; the silver coins of British India are 916·6. In Russia, the roubles are of standard 868, while that of the Turkish piastre is 830. In the Netherlands the standard 945 for pieces of ½ to 2½ florins, which is the richest alloy of silver actually in circulation, is employed; and the standard 720 is employed for the currency of Java, because it is the most homogenous of all the silver-copper alloys.†

The alloys to which reference has hitherto been made, have been simple ones of two metals. In the case of gold coins, the second metal contemplated by law was copper, but silver was, in many cases, used, either to the exclusion of copper, or in conjunction with it. The Australian gold coins first issued contained a considerable proportion of silver, as their colour showed, but in all the examples given the use of triple alloys has rather been the result of accident than of design. It will now be necessary to con-

* Much information of interest relative to the standard fineness of coins of the 17th and 18th centuries will be found in the "Traité des Monnaies d'or et d'argent, examinées sur les rapports du poids, du titre, et de la valeur réelle," par P. F. Bonneville. Paris, 1806.

† Annuaire publié par le Bureau des Longitudes, 1884, p. 292, *et seq.*

* An excellent classification of the alloys used in different countries will be found in "La Question Monétaire," par M. H. Costes, Paris, 1884.

† Levol. Ann. Chim. et Phys. [3] t. xxxvi., Roberts. Proc. Roy. Soc. v. xxiii. p. 481, 1875.

sider triple or complex alloys at some length. In early times, when complex ores were treated by metallurgists who may have possessed considerable skill, without knowing how to insulate each of the metals present in the ore, singular admixtures have been obtained as the result of the operation. A very experienced copper smelter, Mr. Tyrell, of Swansea, has shown * that it is only necessary to smelt copper pyrites with a small addition of an ore which contains tin, in order to obtain bronze of the composition frequently met with in ancient implements or weapons. Numerous instances of the involuntary use of complex alloys for coinage might be given, but the best example is probably presented by the coins of the early Britons, which were of copper alloyed with 20 to 25 per cent. of zinc and 5 to 11 per cent. of silver, together with small quantities of gold, lead, and tin. Mr. John Evans has pointed out that the Saxon stycas range through a wide field of alloys, and may in some cases have been formed by melting together the coins discovered in "hoards" of Roman coins with, of course, very variable results.† In the case of gold, such triple alloys have been used but seldom. A modern instance in which their use was suggested is presented by the triple alloys of gold, copper, and zinc, prepared in 1873, by M. Péligot.‡ He showed that an alloy containing 58·1 per cent. of gold, 36·1 of copper, and 5·8 of zinc is of good colour, can be readily worked, and possesses the advantage of being decimal as to weight. Péligot also suggested the use of three alloys of silver, copper, and zinc, containing respectively 5, 10, and 7·2 per cent. of zinc, and 90, 80, and 83·5 per cent. of silver, the rest being, in each case, copper; and he also described three simple alloys of silver and zinc, containing respectively 5, 10, and 20 per cent. of zinc.§ I have prepared several of the alloys, and entirely confirm his observations respecting them. The alloy of standard 900, used in France, when melted with 78 grammes of zinc per kilogramme, yields an alloy containing—

83·5 of silver.
9·3 ,, copper.
7·2 ,, zinc.
―――
100·0

* Paper published by the Swansea Scientific Society. Session 1880-1.

† Presidential Address, Numismatic Society, 1880, and *Numismatic Chronicle* [3], vol. iii., p. 26.

‡ "Comptes Rendus," t. lxxvi., p. 1,441.

§ Loc. cit., p. 645. 1864.

which is whiter and more malleable than the alloy which is used for the subsidiary coins. Certain coins struck at Alexandria, in the 3rd century,* contained—

91·38 of copper.
3·85 ,, tin and traces of lead.
2·89 ,, zinc.
1·81 ,, silver.
―――
99·93

The Japanese employ, for the purposes of ornament or currency, several such alloys. The Nebus, now withdrawn from circulation, contained 22·75 per cent. of gold, 76·00 of silver, and 1·25 of copper, and I am informed by Mr. Tookey, who was formerly assayer in the Imperial Mint at Osaka, that the composition of these coins was extremely uniform. It is to be regretted that they were extensively and successfully counterfeited by western visitants to Japan, in an alloy which contained, when melted, only 0·47 per cent. of gold.

Triple alloys, in which silver is the main constituent, have often been used. A singular alloy of silver, copper, and zinc, has been extensively employed in Switzerland for the manufacture of subsidiary coins. A very low alloy of silver and copper has long been employed for coins of small value; such an alloy is called *billon*, and was formerly widely adopted on the Continent generally in modern as well as ancient times. The precious metal contained in the mass is not present in sufficient quantity to give the alloy the colour of silver, and, therefore, the copper is removed by the action of a solvent from the surface of the "blanks" before they are coined, but this layer of silver soon wears off when in circulation, and the coins assume the normal tint of the alloy from which they are made.

The advantage of employing precious metal in this way consists in the possibility of striking subsidiary coins of some value, but of comparatively small weight; the objections to the use of such metal are numerous, and were well expressed in 1790 by M. Gabriel de Cussy,† who pointed out that the manufacture of such coins was expensive, that when withdrawn from circulation they are very difficult to refine, and, finally, they may very easily be counterfeited in alloys which contain no precious metal whatever. Much force was imparted to this latter objection by the statement that one-third of the *billon* then in circulation in France was either of foreign

* Lenormant, loc. cit., t. i., p. 205.

† Rapport au Comité des Finances, Paris 1790.

origin or spurious. The use of such coins of *billon* still lingers in Europe, but as M. Mirabeau said, in a speech delivered before the National Assembly of France in 1790, to which I have already referred, this "detestable money" should be abolished, if only because "a false coiner, with less than 20 sols, can counterfeit 12 livres at a profit of 1,100 per cent." * The base alloy he had in view contained only one-sixth of its weight of silver, the rest being copper. He appears, however, to have advocated the use of an alloy of about equal parts of silver and copper, and pieces of 15 and 30 sous, of standard fineness 667, were struck in 1791.

The alloy next in importance to those we have hitherto considered is bronze, which, as has already been stated, played an important part in ancient currency. Its modern use on an extended scale is due to the Government of the late Emperor of the French, Napoleon III., by whose direction the old sous circulating in France afforded the basis for a triple alloy, containing ninety-five parts of copper, four of tin, and one of zinc, the weights of the respective coins of one to ten centimes being a gramme for each centime. The law regulating this coinage was passed by the Assembly in May, 1852, and the issue of bronze from that time up to the year 1868 amounted to no less than 59,300,000 francs. All the facts connected with this coinage have been elaborately described by M. Ernest Dumas in a valuable work to which I have before had occasion to refer.† It is an extremely durable alloy, as will be shown in the fourth lecture. Its coinage was undertaken in England in 1861, by the advice of the late Professor Graham, Master of the Mint, and the amount of bronze coin now in circulation is estimated to be about 3,000 tons.

Brass was extensively used by the Romans for subsidiary coins, and, in fact, silver does not appear to have been employed until "the first Punic war, 269 B.C."‡

Savot mentions the use of a triple alloy of copper, zinc, lead, and a small quantity of tin, to which the name of *potin* was given; and Lenormant states§ that it was only used for money by certain tribes of Gaul, between the wars of Ceasar and the organisation of the Gaulish provinces by Augustus. The coins were always cast, and prove, on analysis, to contain :—

60	of copper.
20	,, lead.
10	,, zinc.
10	,, tin.
100	

The use of nickel is extremely ancient. Dr. Walter Flight, F.R.S., has shown* that coins of the 2nd century B.C. were struck in an alloy containing :—

77·585	of copper.
20·038	,, nickel.
0·544	,, cobalt.
1·048	,, iron.
0·038	,, tin.
trace	,, silver.
0·090	,, sulphur.
99·343	

Pence and half-pence, to the value of £3,000, were coined at the Mint, in the years 1869-71, for use in the colony of Jamaica, of an alloy containing—

75	of copper.
25	,, nickel.
100	

but when a further coinage of nickel of the nominal value of £500 was required, Mr. Fremantle reported that the charge to the colony of Jamaica, for the metal alone "would exceed the nominal value of the coin,"† a fact which points to the difficulty of determining the weight that may be safely given to the individual pieces of a token coinage when the metal employed is liable to serious fluctuations in commercial value. Pieces of 5 and 10 centimes of the same alloy, have long been in circulation in Belgium. In Germany also, the pfennige are of this alloy, and it is also employed for the subsidiary coinage of Brazil. Certain American nickel coins contain 12 per cent. of nickel, and 88 of copper. The important contributions of Herr Fleitmann to the metallurgy of nickel have rendered it possible to use the pure metal for coinage, and the 20 rappen pieces of Switzerland, are now struck in nickel without alloy.

The claims of platinum to be used for coinage did not escape M. Rochon,‡ and the fact is remarkable, considering how comparatively rare the metal was when he wrote in 1786.

* "Collection Complette des Travaux de M. Mirabeau, l'ainé à l'Assemblée Nationale," t. v., pp. 25, 81. Paris, 1792.

† "Notes sur l'émission en France des Monnaies décimales de bronze." Paris, 1868.

‡ Sir John Lubbock, *Nineteenth Century*, p. 797. November, 1879.

§ Lenormant, loc. cit., t. i., p. 205.

* *Numismatic Chronicle*, p. 305, 1868.

† Fourth Annual Report of the Deputy Master of the Mint. p. 11. 1873.

‡ Loc cit. pp 17 and 45.

With regard to metals which have not as yet been employed for coinage, I would direct your attention to those very light specimen coins of pure aluminium, and of aluminium alloyed with 2 per cent. of nickel, for which I am indebted to the distinguished metallurgist, Mr. G. Matthey, F.R.S.

The points with which we started were, you will remember, that the base metal added to a precious one may be viewed, first, as a useful constituent of an alloy, and, second, as a source of gain. I trust it will have been evident that. within certain limits, the standard selected for the alloy is not a matter of much importance, provided the base metal be added to precious metal in such proportions as to combine the maximum convenience with the best physical properties.

Viewed as a source of gain, it must be borne in mind that "any person" has the right to coin gold, provided the actual manipulation of the precious metal is entrusted to the officers of the Mint, and, as has been well remarked by M. Dalsème, of all its ancient rights the governing body in the State alone preserves the privilege of issuing coins, the intrinsic value of which is slightly less than the value at which they are current, and this right is guarded by law, and exercised in the public interest. In the next lecture, I will attempt to show what precautions are taken to secure accuracy in weight and fineness of the coinage, more especially in the case of the sovereign, which is so widely circulated, and the integrity of which is so implicitly trusted, that it may be said to epitomise the financial honour of the nation.

CONFERENCE ON WATER SUPPLY.

The Conference of the Society of Arts on the Water Supply at the International Health Exhibition, was opened on Thursday, 24th inst., with an address by Sir Frederick Abel, C.B., F.R.S., Chairman of the Council, who presided, followed by Mr. Andrew Cassels, Vice-President of the Society.

Papers on the Sources of Supply were read by W. Whitaker, W. Topley, C. E. De Rance, J. Lucas, C. J. Symons, E. Bailey-Denton, E. Easton, and J. Mansergh, and a discussion followed. A report of the Chairman's address, and of the discussion will be printed in the next number of the *Journal*. The Conference was adjourned to Friday, 25th inst.

ON THE AREA OF CHALK AS A SOURCE OF WATER SUPPLY.

By W. Whitaker, B.A., F.G.S.,
Of the Geological Survey of England.

It is only of late years that we have had the means of measuring the area of the great water-bearing formation of the south-east of England that can be reckoned on as a gathering-ground with certainty; and now we can do this for only a limited part of the chalk tract. As it will be a long time before we can do it for the whole, even so far as the London basin is concerned, I have not hesitated to bring forward the subject in its present imperfect state.

On ordinary geological maps, including the greater number of those as yet issued by the Geological Survey, the chalk, beyond the parts where it is covered by the eocene tertiary beds, is shown as bare, except for outlying patches of those tertiary beds (mostly on the high grounds), and for strips of alluvium (or marshland) along the bottoms of the chief valleys. For some years past, however, the Geological Survey has carefully mapped those varying deposits of clay, loam, gravel, and sand, usually grouped under the name of drift, which cover, in a more or less irregular way, the various divisions of the tertiary beds and the chalk, and which have a marked effect on the nature of the country where they occur to any great extent.

It follows that it is only in those parts of the chalk tract where the Geological Survey has mapped the different divisions of the drift, that we are able to tell, with an approach to accuracy, over how much of the surface the rain has a more or less free access to the chalk, and can therefore sink into it, and add to the supply to be got from it at lower levels.

In the course of a somewhat prolonged and detailed examination of this question, I have constructed a set of maps for the purpose of showing over what areas the chalk is bare, over what areas it is covered by beds of a permeable character (allowing of the sinking of water through them to the chalk), and over what areas it is cut off from the reception of water through being covered by impermeable beds. This may seem, on first thoughts, a simple matter; but, on trial, it is hardly found so, and instead of confining myself to three colours, one for each of the three areas above noticed, I was obliged to use a fourth, for various beds of a doubtful character, either from their being of a mixed composition, or of a changeable one, at this place permeable, at that the reverse.

With these four colours I was at first content; but the fact that in some areas where the chalk is protected by impermeable beds, the water flows over the surface until it reaches the chalk, and then sinks into that rock, has led me to show those areas by a lighter tint, as they contribute somewhat to the water in the chalk, and should, therefore, be distinguished from tracts that do not.

Beyond these five divisions the maps now exhibited do not go; but it may, perhaps, be needful to make a sixth, and to mark off from the rest of the bare chalk those parts where the base of the formation, the chalk marl, is so clayey as to be out of the question of water-supply. This tract, however, would be a very narrow band along the outer edge of the chalk.

Possibly too, in extending the work (as I hope to), it may be well to mark areas where beds below the chalk may contribute to its water supply, or where rather the water system of the chalk may join that of some underlying bed. This, of course, would take place where any mass of permeable upper greensand is not divided by clayey chalk marl from the chalk above, in which case there will be but one water system. There is one remarkable part of the chalk tract surrounding the London tertiary basin, where, from the the absence not only of the clayey chalk marl and the underlying (but much more local) upper greensand, but also from the thinning out of the usually persistent gault, a markedly impervious bed of clay, it results that the hard ferruginous sand (or carstone) of the lower greensand at once underlies the hard massive chalk. In the north-western corner of Norfolk, where this takes place, from Hunstanton southwards to near Sandringham, the water systems of the chalk and of the upper part of the lower greensand join; though the lower part of the latter formation is divided off by clayey beds. The supply at Hunstanton Waterworks, close to the base of the chalk, may, therefore, be derived from this composite source, whereas the supply for the Sandringham estate is from the chalk, the clayey chalk marl coming in at that part, and causing an outflow from the more permeable beds above.

The maps which form the text on which this paper is founded, though based on the later geological maps (with drift), follow the latter absolutely in only one particular, that is in the area coloured as bare chalk. As, however, the object in constructing the maps in question was contrast and conspicuousness, their colours are quite different from those of the geological maps; and, whereas, on the latter the chalk is shown by a very pale green tint, on the former it is emphasized by light carmine. It is only fair to the maps to say that they were not made as diagrams, to be seen at a distance; but to be examined more closely, and that they have been coloured at various times, as occasion enabled me to take them up. When the work has been further extended, and a large set of maps can be coloured at once by a better colourist, a more harmonious effect may result.

We may now consider the evolution of these "Chalk Area Maps" from the Geological Survey Drift Maps. It will be at once seen that the geological maps are the far more complicated of the two, having a great number of colours and tints as against the five of the other set. My geological friends may, therefore, be inclined to regard the evolution as a case of degeneration; but, perhaps, engineers may not object to the comparative simplicity of my maps, and to their disregard of theoretical considerations and of geological classification. It should be clearly understood that these maps are meant to show one thing only, that is the accessibility of the chalk to surface-water: they do not always show of necessity the nature of the surface; but their colours are, in some parts, quite independent of what occurs at the surface, which may be neutralised, for our purpose, by something else that occurs beneath.

1.—Bare Chalk.

As in this case the maps follow the geological ones, there is no need to say more than that bare chalk is taken to include those parts where there is merely a thin soil over the chalk, for that soil is practically unimportant as regards water being pervious.

2.—Chalk covered only by Beds of a Permeable Kind.

This includes tracts marked by many colours on various geological maps, permeability being by no means connected with geological age. In colouring these tracts, it was essential to consider not merely the beds shown as at the surface on the geological maps, but to make certain that nothing came between any bed of a permeable character and the chalk, as it is clear, for instance, that ten feet of clay in or beneath 100 feet of sand would stop the downward passage of water through the sand.

The geological beds that fall into this class are as follows: but it should be understood that this is only where one of them rests directly on the chalk, without any bed of an impermeable or mixed kind coming between, or where two or more of them succeed each other without any intervening bed of another kind:—

Thanet Beds, where these are of sand, as in Surrey and West Kent.

Oldhaven and Blackheath Beds, in the few places where they have cut through the underlying Woolwich and Reading beds, and rest on the Thanet sand or as outliers on the chalk.

Red Crag and Norwich Crag, where they rest on the chalk. Parts of the tracts coloured with the latter on the geological maps are not included, however, on account of the occurrence therein of the clayey Chillesford beds, which must stop the downward passage of water.

Sands and Gravels of the Glacial Drift.

Sands and Gravels of the River Drifts.

3.—Chalk Protected by Beds of Mixed or Varying Character.

In this case it is not essential either that the chalk should be directly covered by beds of the kind indicated, or that such beds should be at the surface; it is only needed that they should occur somewhere between the surface and the chalk, and that no absolutely impermeable beds should come in; permeable beds are of course made of no account by the presence of these mixed beds. Many colours of the geological map find themselves massed in this set, as may be seen from the following list:—

Thanet Beds, where to a great extent clayey, as in East Kent.

Woolwich and Reading Beds, from their varying character, here clay, there sand. There are places, however, where it may be well to include this series with the impermeable beds. The overlying Oldhaven and Blackheath beds, in themselves permeable, are almost wholly carried with this underlying series, except where, as above noted, they have cut through the latter.

Loams of the Glacial Drift. Some of the brickearth of this age is so clayey, however, that it has been classed as impermeable.

Loams of the River Drifts.

Brickearth and Clay-with-flints of the high chalk tract. These are beds which commonly occur over the chalk hills, and which, though of a more or less clayey nature, seem not to be wholly impermeable, for they do not give rise to drainage-streams; moreover, they seem, in part at least, to be the result of the dissolution of the chalk by the infiltration of acidulated water. Some outlying patches of sand in East Kent have been classed with these deposits, as they often have a clayey base.

Alluvium.—The silt and peat of our marshes might be thought to be impermeable; but though this may often be the case, these deposits are sometimes sandy, and sometimes very thin, the permeable gravel beneath coming up near the surface.

4.—Chalk Protected by Impermeable Beds.

Here, again, as with the last division, the beds in question need neither rest at once on the chalk nor form the surface; their occurence anywhere between the surface and the chalk is decisive, and relegates the tract where they occur to what, from our point of view, may be called the useless division, save for those parts of it where the surface waters flow towards the chalk. The large tract marked by the grey colour on the maps, owes its classification almost wholly to the two great clay deposits, the London clay and the boulder clay; but some other beds contribute slightly, as shown by the following lists.

Woolwich and Reading Beds.—In North Suffolk, and in Norfolk, where these beds are quite masked by drift and crag, never cropping out to the surface, they seem to consist chiefly of clay, as proved by well-sections, and it is best to class them with impermeable beds. This may have to be done in parts of the Hampshire basin also, when the re-survey of that tract for drift enables us to construct chalk-area maps of it.

London Clay.—As it is not only where this thick mass of clay forms the surface that it stops the downward passage of water, but also wherever it underlies other beds, it follows that all the overlying permeable deposits have now to be classed with it. This includes the whole of the Bagshot series, so largely composed of sand, which forms such large areas in both the London and Hampshire basins, and also the whole of the very local Coralline crag, which occurs only over a few square miles of Suffolk. Great part of the red crag and of the various drift sands and gravels are also included. All such tracts of permeable beds over London clay, are, of course, of some importance as regards water supply, on a comparatively small scale, and over part of Norfolk and Suffolk, no other source of supply from wells is used.

I need hardly say that, in the case of the London clay, my maps add nothing to our knowledge: the position and extent of that deposit being well known, except in East Norfolk and the adjoining part of Suffolk: the above remarks have been made merely to explain the grouping of other beds with it. There are places where the loamy beds at the base of this clay may be sandy enough to allow of the downward passage of water; but such areas must be insignificant.

Brickearth of the Glacial Drift.—In some parts this deposit is not only of fair thickness, but also of an essentially clayey nature, so that it has then to be classed as impermeable. It often, too, extends underneath deposits of a more permeable kind, and so cuts off their water from the chalk; the underground extension is, however, sometimes hard to trace.

Boulder Clay.—This not only covers the chalk, or permeable beds overlying the chalk, over large areas, but also extends under some of the drift gravels and sands, so that it has a great effect in protecting the chalk from the access of water. A good example of this is given by one of the maps exhibited (sheet 50 S.W., in which, on an ordinary geological map (without drift) nearly the whole of the 205 square miles represented, would be coloured as chalk—a most delusive thing, as, in fact, the area of bare chalk therein is very small, and the areas of chalk covered by permeable or mixed beds not large, whilst the protecting cover of impermeable beds spreads over by far the greater part.

The map to the north (50, N.W.) is much the same, though we have here rather more bare chalk; but in this sheet the whole area would be coloured as chalk, on an ordinary geological map, except for the alluvium of the streams.

A larger map, not yet coloured after the plan described (on account of the drift edition not being published) is also a case in point, for, in sheet 47, whilst about half the area (of 820 square miles) is shown on an ordinary map as chalk, the impermeable boulder clay occurs over the greater part thereof, and quite alters the character of the district.

Though for the most part a fairly stiff clay, there is one tract where the boulder clay is so largely composed of chalk, almost to the exclusion of anything else, that one can there hardly take it as absolutely impermeable. I allude to the north-western part of Norfolk; where the thin boulder clay of the higher ground is so like the merely weathered surface of the chalk, that the officers of the Geological Survey often had some difficulty in dividing the two, especially in places without clear sections. In other parts of North Norfolk, too (near Wells), the glacial brickearth seems to be represented by a bed which is little else than reconstructed chalk, a specimen having yielded, on analysis, no less than 91 per cent. of calcic carbonate, the other constituents being, moreover, of a sandy rather than of a clayey character, and the whole having some likeness in composition to parts of the chalk.

From what has been said, it is clear, I think, that the "maps of chalk areas" exhibited are not merely another version, or condensation, of the Geological Survey maps, although depending so largely on the possession of these. They show, indeed, some things not shown on the geological maps, and for which approximate lines had to be drawn, and their grouping of the facts mapped is different from that of the geological maps.

It may be of interest, perhaps, to constrast the areas of chalk, &c., as shown by some of my maps, with those represented on geological maps without drift.

Thus, in sheet 7, whilst in the latter map nearly half the area, or roughly about 400 square miles, is coloured as chalk, half (or a little more) being of tertiary beds, and a small area (in the north-western corner) of beds below the chalk, a measurement of the four different kinds of area, described in this paper, gives the following approximate figures, which seem, however, to err a trifle on the side of excess:—

Bare chalk	about	125	square miles.
Chalk covered by permeable beds	,,	88	,,
Chalk protected by mixed beds	,,	180	,,
Chalk protected by impermeable beds (almost wholly London clay, there being but little boulder clay over the chalk here)	,,	430	,,

Again, in sheet 46, S.E., almost all coloured as chalk on the ordinary plan, we get the following figures, as before erring slightly in excess:—

Bare chalk	about	76	square miles.
Chalk covered by permeable beds	,,	39	,,
Chalk protected by mixed beds	,,	67	,,
Chalk protected by permeable beds..........	,,	27	,,

In 51, S.E., where neither tertiary beds above nor older cretaceous beds below occur, but chalk alone, the figures are about 40, 8, 1, and 155 respectively, various beds of drift (especially boulder clay) generally covering the chalk.

Whilst the general result of the work is to curtail the somewhat excessive estimates that may have been made in bygone years of the amount of chalk area available for the absorption of rain, yet the chalk remains our chief water-bearing bed in the south-east of England; for, though not always coming up to some of the sand-beds in permeability or porosity, it is pre-eminent over all other geological formations in thickness and extent of outcrop.

Although beyond the immediate object of this paper, there is one circumstance connected with the question of water-supply from the chalk which I can hardly help alluding to from its great importance. The present state of the law, as regards deep-seated sources of supply, is the reverse of encouraging to those who advocate the use of pure well-water; for, by a recent legal decision, in the case of Ballard v. Tomlinson, it has been declared to be lawful for any one to pour any filth or noxious matter down his own disused well without any regard to the fact that he may thereby pollute the source from which his neighbours draw their supply! It would be a work of no great difficulty therefore to utterly spoil most well-waters, and this might not only be done by inadvertence, as in the case alluded to, but apparently of malice aforethought. If this is really the law of the land, or rather of the water, there seems to be an opening for law reformers. It is to be hoped, however, that the decision may be reversed in a higher Court than that from which it came. I need hardly say that these remarks apply to all water-bearing beds and not to the chalk only, and, to conclude, I may say the same of the line of observation that this paper brings forward.

ON A POSSIBLE INCREASE OF UNDERGROUND WATER SUPPLY.

By Chas. E. De Rance, A.I.C.E., F.G.S., F.R.G.S.
Secretary of the British Association Underground Water Committee.

For nearly a century the subject of water supply has been constantly before the public, and with the growth of population has become a question of vital importance to the community. The amount of information that has been accumulated is very large, but, investigated by Royal Commissions, inquired into by committees appointed by scientific societies, it is spread over a wide range of literature. It is difficult for any one individual to focus the stores of information already available, still more for him to follow up the numerous lines of investigation these inquiries suggest.

In my work on "The Water Supply of England and Wales," published in 1882, I made an attempt to show what was the probable supply of water available in all the river basins of England and Wales, and what amount was required to satisfy the demands upon that supply, with the result that it appears to be amply demonstrated that the rainfall this country receives is more than sufficient to meet all the requirements of human consumption, manufacturing interests, and the purpose of canalisation; and yet, with these resources, large districts still suffer from all the ills due to a polluted water supply, whilst other large areas are devastated by floods, representing unproductive rainfall passing ro the sea.

It is to this unproductive rainfall that I would chiefly wish to call attention in the present communication. Much has been written on underground water supply since the year 1841, when the Rev. James Clutterbuck stated "the extent of the supply must necessarily be regulated by the quantity of rain falling upon the surface, the rapidity with which it is absorbed, and the reduction to which it is subject by evaporation;" but this definition still expresses the knowledge we have on the subject. Rainfall being the sole source of supply to the waters beneath the surface as well as those flowing upon it, accurate information on the amount of rain falling on a district is a matter of the first importance, and this, to be of any value, must represent the observations of an extended period of years, so that not only may the minimum supply to be expected be ascertained, but the average or mean of several successive dry years also. Happily, through the voluntary labour of Mr. Symons, F.R.S., we have now more than 2,500 stations at which rainfall is recorded, and we are able, by consulting his annual volumes, to obtain the necessary information for a large number of localities; but it is obvious that, considering the direct bearing such observations have on engineering, agricultural, and sanitary questions, the scope of the inquiry should be enlarged by placing it under a Government department, which could enlarge the scope and usefulness of the inquiry without being, as now, partially crippled for want of sufficient funds to carry out the necessary details.

Pervious or permeable formations, by gradually absorbing waters falling on their surface, which slowly percolate through them, act at once as filter-beds and reservoirs, the capacity of which is limited by the area of absorption, and the thickness of the pervious bed. When rain falls upon a perfectly pervious rock, underlaid by impermeable deposits, the water line is generally near the surface; this line or plane of complete saturation, in sandstone and limestone hills intersected by valleys, is found to be slightly above the level on which the deepest valley intersects the various strata, constituting the water-bearing rock.

When bands of permeable and impermeable rocks alternate, each porous band contains a separate sheet of water, which flows down the dip planes of the strata, confined by the impermeable layers above and below. Such water flows with the head, due to the difference of vertical level, of the area of outcrop to that of the area of discharge, less the frictional resistance of the fragments of the rock through which it passes. When the facilities for the discharge of a volume are less than the quantity capable of being received, the porous rock will be full up to the impermeable layer above, which is invariably the case when all outlet is stopped by faults throwing in impermeable strata, or by the dip carrying the strata beneath the sea-level.

Such porous rocks may be regarded, when provided with an outlet, as underground conduits, the depth of which is the thickness of the bed, the width of which is the extent of the outcrop or horizontal strike of the bed, and the inclination of which is the dip of the strata. Where the outlet is blocked, the saturation-level remains unchanged, and unless water is artificially removed, so as to provide space for a fresh supply, no additional water can be added to the existing supply.

In sinking wells, or in boring into a mass of porous rock, the plane of saturation is found to vary within certain limits, being governed by the amount of previous rainfall. This level, by excessive pumping, is artificially and locally lowered, but the old "rest-level" is restored after a certain number of hours' cessation from pumping. The difference between the "rest level" and the pumping level is, in some wells, in porous strata as much as 100 ft. The area of exhaustion resembles an inverted cone, the apex of which rests on the point at which the pumps abstract the water, and the base of which is a circle at the surface around the well. If over-pumping has taken place, the pumps have to be lowered; the cone increases in vertical height, and a larger concentric circle is added to the central one.

In porous rocks of great thickness the plane of saturation is often at a considerable distance from the surface, the annual rainfall absorbed being balanced by the springs run off at low level, and the floods passing across the outcrop too quickly to sink into the strata. In these cases it would be possible to raise the height of the *saturation-level*, and thus increase the storage powers of the rocks by sinking "dumb-wells" in the porous strata, and draining the storm-water channels into them, which would have the effect of increasing the summer discharge of the springs.

From an investigation I made in 1878, as to the area of each of the various rocks in each river basin, which forms the basis of the paper I laid before the Society's Water Congress, convened by his Royal Highness the President, I estimate the area in England and Wales, occupied by porous rocks, to be not less than 26,633 square miles; while the tertiary, gault, weald, oolitic, liassic clays, the triassic and permian marls, and the shales of the carboniferous occupy a further 19,308 miles, in nearly the whole of which occur pervious rocks, a larger portion of which might be rendered available for storage purposes by sinking dumb-wells through the overlying strata, and discharging the land drains into them, which would prevent the water passing away in devastating floods.

Experiments were made simultaneously on the percolation of rainfall by Dr. Dalton, at Manchester, and by M. Maurice, at Geneva. Dalton's gauge consisted of a cylinder, 10 ins. in diameter, and 3 ft. deep, open at the top, closed at the bottom, and filled with earth, and sunk to the ground level; his experiments were carried on from 1796 to 1798, 25 per cent. of the rainfall being absorbed. M. Maurice's observations, from 1796 to 1797, gave 39 per cent. of percolation. Mr. Dickenson's, from 1836 to 1843, gave 42 per cent. Mr. Greaves' observations, extending from 1852 to 1873, with an average rainfall of 25·8 inches, gave the percolation of 26·6 per cent., his gauge being a slate box with an area of one square yard, a yard in depth filled with soft earth, loam and gravel mixed, trodden in, and turfed over. Mr. Greaves states, "the gauge stands at Lea Bridge, $1\frac{1}{2}$ miles west of, and 6 miles north from the meridian of Greenwich." He finds the abundance of water in a river to be more closely dependent on percolation than on mere rainfall; for consecutive months there is no percolation whatever; five times there was no percolation for six months; and only in one year (1860) was there percolation every month. The greatest percolation is after thaws of snow, especially after frequent thaws of small falls of snow. A wet winter gives abundant springs in the following autumn; but if that be followed by a dry winter, it will obliterate the effect of the previous wet winter, this is the case in the present season, 1884, when the springs are remarkably low, as has been pointed out in the *Times* of June 7, by Mr. Baldwin Latham.

Mr. Greaves's experiments show the smallness of percolation through earth on the whole, and its entire absence during warm summer weather; and they also show the small thickness of earth under which water may be safe from evaporation, which he places at a depth of 36 inches; and even at 24 inches he considers it doubtful "whether, in the latitude and temperature of London, capillarity has more than a negative action beyond 12 inches in depth." Probably, in a moderately open soil, capillarity extends only a few inches, but the higher capillary power of clay soil causes a constant summer exhalation. From these facts it is evident that the more thoroughly a soil is underdrained, the nearer it resembles the "percolation gauge," and the less likely is water to pass off as flood in an open water-course. The more free drainage is promoted, and the more "dumb wells," or "inlet drains," are constructed, the greater will be the quantity of water stored; in other words, the percolation period, ending naturally in February or March, will be artificially extended so as to catch a large proportion of the summer rains; and "intermittent springs," which are dependent not on surface-present rain, will be increased in volume, and to some extent rendered more permanent, at times when the heavy rains of summer, through excessive evaporation, are adding nothing by percolation to the underground stores.

The investigation of individual observers, and the ten Reports of the Underground Water Committee of the British Association, which I have drawn up, as Secretary of the Committee, have made well known the large quantities of water now pumped from the millstone grit, the permian sandstone and triassic sandstones, the oolites, the greensands, and the chalk; towns like Liverpool, Birmingham, Birkenhead, and Nottingham, receiving from the triassic sandstones quantities reaching, in the case of the city of Liverpool, $6\frac{1}{2}$ million gallons per day; while the analyses of the Royal Rivers Pollution Commission, show us the pure quality and great value of these waters from a sanitary point of view.

In England and Wales, the pervious portions of the carboniferous, the secondary, and tertiary rocks, occupy an area of not less than 26,600 square miles, while an additional area of 19,000 square miles exists of rocks of this age, which, though impermeable and carrying off the rainfall in floods, yet overlie pervious strata that might, to a great extent, be made available for storage purposes, were dumb-wells carried into them from the surface; such dumb-wells would artificially act as do the swallow holes which feed the chalk and carboniferous limestone waters.

In the chalk, though water is absorbed with great rapidity, and retains a quantity, according to the experiments of Professors Ansted and Miller, equal to one-third of its bulk, it parts with it with excessive slowness; and the water available to feed springs, and to supply well-borings, is mainly due to free water passing down the cracks and fissures which traverse the chalk surface in all directions, the larger fissures allowing the passage of rain water down to the lower portions of the chalk. That the deep-seated impermeable beds occurring at the base of the chalk formed the surface on which the passage of water chiefly took place, was pointed out by Professor Prestwich, in 1851; and the gradient on which water stands in the chalk was described in the Sittingbourne district by Mr. W. Bland, in 1852, which gave an inclination of 47 feet per mile of fall in one direction, and 45 feet per mile in the other; in Hertfordshire, the average inclination between Dunstable and Watford was found by the Rev. J. Clutterbuck, in observations extending from 1842 to 1850, to be only 14 feet per mile. The later observations of Mr. Baldwin Latham on this subject show the remarkable increase of gradient, produced by the temporary rise in the water level of the hilly districts of the chalk, after heavy and continued rains, which becomes gradually depressed after their cessation, before the springs in the low ground has ceased to give their maximum yield.

Over the whole of the area of 26,600 square miles, drawing wells may be sunk with advantage, and their supply increased by sinking inlet or drainage wells to carry into the strata water now almost entirely lost, and rendered not only unproductive of good, but the agent of actual harm, in the destruction of property and agricultural produce by floods. Care will have to be taken that, in constructing such dumb-wells, communication is not set up between drains carrying objectionable matter and the underground sheet of water, and that in draining wells and bore-holes the point at which the water is abstracted is sufficiently removed from the surface to insure the water having naturally filtered through the superincumbent strata.

In the case of the 19,000 square miles of impermeable strata overlying pervious strata, for the most part already containing water absorbed, in the area of outcrop of the pervious, artesian borings will give large supplies, in numerous districts where no attempt in this direction has been made; and where the artesian gradient, or water level, is not as high as the base of the impermeable stratas overlying the permeable bed, dumb-wells may also be sunk with advantage, and in relieving the clay beds of their floods in winter, will help to increase the summer discharge of the rivers, and render the intermittent springs of more permanent value.

Miscellaneous.

BEETROOT SUGAR INDUSTRY IN GERMANY.

In a report recently presented to the United States Department of State, on the sugar industry in Germany, some details are given, showing what rapid strides have, of late years, been made in its development, and how materially it affects the augmentation of national wealth in the country. Consul Kiefer states that the exportation of German sugar, to any great extent, only commenced in 1860, and that, in order to foster and promote it, the Government refunded the taxes paid on sugar manufactured when exported, and as the tax was levied by an assessment on each centner of beets used, and the drawback calculated according to the weight of sugar to be exported, it happened that gradually, in an indirect manner, a premium was paid on exportation. It was agreed, and taken for granted, that 12·5 centners of beetroots (the centner being equivalent to 110 lbs.) were required to produce one centner of raw sugar; the centner of beet paid 80 pfennings tax (100 pfennings being equal to one shilling), and a drawback of about nine shillings was allowed on each hundredweight of sugar exported. By improved methods of manufacture, and better cultivation of the beetroot itself, during the last twelve years only 11·39, and even in the last two years only 10·46 and 10·47 centners respectively of beets were needed to produce one centner of raw sugar, and, therefore, there was refunded on each centner a tax on 1·10 to 2·04 centners of beetroots which had never been paid for, this being equivalent to a premium paid on export. The consequence of this was, that manufacturers found it more profitable to send their products abroad, and it is stated that, from the one district alone, namely, Stettin, the value of raw sugar exported to the United States, which amounted, in 1881, to about £2,750, rose to £27,000 in 1882; and it is expected that it will go on steadily increasing each year. In order to correct this state of things, a commission was appointed last year to inquire into the question of the tax on sugar, and the industry generally. This commission, though it has far from completed its labours, has already decided, as a temporary measure, that the drawback should be reduced 40 pfennings on each centner of sugar for the next two years. In 1871-2, the tax on beetroot sugar amounted to £1,800,000, and the duty on imported sugar to £625,000; and as the drawback paid on exported sugar was £194,000, the net income amounted to £2,231,000. In 1882-3, the beetroot tax was £6,998,000, import duty £86,000, the drawback paid £3,675,000, and the total net income £3,409,000. To those taxes to be refunded must be added those that have not yet been actually paid out, being due only at the expiration of six months, leaving, in fact, only a net income for 1882-3 of £2,582,000. The development of the sugar industry, particularly in Pomerania, during the last twelve years, has made very rapid strides. Comparing the periods 1871-2, and 1882-3, it will be found that during the former year 38,000 tons of beets were in that district consumed, and 3,000 tons of sugar produced; while in the latter, 84,000 tons of beets were used, and over 7,700 tons of sugar obtained from them. The total result of the fiscal year 1882-3 shows an extraordinary increase of production compared with the previous year, caused partly by the establishment of new factories and the enlargement of those already existing, and partly by the cultivation of the beetroot on a larger scale, and it may also be attributed to the exceptionally rich harvests. It is estimated that at the present day there are 525,000 acres of land under beet cultivation in Germany, and it appears that during the year 1882-3 there were 358 factories in operation, compared with 343 in the previous year, and they produced 835,164 tons of raw sugar against 599,722 tons in 1881-2. The taxes paid amounted to nearly £7,000,000, as compared with £5,017,000. It is expected that for the year 1883-4, it will be found that there will be an increase of at least 15 new factories over those in operation in 1882-3. The revolution which has taken place during the last twelve years in the German sugar industry becomes more apparent when a comparison is made of the periods 1871-2 and 1882-3. In the former year, 2,251,000 tons of beets were consumed, producing 186,442 tons of sugar; while in the latter, 8,747,000 tons of beets were used, producing 835,164 tons of sugar. It was found that the quantity of beetroot necessary to produce one pound of raw sugar decreased from about twelve to a fraction over ten pounds. The importation of all kinds of sugar during the same period fell from 50,000 tons to 6,000 tons, and the export rose from 14,000 tons to 472,000 tons; while the quantity used for home consumption increased from a little over twelve pounds to about eighteen pounds per head of population.

THE MINERAL WEALTH OF LOWER CALIFORNIA.

Consul Viosca, of La Paz, in his last report on mines and mining in Lower California, states that the peninsula is divided into several ridges, the northern range terminating on the plains of San Ignacio, running along the western coast to San Borjas, and from thence crossing to the eastern side. A section of the northern range, as well as the central which follows it, extends to the Bay of La Paz, having on their western slopes extensive plains and table lands. The mineral veins in the mountains, which extend from the territory, run north and south, with an inclination east and west; the largest quantity of the veins are superficial, being covered thinly with a kind of stone used for grinding, limestone, &c.; the metallic veins are deeper and richer, although they have not yet been excavated to any very great depth. The chief mineral producing districts are Mulege, Las Virgenes, San Marcos, Comondu, San José, Cacachiles and La Trinchera, and Triunfo. Gold, silver, copper, graphite, sulphur, alum, and magnesia are found. The mountains between San Ignacio and San Borga have numerous metallic veins, among which predominate sulphurous pyrites, carbonates, and sulphurets of gold, silver, and copper, besides a large quantity of oxides of iron. In Las Virgenes mountains, the principal group terminating the range is composed of three conical mountains, volcanic, surrounded at their base by two large streams, the Santa Anna on the north, and the Santa Maria on the south. The principal crater is on the northern slope of the central mountain. The table opposite on the north west is noted for its sterility. An acrid vapour, indicating the presence of sulphurous acid, is almost constantly escaping from the crater. On its borders, and lower down, within a radius of 55 metres, the ground is perforated by innumerable orifices, emitting sulphuric streams, which, coming in contact with the atmosphere, form crystallised needles and threads of pure sulphur. From the principal crater runs a stream of water, strongly impregnated with sulphuric acid, which leaves in its course a whitish sediment similar to chalk, insoluble in fresh water, and of a styptic nature, and presents the remarkable phenomenon of petrifying everything with which it comes in contact capable of absorbing it. Another curious circumstance is the existence of small fishes, called *cabezones*, that are found in the reservoirs which the water has formed in the mountain side. One-fifth of the ground constituting the solid surface of the volcano contains *caliche*, a term given by the natives to earths of pure sulphur. Under this covering there is a mass of fine liquid mud, about 36 ft. deep, and a temperature of 90 degrees. There is also a warm spring running from the side of a low hill, and irrigating with its waters a small piece of land covered with wild palm and fig trees, which forms an oasis in the midst of an arid and solitary desert. The Santa Maria creek, which runs round the southern base of the Virgenes ridge, empties itself in the bay of that name. It runs through hills composed of sulphuret of lime, which presents itself in every form, aspect, and colour, owing to the metallic oxides with which the soil is impregnated. Slabs of gypsum have been found, of magnificent quality, the prominent colours being dark and pale yellow, produced by the oxide of iron, sea-green, emerald, deep red, and even black. In the Comondu district, at a place called Sance, situated on the eastern slopes of La Giganta mountain, some very rich copper veins have been discovered, entirely different in their composition to that of all other copper known. They contain free copper, that is, copper in its metallic state, sulphurous pyrites, and, it is supposed, an alloy of gold. In this district there are also numerous copper and silver veins. In the island of San José there is a vast number of matalliferous veins, and all the sections of the ridge bounded on the west of the bay of La Paz, south of La Trinchera, and east of the Gulf of California, are profusely crossed by metalliferous veins, which contain silver ore of great richness. In these districts the richest productions of the territory differ materially from the minerals extracted from other localities; they are sulphurets of lead, silver, chloride of silver mixed in quartz, together with carbonates. Sometimes these sulphurets are mixed with a layer of clay containing metallic oxides; in some places silver is found. The native Mexicans of California are stated to be excellent miners; they are sober, industrious, and frugal, and their labour can be had to any extent at from 3s. 9d. to 4s. a day. Consul Viosca says, in conclusion, that "the laws of Mexico are generally and specially protective to mining enterprises. That mining can be prosecuted at a profit is without doubt a practical fact. Every material for the treatment of the ores, if not produced in the country, is free of duty, and all possible convenience is afforded by the local authorities towards encouraging miners and mining capital."

PATENT FUEL IN FRANCE.

The United States Commercial Agent at Nantes says that the coal dust, which was formerly rejected as worthless, is now consumed in immense quantities in France in the form of "patent fuel," or coal bricks. The natural supply of dust from the yards of the coal merchants being entirely insufficient for the needs of the brick works, the manufacturers, particularly in the Nantes district, import a large quantity of coal dust from Cardiff, Swansea, and Newport. The process of manufacture is very simple. The coal dust is mixed with pitch, and the mixture poured into cups attached to a belt, each cup containing just enough material for a brick of the size desired. The belt in its movement passes this material through a chamber where it is exposed to steam which fuses the two substances into a homogeneous mass. This is poured by the descent of the belt into moulds, where it is subjected to an enormous pressure by a hydraulic press or by machinery set in motion by a steam-engine. The brick is square in form, its thickness being about one-third of its other dimensions, and it weighs five, ten, or fifteen pounds. Certain of the French railway companies refuse to accept fuel unless at least 10 per cent. of pitch has been used for its agglomeration. It is stated that *briquettes* are preferable to ordinary coal for exportation to the colonies and to warm climates on account of their compact storage and freedom from small fragments and dust, also for use on locomotives both on account of economy of space, and because firemen can always determine the amount of fuel they are employing in a given time, the weight of each brick being exactly known. The manufacturers claim that the "patent fuel" is more healthy for domestic use than ordinary coal, citing in support of this theory the declaration of certain well-known physicians. At the present day a large number of bricks are made for domestic use, of small size, and perforated with circular or longitudinal openings.

SEA FISHERIES OF ALGERIA.

A report has recently been presented by the French Government on the Algerian sea fisheries, from which it appears that in the year 1882, 4,916 fishermen were engaged in this industry, and 1,044 boats. The value of the fish caught amounted to about £163,000, consisting chiefly of mackerel, thon, sardines, and anchovies. Comparatively, few mussels or oysters were taken, but there was a large take of shell-fish. The total weight of fish taken amounted to over 11,000,000 pounds. On the coast of Algeria there is an abundance of fish, and the fishing is particularly good in the Gulf of Oran and Arzew, but from these points to Castiglione, a distance of over 1,200 miles, the industry is little followed owing to the want of a market along the sea coast. Algiers and its neighbourhood is a very important centre for fish, particularly Phillippeville and the bay of Callo. At Bône and La Calle there is less animation, but sedentary species are caught there which are not found elsewhere. Coral fishing is largely followed in Algeria, 40,000 to 45,000 pounds of coral, valued at about £38,000, being the yearly production; La Calle is the centre of this industry, and there are employed annually 160 boats and about 1,300 men. The coral is obtained by means of a wooden apparatus in the shape of a cross, having in its centre a leaden slug or stone for ballast. Nets, the meshes of which are loose, are hung on the bars of the cross and dragged at the bottom of the sea, and among the nooks and crevices of the rocks. These nets, winding about the coraline plant, break up or tear off its branches, which adhere to the meshes. The apparatus is drawn up by the fisherman whenever he thinks it sufficiently laden. There is also a net which is provided with large iron nails, having thus great force to break the coral, but this apparatus is forbidden to be used. The *scaphandre*, or cork jacket, is used only in exceptional cases.

General Notes.

COMMERCIAL EDUCATION IN FRANCE. — In Germany there are no less than 200 institutions for commercial instruction, and efforts are now being made in France to provide similar advantages for the youth of that country. On October 1st will be opened the *Institut Commercial de Paris*, under the direction of M. Bernardini, formerly secretary of the Mulhouse Chamber of Commerce, and director of the Rouen Industrial and Commercial Institute. A company, with a capital of £8,000, has been formed to carry this scheme into effect.

UTILISATION OF SLAG. — It is said that in Germany alone, in the production of steel from phosphoriferous pig-iron, no less than 20,000 tons of phosphoric acid remain in the slag unutilised. Professor Scheibler, of Berlin, has invented a process for extracting this valuable substance. He first calcines the slag in an oxydising flame, then pulverises and sifts it. The powder is dissolved in hydrochloric acid, and the solution saturated with milk of lime. In this way a substance is produced which is said to contain from 35 to 37 per cent. of phosphoric acid, under the form of bi-basic phosphate of lime. A second calcination is reported to afford a product containing as much as 45 per cent. of phosphoric acid.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third lecture of the course by Prof. Chandler Roberts, on "Alloys used for Coinage," will be published in the next issue of the *Journal.*

EXAMINATIONS, 1885.

The Programme for 1885 is now ready. Copies can be obtained gratis on application to the Secretary.

Proceedings of the Society.

CONFERENCE ON WATER SUPPLY.

The following are some of the papers read at the Conference of the Society of Arts on the Water Supply, held at the International Health Exhibition on Thursday and Friday, July 24th and 25th :—

WATER SUPPLY IN ITS INFLUENCE ON THE DISTRIBUTION OF THE POPULATION.

By W. G. Topley, F.G.S., Assoc.Inst. C.E.

Geological Survey of England. Lecturer on Geology at the Institute of Agriculture, South Kensington.

One of the most essential conditions for the comfort and well-being of a population is water, and a little consideration will show that the early settlements of a people have been where, and only where, water occurs.

In a broad and general sense, this fact is patent to all—the banks of rivers and streams are usually well populated—the wide areas of waterless districts are unpeopled; but the fact is equally true in a very limited and restricted sense, not at first so obvious.

The source of all water is the rain which falls on the land; this acts in two different ways, according to the nature of the soil on which it falls. If the soil is porous, or pervious to water, a certain portion of the rain sinks in; if the soil is impervious, the whole of the water either drains off the land into brooks, or passes back by evaporation into the air. The water which soaks into a porous soil or rock, accumulates there until it flows out again as springs, or is artificially tapped, and drawn away by means of wells.

The conditions under which springs most commonly occur may be illustrated by the following "sections," which represent the rocks cut through from the surface downwards. The positions of springs are marked × × ×, and in all cases these also mark the positions in which villages and towns occur.

Sections Illustrating the Origin of Springs.

Fig. 1

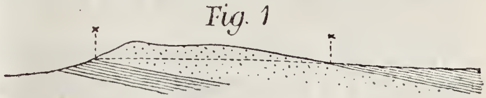

Fig. 2

Fig. 3

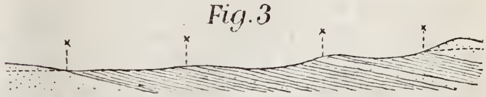

Fig. 4

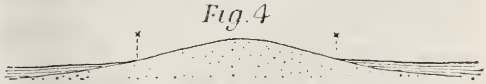

Fig. 5

× × Indicate the more common sites of early settlements; dots indicate porous beds; lines indicate impervious beds.

Springs occur near where a pervious bed overlies or underlies an impervious bed (Fig.

1), or where a valley reaches down to the level at which the rock is saturated with water (Fig. 2). In the case of valleys cutting deeply into the rock, the valleys themselves determine the level of saturation.

A soil which allows water to sink into it is a dry soil, and is, therefore, suited for habitation and for agriculture. Hence the main conditions which favour the settlement of a district are found in the same soil, or along the outcrop of the same bed. We thus see that geological structure controls the distribution of the population; not only in such great features of the earth's surface as mountain-chains, plains, and valleys, but also in the minor divisions of the district.

The outcrop of a narrow band of porous rock, between wide beds of clay, is strongly marked by the occurrence of a long line of villages, each of which obtains its water from shallow wells or springs. The cornbrash, between the Oxford clay and the great oolite clays, is an excellent example of this. So, too, is the marlstone rock-bed, between the upper and lower lias. Even a thin and comparatively unimportant bed of sand, ironstone, or limestone, if it only affords a small space fit for arable culture, will be marked by a line of villages (Fig. 3). A thin bed of ironstone in the lower lias of Lincolnshire is a good example of this.

When rocks rise from beneath a covering of clay there are often springs at the junction. Fig. 4 shows a very common arrangement in East Northumberland, where sandstone rises from beneath the boulder clay.

The base of the chalk escarpment, with the line of outcrop of the adjacent upper greensand, gives another good example. Here the villages always lie thickly along a definite line. There is a well-marked and constant relation between the outcrop of porous strata and the parish or township boundaries, the longer axes of the parishes crossing the outcrops more or less at right angles. A careful study of the distribution of the villages, and of the relation of their parish boundaries to the main physical features, throws much light upon the past history of the country, and often enables us to determine the relative ages of the settlements. This branch of the subject does not now concern us;* we need only note that the arrangement of the parish boundaries depends upon the sites of the settlements, and that these are controlled by the outcrops of water-bearing beds.

The early settlements in England were nearly always controlled by such circumstances as have been here referred to; but the later development of special towns and districts has depended upon a variety of circumstances. In early times it was around some shrine of special fame or sanctity, or under the shadow of the castle of some powerful noble, that the population clustered and the town increased. A little later it was also in places especially well suited for various manufactures. Within the last 200 years the great development of our mineral wealth (especially of coal and iron) has entirely transformed the country. Large towns have sprung up over the coal-fields, often on wide tracts of clay, where few settlements would otherwise have taken place. The natural surface water supply of such places is often bad and small, and the mining operations frequently drain even this.

The water supply of modern towns is, in nearly all cases, either (*a*) obtained from a neighbouring river, (*b*) brought from a distance, or (*c*) obtained from deep wells beneath the town. It thus, except in the first case, differs from that of the original settlement, which always obtained its water from streams, springs, or shallow wells. In far too many cases the primitive source of supply has been continued in use long after the time when it should have been abandoned; and the local source of water supply, essential to the early development of a town, has become a source of danger as the population has increased.

Of the points just mentioned, London affords an excellent example. The old parts of London and its suburbs are built upon gravel resting on London clay (Fig. 5). Where small valleys (such as the Fleet) cut through the gravel, there are natural springs; but everywhere water can be obtained in shallow wells sunk through the gravel. So long as the inhabitants were dependent entirely upon these springs and wells, the houses were confined to the gravel; when a general system of water supply was introduced, the population extended over the intervening area of clay. Meanwhile, the increasing population, without any adequate system of drainage, fouled the shallow wells, and rendered them all more or less impure. It is only within the last few years that some of these have been closed by authority.

Below the superficial deposit of gravel, there are other sources of water supply for London.

* For discussion on this question, see a paper by the author, in "Journal of the Anthropological Institute," vol. iii. pp. 32-55 (with maps), 1873.

The strata beneath lie in a basin-shaped form, and thus favour the accumulation of water. Underneath the London clay there are the lower tertiary sands, holding water which rises in the wells when these are sunk through the clay. Still lower, there is the great mass of chalk in which there is an enormous store of water. Still lower, and separated from the chalk by a bed of clay (gault), is the lower greensand. This, on the south side of London, may yet yield some water, but it can never be the great source of supply which was once hoped for.

There are, then, with the river, four different sources of water supply at or beneath London, each giving a different quality of water. Probably no large city in Europe is better situated than London for supplying itself with water from within its own area; but so vast has London now become, that all these taken together are insufficient, or inefficient.

It is a curious circumstance that some others of the great capitals of Europe are built on "basins" like that of London, and hence are able to obtain deep well-water from beneath. Paris, Berlin, and Vienna are good examples. This is a circumstance that could not have been known to the early settlers, who concerned themselves only with the surface sources of water supply.

WATER FROM THE CHALK.

By Joseph Lucas.

At the first Congress on National Water Supply, convened by the Society of Arts in 1878, I had the honour to read a paper indicating an opinion "that the real stumbling block to the practical solution of the water question of the country in general is not, as has been alleged, its cost, but the general absence of data respecting its sources," and advocating a survey of the water-bearing strata on principles described in the paper, and which I now reiterate.

The proposition met with the support of water engineers, and was endorsed in a leading article in the *Times*, summing up the results of the Congress.

At the next meeting in 1879, at which the Council of the Society of Arts did me the honour to confer upon me their silver medal for a paper on "National Water Supply," in a second paper, entitled "Watershed Lines," I gave the measurements in square miles of the apparent and real areas of chalk country lying within the basins of thirteen rivers between and inclusive of the Medway and the Meon, in South Hants, as determined by my hydrogeological surveys.

In the following year, the Institution of Civil Engineers, who had previously published a map and paper giving the results of a somewhat crude survey of the chalk water system (1872-6), did me the honour to publish a map and paper descriptive of the "Lower Greensand Water System of Surrey and Hants." For this survey the Council of that institution awarded a Telford medal and premium. In its application to the subject of London water supply, the hydrogeology of the question has frequently been called into requisition by the water companies, and was mentioned on the Committee of the House of Commons on London Water Supply, over which Sir William Vernon Harcourt presided, in 1880, by Professor Thorold Rogers, and in the evidence of the late Mr. E. J. Smith. That Committee never got beyond the financial view, and the question of London water supply was practically hung up to await the creation of a Municipal Corporation.

As it appeared to me unfortunate that the survey of the source of water supply should be hung up with it, I have continued to the present time (with the exception of a few months in which I was laid up from ill health) to extend, over large areas, the series of field observations which I have now carried on for nearly twelve years. These materials are in frequent use as evidence before Parliamentary Committees, in the Law Courts, and in arbitration cases at the Surveyors' Institution. As regards special areas, my friend Mr. Baldwin Latham has for years taken a large series of gaugings of wells and streams daily, which are probably unique in this country; and my former colleague, Mr. De Rance, has long edited a collection of observations under the auspices of the British Association, which will be of great value.

This is not the time to go into details of any particular areas, but I may be allowed to present one or two facts from a large mass of unpublished material, in support of any contention that a comprehensive and uniform survey of the sources of water supply is the stimulant required for the flagging water question.

The chalk of the County of Hertford is covered by a varying thickness of drift clay and clay with flints, and the wonderful plains of gravel that occupy nearly all the upland surfaces. From surveys made in 1876-7 and 1884, I have traced out two distinct water systems—one, the deeper, that of the chalk, which at the present time lies far below most of the valley-lines in the chalk basin of the Lea, and another, that of the surface gravels. Many of the various tributaries now in water are surface streams only, and here and there plunge into the chalk beneath. There should be no difficulty in supplying any village in the county, yet such considerable villages as Reed, Kelshall, and Sandon, have no well, and are dependent on ponds, which before the storm of July 9th were reduced to the last extreme of filth.

Essenden is also without a supply, and is under notice from the Rural Sanitary Authority; but I am told by a member of the Board that they have no knowledge how to supply themselves. As compared with some other chalk counties, there are no very deep wells in Hertfordshire. Along the base or boundary of the tertiary clays it occasionally happens that the drainage of considerable clay surfaces is discharged into the chalk, either by large swallows, as at Farnham, South Mimms, and Chislehurst, or by invisible leakage. Such points afford grand opportunities for collecting water, a fact that has not been lost upon the Kent Water Company at Crayford and Chislehurst, and might be turned to useful account elsewhere.

The chalk of the South Downs presents one or two notable points. Taking the geological unit of some 45 square miles area, between the Arun and the Adur, which it was my privilege to survey in the winter of 1878-9, and the summer and autumn of 1883, the water system shows three basins, one draining west, towards the Arun; another east, towards the Adur and coast; and a third, the Finden basin, between the two. The extreme height of the boundary water ridges of the Finden basin, under the escarpment at Sullington Down on the west, and Chanctonbury on the east, is 300 ft.: the distance from the rivers, west and east, which run in at mean tide level, being respectively 4½ miles and 3 miles; and distance from the sea 6 miles. On a cross section of the intermediate or Finden basin, from Sullington Down to Chanctonbury, we find a fall under the valley of upwards of 200 ft. in the water line, the water not attaining 100 ft. above O.D., at 6 miles inland along the valley. In the Michelgrove basin it falls short of 20 ft. above O.D. at 5½ miles inland, under the valley, while 1½ miles to the west it attains 257 ft. A third case is at Lychpole, where, at 3 miles from the coast and the Adur, the water falls to 6 ft. above O.D. I have met with no other area which exhibits such clearly defined channels underground as the block of chalk between the Arun and the Adur.

The upper greensand, generally a slender source of supply, prevents a notable exception. In June, 1882, I was invited to make a survey in search of a supply for the town of Warminster, and in the course of a few days was surprised to find some abundant springs issuing above Sheerwater Lake.

(1.) Sheerwater Spring Pond, discharging 132 cubic feet per minute (or twelve times the requirements of the town) at an altitude of 476 feet O.D., and 68 feet above the highest point in Warminster. (2.) Glasswell Spring, discharging 7 cubic feet at an altitude of 482·79 feet O.D., or 74·74 above Warminster. (3.) A spring rising in boggy ground at Aucombe, discharging 55 cubic feet per minute. This spring I did not recommend, as it is muddy and peat stained. The total discharge of Sheerwater Lake was 200 cubic feet per minute, or vastly in excess of all the above which flow into it. The elevated situation of these fine springs places them out of the reach of contamination, an advantage enjoyed by few towns in England. In the case of Warminster it is the more remarkable, as that town stands on the watershed ridge between the two channels. The Local Board is now taking steps to acquire water from them for the town. It is important to note the millowners of the Alyn, last year, failed to establish their claim to compensation in water for the quantity proposed to be abstracted from that flowing down the Silurian mountains on to the mountain limestone in which it sank, before a Committee of the House of Commons. Gaugings were specially taken last July, a temporary dam being formed above the inflow, and suddenly removed to let down a rush of water, which was found to issue a quarter of a mile below, after which it again sank and re-issued. This decision affects several English rivers and streams. Hydrogeological evidence is of the utmost importance in all such cases.

I must call attention to the recent decision by Justice Pearson in the case of "Ballard v. Tomlinson" (I being a witness as to facts below ground on behalf of the defendant), that the owner of a well is at liberty to pour sewage, or arsenic, down it if he likes, and to suggest that there is need for a change in the law upon this point, which will become more important if London should ever (and the attention of Sir Francis Bolton should be called to this point) draw more largely than at present from the chalk, as would appear possible after the recent demonstrations of Colonel Beaumont's rock-boring machine in the Channel and Mersey tunnels, and the Halkyn drain in the mountain limestone.

In conclusion, I trust that the present Conference will not break up without passing a resolution to the effect "that a national survey of the sources of water supply, both surface and subterranean, to produce maps defining levels, areas, and quantities of water, should be set on foot by Her Majesty's Government with the least possible delay." I trust that the spirited perseverance of the Society of Arts will be rewarded by a practical outcome from their several Conferences.

THE ORIGIN OF WATER SUPPLY.

By G. J. Symons, F.R.S.

This title might possibly be supposed to imply a history of the past, but in this Health Exhibition, *pace* Old London, we deal chiefly with the present and with the future.

I know no better word than origin wherewith to describe the small portion of the great subject of water supply which I am permitted to discuss.

All water supply comes from the clouds, and it is with the products of the clouds as rain (including therein snow and hail) that I have to deal.

Perhaps, before describing the general features of rainfall distribution, it may be permissible to explain (for the use of those who have never done it) how the fall of rain is measured. If we imagine a flat dish—a tea-tray, for instance—placed upon a lawn during rain, it is obvious that (subject to loss by splashing) that tray would at the end of the shower be covered by a layer of water of a depth approximately equal to that which fell upon all portions of the lawn, and the depth of the water on it (say ½ in.) would be the depth of the rain fallen. Obviously, besides the loss by splashing, the water on this tray would soon evaporate and be lost, besides which the depth could not easily be accurately measured. For these reasons, some form of funnel is always used, so that the rain may be, as it were, trapped, prevented from splashing out, and from evaporation. In the gauge before you (a very inexpensive one) all known sources of error are guarded against, and, as the water collected by a 5-in. funnel is measured in a jar only 1½ in. in diameter, it will at once be seen that its vertical depth is multiplied nearly tenfold, and, therefore, even $\frac{1}{100}$th of an inch is easily measured.

There are other patterns specially adapted for observation on mountain tops, where they can only be visited once a month, others for observations during heavy thunderstorms, so as to obtain data needful for drainage questions. others in which every shower that falls writes down its history, the instant of its commencement, its intensity during every minute, and the time of its termination; but I must not stand between you and other papers with a discourse on the many interesting points which these guages bring out.

During the last 25 years, I have done what I could towards establishing a complete system of recording the rainfall in this country. In early days the British Association for the Advancement of Science gave considerable help, but some ten years since they dropped it. Government have never given any help at all, and now the whole cost, or 99 per cent. of it, is borne by the observers themselves, a body which has now grown to the very large number of nearly 3,000. I do not know the precise number, but there are every year new stations beginning, old ones stopping, and others interrupted; yet for 1883, I have just had the pleasure of printing perfect records from 2,433 stations, every record having been previously carefully examined and verified.

Hitherto, I have been so overworked, and my staff has been so small, that the discussion of the data falls behind the collection; for this reason I cannot lay before you such data as I wish. However, the map on the wall is the one I drew many years ago, and which was inserted in the sixth report of the Rivers Pollution Commission. It is not perfect, but as it is tinted with increasing darkness for places with heavy annual falls of rain, it will at least show you the broad features of the distribution over the country.

I refrain from going into the subject in detail, desiring chiefly that you should realise the fact that large tracts of country have twice and even three times as much rain as others. If we descend to single stations, the differences are of course greater, *e.g.*, in 1883, the rainfall at The Stye, in Cumberland, was 190·28 inches, and at Clacton-on-Sea, in

Essex, it was only 18·71 inches; that is to say, the one was more than ten times the other.

Here I should like to interpose a question as to public policy. There is often a great outcry if the water of one district is taken to another. Surely, while there is no relation whatever between the density of population and the quantity of rainfall, one early duty of a Government is to see that all parts are amply supplied with the chief necessary of life. Englishmen have a dread of centralisation, but in many ways they pay a long price for their dread. At present, it is not often that any town can even state before Parliament its views as to the effect upon it of what its next neighbour may be obtaining powers to do. Having suggested one semi-legal question, I may as well mention at once another. Up to the present time, there being no Hydraulic-office (as I hold that there should be) in this country, all the larger water questions come before Parliament as private Bills, and, provided that they get through Committee, they, as a matter of course, become law—law for all time to come. No one can foresee what will be the total population of this country a century hence. No one can tell where the bulk of the people will reside, nor what will be the need for water in various parts of the country. Water-rights are already very valuable, and they will probably become still more so. Would it be possible to safeguard our successors by insisting that special water-rights, if now asked to be created, shall be subject to revision, *without compensation*, after the lapse of 100 years.

However, to return to rainfall, and explain why I stated it to be the origin of water supply. All rain and melted snow must be disposed of, either by evaporation, percolation, or flow into streams and rivers. The first class, evaporation, is, of course, not a supply, and therefore we must not pursue it. Percolation is the source of all springs and of all well-water. Sometimes, as at Lancaster, the springs are so large, that even a considerable town can be supplied by merely laying pipes to the sources whence they burst forth; sometimes they run into the reservoirs of gravitation water-works; sometimes they pass, as in the chalk districts, for miles beneath impervious strata, finally being either pumped up from wells, or even, in rare cases, rising as true artesian wells above the surface of the ground; and sometimes they pass even deeper, as in the red sandstone supplies pumped from extreme depths for Liverpool and other towns.

The water which runs off the surface is sometimes utilised by throwing a bank across a stream, and thereby forming a reservoir behind it, as, for instance, in the new supply for Liverpool from the Vyrnwy, where the reservoir will form a lake larger than many of those in Cumberland. Sometimes the lakes themselves are utilised as reservoirs, as, for instance, Loch Katrine and the surrounding lakes, and sometimes, as at York and London, the rivers are drawn from by powerful pumping machinery.

It is often said that there are few things so uncertain as the rain. That is both true and false. True as regards our ignorance of the future, false as regards our knowledge of the limits within which the quantity of rain will be found to vary.

There are now hundreds of records of rainfalls in this country of thirty or more years each, and in a very large majority of them it will be found that the following proportions will be within 7 per cent. of the truth :—

Wettest year, 45 per cent. more than the average.
Driest year, 33 per cent. less than the average.
Driest two consecutive years, 26 per cent. less than the average.
Driest three consecutive years, 21 per cent. less than the average.

There are many other facts respecting the laws of rainfall distribution, concerning which time prevents my saying anything, but I trust that enough has been said to establish the necessity of a perfect system of rainfall registration as the basis of any efficient hydraulic organisation.

WATER SUPPLY TO VILLAGES AND RURAL DISTRICTS.

By Eardley Bailey-Denton, C.E., B.A., Oxon.
Author of Handbook on House Sanitation.

I believe that I am uttering a fact which no one can discredit, when I state that there is no object in social economy which is more important, having regard to the aggregate number of persons affected by it, than the supply of water to village communities and rural districts.

At the present moment, when the International Health Exhibition may help to draw attention to sanitary objects of varying degrees of importance, it may be well to make clear that the condition of rural districts, in relation to water—the first essential of healthy life—is a positive disgrace to a country represented by a State Department whose efforts, it appears to me, should be specially directed to the protection of small communities less able to help themselves than large ones; and is a sad reflection on the present advanced stage of sanitary knowledge—an admission which the special meteorological condition of the present season, and a possibility of a visit of cholera, brings home to all minds with increased force.

If it should be understood, too, that the existence of this condition of things is to be traced, not so much to the absence of potable water, or the difficulty of bringing it into use, as to the disinclination of local authorities to develop the capabilities at their command.

It may be said with truth that, as a general rule, Local Boards and Boards of Guardians having jurisdiction in rural districts, who have been called into existence to supply the sanitary requirements of those districts, are animated with less desire to perform the duties devolving upon them than to avoid them. It is indeed notorious that the majority of members of Local Boards are elected under a pledge to oppose such works as sewage and water supply, on the ground that the rates will be increased; and knowing this to be the case, and that few persons of superior position are willing to take part in Local Boards, because they would invariably be outvoted, it is easy to understand why rural districts should be the last to move in the water question. It is, however, very difficult to explain why the clergyman and medical man of rural parishes, whose higher education should be a guarantee that the right thing would be done, fail to exercise proper influence. If, perchance, they are elected to serve on Local Boards, it almost invariably follows, that the one forgets what he has said in the pulpit as to the influence on the Future of sudden death; whilst the other ignores the advice he has given his patients in their sick-chambers, in relation to the fatal effects of inhaling and imbibing those germs of disease which float in foul air and impure water. Directly they are easy in their chairs as members, they content themselves with the the *laissez faire* policy of their colleagues.

These influences explain how it is that local authorities abstain from appointing as surveyor or sanitary inspector any man with a capability and courage to expose local defects and requirements, and why, when a medical officer does his duty in explaining the defective character of the water supply of any portion of his district, some reason is soon found for relieving him of his duties, and for appointing another in his stead; the actual result of all this being that the governing bodies of rural and small urban districts exercise their functions, when compelled to act, not by taking the advice and opinion of men technically qualified to guide them, but by the exercise of their own judgment. You may often observe a small publican or a grocer—excellent tradesmen in their respective vocations—directing the sinking of wells in village streets in close proximity to leaky sewers, ditches, or cesspools, by which the water intended for the supply of the poorer inhabitants soon becomes foul and unsuitable for domestic use. So general, indeed, has been this abuse, that it is no exaggeration to state that nineteen out of twenty existing village wells are quite unfit for their purpose, and that if samples were honestly taken and submitted to a competent analyst they would be condemned. Yet they are permitted to exist, and nothing is said about them, because the populations interested are comparatively small, the death-rate is not excessive, the dwellings are low in value, and, above all, because the rates would be increased if a proper water supply was substituted.

I have been induced to offer some remarks upon the present occasion, not because I have anything especially new to lay before you, but because the facts I have just referred to, on the constitution of local authorities and the performance of their duties, have been made more pertinent by the circumstance that, at a time when there exists the apprehension of a visit of cholera, a scarcity of water may occur, owing to a remarkably dry winter being followed by an unusually hot summer, which the recent thunderstorms may not sufficiently counteract. It is unnecessary to explain that the summer supply of water is very greatly dependent upon the fall of rain during the preceding winter, *i.e.*, upon the rain falling in the non-evaporating and dormant months of November, December, January, and February. The mean amount of rainfall in those months of the last winter did not reach two-thirds of the average quantity due to the same months for the preceding 60 years. This deficit would have been much more severely felt at the present time, and would have affected our subterranean supplies much more than it is now likely to do, had it not been in some measure counterbalanced by the excesses of rain which occurred during the last seven years, from 1876 to 1883, which gave us, on the whole, a considerable balance to carry over. This advantage, coupled with the frequent and heavy thunderstorms which have occurred within the last month or two, will go far to prevent the scarcity of water which would otherwise have occurred during the coming autumn; though, unfortunately, this national advantage will be a poor compensation to the agricultural interest, which has suffered so severely from the excessive wetness of the last few years.

Without taking into consideration on the present occasion the use of rain water, which, under careful management, may be collected from roofs, and other impervious surfaces, and stored in tanks, and which will always form a valuable means of supply to private dwellings, and in special instances may be made available even for villages, our rural supply, now so often derived from dirty ditches and shallow wells, more or less polluted by foul matters, may, in the absence of springs, rivulets, and impounded upland surface waters, be obtained from subterranean sources of "wholesome" character. These are to be found in various beds or outcrops of a water-retaining character, which gather water at a comparatively shallow depth below the surface, such as the post-tertiary beds of Norfolk and Suffolk, and the different drift beds covering the London clay; the Bagshot sands; the green sand overlying the wealden and gault clays; the surface sands and beds of the wealden formation; the calcareous grit and coral rag outcropping between the Kimmeridge and Oxford clays, and other beds of like nature; or, from the well defined water-bearing strata of the chalk, the oolite, and the red sandstone formations which are deep lying, and to reach which it is often found necessary to pass through superincumbent impervious beds or strata of varying thickness.

From the first source, it requires comparatively little motive power to raise the supply to the height required; in fact, in many cases, the application of the ordinary lift or atmospheric pump suffices; in others, where the depth exceeds thirty feet, additional power is called for. The second source requires more powerful pumping, and may involve the use of several pumps working in unison. All this has been said and explained before. My desire now is, if possible, through the influence of this meeting, to impress upon Local Boards and Boards of Guardians in rural districts where, in order to obtain unexceptional potable water they are obliged to seek it from beneath the surface, that the experience already gained in tubular wells goes far to prove that, in the majority of instances, the "tubular" system may, with good effect, take the place of the old and more expensive practice of sinking large wells involving brickwork, steining and staging. Economy, important though it be, is however secondary to the more important fact that a tubular well signifies continuous and watertight piping from the surface of the ground to the subterranean water level beneath, so that the entrance of polluted surface or subsoil water (as is so frequently the case in ordinary shaft wells) is rendered impossible. In addition to this advantage, it should be pointed out that tubular wells are very rapidly made, and can be readily removed should it occur that the water found or sought has not answered expectations in quantity or quality. Moreover, the whole of the materials employed may be applied, when withdrawn, to the same purpose in another place.

I may here state that there are some few disadvantages attending the adoption of tube wells which it is right at once to refer to. One is that, if owing to accident pumping is stayed, there will be no supply during such time, and if it should happen that the stored supply should run out before the pumping is resumed, much inconvenience may be experienced; whereas in ordinary shaft wells, there being room for more than one pump, such an objection may be obviated. Another disadvantage is that should the demand for water increase beyond the capability of supply the only remedy is to sink others, and to utilise two or more in combination.

To render the nature and cost of tubular wells, which necessarily vary in character and size according to local circumstances, as intelligible as it is possible to make them to rural sanitary authorities, I may shortly state that, adopting for illustration the two characters of the tubular wells already mentioned, *i.e.*, those that can be worked by ordinary lift and atmospheric pumps at a depth of less than 30 feet from the surface, and those that raise water by more powerful machinery from deep subterranean water-levels, the *modus operandi* and cost will be as follows:—

In the first instance, taking, as examples, cases where the populations may severally be 400 and 1,000, and where there exists a constant supply of water at 20 feet below the surface, recourse may be had to Norton's Abyssinian tube wells. The water is reached by driving tubes down through the ground to the water level. The first tube is pointed and perforated for a few inches with holes varying in size from ⅛ to ¼ inch. Length after length of tubing is driven into the earth at the selected site, and each succeeding length is connected with the last by a screw joint. The perforations at the base are four times as much as is necessary to obtain the full flow of water from the tubes, and they are kept clear by an arrangement adopted by Messrs. Legrand and Sutcliff, of Bunhill-row, City, for forcing out any sediment or matter that may obstruct a free influx of water. This is effected by suddenly liberating a column of water after it has been raised to a sufficient height above its normal level. The number of tube wells required in a village of 400 would probably be two, and in one of a 1,000 people, probably five. From figures kindly given to me by the patentees, it would appear that the capital expended in providing the wells and appliances will not exceed 2s. per head of the population. Of course, this only refers to the provision of the tubes, the pumps, and the cost of fixing them. There are many instances of small villages and hamlets where one well and pump alone would suffice; but there are others besides those given as illustrations where a number of these wells may be necessary, and which should be united by means of a cast-iron horizontal main or mains, with intervals between the vertical pipes, governed by the nature of the water-bearing seam out of which the water supply is obtained. This distance may vary from 18 to 30 feet. The motive power to work the pumps may vary in kind; water-power may be used when it is close at hand, or gas where it can be readily obtained.

In the second instance (deep sources), the tube wells consist of iron piping fixed in bore holes, which latter, in fact, form the well, with the piping to serve as the pump barrel and rising main, to raise the water into a service reservoir. These bore holes will vary in depth according to local features, and in diameter from 5 to 15 inches, according to the quantities of water to be raised. The core of pipes form, as already intimated, a continuous tube from the surface of the borehole to the water level below, and are made perfectly flush both inside and out, and must be watertight. They are sunk for a sufficient depth below the standing water level as to secure an effective discharge. The pump is fixed within the tubing, which forms a cylinder, and it is connected with the engine on the surface, by rods properly guided within the tube. Special pains are taken so to construct and fix the pump, that it may be readily brought to the surface, repaired, and replaced. For the first 15 or 20 feet of the well, a shaft 5 or 6 feet in diameter is necessary, in which to fix the necessary gearing connecting the engine with the pump, and to place the air vessel, &c., regulating the lifted supply to the reservoir. It would appear from figures, supplied me by Messrs. Tilley, of Walbrook, for works which we have now in hand, that the primary outlay varies from £500 in a case where the lift is 100 feet, the supply 40 gallons per minute, the depth of the bore-hole 300 feet and its size 7 inches, to £750 where the lift is upwards of 250 feet, the supply 50 gallons per minute, the depth of the bore-hole over 300 feet, and its size 9 inches.

Besides tubular wells sunk perpendicularly into subterranean water, supplies may not infrequently be obtained by the use of syphons for drawing water out of water-yielding basins, to which there is no natural outlet, by deflected pipes laid over or through the rims of the basins. The extraction of the required supply is effected by dipping the shorter leg of the syphon into the water bed forming a ready-made reservoir, and carrying the larger leg into the village requiring the supply, to act, with proper appliances, as a service main. This automatic mode of raising and delivering water has already been found available for towns as well as villages.

In the cases of Abingdon and Warwick, a syphon arrangement has been found very beneficial. The firm to which I belong, when devising the water supply for the former town (under the immediate supervision of Mr. C. F. Gower), adopted this expedient for raising the necessary supply for a population of over 6,000, which we had intended to obtain from a direct adit driven into the bed of coral rag, or calcareous grit, outcropping between Boars Hill and Abingdon; but which we abandoned in favour of a suggestion from Mr. J. Thornhill Harrison, of the Local Government Board, who, at an inquiry held by him, pointed out that the water bed which we were making preparations to tap might be considered a natural reservoir, from which the required supply could be raised by means of a syphon passing over the bank impounding the water. This object was effected by means of a 9 in. pipe capable of discharging 330 gallons a minute, laid from a reservoir holding 125,000 gallons (which it was found necessary to make within the calcareous grit for storage and ready discharge), the bottom of which was 40 feet higher than the highest part of

Abingdon. The shorter leg of the syphon is about 9 feet in length, and reaches very nearly to the bottom of the reservoir. When the water, finding its way out of the calcareous grit into the reservoir, rises above the crown of the syphon (which it generally does during the night), the discharge is by gravitation independently of the syphon; but when it sinks below that level, then the syphon action is called into play. This arrangement has been in existence at Abingdon for four years, without any hitch or difficulty of any kind.

At Warwick, Mr. Edward Pritchard, C.E., adopted a somewhat similar contrivance, whereby he effected a very great saving in the cost of the works. It has now been in operation for more than eight years, and is stated by Mr. Pritchard to work satisfactorily. Syphons, whilst working automatically, involve very little outlay in maintenance, and they would be adopted much more frequently than they are at present, if their special nature and advantages were more fully understood. They have been used with great advantage for the drainage of land and for the lowering of water standing in bogs. I may mention, as an illustration, that in Scotland the Earl of Stair drained by this means a wet marsh near Culhorn-house, which had rendered that residence unhealthy. The syphon-pipe (seven inches in diameter) was half a mile long, and it has drawn down the water nine feet.

There is yet another means of obtaining water for villages, which it would be wrong to exclude from the consideration of sanitary authorities, as in some instances, we know from experience already gained, that it can be resorted to with advantage; I refer to the use of waters from cultivated surfaces, which the Rivers Pollution Commissioners have designated "suspicious" waters. To raise them above suspicion they should be collected and filtered through a bed of natural soil, extending to about one pole (of superficial area) per head of population. By this means the water would be made very superior to that consumed by the majority of householders in rural districts. The preparation of filter-beds of natural soil is simple enough. A plot of land, as porous and free in its subsoil as can be obtained, should be selected, and made suitable by special treatment, at such an elevation relatively to the land from which the water would be obtained, and to the village which it is intended to serve, as will receive the off-flow from the former on its surface, and allow it, after it has passed through the filter, to collect in a storage reservoir, and thence to reach the village at a serviceable height. The filter itself should be deeply underdrained, and the water to be filtered through it evenly distributed over its surface. No manure whatever should be applied to it.

The water of underdrainage, when found to contain ingredients of an objectionable character, which the analyses of Professor Way have shown may be the case, can be rendered perfectly unobjectionable by a second filtration through a plot of prepared soil, rigidly preserved from the application of manure.

When we are taught by chemists to believe that the extraordinary purifying powers of aërated soil will render innocuous the discharged sewage of towns in which exists organic nitrogen in considerable amount, we must be satisfied that, by a second passage through natural soil, the water of underdrainage, already once filtered, may be freed from any putrescible ingredients it may have once contained.

This expedient is only suggested where a village being in the neighbourhood of an estate which the owner has underdrained, such owner will allow the water to be diverted from a natural stream, and filtered before it is supplied for domestic use.

I will close this short paper by drawing the attention of sanitary authorities in rural districts to the "Reservoirs Act, 1877," by which powers are given to the owners of land to supply water "to any sanitary or other local authority" by contract, and to charge their estates with the outlay on works.

WATER SUPPLY.

By Edward Easton, M.Inst.C.E.

The object of this paper is to put before the Conference, in as concise a form as possible, the considerations which should govern the supply of water for domestic and other purposes, not with the intention of enunciating any new thing, but with the hope of drawing attention to well-recognised principles, which are too often forgotten or neglected.

The three chief points which have to be considered in relation to this subject are:—

1. The source of the water,
2. Its distribution.
3. The conditions under which it is used.

1. With regard to the source, it is evident

that, in designing a waterworks, the engineer has to provide that the water shall be adapted to the purposes for which it is intended to be used, both as regards quality and quantity.

The question of quality will depend upon circumstances. It is essential, of course, that in every case the water shall be free from contamination by organic and other impurities; but the necessity of its being chemically free from other constituents will depend, to some extent, upon the purpose for which it will be used; for instance, in a manufacturing district, where the water is required for dyeing and such-like purposes, it must be free from certain mineral ingredients, whereas for the supply of drinking water and for general purposes, this is a qualification which need not be insisted on.

It is now generally admitted that a soft water is preferable to a hard water, provided that the storage amd distribution are properly carried out, and in every case where there is a choice of supplies, that which is soft, or which can be softened by simple means, should be chosen.

The process invented by Professor Clark for softening hard water by the deposition of a portion of the lime, is of a very simple character, and it has been successfully adopted in many cases.

Sources of water proper for use may be classed under two distinct heads. 1st. Those which are afforded by nature in a state absolutely pure and fit for use, such as water drawn from wells and deep-seated springs. 2nd. Those derived from water-courses or gathering grounds which are open to the atmosphere, and which must necessarily be exposed to the risk of contamination from external agencies.

In the case of the former, no works for storage or purification are necessary, the stratum of rock or other material from which the water springs, forming a natural reservoir and filter.

In the second case, it is necessary (*a*) that all direct pollutions shall be prevented from coming into the source; and (*b*) that in almost every instance, efficient means of filtration should be provided. The filtration ought, wherever it is found impossible to altogether prevent the chance of contamination, to include the use of some deodorising agent, of which there exist more than one capable of practical application.

As instances may be mentioned the filtration at Wakefield, where, for many years, by the use of Spencer's magnetic carbide of iron, a water very much contaminated was rendered perfectly wholesome; and that at Antwerp, where Professor Bischof's spongy iron is employed with an equally good result.

2. Essential as it is to ensure that the source of supply is proper for the required purposes, it is equally essential that the mode of distribution shall be such as shall prevent its deterioration before being used.

To effect this, it is absolutely necessary that the reservoirs, into which the water is collected for distribution, should be covered, and that the mains and pipes should be perfectly air-tight, and laid at a proper depth below the surface, so as to preserve the water in its original state of purity, and, as much as possible, at the same temperature, during its passage from the source to the consumer.

One great cause of the complaints of the quality of the water in most large towns, is the use of cisterns for storing it in the houses, which it is impossible to employ without the risk of some injurious effect upon the water.

In the Session 1877-8, two Bills were introduced into Parliament, at the instance of the Metropolitan Board of Works, for purchasing the undertakings of the London water companies, and for providing a separate supply of drinking water from the chalk. During the exhaustive examination of the waters supplied by the companies, made by the eminent gentleman who so fitly and ably occupies the chair, Sir Frederick Abel, assisted by Dr. Dupré, Mr. G. H. Ogston, Professor Voelcker, and the late able chemist of the Metropolitan Board, Mr. Keates, it was found that, whilst the water delivered in the mains was in almost every case excellent, the position and condition of the cisterns too frequently rendered it utterly unfit for human consumption. A great number of cistern deposits from all quarters of London were examined by these five gentlemen, with the general result just stated.

It is scarcely credible that the favourite place for fixing the cistern from which the water for drinking and culinary purposes is drawn is immediately over the water-closet or next to the dust-hole, whilst even in the better class of houses, where the cisterns are fixed in the roofs, they are very rarely sufficiently covered, and are open to contamination from soot, dust, inroads of black beetles, and other abominations. The latest researches of scientific men show that there is no more fruitful source of disease than such a condition of things affords. Although, doubtless, a great deal has been done by the expansion of the system of constant service in London and elsewhere to remedy this frightful evil, the following extract from Sir F. Bolton's report for the month of May shows that there is still much room for improvement. He says:—

"In the monthly and annual reports on the metropolitan water supply, attention is drawn to the necessity which exists for a regular cleansing of cisterns, and also to the fact that contamination of water from gases generated by sewage is of far more frequent occurrence than is generally understood. Waste pipes from cisterns are still to be found which are in direct communication with drains, so that gases may flow back into the cistern and become absorbed by the water. To prevent this an overflow pipe should be brought outside each house and the end left exposed to the air, instead of being carried into a drain, as is often the case. By the adoption of this plan poisonous effluvia and gases from drains will be got rid of, which would otherwise ascend through the pipe, and not only be partly absorbed by water in cisterns, but be mixed with the air in the houses, thereby becoming a cause of disease.

"The attention of consumers has been drawn to the fact that, in houses supplied on the constant system, all danger of drinking stale or contaminated water from cisterns may readily be avoided if the following recommendation is carried into practice, viz., to attach a small draw-off tap to the communication pipe which supplies the cistern from the main in the street, from which water may be drawn at any moment, day or night, direct from the works, thereby taking full advantage of any efforts made by the companies to purify the water to the utmost extent. This water should be used for drinking and cooking, and the contents of cisterns made use of for washing, flushing, baths, and similar purposes."

An abstract from these reports of the water examiner is printed by the companies at the back of the collectors' rate papers, so that no consumer of water can now be exonerated from the charge of negligence if this abuse is allowed to continue in his house.

3. This consideration naturally leads up to the third division of the subject, viz., the conditions under which water should be used. And first it is essential that a constant supply should be given, without which it is difficult to avoid the deterioration of the water above alluded to.

Not only is it impossible to give an adequate supply by the intermittent system without having storage cisterns in the houses, but there is also a serious danger of contamination by the possible admission of foul air or gas into the mains when the water is turned off. There have been several instances of a water supply being seriously affected from this cause.

But to give constant service it is absolutely necessary also that the supply should be under proper regulations, which shall ensure the prevention of undue consumption and misuse of the water.

Not only are the difficulties of providing the supply greatly increased where waste is allowed to prevail, but the cost to the community is augmented without the slightest corresponding benefit to health.

Nothing is more fallacious than the idea, prevalent among a large section of consumers of water, that the allowing of taps and water-closets to run to waste assists in the flushing and cleansing of the sewers, and therefore conduces to health. These continuous dribblings of water can have no effect whatever in removing any obstructions or accumulations which may exist in the large drains. The only proper and effectual way of removing fœcal matter is so to regulate the use of water that it shall be proportionate to the work it has to do at the moment. Where this is done, by the use of properly constructed water-closets, well-proportioned drains, and by keeping out from the system of sewers the rainfall on the streets and houses, the ordinary quantity supplied to a town is quite sufficient to perform this service without having recourse to extraordinary means. The question of dealing with the sewage of large communities, which is now so full of difficulty, would be much more easy of solution if these principles were more generally acted upon.

For these reasons, it is not desirable that the supply should be unlimited in quantity; on the contrary, every precaution should be taken to make that quantity commensurate with the real wants of the consumers.

It is quite certain that in almost every town a very large proportion of the water delivered through the mains runs needlessly to waste.

To take an example on the largest scale, the quantity supplied to London, according to Colonel Sir F. Bolton's return for the month of May, amounts to 32 gals. per head per day, about 20 per cent. of which, or say 6 gals., it is estimated is used for other than domestic purposes, leaving 26 gals. per head as the quantity supposed to be absolutely consumed in the houses. Now it has been ascertained that, on the average, the water really required is not half this quantity; and there is also no doubt that, by taking proper precautions, the amount delivered can be made to approximate very nearly to the actual use.

At Liverpool, by means of careful inspection of fittings, aided by the use of Deacon's meter, a most ingenious arrangement, by which it is easy to localise, and therefore detect, waste, the consumption of water has been reduced from 33 to 22 gallons per head per day, and, within my own experience, the adoption of the same system has, in six or seven instances, produced even more satisfactory results.

The waste of water, whether it arises from leaky joints in the mains and service pipes, or from defective fittings inside the houses, can only be injurious to health from the increased humidity which is thereby imparted to the soil and atmosphere, and which, as is well known, contributes so much to the spread of infectious diseases and the establishment of epidemics.

At this moment, when we are suffering to a greater extent than usual from the contamination of the Thames, owing partly to the presence of a large quantity of sewage, but also to the abstraction of so large a proportion of the summer flow of the river, it is manifest that the reduction by 33 per cent. of the amount drawn from and discharged into the river would go far to ameliorate the condition of things now complained of.

Among the different proposals which have been made for the introduction of a system which would ensure the prevention of waste, is that of furnishing the supply by meter. This is open to the grave objection that, in order to save money, people would be tempted to go to the other extreme, and to content themselves with an insufficient quantity. To obviate this, some such arrangement as that proposed by the writer to the Select Committee of the House of Commons, over which Mr. Ayrton presided in 1867, might be effectual. The following extract from the evidence given before that committee will explain the proposal :—

"I think a better method altogether might be devised of supplying the houses in London with water—a better system might be adopted to prevent waste. I should provide a constant service by meter, but under different conditions to any hitherto proposed. I think it could be designed with perfect fairness to the water companies and to the consumers, by making certain arrangements, and the general principle upon which I would propose that that should be done would be this: that there should be a sliding scale adapted to the class of house, each house should have a certain amount of water allotted to it. I would take a £100 house, and allot to it 150 gallons per day, and to a £200 house I would allot 300 gallons of water per day, and so on, upwards and downwards, provided that no house should have less than 50 gallons. Let the companies charge the same rate as they do now for that minimum quantity of water, and if more is consumed or passes through the meter the consumer would have to pay for that additional quantity."

Although at first sight the expense of the meters would appear to be prohibitive, both the consumer and supplier would soon be reconciled to the outlay, the one because he would know what he was paying in proportion to the water he received, and the other because they were only supplying water for which they were paid.

The consideration of the subject of this paper would not be complete without a reference to the important question of the conservancy of our rivers.

It is useless to discuss the method and conditions of supply, if the sources of water are not to be preserved to us, and it is quite certain that, with the immense growth of the population of this kingdom, it will not be long before this preservation becomes a pressing necessity.

In the report presented to Parliament by the Duke of Richmond's Select Committee on Conservancy Boards, in 1877, a very workable scheme was recommended by their Lordships. The Commitee say that :—

"In order to secure uniformity and completeness of action, each catchment area should, as a general rule, be placed under a single body of Conservators, who should be responsible for maintaining the river, from its source to its outfall, in an efficient state. With regard, however, to tributary streams, the care of these might be entrusted to district committees, acting under the general directions of the conservators; but near the point of junction with the principal stream they should be under the direct management of the conservators of the main channel, who should be a representative body, constituted of residents and owners of property within the whole area of the watershed."

But although the question of improving the water supply, by preventing the pollution of the rivers, was incidentally mentioned by their Lordships, it is evident that the main object of the report was the prevention of floods, and not the conservancy of water for the supply of populations. Now, it may well be said that the one subject is at least as important as the other, and just as the recurrence of a number of wet seasons at that time brought the question of the floods prominently before the Duke of Richmond's Committee, it may safely be asserted that a corresponding succession of dry seasons will compel the serious attention of the Government to the other part of the subject. We need go no further than our metropolis for the proof of this, for if, in addition to the saving of water by the prevention of waste, the flow of the Thames were properly regulated by works in the higher parts of its watershed, there is no reason why the river should not be in a condition which, although leaving very much to be desired in the way of improvement, would yet be tolerable, and, according to past experience, absolutely not injurious to health.

When presiding over the Mechanical Section of the meeting of the British Association, at Dublin, in 1878, on which occasion the opportunity was taken to very fully discuss, from a variety of aspects, this question of rivers conservancy, I made a suggestion which, I believe, is worth repeating at the peesent time. In my address to the Section it was stated :—

"When it is considered that many lives are annually sacrificed, either directly by the action of floods, or by the indirect but no less fatal influence of imperfect drainage,—when it is remembered that a heavy flood, such as that of last year, or that of the summer of 1875, entails a monetary loss of several millions sterling in the three kingdoms; that during every year a quantity of water flows to waste, representing an available motive power worth certainly not less than some hundreds of thousands of pounds; that there is a constant annual expenditure of enormous amount for removing *debris* from navigable channels, the accumulation of which could be mainly if not entirely prevented; that the supply of food to our rapidly growing population, dependent as it is at present upon sources outside the country, would be enormously increased by an adequate protection of the fisheries; that the same supply would be further greatly increased by the extra production of the land, when increased facilities for drainage are afforded; that, above all, the problem of our national water supply, to which public attention has of late been drawn by H.R.H. the Prince of Wales, requires for its solution investigations of the widest possible nature, I believe it will be allowed that the question, as a whole, of the management of rivers is of sufficient importance to make it worthy of being dealt with by new laws to be framed in its exclusive behalf.

"A new department should be created—one not only endowed with powers analogous to those of the Local Government Board, but charged with the duty of collecting and digesting for use all the facts and knowledge necessary for a due comprehension and satisfactory dealing with every river-basin or watershed area in the United Kingdom—a department which should be presided over, if not by a Cabinet Minister, at all events by a member of the Government who can be appealed to in Parliament."

It is earnestly to be hoped that no further time will be lost in passing an Act to deal with this subject, and that no considerations of a party or private nature will be allowed to prevent a scheme of so important and imperial a character being made as complete and comprehensive as possible.

In conclusion, as I commenced by saying, I have not attempted to say anything new; indeed the subject has already been in the hands of far abler exponents than myself; especially would I refer to Dr. Frankland's very able and comprehensive Sixth Report of the Rivers Pollution Commission, the careful study of which is recommended to everybody who wishes to master the details of the question.

SOURCES OF WATER SUPPLY.

By James Mansergh,
M.Inst.C.E., and M.E., F.G.S., F.M.S.

It used to be a popular belief that if a well were sunk at any place to a sufficient depth into the ground, there would be reached an inexhaustible reservoir of water, a store that had been filled in some mysterious manner at the creation of the world, and would suffice for the use of man for all time.

It is now well known that all supplies of water, whether found upon the surface, or below it, in underground depths, are derived from the rain which falls upon the earth, and that it depends upon the geological character of the surface receiving the rain whether it shall run off in the form of streams and rivers, or soak in and be apparently lost.

Rain is produced from the evaporation of invisible aqueous vapour, principally from the ocean, by means of solar heat, its condensation, primarily into the shape of clouds, and subsequently into the form of drops, which fall to the ground.

The sea is thus a storage reservoir of boundless capacity, and the sun is the great prime mover which pumps the water up from this reservoir, distributes it over the land, and lifts it to the hills, where it may be impounded in natural or artificial lakes, and thence delivered by gravitation to the plains below.

After being discharged on the earth in the shape of rain or snow, a part of the water is re-evaporated, but the greater part begins at once to travel downwards, either over the surface, in the form of rills and streams, and so on to the ocean whence it came, or through the surface, if this is permeable, into fissured or porous rocks below.

A portion of this latter water passing into the ground at high levels, has several courses open to it. It may appear in the shape of springs at lower levels, or rise in the beds of rivers, or run out through fissures on to the sea beach, or sink below sea level, whence it will be recoverable only by artificial means.

Nature has in this way provided water from one great source in ample quantity for the use of man, but works of varying character, under differing local circumstances, must be constructed to store and utilise it.

Altitude and the geological structure of a district are the two principal factors which determine what the source of water supply must be in such district. The two great classes into which sources may be divided are (*a*) above-ground and (*b*) underground sources.

The former (*a*) has several subdivisions, which may be described as follows :—

1. Water may be taken from the heads of streams by laying pipes right up to the springs, to convey it away for supply without any intermediate storage, as in the case of Lancaster. This is a source which in some sense belongs to the two classes, for the water is taken just as it ceases to be underground water, and is being delivered on to the surface above ground.

2. It may be obtained from a natural lake like Loch Katrine, as in the case of Glasgow.

3. It may be collected from a high-lying watershed area, by impounding a number of small streams in artificially constructed reservoirs, as is done for the supply of Manchester.

4. It may be taken from a large river flowing past a town, as is done in the case of the Thames and Lea for the supply of London.

The second class (*b*) is not divisible in the same way as (*a*), but may be taken a sembracing supplies of water obtained from many varieties of geological stratification, such as chalk, oolites, coal measures, millstone grit, magnesian limestone, Bagshot sands, and many others.

All water, when discharged upon the earth as snow or rain, is practically pure, but its character is very soon changed by the material it comes in contact with on the surface, or in passing through underground fissures and channels. Take, for example, the rain which falls upon the chalk downs of Sussex or any other similar geological area. It sinks at once beneath the smooth and rounded surface, and percolates through innumerable minute cracks or larger fissures, dissolving away the chalk which it touches, and finally issues naturally in springs along the coast, or is pumped out artificially, a water which contains from fifteen to twenty-five grains per gallon of carbonate of lime.

Such an alteration in character depends of course upon the nature of the rocks which the water traverses, some rocks being easily soluble, others not.

The taking up of lime or magnesia in this way has the effect of rendering the water "hard," that is, increasing its soap-destroying properties. For many manufacturing processes this is a most undesirable quality, and we therefore find that many of the important industries of the country are located in districts where soft water is easily procurable.

The following are the formations which yield as a rule soft water:—Igneous, metamorphic, cambrian, silurian (non-calcareous), Devonian (non-calcareous), millstone grit, coal measures (non-calcareous), lower greensand, London and Oxford clay, Bagshot sands, non-calcareous gravels.

On the other hand the following geological formations almost invariably yield hard water:—Silurian (calcareous), Devonian (calcareous), mountain limestone, coal measures (calcareous), new red sandstone, conglomerate sandstone, lias, oolites, upper greensand, chalk.

The manufacturing towns of Lancashire and Yorkshire obtain their supplies from sources which, even if the water had passed underground, would leave it comparatively soft, but this quality is fully secured by the character of the works, which consist of large reservoirs impounding the water which has principally run merely over the surface. For dietetic purposes, the quality of hardness, if not excessive, that is if it does not exceed twelve grains on Dr. Clark's scale (equivalent to twelve grains of bi-carbonate of lime per gallon), is not considered objectionable on physiological grounds. For ordinary domestic purposes, and especially for personal washing and cleaning generally, soft water is infinitely preferable to hard, both in respect of comfort, efficiency, and economy.

Taking into account all the purposes for which water is used, it can hardly be questioned that a pure soft water supply is on the whole preferable to a pure hard water supply. The term "pure" is here used to imply the absence from the water of organic impurities as distinguished from the dissolved inorganic matters which have before been referred to. Except as producing hardness, the inorganic matters usually found in water are practically harmless; but organic pollutions may be of the most disgusting and dangerous character, those for instance which are the result of contamination with town sewage or cesspool manure.

It is to avoid the risk of such pollution that many towns have in great measure been led to seek their sources of supply on elevated moorlands, above the level, at which arable cultivation is carried on, and where it follows that there are no towns or villages, and the scattered population is very sparse. In this country the plough is rarely seen above the 800 ft. contour, and as it will not pay to cart manure to such an elevation; these high lands are merely used for the pasturage of sheep and the rearing of grouse.

Water obtained from such sources is practically, therefore, in the condition in which it falls from the clouds as snow or rain. The only impurity it may contain is a little organic matter derived from passing over the peaty soil, which often occurs on high moor-lands, especially where the summits are broad and comparatively flat. This contact with peat, and with growing heather, gives a stain to the water to such an extent that, when seen in deep reservoirs, it looks like dark coffee.

As seen in an ordinary white glass bottle or tumbler, the tinge is rarely deeper than a very faint straw colour. There is nothing harmful in this colouring matter, because it is of purely vegetable origin, and to some extent it may be removed by storage in open reservoirs, or running in open channels exposed to the air.

Many towns are so located in this country that it is practically impossible that they should obtain pure water supplies from elevated watersheds, on account of the enormous expense that would be entailed in the construction of the necessary works. Such places must be content to be supplied from rivers in their immediate neighbourhoods, and which, having run their courses through many miles of highly manured lands and past thickly populated towns and villages, contain water which has necessarily become polluted by the washings from the lands and the sewage from the towns. Such sources as these would be inadmissible, but for the great rehabilitating process which nature silently carries on in a river, and to which chemists apply the term "oxidation." In this wonderful process, the polluting organic matters which the water contains are converted by the agency of oxygen into harmless inorganic salts, and the water again becomes fit for the use of man.

This statement must, however, not be made without some reservation and explanation, because chemists of the very highest standing are not agreed as to the extent to which rehabilitation of the water is carried. This has, in fact, become quite a burning question, and the battle has been fought long and frequently over the water which is taken from the Thames, and delivered for consumption by the inhabitants of London.

The difference of opinion is now narrowed down into a small compass, and to outsiders it would appear that there is a chance, sooner or later, an agreement may be come to between the authorities.

As representatives of the two sides may be named Dr. Frankland and Dr. Meymott Tidy. Dr. Frankland admits that oxidation is effective in burning up, or converting into a harmless condition, even such vile contaminations as human sewage, if this is in a normal or healthy condition; but he contends that the virulent zymotic diseases are propagated by organised germs contained in the sewage which are indestructible, and which may travel scores of miles in a running stream without being deprived of their fatal potency.

Dr. Tidy contends, on the other hand, that there is no evidence of the existence of these animated germs, and affirms that a run of a few miles in a river fully oxygenated, and in which the pure water bears a sufficiently high ratio to the polluting matter, will suffice to render such water again fit for human consumption.

Dr. Frankland's theory is naturally a disquieting one; and his opponents certainly have facts in their favour, for London is undoubtedly one of the healthiest cities in the world, and its inhabitants have never been known to suffer from disease induced in the way suggested.

The "germ" theory is, however, making steady advances under the investigations and researches of competent men, and it is to be hoped and expected that if the historic germ is at last discovered, and exhibited to the incredulous gaze of Dr. Meymott Tidy, he, or some of his *confrères*, may speedily discover a method of scotching it before it has time to do any mischief.

It may now be convenient to describe shortly a few typical examples of the utilisation of the different sources of supply which have been thus generally referred to.

I. Take, first, such a case as that of Lancaster, whose works supply a population of between 30,000 and 40,000. The town is situated on the River Lune, about seven miles above its junction with Morecambe Bay, and is built upon a site which, rising from the river, varies in elevation from 15 to 200 feet above Ordnance datum, or mean tide level. The water is obtained from the high moorlands of Wyresdale, at a distance of eight or ten miles from the town, in a south-easterly direction. These fells, as they are locally called, constitute the extreme north-easterly portion of the watershed of the River Wyre, a small river which also falls into Morecambe Bay near the town of Fleetwood. That portion of the fells which is secured by Act of Parliament as a source of water supply for Lancaster, has an area of 2,700 acres, and an altitude varying from 850 to 1,800 feet above the sea.

The geological formation of the gathering ground is millstone grit, covered with scant herbage suitable for sheep pasturage, and heather. Interstratified with the beds of permeable grit stone there are layers of impervious shale which, at various levels, throw out the water percolating downwards from the surface, in the shape of springs, and a number of these springs have been intercepted by small pipes communicating with mains laid along the hill side, and leading their combined waters to the south-west corner of the reserved area.

One of these mains forms part of the original works constructed under the superintendence of Sir Robert Rawlinson, C.E., C.B., in the year 1852; the other, which runs (broadly speaking) parallel to the first, but about 200 feet lower down the hill side, was laid six years ago, as part of an extention earried out by the writer.

The water derived from these is of necessity of the purest possible character, for the rain which feeds the springs falls upon the clean open moor-land, and sinks at once into the millstone grit rock, in which it finds nothing to dissolve and cause hardness, and nothing to organically pollute.

The water issues from the springs in a bright sparkling condition, at a constant temperature of about 45° F.; it contains only one grain in 15,500 of solid matter, and its hardness is under 1° on Clark's scale.

This may be fairly regarded as an ideally perfect source of supply, and it has been an inestimable boon to the inhabitants, especially as it replaced water obtained from shallow wells in the town, polluted in the vilest possible manner by percolation from numberless foul and reeking privy pits and middens.

Between the fells and the service reservoir, which is situated on the town moor 240 feet above Ordnance datum, the country is intersected by several valleys, across which the water is conveyed in iron pipes.

At two intermediate points the pressure is broken by small covered tanks, and the water is never exposed to the open air from the time it sinks into the ground as rain or snow, and is drawn from the consumers' taps in the town.

Perhaps it may be as well to explain here that, when water is obtained from elevated watershed areas of this character, Parliament almost invariably insists upon "compensation" being made to the river for such abstraction. This compensation is secured by the construction of reservoirs somewhere upon the main river or its tributaries, in which water is stored in time of flood, and given out in a constant stream in times of dry weather, the assumption being that floods are utterly useless, if not damaging, to riparian owners and mill owners, whilst it is of advantage to every interest to have the dry weather flow increased in volume.

Thus, in the Lancaster case, whilst the Corporation have the right to take 2,000,000 gallons a day from the springs for the use of the town, they were put under the obligation to construct upon the River Wyre a reservoir capable of holding 185,000,000 of gallons, from which the millowners have the right to draw water according to their needs during the summer months. By means of such works, all the parties concerned are very greatly benefited.

II. The second type of utilisation of sources which may be referred to, is that which is exemplified on so magnificent a scale in the works supplying Glasgow, and constructed from the designs and under the superintendence of Mr. John Frederick Bateman, C.E.

In this case, advantage is taken of three natural lakes, viz., Loch Katrine, Loch Venachar, and Loch Drunkie. The watershed area draining into these lakes is 45,800 acres in extent, and consists of unpolluted sparsely populated moor-lands, the geological formation being of silurian age.

Loch Katrine has a water surface of 3,000 acres, Loch Venachar 900 acres, and Loch Drunkie 150 acres. They are all of course supplied by the rain which falls upon the 45,800 acres, and as a considerable proportion of this area is of a peaty character, the streams which run down the mountain sides are frequently as dark as London porter. By the deposit of the heavier parts of the peaty matter, and the bleaching action of the air, the water is drawn from Loch Katrine with only a faint tinge of colour.

The two smaller lakes are utilised as compensation reservoirs, the artificial storage necessary being obtained by raising the original normal level of Loch Venachar 5 feet 8 inches with power to draw it down 6 feet, and by raising Loch Drunkie 20 feet, the raising in both cases being done by masonry dams across the outlet valleys, furnished with draw-off sluices.

The storage for the supply of Glasgow is obtained by works which raised the normal level of Loch Katrine 4 feet and admit of drawing down 3 feet. Its capacity is, therefore, 3,000 acres of area, by 7 feet in depth, equivalent to nearly 1,000 million cubic feet, and competent to furnish 50 million gallons a day during a four months' drought.

The water surface in Loch Katrine is 360 feet above mean tide level at Glasgow. The conduit conveying the water to the City commences on the south side of the lake, about three miles from its western extremity, and runs generally in a southerly or south-westerly direction. At 26 miles from the Loch it discharges into an artificial reservoir of 70 acres in extent, and holding 500 million gallons near Mugdock Castle, the top water of this reservoir being 311 feet above mean tide at Glasgow. Two lines of three feet cast-iron pipes, one seven miles long and the other eight miles, convey the water to the city.

For thirteen miles out of the 26, between Loch Katrine and Mugdock, the conduit is formed by tunnelling through very hard rock, such as whinstone, gneiss, and mica slate; the tunnels being seventy in number, nine miles of the remaining length is "cut and cover" work, and the rest consists of cast-iron or wrought-iron pipes across valleys.

The advantage of such a source of supply as Glasgow's is the facility and small cost with which the storage capacity necessary to furnish the requisite daily quantity for consumption and compensation is obtained.

In Loch Katrine, the narrow outlet from the lake had only to be dammed up four feet, requiring artificial works of the simplest character, entailing no risk or contingency in their execution. Having a flat area 3,000 acres in extent to begin with, a simple plank one foot high would have sufficed to impound 816,000,000 gallons. The desirability of securing such a reservoir site as this can only be fully appreciated by those who have had the responsibility and anxiety of forming large storage reservoirs, by the construction of high embankments across valleys. The relative amounts of labour and outlay in such reservoirs, and in cases like Loch Katrine, will be better realised in considering the next type.

III. The third type of works for the utilisation of mountain watershed sources of supply is well examplified in the Longdendale valley, where a number of reservoirs have, during the last thirty years, been constructed for the supply of Manchester. Here, instead of having a level plain 3,000 acres in extent as in Loch Katrine, upon which to commence as the bottom of a reservoir, was a valley with a fall along the bed of its main stream—the Etherow —of between 60 ft. and 70 ft. in a mile. Across this valley five embankments have been constructed of earthwork, one above another, forming five lakes with a combined water surface area of 462 acres. Beginning from the lowest part of the valley, the following is a list of the reservoirs, viz.:—

	Height of Bank. Feet.	Water area. Acres.	Capacity. Gallons.
Bottoms	66	50	407,000,000
Vale House	55	63	343,000,000
Rhodes Wood	75	54	500,000,000
Torside	100	160	1,474,000,000
Woodhead	80	135	1,181,000,000
Total	376	462	3,905,000,000

These embankments, which cost something like £100,000 apiece, have an aggregate height if placed one above another of 376 feet, and the quantity of water they impound is 3,905 million gallons. The raising of the water surface of Loch Katrine 5 feet would create the same amount of storage. The watershed area supplying these reservoirs is 9,300 acres, and the geological formation is millstone grit. The gathering ground is a portion of the western slope of the "backbone" of England, otherwise the Pennine range, upon which, over its whole length on both sides, many similar works are located for the supply of the manufacturing towns of Lancashire and Yorkshire. The rocks in this district are very much fissured and broken, and the rain falling upon the higher grounds percolates below the surface and re-appears as springs at lower levels. Advantage is taken of this by conducting the spring water along special channels into the Rhodes Wood reservoir, from which the supply is taken by a conduit to the town.

Although the quantity of water yielded by the whole gathering ground is that due solely to its area and the rainfall upon it, the fact of there being these springs renders it more valuable, because it implies that water which would have run off a district composed of harder and less pervious rocks, is here absorbed into the mass which thus acts as so much storage or reservoir space. The effect of this is to increase the dry weather flow of the streams, and to furnish water which is clear, cool, and colourless. The average annual rainfall upon the 19,300 acres is about 50 inches, and the works utilising this area are competent to provide 38,000,000 of gallons per day, of which 13,500,000 have to be delivered into the stream below the reservoirs as compensation water. Besides the five reservoirs above-named, there are other large impounding and service reservoirs at Godley, Denton, Gorton, and Prestwich. In the construction of these works enormous difficulties have been encountered, and at Woodhead, the highest reservoir of the series, the embankment, as at first made, was not watertight, so that a second trench had to be put down in which to build the puddle wall, and so much were the measures disturbed and distorted, that on the south side of the valley this trench had to be excavated to 167 feet below the surface of the ground, before sound and tight material was reached upon which the wall could be based.

The three types of works thus described may fairly be said to exhaust the methods of obtaining water from sources situated on elevated mountain gathering grounds. They are good examples of the gravitation system of supply, by which water is delivered at high pressure above the highest parts of the towns without any artificial pumping being required, the sun having done this work in the process of evaporation.

IV. We will now consider a case where the town to be supplied is at such a distance from high ground that the cost of bringing it through conduits or pipes by gravitation is prohibitive.

Take a town built along the banks of a river anywhere above the range of the tide. If this river flows through an agricultural district, and is thus not polluted by manufacturing refuse, and not seriously by either manure or sewage, it may be adopted as the source of supply. In this case the water will have to be lifted by artificial means to such an elevation as is necessary to command the whole town.

The water will also require filtration, because in running its course through the country the river receives the washing from the land; and in times of heavy rain, at all events, the water will be discoloured and turbid through the presence of suspended matters.

The works for the supply of London are in great part of this character, the Rivers Thames and Lea being the two sources.

Three hundred years ago, water was obtained from the Thames at London-bridge, and pumped by means of a water-wheel under one of the arches through wooden pipes into the streets and houses in the neighbourhood. These works were continued in operation for 200 years, and were supplemented early in the 17th century by other pumping stations, taking water from the Thames at Charing-cross, Battersea, Vauxhall, and Hammersmith, all within the range of tidal influence.

In 1848, the Lambeth Water Company obtained powers to go into the non-tidal portion of the river above Teddington Lock, and by the year 1851 they were in a position to deliver water by means of a large steam-pumping establishment erected at Seething Wells.

In 1852, an Act was passed which made it unlawful for any company to supply water taken from the river below Teddington Lock, or from any of its tributaries within the tidal range. This led, finally, to all the companies drawing water from the Thames so rearranging their works as to have their intakes above Moulsey Lock, in order to be above the junction of the River Mole, which frequently brings down very dirty water.

Owing to the changes in the points of intake, the works of the London companies are divided into portions at great distances apart. Thus the Southwark and Vauxhall Company have at Battersea the reservoirs, filter beds, and pumping machinery constructed for the purpose of taking in water from the river at that point. They are well-known to all Londoners by reason of the tall stand-pipes which form a prominent object in the view from the trains running out of Victoria-station.

These works are of so costly and extensive a character, that they could not be abandoned when the source of supply was changed to Hampton, 21 miles higher up the river, but the water abstracted there is pumped down to them through large cast-iron mains, to be filtered and distributed by the original machinery and mains.

In the case of the Lambeth Company, the water is taken from the Thames at Molesey, and sent down to Surbiton, which is the site of the filtering and pumping station, through a large brick conduit, by gravitation.

From these circumstances, none of the London works are good examples of the type now under consideration; but the following description will explain the nature of the works required for the utilisation of such a source as the Thames above London.

First of all, then, provisions must be made to meet the difficulty of the water arriving at the intake in times of flood in a state of great turbidity or muddiness. This is met by the provision of large reservoirs, which are always kept full so long as the water is coming down in good condition, and the inlets into them from the river are closed, and they themselves are drawn upon when the water of the river is turbid.

These reservoirs used to be of smaller capacity than at present, and were worked as subsidence tanks, that is to say, the water (which might be somewhat turbid) was let in at one end and drawn off only from the surface at the other, the suspended matters causing the turbidity subsiding to the bottom during the water's slow passage through the tanks.

In London, since the works of the several companies have come under the official supervision of Sir Francis Bolton, very large sums of money have been spent in increasing the efficiency of these subsiding tanks, by greatly augmenting their capacity, and practically changing their character into that of storage reservoirs.

In some of the works, these reservoirs are constructed at such a level that the water from the river flows into them by gravitation; in others they are elevated above the ground, and the water is pumped into them. In either case it is next delivered on to the filter-beds, the construction of which is shown very clearly in the most interesting pavilion erected in the Health Exhibition by the water companies. These filters consist of reservoirs or tanks made either by excavation in the ground or partial excavation, and partial embanking, as circumstances may dictate, having their sides sloped and pitched, or of vertical brick, stone, or concrete walls. The bottom is formed in many different ways, but it is always furnished with a number of open-jointed or perforated pipes or drains into which the water can pass, and by which it may be conveyed away to a pure-water chamber or pump-well. Upon this floor the filtering material is placed, and consists of clean stones, flints, gravel, shells, and sand, arranged with the largest sized material at the bottom and the finest at the top.

Probably the oldest style of filter shown in the Exhibition is that designed by the late James Simpson, C.E., for the Chelsea Company, and it contains all the materials above-mentioned, and has a total depth of 6 ft. 3 in.

As, however, the really operative and effective portion of the filter is the sand, modern practice is tending in the direction of diminishing the depth of filtering material, and of omitting entirely several of the strata originally used. For instance, the New River Company's engineer exhibits a filter composed solely of 2 ft. of sand, resting upon 6 in. of gravel, the total depth being only 2 ft. 6 in. In working the filters, the water is brought from the storage or subsiding reservoir on to the top of the sand, and stands from 2 to 3 ft. above its surface. It then percolates downwards through the filtering material into the drains below, and is run away to be pumped for distribution.

The speed of filtration may be adjusted by the head under which the filter is worked, that is, the difference in level betwixt top water and the draw-off. In some cases this is only 2 or 3 inches. The speed at which the water should pass vertically downwards through the sand used to be stated as 6 in. per hour, which gave 675 gallons per square yard per day of 24 hours, but the London companies are now not filtering more than 450 to 500 gallons, or from 4 to 4½ in. per hour.

The matter which is arrested by the filters consists principally of finely divided mineral matter washed from the surface of the land, of some vegetable and a trace of animal matter. These impurities are caught almost entirely in the top half-inch of the sand, which in course of time they choke and render impervious. The filter is then put out of use; the water is drawn off, and a skimming of the fouled sand is carefully removed and washed in apparatus which separates the light muddy matter and leaves the clean sand which is again put upon the filter. Of course, the washing process involves some loss of sand, and periodically additions have to be made of new material. After filtration, the water is in a fit condition to be pumped and distributed to the consumers.

Thus far we have been dealing with "above ground" sources of supply, obtained either by gravitation or by artificial pumping, under the four heads numbered—(1) being springs at high elevation, without storage; (2) being surface water from moor-lands drawn from natural lakes; (3) being surface water from similiar watersheds, impounded in artificial reservoirs; (4) being river waters filtered, and artificially pumped for supply.

There are in this country a few examples of hybrid schemes, that is, where water from comparatively low agricultural land is impounded in large reservoirs, and where it has to be subsequently filtered and pumped for distribution in the district. There may also be cases where water collected at a sufficient elevation to supply a town by gravitation has to be filtered before delivery.

We now come to the underground sources of supply, and one or two examples will suffice to explain how these are made available. We need not go far from home to learn all about one of the most important of these underground sources, for it lies under our feet in the chalk forming one great feature of the London basin.

London is actually built upon the tertiary deposits, which consist of Bagshot sands, London clay, and the sands and mottled clays of the lower strata; but underlying all these is a mass of chalk having the southern edge of its outcrop on the north of London about Hatfield, and the northern edge near Royston, and its southern outcrop extending from Croydon to Merstham. On the west the chalk reaches as far as Devizes, and on the north-east to near the coast of Norfolk and Suffolk. Portions of this vast area are no doubt covered by impermeable drifts of varying character, but there is still a very large tract of country upon which the rain which falls sinks below the surface, and goes to charge the great underground chalk reservoir below.

Possibly, the term "reservoir," though a common one, is a little misleading as applied to the chalk, because for water supply purposes, a large proportion of that which percolates into its mass is not recoverable by ordinary means. It is the water which circulates through the cracks and fissures which is really available, and not that which is held in the minute capillaries of the mass. Some chalk will contain 20 per cent. of its own bulk of water, and yet will not yield a drop of this under ordinary conditions.

Of the water which thus sinks into the chalk, a large portion finds its way out again into the bed of the river, another portion appears in the shape of large springs, such as those at Carshalton and Croydon, which go to form the River Wandle, by flowing over the edge of the impervious tertiaries.

Very rarely are there any streams where the chalk itself comes to the surface, but after heavy and continuous rains, streams do appear and flow for a time, and these are known as "bournes." As the chalk is 500 or 600 feet thick, a very large quantity of water is, however, left in it below the level of any of these natural outlets, and this water can be obtained in London by sinking wells through the overlying impervious beds of London clay, and allowing the water to rise, as in an artesian well.

There are a large number of wells in the London basin, and one of the metropolitan water companies, the Kent, obtains its supply exclusively from such wells. The ordinary practice is to sink a well from 5 feet in diameter upwards, and line the same either with brickwork or cast-iron cylinders down to the chalk. This will pass through superficial gravels, blue clay, bands of sand, mottled clay, &c., and sometimes on the top of the chalk a band of flints will be found. Below the bottom of the well a boring is then made from 4 inches up to 15 or 18 inches in diameter, and lined with iron whilst in soft or much broken chalk, and left unlined where the material is more compact.

In those parts of London which are not elevated many feet above the level of the river, the water rises to very near the surface of the ground, and in some cases overflows; but wherever large quantities are required, resort must be had to artificial pumping so as to lower the level of the water in the well, and thus open out a larger cone of exhaustion in the chalk. Favourably situated chalk-wells yield as much as 2,000,000 to 3,000,000 gallons a-day.

In many cases wells and mere borings have been put down right through the chalk to the upper greensand or gault below, and have yielded only a very small quantity of water. This arises from the fact before referred to, that the water circulates freely only in the cracks and fissures, and if some of these are not cut into by the boring, little water is obtained. The most certain way, therefore, of ensuring a supply from the chalk, is by sinking a well down to below the permanent level of saturation, and then driving headings or adits in various directions, for the purpose of reaching some of these fissures. Many of the towns along the south coast of England are supplied by works of this character. It has been found that where the chalk of the South Downs has been undisturbed and is unfaulted, there are large vertical fissures which run, broadly speaking, from north to south, that is, at right angles to the coast. Along these fissures the water travels freely, and has its outlet at the base of the cliffs on the coast, and may be seen running down the beach in many places into the sea.

Parallel to the coast, the water is found to lie with its surface nearly horizontal, because of these permanent outlets, but on lines at right angles to the coast, the surface of the water rises rapidly inland, on a nearly uniform slope, so much so that, at six miles from the coast, it stands more than 200 feet above mean tide level. Advantage has been taken of these conditions at Brighton, and other places similarly situated, to sink wells and drive headings parallel to the coast, at about the level of low water.

At Brighton there are two such stations, one at Lewes-road, on the east, and another at Godstone Bottom on the west. These wells are both about a mile and a quarter from the sea, and headings are driven to a total length east and west, from Lewes-road, of 2,400 feet; and at Godstone Bottom, of 1,300 feet. In the first case, fissures are met with about every 30 feet, but as a rule these are small, and do not yield more than 100 to 150 gallons a minute. In the latter they are further apart, but some of them yield 700 or 800 gallons a minute, or over a million gallons a day. This water, being intercepted by the headings, is led to the respective wells, where, by means of suitable steam machinery, it is pumped up to the several service reservoirs supplying the different zones of the town.

The water so obtained requires no filtration. It is bright and sparkling, but of necessity hard, and although not objectionable for dietetic use, is not well fitted for cooking or cleansing purposes, and would be utterly unsuitable for the manufacturing processes of Lancashire and Yorkshire, though thoroughly well adapted for paper-making.

In addition to the chalk, good supplies of underground water are obtained in the South of England from the Hastings sands and the oolites, and in the north from the new red sandstone, magnesian limestone, and other formations; but in all cases the works required for the utilisation of these sources are very similar, consisting of wells, borings, and adits, with competent pumping machinery.

Comparing very generally "above-ground" supplies by gravitation with "under-ground" supplies involving pumping, there are advantages and disadvantages on both sides which may shortly be summarised as follows:—

"ABOVE-GROUND" GRAVITATION SOURCES.

Advantages.	Disadvantages.
1. No pumping.	1. Distance from place to be supplied.
2. No filtration.	2. Peaty stain.
3. Softness.	3. Costly and somewhat risky impounding reservoirs.
4. Low charges for maintenance.	4. Large works involved to provide water "compensation."

"UNDER-GROUND" PUMPING SOURCES.

Advantages.	Disadvantages.
1. Proximity of source to place to be supplied.	1. Annual charges for pumping.
2. Low first cost.	2. Hardness (generally).
3. Few structural contingencies attending works.	
4. No filtration.	
5. No compensation for abstraction of water.	

Miscellaneous.

HORSE BREEDING IN RUSSIA.

An interesting account is given in Consul-General Stanton's last report of horse breeding in Russia. He says that the horse has played an important *rôle* among the inhabitants of the steppes from the earliest period of the history of the Slavonic breeds. Oley, and succeeding princes, took measures to improve the breeds, and Yaroslaff punished horse stealing by loss of liberty and fortune, but until the middle of the 13th century the Russian Government was lukewarm in the matter of encouraging the breeding or improving their breed of horses. From the time of Ivan III., Government measures became more systematic, imperial studs were established, thoroughbreds purchased, and stallions were lent to boyars and monasteries for breeding purposes. At the present time there are six imperial studs: the Orloff, where English thoroughbreds, trotters, and saddle horses are reared; the Novo-Alexandrofsk, for English half-breds and large horses; the Strelitz, for oriental saddle horses; the Derkulsk, for farm and carriage horses; the Tanoff, for large saddle horses and English half-breds; besides these there was, until 1881, a stud at Orenburg for breeding steppe horses.

There are fifteen covering stations, which are open to all. The stallions are distributed each year from February 15th to June 15th among these stations, and here mares are served by thoroughbred stallions at a fixed rate. In 1881, there were 1,077 stallions at the 15 stations, and 39 stallions were placed at the disposal of the agricultural establishments at separate stations. The imperial studs, after replenishing their stock, dispose of their increase by auction every four years. The thoroughbred Orloff colts are, however, sold each year. In 1880, 555 horses and 15 foals were sold for £11,480; and in 1881, 687 horses realised £10,064. Three thoroughbred English and two Arabian stallions were added in 1880, and eight English thoroughbreds in 1881. The department receives annually about £11,450, to be spent in encouraging private breeding establishments. At present there are eight jockey clubs and twenty-seven trotting establishments. There are 3,430 private studs, with 9,560 stallions and 92,971 mares. Besides these, a large number of horses are bred in herds on the steppes, chiefly in the governments of Semipalitinsk and Akmolinsk. The total number of horses in European Russia, exclusive of Poland, is 17,785,975. In the Caucasus there are about 500,000, in Siberia about 2,500,000, and about the same number in Central Asia. In consequence of the varied elements from which the modern Russian horse has been developed, and the manifold character of the climate, topography, &c., in Russia, the horses are of very different types, viz. :—Mountain horses, to which group belong horses of Oriental extraction, and bred in Caucasia; they are characterised by medium size and great beauty, and on account of their speed and sure footedness they are especially adapted for riding and driving in mountainous districts. Steppe horses, which are the horses of the Don, Calmuck, and Bashkinian races; they are characterised by leanness, great powers of endurance, and a contented disposition. Forest horses; to this group belong the Smudish, Obrimian, Viatkan, and Kasan horses, which are bred in the Northern forest regions. And, finally, horses of the Blackearth districts, which are large and powerful cart horses. Besides these breeds there are also the Polish and Little Russian breeds. Horse dealing is concentrated in the yearly markets, of which there are about 1,090 in European Russia, and the total number of horses sold in these markets averages about 360,000 annually. A considerable sale of horses is also carried out throughout the Empire, irrespective of these markets, and fifteen thousand are annually sold in Moscow alone, at prices ranging from £8 to £9, and a number of Orloff horses, which command from £400 to £500 each. The total value of the horses annually sold in Russia is estimated at £1,000,000. Prices vary considerably, according to season, age, and race, the average price of a common horse being £5, that of a good cart-horse from £10 to £30; a good trotting horse from £400 to £600, and of a good cavalry horse from £8 to £15.

OLIVE OIL IN TUSCANY.

It is stated that the olive crop in Tuscany for 1883 did not exceed 25,000 barrels, or 5 per cent. of a full crop. In some of the olive districts the crop failed completely, in others the fruit suffered much from long drought, and in general the yield was far below the average, not only in Tuscany, but in Puglia and Liguria. A large quantity of Tuscan oil is annually sent to Nice, where it is used to improve the local produce, which is then exported to France and Russia under the name of Nice or Provence oil. The bulk of the Tuscan oil is bought up by the Leghorn merchants, and after undergoing a purifying and refining process by filtering, which makes it brilliant and clear, it is exported to England, France, Germany, Russia, &c., the largest shipments being made to England. The best qualities of genuine olive oil are sent abroad in pipes, half-pipes, and in casks of various dimensions. On the other hand, the oils which are made up in half-chests and square boxes, and sent to England only, containing thirty flasks, are usually very inferior, being mixed with cotton oil. This may be accounted for by the enormous competition prevailing in London, Liverpool, Bristol, and other markets, and the great demand for a cheap article; the consequence is a deterioration in quality corresponding with increased production, so that the price of these descriptions has now gone down considerably. In connection with this subject, the following particulars, from a detailed account of the growth of olives, and the production of oil in Tuscany, recently furnished to the British Consul at Leghorn by one of the principal exporters of that place, will be read with interest. He says that the best quality of oil can only be made from fruits that are perfectly and uniformly sound, well ripened, gathered as soon as they are dropped from the trees, and crushed immediately. The highest quality of olive oil for eating purposes should not only be free from the least taint in taste or smell, but possessed of a delicate appetising flavour. When so many favourable conditions are needed as to growth, maturity, and soundness of the fruit, coupled with great attention during the process of oil-making, it is not to be wondered at that by no means all or even the greater part of the oil produced in the most favoured districts of Tuscany is of the highest quality; on the contrary, the bulk is inferior and defective. These defective oils are largely dealt in both for home consumption and for export, when price and not quality is the object. In foreign countries there is always a market for inferior defective oil for cooking purposes, &c., provided the price be low. Price, and not quality, is the object, so much so that when olive oil is dear, cotton-seed, ground-nut, and other oils are substituted, which bear the same relation to good olive oil that butterine and similar preparations do to real butter. The very choicest qualities of pure olive oil are largely shipped from Leghorn to England, along with the very lowest qualities, often so adulterated. The oil put into Florence flasks is of the latter kind. Many years back this was not the case, but now it is a recognised fact that nothing but the lowest quality of oil is put into these flasks—oil utterly unfit for food, and so bad that it is a mystery to what use it is applied in England. Importers in England of oil in these flasks care nothing, however, about quality; cheapness is the only desideratum. The best quality of Tuscan olive oil is imported in London in casks, bottled there, and bears the name of the importers alone on the label. There is no difficulty in procuring in England the best Tuscan oil, which nothing produced elsewhere can surpass; but consumers who wish to get, and are willing to pay for the best article, must look to the name and reputation of the importers, and the general excellence of the articles they sell, which is the best guarantee they can have of quality.—*The Gardeners' Chronicle.*

Correspondence.

CAPE RAISINS.

I have had sent me, as a present from Montagu, Cape of Good Hope, a small quantity of raisins. They seem to be made of white grapes, but are remarkable for pulpiness and a distinct muscatel flavour. Having long lived in raisin countries, this specimen attracted my notice, and the produce appears to me suitable to be brought to this market by Cape steamers.

HYDE CLARKE.

General Notes.

RAILWAYS IN INDIA.—The length of railway open in India is 10,832 miles, of which 549 were opened dnring the year 1883-4. A report recently quoted in the House of Commons, but not yet published, showed that the capital expenditnre amounted to £142,606,900, including lines under construction; that the average cost per mile came to £11,300; that the net receipts from all the lines were £8,418,900, compared with £7,684,200 of the previous year, the return being £5 13s. 6d. per cent. compared with £5 7s. 3d. The proportion of working expenses to gross receipts was 48·39, as compared with 49·97 in 1882. On the East India Railway the proportion was only 36·91 per cent.

NUREMBERG EXHIBITION.—Further information has been received from the German Consul-General respecting the proposed International Exhibition of Gold and Silversmiths' Work, Jewellery, and Bronzes, to be held at Nuremberg, from the 15th June to the 30th September, 1885, which was noticed in the *Journal* for April 11, 1884 (see *ante* p. 517). Forms of application for space can be obtained from the Director of the "Bayrisches Gewerbe Museum," Nuremberg, and these forms must be filled in and returned before the end of November of the present year.

SOLDERING ALUMINIUM.—The use of aluminium in the arts has been much restricted by our ignorance of any method of soldering it, either to itself or other metals. Now, however, a French engineer, M. Bourbouze, has discovered a way of effecting both classes of the operation with ease. The process consists in plating both surfaces to be soldered, not with pure tin, but alloys of tin and zinc, or tin, bismuth, and aluminium, &c. Good results are obtained with all such alloys, but those containing tin and aluminium are best. They should contain different proportions, according to the work the soldered parts have to do. For parts to be fashioned after soldering, the alloy should be composed of 45 parts of tin and 10 of aluminium, as it is sufficiently malleable to resist the hammer. Pieces thus united can also be turned. Parts which have not to be worked after being soldered, may be united with a soft solder of tin containing less aluminium. This last solder can be applied with a hot soldering iron, as one solders white iron, or even with a flame. Neither of these solders requires any prior preparation of the pieces to be soldered. It suffices to apply the solder, and extend it by help of the iron over the parts to be joined. When, however, it it desired to solder certain metals with aluminium, is is best to plate the part of the metals to be soldered with pure tin. It is sufficient then to apply to the part the aluminium plated with alloy, and to finish the operation in the usual manner.—*Engineering.*

RAILWAYS IN GREECE.—According to an official report, the new line, which is a single one on the narrow gauge system, from the Piræus to Patras, *viâ* Athens, Eleusis, Megara, Kalamaki, New Corinth, and thence along the shores of the gulf of that name to Vostizzia and Patras, is practically completed for a distance of twelve miles to Eleusis, and in the course of the present summer it will be finished to Megara. The same company has constructed a line across the Isthmus of Corinth, a distance of six miles, to be opened about the same time as that to Eleusis, and it is expected that the main line will be completed as far as Corinth before the beginning of next year. A new line is also being constructed from Ergasteria, Laurioum, *viâ* Port Thoriko to Athens, with a branch line from the village of Colandri to Morous and Kephissia. This is also a narrow gauge line, the width between the two rails being one metre, and its construction is being pushed forward with activity. It is expected that the main line of this railway will be opened to the public from Ergasteria to Markopoulo, half way to Athens, by September next. The construction of a new line from Volo to Larissa has been much retarded by the floods during the late severe winter, these floods having done considerable damage to the line, which is said to have been constructed in a faulty manner.

GOLD TRIAL PLATES.

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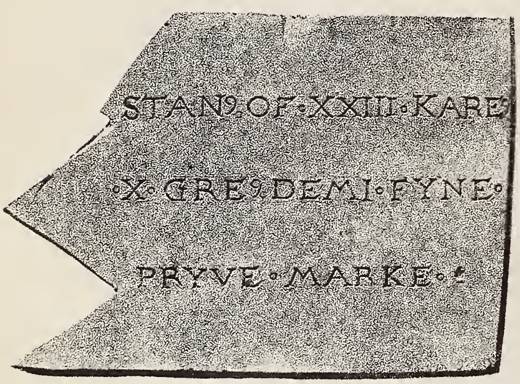

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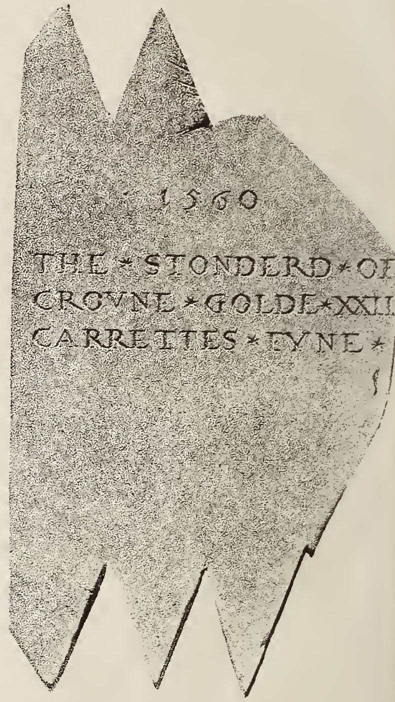

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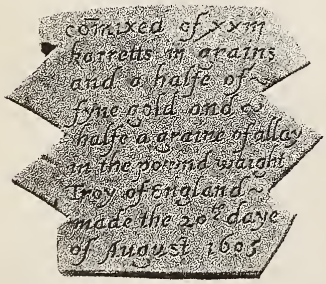

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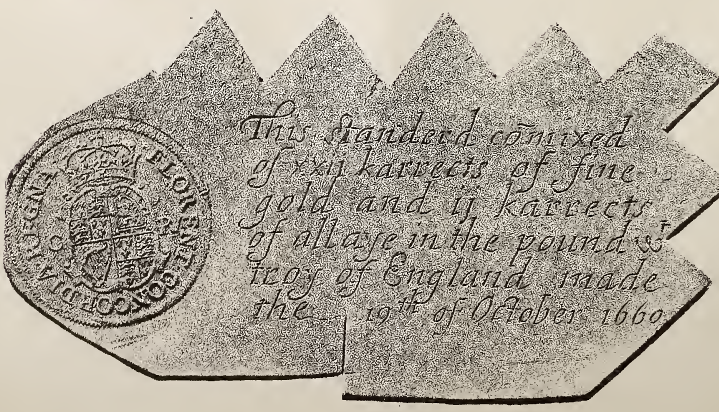

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1885.

The Programme for 1885 is now ready. Copies can be obtained gratis on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS USED FOR COINAGE.

By W. Chandler Roberts, F.R.S.
Chemist of the Royal Mint; Professor of Metallurgy, Royal School of Mines.

Lecture III. — Delivered Monday, March 31st, 1884.

On the Precautions Adopted with a View to Secure Accuracy in the Fineness of Coins.

In the last lecture we considered the changes through which the standard fineness of alloys used for coinage have passed in this country since the Norman conquest, and we saw that at a critical period of our numismatic history the silver coins contained only a quarter of their weight of precious metal, and therefore fully justified Latimer's attribution, "Your silver has become dross."

The questions we have now to deal with relate to no violent changes, and do not comprise the history of either national disaster o national success; but they have a certain importance of their own, as they refer to the methods by which standard fineness can be recognised and maintained.

The want of a method for ascertaining the degree of purity of gold and silver, or for determining the amount of precious metals present in their alloys, must have been felt as soon as the use of metals for currency was established. The history of assaying has yet to be written, but in rapidly reviewing the methods of assay which have been practised or proposed, it will be well to consider them in an order that is in the main chronological, but which enables the physical methods, as distinguished from the chemical, to be dealt with first.

The nation for which the honour of striking the first coins is claimed, gave its name to the "Lydian stone," or, as it is called in more recent times, the "touchstone." It is a dark basaltic rock, of fine texture, upon which a fragment of precious metal readily leaves a streak when drawn over its surface. The comparison of the streak left by the gold to be tested with similar traces derived from alloys of known standard and composition, afforded a ready means of ascertaining, approximately, the fineness of the metal under examination; while further insight into the character of the alloy was gained by submitting the streaks to the solvent action of an acid. There is an abundant literature* showing the degree of accuracy that may be attained by means of this stone; its use has survived for approximate assays until the present day.

Then, again, there was the method of ascertaining the purity of metals by their density, as compared with that of water, devised by Archimedes, B.C., 212, which is applicable to both gold and silver, and is still often resorted to when the metal to be examined must be preserved intact. The usefulness of density, as affording a trustworthy indication of standard fineness, has often been pointed out, notably by W. Symonds,† in 1756, and more recently by Dr. O. Broch.‡

The possibility of ascertaining the standard fineness of alloys by the aid of electricity long ago occupied the attention of physicists. In 1823, Becquerel § suggested that trustworthy indications might be afforded by the electromotive force developed when the alloy to be

* "De re Metallica," by George Agricola. Lazarus Erckern's work, translated by Sir John Pettus, 1683, chap. ix., p. 130.

† Essay on the weighing of gold, &c. London, 1756.

‡ "Norwegian Nyt. Mag. fur Naturvsk," Christiania, 1876.

§ "Ann. de Chim. et de Phys.," vol. xxiv., p. 343.

tested is placed in an exciting fluid together with an alloy of known composition. The subject was partially investigated by Oersted,* in 1828, and its practical importance was further pointed out by Gay-Lussac,† in 1830. In 1878, the use of magnetic induction for indicating the composition of alloys was suggested by Professor Hughes,‡ who showed incidentally that the induction balance affords a ready means for detecting counterfeits, and I have elsewhere pointed out the degree of accuracy of which this instrument is susceptible.§ The method which involves the use of the spectroscope also deserves mention here, although it is, as yet, more delicate than trustworthy.||

These physical methods, both ancient and modern, are open to the objection that the uncertainty of the results they afford increases with the complexity of the alloys under examination; and further, the indications are complicated by changes in the physical state of the metals, produced either by hammering or annealing.

Pliny states that in his time a method was in use for estimating the amount of silver in an alloy of silver and copper, by the degree of discolouration or blackening which attends the heating of the alloy in air. This method, long practised in France, and known by the name of *essais à la raclure* (scrapings), or *à l' échoppe*, is described by Rochon,¶ who says that it was generally recognised in the Roman mints in the time of Marius Gratidianus, triumvir of the money, and later by Chaudet,** who gives a table showing that silver of the English standard (925), when heated to low redness in a muffle, becomes uniformly grey-white, while intermediate tints are produced by heating lower alloys, until the standard used for the French subsidiary coinage (835) is reached. As this becomes quite black under the treatment, the process ceases to be useful for alloys of lower standard.

In very early times, the need must have been felt of some chemical method of isolating the precious metals—of separating them, that is, from their base associates, so that the gold or silver, when purified, could be weighed, and the amount originally present in the mass deduced by calculation.

The crude method of assay, already described, which depends on the change of colour produced by oxidation of the baser constituent of an alloy, leads up to the method used from very early times, which also depends on the principle that precious metals will resist oxidation, while the metals with which they are usually associated will not.

Its main outlines may be indicated as follows. When lead is melted with free access of air, a readily fusible substance forms upon its surface. This substance may be allowed to flow away, or, if the metal is contained in a suitable porous receptacle, called a cupel, the fusible oxide sinks into this containing vessel; in either case the oxidation of the lead affords a means of separating it from precious or inoxidisable metals, if any be originally present in the lead. I found lead in the ancient ornaments both of gold and silver, which Dr. Schliemann permitted me to analyse, and Pliny teaches that the Roman metallurgist used lead for the purification of gold and silver, for he says, "*excoqui non potest, nisi cum plumbo nigro aut cum vena plumbi.*" The greatest of the early alchemists, Geber, who died in A.D. 777, knew perfectly that the lead "acquired a new weight" when heated in air, and I have elsewhere* tried to show how important the recognition of this fact was to the whole fabric of modern chemistry; it is not a little interesting that, among the very first experiments recorded by our own Royal Society, is a metallurgical series relating to the weight of lead increased in the fire on the "copels" at the assay office in the Tower, the account being brought in by Lord Brouncker, in February, 1661.†

The interest of the art of assaying, from a purely scientific point of view, was generally admitted in the 17th century. Lazarus Erckern, for instance, described it as "the very inlet and mother of many other honourable and profitable sciences, while William Badrock,‡ apparently regarding the art as an element of general culture, pleads its claims to be studied by "all gentlemen."

Having shown the great amount of interest attached to the subject, I will now return to

* *Ibid.*, vol. xxxix., p. 274.
† Instruction sur l'Essai des Matières d'Argent par la voie Humide.
‡ Proc. Roy. Soc., vol. xxix., p. 56.
§ *Ibid.* and Phil. Mag. [5], vol. viii., p. 50. Tenth Ann. Report of the Mint, p. 46. 1879.
|| Phil. Trans. Royal Society, vol. clxiv., p. 495. 1874.
¶ Essais sur les Monnoies, p. 17. 1792.
** L'Art de l'Essayeur, p. 77. Paris, 1835.

* Introductory lecture to the course of Metallurgy at the Royal School of Mines, Session 1880-81.
† M.S. Register Book of the Royal Society.
‡ Author of a "New Touchstone for Gold and Silver wares," p. 31. London: 1679.

the actual practice of the art as a metallurgical operation.

Geber, the Arabian, gives, if medieval translations of his works are to be trusted,* a sufficiently accurate description of the process to enable it to be conducted at the present day with no other aid than his; but it must be remembered that it was the object of the alchemist to distinguish silver from gold, and to isolate the metals, rather than to determine the amount of one metal present in admixture with another. Geber calls the process of cupellation the trial of the *cineritium*, and he points out, in the course of a description that deserves to be reproduced here, that "there are two bodies perfect, abiding the trial, to wit, *sol* (gold), and *luna* (silver). Take," he says, "sifted ashes or calx, or powder of bones of animals calcined . . . . moistened with water, and make the mixture firm and solid with your hands, and, in the midst of it, worked into a round flattish lump, make a round and smooth hollowness, and upon the bottom of it strew a small quantity of glass beaten to powder, which lay to dry. When dry, put your metal into the hollowness thereof, which you would try to prove, put coals of fire upon it, then blow with bellows upon the surface till the metal flows: upon which, being in flux, cast part after part of lead, and blow with a flame of strong ignition;" this is to be continued "until the lead is vanished," and precious metal is left "still or quiet, and you see it clean and clear in its surperfices," that is, the lead has dissolved the oxides of the base metals, and has carried them into the cupel, leaving the gold or silver, or an alloy of both, in the form of a button on the cupel.

This operation, as described by Geber, would more nearly correspond to a refining operation conducted on a large scale, with a view to the extraction of silver from lead, rather than to the method of assay as practised at the present day on a few grains of metal.

The method of conducting assays, on what would at the present day be considered to be a very large sample of metal, seems to have been held to be necessary in the 12th century, for in the official trials of the coin in the time of King Henry II., 1154-89, the "Miles Argentarius" and the "Fusor"† are instructed to take before the Barons of the Exchequer a pound of "twenty solidi" of the coin, which they are to place on a "*vasculum ignitorum cinerum quod in fornace est.*" The metal resulting from the trial is then weighed, and the amount it has lost is noted, and, if it is considered that the result of the trial is inaccurate, or "too much metal has been lost, say by the boiling, or by being carried off in the lead" [*illud quasi plus justo consumptum fuerit ignis scilicet exæstuatione vel plumbi infusione*], then it is to be repeated.

The amount of metal which has, for at least two centuries, been taken for assay is 12 grains troy, and this weight, which is known as the "assayer's pound," has the same number of divisions as the troy pound; the fineness of any given weight of metal is, therefore, indicated by the results of an assay, without tedious calculation. It has been shown that the process was officially recognised in this country in the reign of Henry II., and in France the first official mention of it occurs about the year 1314. It is the only method of assaying silver practised at the present day in the English Mint, although another method is used for verifying the composition of its alloys.

With regard to the apparatus required:—In Geber's work "of furnaces" there is no mention or illustration of the "muffle" furnace, so that he seems to have conducted the process in a cupel surrounded by incandescent fuel.

Biringuccio (1540) gives illustrations and detailed descriptions of appliances which hardly differ from those now in use, and so does his contemporary Agricola.* Budelius† (1591) gives a drawing of a furnace which somewhat resembles the type still used in continental mints, except that the muffle, or oven, is placed close to the base of the furnace; and the "Sculptures" of Sir John Pettus, reproduced from the works of Lazarus Eckern,‡ show various forms of muffles and furnaces, some used by the ancient assayers, others adopted in the middle of the 17th century at Nuremberg, where the goldsmiths flourished so vigorously. He also gives an improved form of furnace, "made of armour plates," closely corresponding in its general arrangement with a furnace now lent by the Mint to the science collection at South Kensington, which is specially interesting, as tradition points

* There is a good English edition of the 17th century "The Works of Geber," translated by R. Russell. 1686.

† Quoted by Lowndes, "Essay for the Amendment of the Silver Coins," p. 155 (London, 1695,), from the Black Book of the Exchequer, written in the time of Henry II., cap. 21, Officium Milites Argentarii et Fusoris.

* "De re Metallica."

† "De Monetis et Re Numaria, Coloniæ Agripp." 1591.

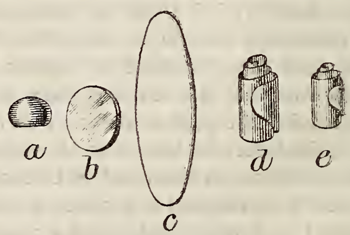
‡ Op. cit., p. 17.

to it as being the furnace used by Sir Isaac Newton in his experiments on cupellation when Master of the Mint. Several transitional forms of furnace between the old one just mentioned and those now used by the Mint* are still preserved in the Assay-office. The tongs and other tools incidentally used do not require special notice, as the changes that have from time been made in them have only rendered their forms more delicate and handy, and have hardly altered their general type.

With regard to the balances employed, it may be sufficient to point out that, for centuries, they have been constructed with great delicacy, and that they now turn with $\frac{2}{1000}$ths of a grain, when loaded with 10 grains. In fact, the use of the balance in very early times, for the purpose of assay, absolutely demolishes the claim of quantitative chemistry to be considered of comparatively modern origin. The indications afforded by the balance as to the result of an assay are not absolute, as the process is liable to error from several sources, and needs to be controlled in the manner which will be described subsequently.

The point to bear in mind at this moment is, that if the silver has been associated only with readily oxidisable metals, especially copper, as is usually the case when silver coins are assayed, then it only becomes a question of providing the amount of lead necessary to furnish, by oxidation, sufficient litharge to dissolve the oxides and carry them away. If, however, the silver is associated with gold, the latter metal resists oxidation, and will remain on the cupel with the silver, for—again to quote Geber—it will in "nowise forsake it." The cupellation stage must then be supplemented by a "parting" operation, that is, the silver must be dissolved away by some solvent which will leave the gold untouched, and for this purpose nitric acid is universally employed. If the silver contains but a minute quantity of gold, the presence of the latter will be indicated by a few specks of brown powder left at the bottom of the vessel in which the silver is dissolved; if, however, the silver contains about one-third of its mass of gold, and has been extended into a strip, the gold will remain after the action of the acid, as a coherent band, retaining the original form of the strip, but much reduced in volume. This action of nitric acid on an alloy of gold and silver was certainly known to Geber and the early alchemists, but the first official mention of the use of the parting assay appears to be in a decree of Philippe de Valois,* in the year 1343, confirming its use in the French Mint. The assay methods for silver and gold are analogous, in so far that both are purified by the action of a solvent, but the base metals are removed from silver by fused litharge, while in its turn silver is parted from gold by nitric acid. There is, then, this difference between the assay of gold and silver. In the case of the cupellation assay of silver, the button of metal has only to be removed from the cupel, and when the adhering bone ash has been removed by a brush, it passes direct to the balance. The process would also be sufficient for gold, if it contained no other precious metal; when, however, the problem is to ascertain by assay how much gold is contained in an alloy, which may contain silver, or platinum and other metals of similar properties, then care must be taken that the amount of gold believed to be present in the alloy does not exceed the one-third part of the mass, as a larger proportion of gold would protect the alloy from the solvent action of the acid, and the greater the amount of gold, the less perfect would be the attack of the acid.

In any case the first stage of assaying a gold alloy, say a sovereign, is to melt it with such an amount of silver as shall yield a button containing rather less than one-third of its weight of gold.



Scale about ½.

For the sake of convenience, and for the incidental advantage that the solvent action of fused litharge removes copper and other impurities, the first stage of the assay of gold is conducted on a cupel, the object to be attained being mainly to secure a button (*a*) of gold and silver in a convenient form for submitting to the subsequent operations. The alloying stage would, however, be just as effective if it were conducted in a small non-porous receptacle, such as a small crucible of glazed porcelain.

The subsequent operations are, flattening the button (*b*), annealing it, rolling it into a strip (*c*),

* A drawing of the modern furnace was prepared for Dr. Percy's work, "Silver and Gold." Part I., p. 256. 1880.

* Boizard, "Traite des Monnoies," p. 176. 1692.

and annealing it a second time. It is then coiled into a spiral, or cornet (*d*), and treated by two successive portions of nitric acid, in order to remove the silver; after this the spiral of spongy gold (*e*), which retains the original form given to the silver-gold alloy, is heated to redness, when it becomes bright, and is sometimes so coherent that it may be unrolled without fracture.

This is an outline of the processes of assaying; the precautions which are adopted with a view to secure accuracy remain to be considered. Inaccuracy in silver assaying mainly arises from loss of silver, which may disappear in small but variable quantities, either by volatilisation or by sinking into the cupel with the litharge. The amount of metal lost varies with the temperature, which is never uniform throughout the muffle; and the results of assays, as indicated by the balance, have, therefore, to be controlled by assays on pieces of metal of known standard, distributed in such a way as to represent the varying degrees of temperature throughout the muffle. The metal lost by any given check-piece is added to the assays in close proximity to it, and, as the amount of metal lost very often amounts to 1¼ per cent., the apportioning of the additions to be made demands great skill on the part of the assayer, who has also to decide from the appearance of the buttons whether they have retained lead or not, in which case they would, of course, be unduly heavy. In gold assaying, on the other hand, although as Geber knew, gold resists the action of molten litharge better than silver does, some precious metal may be lost either by volatilisation, or by retention in the cupel, but the chief sources of error are (1st), solution of gold in the acid used, which would reduce the weight of the cornets, and (2nd), retention of silver by the cornets; but these inverse causes of error may be combined, without neutralising each other. Some means of checking the results must, therefore, be provided, and it would appear that for centuries implicit confidence has not been placed in the indications afforded solely by the assays, as comparisons have invariably been instituted between the pieces of metal taken for assays, and standard trial plates, or pieces of known composition, assayed side by side with the coins, so that any error affecting the coin assays also affects the check pieces, and, therefore, the error can be allowed for.

The trial plates by which silver and gold coin have been tested, possess, it seems to me, an amount of interest that can hardly be overrated. The oldest of them to which a date can be assigned, is a silver-plate, imperfectly impressed with the dies of a coin of the time of Henry III. (1216-1272). A silver plate is alluded to as follows, in the *Rotulus de Moneta*, of the 7th and 8th years of King Edward I.:—"Premerement qe hom doit fere un estandart, qe doit demorer al Escheker, ou en quel lieu qe nostre seignor le Roy vodra," and in 1326 there is a record of the provision of two silver-plates for testing the silver coined by King Edward II., for his Duchy of Aquitaine, "one plate to be of the just weight before the fire, and the other such as it (the metal tested) ought to be after the assays." * This is interesting, because it seems to point to the fact that the amount of silver which should be "lost in the fire," had been experimentally determined at that early period. Many of the old trial plates were formerly kept in the Pyx Chapel Abbey, Westminster Abbey, almost the only relic which remains of the church built by Edward the Confessor, and on the altar tomb believed to be that of Hugolin the first Chancellor of the Exchequer, there is a circular dish-shaped cavity on which a small furnace may have rested, if,† as is probable, the trial of the Pyx was at one time conducted in this building. The trial plates were removed in 1842 from the Pyx Chapel to the office of the Queen's Assay Master in the Mint; and I am fortunate in being able to offer to the Society photographs of some of the more interesting of these.‡ The trial plates were always divided into several portions, and, like the old Exchequer tallies, "this division was effected in rough serrations, so that portions of the original plate entrusted to the different officers, could be readily identified. A table, showing the composition of these ancient trial plates, is appended to this lecture, and I will only add here that most of the standards shown in the diagram § are represented in the Mint collection. Of those which are photographed, the more interesting are probably No. 1, made in the 17th year of King Edward IV. (1477), and No. 2, which marks the introduction of the standard now in use, 916·6̇, by King Henry VIII. All the plates, however, possess peculiar interest, for in relation to the assays of the "alloys used for coinage," they are the signs

* "Ruding," vol. 1, p. 209.

† "Notes and Queries," Nos. 17, 19, 20 and 23. 1880.

‡ These are issued as a Supplement to the present *Journal*. The photographs were prepared by the Autotype Company, and have been reproduced by the "Ink-photo" process of Messrs. Sprague.

§ See second lecture, p. 841

of centuries of responsibilities, which I am fully sensible it is a privilege to be permitted to sustain.

An examination of a series of assays made of the trial plates shows that, although the standards of fineness were always prescribed by law, the plates have, nevertheless, at times been very inaccurate.

The imperfections of the gold plates are mainly due to sources of error which had been recognised, but which were ignored when the last plates were made; and it is well to explain, therefore, that plates were, in former times, authoritatively pronounced to be "standard" simply with reference to the results of an inaccurate process of assay. The process now consists in submitting an accurately weighed portion of the alloy to a rapid method of chemical analysis, whereby impurities are eliminated, and the precious metal, thus purified, is again weighed, but the method is complicated, and the accuracy of the result may be affected by the retention of impurities, or by an actual loss of metal during the process. The weight of gold as indicated by the balance will, in consequence, not represent the amount originally present in the alloy, and it is, therefore, necessary to control the results by assaying, side by side with the alloys under examination, "standards" or check-pieces the composition of which is known. As, however, any error in the composition of these checks will be reflected in the result of the assay, it is preferable to use pieces of pure metal corresponding in weight to the amount which the alloys to be tested are anticipated to contain.*

* The corrections to be applied to a gold assay will be readily understood from the following formula:—

Let 1,000 be the weight of alloy originally taken;

p. The weight of the piece of gold finally obtained;

x. The actual amount of gold in the alloy expressed in thousandths;

a. The weight of gold (supposed to be absolutely pure) taken as a check, which approximately equals *x*;

b. Loss or gain in weight experienced by (*a*) during the process of assay;

k. Variation of "check gold" from absolute purity, expressed in thousandths;

Then the actual amount of fine gold in the check-piece $= a\left(1 - \frac{k}{1000}\right)$, and the corrected weight will be $x = p - \frac{a k}{1000} \pm b$, (*b*) being added or subtracted according as it is a loss or gain.

If (*a*) be assumed to be equal to (*x*) this equation becomes

$$x = \frac{p \pm b}{1 + \frac{k}{1000}}.$$

Formerly, such checks of pure metal were not employed, and a small amount of silver varying from $\frac{2}{10000}$th to $\frac{1}{1000}$th part of the initial weight of the assay piece which remained in association with the gold was consequently reckoned as gold in the assay report. It follows, therefore, that even the more recent plates, when accurately assayed, are usually found to be sensibly below the exact standards which they were intended to represent.

The experiments made with a view to ascertain the composition of the standard gold plate prepared by me in 1873, show that the greatest variation of this plate from the exact standard does not exceed the $\frac{2}{10000}$th part; but the use of even a fairly accurate standard plate is liable to be attended with error, as the actual amount of precious metal in the amount taken for the check-piece may exceed or fall short of the true standard. It follows, therefore, that the assay reports on portions of metal tested by comparison with this check may indicate the presence of too little or too much precious metal.

The objections to the use of a standard silver plate are far greater, as the alloys used for the silver coinage, in this and in other countries, are mechanical mixtures, the molecular arrangements of which are very peculiar, and so far as my experience goes, a plate of the legal standard cannot be prepared of uniform composition.

With regard to the use of pure gold and silver plates, it should be pointed out that, if it were possible to obtain gold and silver of absolute purity, there would be no limits to accuracy in assaying, except such as arise from operations of a purely mechanical nature. Of course, it is not possible to attain to chemical purity, and the presence of traces of impurity in the checks causes the results of assays made in comparison with them to indicate the presence of an amount of pure metal in excess of that actually present in the alloy; but as the converse can never be the case, that is to say, as the gold cannot be more than pure, no danger can arise from this cause, and the error can be easily allowed for.

The supplementary fine gold and silver plates, prepared in accordance with instructions I received from the Lords Commissioners of the Treasury in 1872, proved eminently satisfactory. I have not been able to prepare, or to obtain from any source, gold of greater purity, even in small quantities. The silver plate leaves little to be desired, although it is not quite as pure as silver prepared by M. Stas, in comparison with which it is as 999·95 to 1,000.

In conducting official trials of the pyx, minute accuracy is secured by a final appeal from the standard plates themselves to pure gold or pure silver.

We are now in a position to consider another question, the importance of which has long been recognised by law, and that is, the difficulty of attaining an exact standard, either of weight or fineness, in the case of all the individual coins issued from a mint. The law has for centuries, and in all nations, permitted a certain deviation from the exact standard. The amount of such "remedy," as it has always been termed in this country, has changed from time to time, but has gradually diminished as the art of coining has advanced.

It follows, that although the component parts of the alloy may not bear to each other with mathematical precision the proportion prescribed by the regulations under which they are manufactured, they may, nevertheless, be considered to be of standard fineness. The earliest reference to a "remedy" I have met with is in the reign of Saint Louis, of France, 1253,* who granted an allowance of ¼ carat, for the fineness of Louis d'or. The Mint agreement between King Edward I., and William de Turnemire,† in 1279, provides a remedy of 2½ dwts. on the pound troy of the silver coins. The law does not appear to have contemplated that the "remedy" should be systematically made use of as a source of profit, either to the Crown or to the Master of the Mint; it was rather considered to define the limits within which occasional variations of standard weight were unavoidable, and its true function has been well defined by the late M. de Jacobi, who, representing the Russian Government at the International Monetary Conference, held in Paris, in 1867, said, "the remedy is not an arbitary stipulation, but is the limit of errors which belongs to every thought, to every chemical analysis, to every composition of alloy, and as such depends on the precision of the balances, and the methods employed in the fabrication of money. It may be determined rigorously by applying the calculus of probabilities."

The Mint indentures have been drawn up in just the same spirit. Remedies were accorded "because the said moneys may not continually be made in all things according to the right standard, but, peradventure, through default of the master or workers, they shall be found sometyme too strong or too feeble in weight or alloy," but this has not prevented a very different view having been taken of the privileges accorded by them, both to the Sovereign on the one hand, and the Master of the Mint on the other. Queen Mary, for instance,* seems to have considered that the Sovereign was entitled to add as much base metal to the coinage as the law permitted, the sum so derived after deducting coinage expenses, to be considered seignorage, but she held that the Crown could not debase the coin, or increase the amount of base metal in it for private ends.

With regard to the action of Mint Masters in this respect, the history of the coinage abundantly proves that they frequently availed themselves of the "remedies," viewing them as a legitimate source of profit, or as a means, incidentally provided by their contracts, for reducing the current expenses of working the best known case being probably that of Lonison, Master of the Mint in the reign of Queen Elizabeth

The scale of remedies is fixed by the Coinage Act of 1870, at present we will only consider the remedy of fineness, which, in the case of the gold coin, has a range of + $\frac{2}{1000}$th, and in the case of silver + $\frac{5}{1000}$th. The gold coins of the nations who have joined the Latin Union have also a remedy of $\frac{2}{1000}$th. In America, the remedy in the case of the gold coins has been reduced to $\frac{1}{1000}$th. "I do find," said Rice Vaughan,* writing in 1675, "that some men of great experience and understanding, even in this mechanical part, do hold that the moneys, both of gold and silver, may be made without any remedy to be allowed either for weight or fineness," but he subsequently adds, "I undertook this discourse of the mechanical part of money with scruple, so I do leave it with alacritie." It is certainly not the opinion of Mint officers at the present day that the remedies should be reduced to the lowest possible point, as this would involve the rejection and re-coinage of a large number of pieces before they could be permitted to leave the Mint; but, on the other hand, all agree that a persistent variation, however slight, above or below standard, has never been contemplated by law. The effect of such a mean variation would be remarkable.

If, for instance, the Mint were to issue

* Jean Boizard, "Traite des Monoyes," p. 25, 1692.
† Report on Royal Mint, p. 41, 1849.

* Report on the Royal Mint, p. 39. 1849.
† "Discourse of Coin and Coinage," p. 91. 1675.

sovereigns which were either persistently too rich or too poor in gold, to the extent actually permitted by law, a loss or profit would accrue of over £2,000 on each million coined, and a persistent variation of only $\frac{1}{10000}$th part would be equivalent to a profit or loss of £100 a million. In Mint practice, at the present day, even this comparatively small variation should be avoided, and the public trials of the pyx prove that it does not exist.

I have dwelt on these facts because the maintenance of rigid accuracy in the operations of coinage becomes of great importance in international currency. One Government might, as the late Professor Stanley Jevons pointed out, "coin money slightly inferior to the proper standard, and such money once introduced would, in virtue of Gresham's law, be difficult to dislodge." I admit, with him, that it is hardly to be supposed that a State issuing money under international obligations would wish to make a profit of one or two parts in a thousand, which the remedy would legally cover; but nevertheless, the degree of accuracy with which the coinage is executed would be of much importance, for the following reason. A nation would be bound by the International Convention to withdraw and re-coin such coins of other nations as might be circulating within its borders at the time they were reduced by wear below the lowest weight at which their circulation would be legal, and it follows that any deficiency of standard which might exist would have to be made good by the nation on whom the recoinage happened to fall, and a nation coining with rigid accuracy would suffer from the shortcomings of those who did not.

TABLE SHOWING THE COMPOSITION OF THE ANCIENT GOLD TRIAL PLATES, OF WHICH PORTIONS ARE PRESERVED IN THE MINT.

Date.	Standard Prescribed by Law. In carats and grains.	Standard Prescribed by Law. Decimal equivalent.	Actual Composition.	Remedy or permitted variation in carats and in thousandths.	Remarks.
1349				⅓ carat or 13·9	Amongst the Cotton Manuscripts is preserved the account of a trial of the pyx of gold nobles in the year 1349. The coins were to be compared with one ounce of florins of Florence, kept in the Treasury as standards.
1477	23 3½	994·8	Gold ... 993·5 Silver ... 5·15 Copper* ... 1·35	⅛ carat or 5·2	This, the earliest gold Trial Plate of which there is any record, was made in the 17th year Edw. IV. Special legal provisions were enacted for the protection of the coin of the realm, which appears to have been debased in every possible way. When gold coins were first introduced into England by Henry III., in 1257, they were 24 cts. fine, that is, pure gold. Edward III., in 1345, was the first to use the standard of this plate, 23 cts. 3½ grs. fine, or 994·8. (See **No. 1** of the plate of photographs.)
1527	22 0	916·6	Gold ... 915·5 Silver ... 78·3 Copper ... 6·2	⅙ carat or 6·9	In 1526, Henry VIII. issued a proclamation directing that crowns of the double rose should be coined of the standard 916·6 for concurrent issue with sovereigns and other coins of the original standard of 994·8. This plate was made in the following year. (Photograph **No. 2.**)
Probably 1543	23 0	958·4	Gold ... 954·4 Silver ... 34·8 Copper ... 10·8	⅙ carat or 6·9	This plate was probably prepared to correspond with the debasement of standard which took place in this year from 994·8 to 958·4. In 1544, the standard for all gold coins was reduced to 916·6, and again in 1546 to 833·4; the lowest point ever reached in England.
1553	23 3½	994·8	Gold ... 990·3 Silver ... 9·7 Copper ... —	⅙ carat or 6·9	This is the first plate bearing an inscription, which runs as follows:—STAN9 ∘ OF ∘ XXIII ∘ KARE9 ∘ X ∘ GRE9 ∘ DEMI ∘ FYNE ∘ PRYVE ∘ MARKE9 ∘Φ. It bears no date, but the "pryve marke" (a pomegranate) is the same as that borne by the sovereigns and "angels" issued by Mary in this year. In a proclamation, dated 1553, it is stated that the coins shall be made of "fine gold," which doubtless, means the old standard of 994·8, which, according to Ruding, was in use in this year. (Photograph **No. 3.**)

* With copper are included any minute quantities of other base metals which may be present.

Date.	Standard Prescribed by Law.		Actual Composition.	Remedy or pre-mitted variation in carats and in thousandths.	Remarks.
	In carats and grains.	Decimal equivalent.			
1560	22 0	916·6	Gold ... 913·7 Silver ... 60·8 Copper ... 25·7	$\frac{1}{6}$ carat or 6·9	On her accession to the throne in 1558, Elizabeth took active measures to continue the improvements in the standard of the coinage which had been commenced by Edward VI. (Photograph **No. 4.**)
1560	23 $3\frac{1}{2}$	994·8	Gold ... 994·3 Silver ... 5·7 Copper ... —	$\frac{1}{8}$ carat or 5·2	On the 8th November, 1560 (the year in which these plates were made), an indenture was made with Thomas Stanley to coin gold of both standards.
1593	22 0	916·6	Gold ... 915·9 Silver ... 52·1 Copper ... 31·9	$\frac{1}{6}$ carat or 6·9	In the 35th year of Elizabeth's reign (1593) a commission was granted to Sir R. Martin to issue coins of the standard 916·6; this plate was, doubtless, made with reference to that coinage.
1605	23 $3\frac{1}{2}$	994·8	Gold ... 990·3 Silver ... 8·3 Copper ... 1·4	$\frac{1}{8}$ carat or 5·2	In the first two years of his reign (1603-4) James I. issued coins of the standard of the previous plate, namely 916·6. In 1605, however, he raised the standard back to the original 994·8. (Photograph **No. 5.**) A plate of the standard 916·6, dated 19th November, 1604, is mentioned in "Pollett's Abstracts of Pyx verdicts," but no portions of it remain in the Mint.
1649	22 0	916·6	Gold ... 913·0 Silver ... 51·1 Copper ... 35·9	$\frac{1}{6}$ carat or 6·9	On the 16th of November, 1649 (the first year of the Commonwealth), an Act of Parliament was passed empowering the council of state to administer an oath to a jury of goldsmiths charged with the preparation of this plate. It was accordingly made on the 20th December following.
1660	23 $3\frac{1}{2}$	994·8	Gold ... 990·9 Silver ... 3·7 Copper ... 5·4	$\frac{1}{6}$ carat or 6·9	Charles II., soon after his accession, ordered these plates to be prepared, rejecting those made under the Commonwealth, which had only been employed at one trial of the pyx. (Photograph **No. 6.**) With regard to the 994·8 plate, it may be mentioned that no coins appear to have been issued of this composition after the year 1640. No record of the preparation of these plates is preserved at Goldsmiths'-hall.
1660	22 0	916·6	Gold ... 912·9 Silver ... 53·3 Copper ... 33·8	$\frac{1}{6}$ carat or 6·9	
1688	22 0	916·6	Gold ... 914·6 Silver } 85·4 Copper }	$\frac{1}{6}$ carat or 6·9	
1707	22 0	916·6	Gold ... 917·1 Silver ... 59·5 Copper ... 23·4	$\frac{1}{6}$ carat or 6·9	This plate appears only to have been used at the trial of the pyx, which took place on the 21st August, 1710. After this it was finally abandoned, probably because it contained too much gold, and was, therefore, to the disadvantage of the Master. At the next trial, on the 7th Aug. 1713, the use of the 1660 and the 1688 plates was resumed, both of which were considerably below standard.
1728	22 0	916·6	Gold ... 916·1 Silver ... 50·4 Copper ... 33·5	$\frac{1}{6}$ carat or 6·9	
1829	22 0	916·6	Gold ... 915·3 Silver ... 37·6 Copper ... 46·5	$\frac{1}{16}$ carat or 2·6	It may be observed that in 1817 an effort was made to attain greater accuracy in the coinage, the remedy being in that year reduced from 6·9 to 2·6 parts in a thousand.
			New Trial Plate.		
1873	22 0	916·6	Gold ... 916·61 Copper ... 83·39	2·0	The standard plate was alloyed with copper only, in order that it might correspond with the composition of the British gold coins.
1873	Supplementary Plate.		Pure gold.	[illegible]	Both plates were prepared at the Mint, and verified by the Goldsmiths' Company, 22nd December, 1873.

TABLE SHOWING THE COMPOSITION OF THE ANCIENT SILVER TRIAL PLATES, OF WHICH PORTIONS ARE PRESERVED IN THE MINT.

Date.	Standard Prescribed by Law. In ozs. and dwts.	Standard Prescribed by Law. Decimal equivalent.	Actual Composition.	Remedy or permitted variation in dwts. and in thousandths.	Remarks.
No date.			Silver ... 757·4 Copper ... 246·6		This plate bears no date, nor is it accompanied by any label, but its form would appear to indicate that it belongs to a very early period. Until the year 1842 the trial plates were kept in the Pyx Chapel, in the cloisters of Westminster Abbey, where certain assay pieces of gold and silver, with ancient memoranda relating to them, were also found. One of these pieces is the extremity of a bar or ingot of silver, which has its upper surface rounded and imperfectly impressed with the dies of a coin of the time of Henry III. (1216-1272.) Mr. Black, formerly Assistant Keeper of the Public Records, considered that this had been employed at the trial of the pyx, and that it is probably the remains of the oldest standard piece which has been preserved. It proved on assay to contain 921·0 of silver and 2·0 of gold, a result which points to its representing the new coinage introduced 1267.
1477	11 2	925·0	Silver ... 923·5 Copper ... 76·5	2 dwts. or 8·4	
Probably 1527			Silver ... 855·5 Copper ... 114·5		These three earlier plates differ in form from all those which succeed them. They are chisel-shaped, the ends being hammered out apparently in order to receive the impression of a coin. This impression is, however, only preserved on the 1477 plate. There is no record of any coinage having the composition of this plate, but a label is attached to it, bearing the date "13th October 18th Henry VIII." (1527.)
1542	9 6	775·0	Silver ... 763·6 Copper ... 236·4	Probably 3 dwts. or 12·5	Henry VIII. issued in Ireland, in his 33rd year (1542), coins of this standard. Their circulation in England was prohibited, but within four years he reduced the standard in England to 333·3 parts of fine silver in 1,000.
1553	11 2	925·0	Silver ... 927·0 Copper ... 73·0	2 dwts. or 8·4	Mary, on her accession to the throne, issued a proclamation stating that a coinage of "Silver in fineness of the standard sterling" should be commenced; in the indenture, however, of the same date (1553), the composition is fixed at 916·6. This plate, which bears an inscription similar to that on the gold plate, and the same privy mark (a pomegranate) appears to have been prepared to correspond with the composition named in the proclamation, but no plate having the composition prescribed in the indenture (916·6) exists in the Mint. Several coinage arrangements introduced by Mary were convenient. The standard of silver was the same as that of gold, and their values, therefore, were easily comparable. The weights of the coins were so adjusted that a crown in silver or two sovereigns in gold weighed one ounce.
1560	11 2	925·0	Silver ... 930·2 Copper ... 69·8	2 dwts. or 8·4	On the 27th September, 1560, Elizabeth issued a proclamation, stating that "to make an end of all troubles arising from debased monies, Her Majesty had already begun a coinage of fine money in the Tower of London." This plate probably marks the restoration of the old standard, which took place in this reign. The convenient arrangements introduced by Mary were discontinued, a change which was subsequently regretted by Lord Liverpool, in his letter to George III. (p. 100), as it introduced difficulties in the comparison of the values of gold and silver coin. Had Mary's regulations been allowed to continue, the composition of both gold and silver coins in Great Britain and British India would at the present day have been identical.

Date.	Standard Prescribed by Law. In ozs. and dwts.	Standard Prescribed by Law. Decimal equivalent.	Actual Composition.	Remedy or permitted variation in dwts. and in thousandths.	Remarks.
1600	3 0	250·0	Silver ... 252·0 Copper ... 748·0	3 dwts. or 12·5	This plate is labelled "Standard for Ireland, An° 1600"; and in 1601 Elizabeth decreed that coins of about this standard should be issued in Ireland, or, as the indenture states, "with such provision and moderation as in former times had not been done, and so as none of our Highness' loving and faithful subjects should be thereby prejudiced." Considering how extremely debased this coinage was, it is difficult to understand these expressions. Simon states that the standard was 241·5, but Malynes fixes it at 250, a statement which is confirmed by the composition of this plate.
1601	11 2	925·0	Silver ... 925·1 Copper ... 74·9	2 dwts. or 8·4	This plate was employed at the trials of the pyx up to the 20th June, 1605, and its composition is very closely in accordance with the true standard.
1604	11 2	925·0	Silver ... 922·7 Copper ... 77·3	2 dwts. or 8·4	
1649	11 2	925·0	Silver ... 923·7 Copper ... 76·3	2 dwts. or 8·4	The jury of Goldsmiths empanelled to prepare the gold plate on the 16th November, 1649, were also ordered to make this silver plate of the standard 925, to be used as "Standard Trial Pieces." These pieces were "to be indented and printed according to the pleasure of the Parliament."
1660	11 2	925·0	Silver ... 924·2 Copper ... 75·8	2 dwts. or 8·4	As in the case of the gold plates of this date, there is some uncertainty as to where this plate was prepared.
1688	11 2	925·0	Silver ... 922·0 Copper ... 78·0	2 dwts. or 8·4	
1707	11 2	925·0	Silver ... 922·0 Copper ... 78·0	2 dwts. or 8·4	
1728	11 2	925·0	Silver ... 928·9 Copper ... 71·1	2 dwts. or 8·4	
1829	11 2	925·0	Silver ... 925·0 Copper ... 75·0	1 dwt. or 4·2	Prepared by a jury of Goldsmiths, and verified by the King's Assay Master.
			New Trial Plate.		
1873	11 2	925·0	Silver ... 924·96 Copper ... 75·04	4·0	Prepared at the Mint, and verified by the Goldsmiths' Company, 22nd December, 1873.
1873	Supplementary Plate.		Pure silver.		

CONFERENCE ON WATER SUPPLY.

The following is the discussion on the papers read at the Conference of the Society of Arts on the Water Supply, held at the International Health Exhibition on Thursday, July 24th; Sir Frederick Abel, C.B., F.R.S., in the chair:—

The Chairman, in commencing the proceedings, said the active interest displayed by his Royal Highness, the President of the Society of Arts, on this subject, had led the Council to hope that it might have been in his power to open the proceedings; indeed, at one time, there was no doubt that this Conference would have been the opening one of the series arranged by the Executive Council of the Health Exhibition, and that his Royal Highness would have presided, at any rate, over a portion of the proceedings, when that unexpected calamity occurred which had so deeply afflicted the Royal Family and the nation. The fact that even quite recently the Prince had fixed the present date for this Conference was an indication that, had it been possible, he would have marked his sense of its importance by attending at the opening. In 1878, his Royal Highness addressed a letter to the Council of the Society of Arts, calling attention to the importance of the subject of water supply; pointing out that whereas various large towns were at that time incurring heavy expenditure to improve their water supply, smaller towns, and particularly villages, were left to shift for themselves; and suggesting that it might be desirable to discuss fully the question how far it might be possible to apply the great natural sources of water supply according to some national comprehensive scheme. The Council of the Society, acting on that suggestion, issued inquiries and invitations for papers, and received more than twenty papers in response, some written by men of eminence who had devoted a great deal of attention to this subject. Those papers, and the topics arising out of them, were very carefully discussed, and the general conclusion arrived at was that local conditions and circumstances presented such very considerable variations that it appeared impossible to devise any comprehensive national scheme for the supply of water to communities. But a resolution was passed that it was desirable to memorialise the Government to appoint a small permanent Commission to collect facts connected with the water supply throughout the kingdom, in order to utilise the natural resources, as indicated by his Royal Highness, according to some general system for the benefit of the country as a whole. That suggestion was not acted upon, but, nevertheless, the discussion which took place in 1878 had been fruitful of beneficial results, and it was quite certain that the subject of improved water supply had made an important advance since that time. The influence of polluted water in promoting the spread of epidemics had become more thoroughly understood and recognised, and the mischievous effects of using water derived from surface wells, and from the careless storage of water in houses, arising out of intermittent supply and other circumstances, had received much public attention; but there could be no doubt that many points bearing upon the supply of wholesome water still required further elucidation. Many interesting discussions connected with one branch or another of this subject had taken place since 1878, and probably none were more interesting than those connected with the questions as to what constituted a good water for drinking and domestic purposes, and how a sufficient quantity might be insured. It was scarcely necessary to remind the audience that amongst the most intelligent men who had given attention to this subject there had existed, and still remained, diversities of opinion on some important points more especially connected with the question of how the purity of water was affected, and how it was re-established if the water were once polluted. Thus some authorities had maintained that no river which had been in any way polluted could ever be fit for use afterwards, or, at any rate, that the time when it might become fit for use as potable water was very remote; but that, on the other hand, it was only necessary to sink wells deep enough in order to obtain water absolutely free from injurious organic contamination, so that water could be furnished in any degree of abundance by means of artesian wells. On the other hand, there were authorities, not less well recognised as possessing special knowledge and experience, who had maintained that it was quite erroneous to suppose that river water, when it became polluted by sewage, was thereby rendered permanently unfit for potable purposes; that a river had only to flow a comparatively short distance for its self-purification to take place, a purification which, although it might vary in degree according to circumstances, must ultimately be carried out to a sufficiently perfect extent to render the water absolutely wholesome. Probably the truth lay between the extremes; in fact, it was already recognised that it did so, and there were indications that amongst the most extreme exponents of either view there was a tendency to an assimilation of opinions. These subjects had been lately so warmly fought out on many battlefields that the weak points on each side had become more and more apparent to advocates and adversaries alike; and, therefore, there was a hope that something like that unity of view might, before long, be arrived at, without which any real progress could hardly be looked for. There was probably no subject which could be selected for discussion which involved so many considerations of primary importance as that of water supply. On the one hand there were geological, medical, chemical, and engineering considerations; and, on the other hand, there were financial, legal, municipal, and it might be even political considerations. As the Society met, on this occasion, in conference in connection with the Health Exhibition, he thought they were primarily concerned with the first-named set of considerations, and their hands would be quite full enough if they limited themselves to these, avoiding, as much as possible, any discussion on the extremely debatable ground of financial or legal questions. They would now at once enter upon the consideration of the first branch of the subject, viz., the Sources of Supply.

Papers were then read by W. Whitaker, W. Topley, C. E. De Rance, and Joseph Lucas.

Mr. HENRY ROBINSON said he feared, without some further explanation, that the allusion made by Mr. Lucas to the decision of the Parliamentary Committee, not to give the mill owners on the River Alyn compensation for water abstracted, might be misunderstood. He was engineer of the Bill before the Committee, and the facts were these. There was a petition from the mill owners, asking that the company should give what was regarded as the usual clause, providing that a certain amount of water from the gathering ground should be sent to the stream, but the Committee were of opinion that it was not sufficiently proved that a large volume of the water which went into the River Alyn was connected immediately with the gathering grounds from which the company were to take their supply. There was a doubt whether a large portion of it did not disappear in a swallow, even at the present time; and as regarded the future, the Halkyn level, which had been referred to, having been authorised by Parliament, was in course of construction, for the purpose of draining a large area of mining grounds; and therefore it was put before the Committee that a large body of water, which was part of the river now, would cease to be so. The case, therefore, was exceptional, and could not be relied upon as a precedent for other cases.

Mr. CONDER said he noticed in the four papers which had been read an echo of what was stated in 1878. A number of individual projects were then brought forward, and, to a certain extent, much harmony appeared to prevail on that occasion. Before those projects were entered upon, he ventured to submit to the meeting that, being so far in accord, it would be well to put their accord on record, and to pass a resolution which might be taken as the unanimous opinion of the Conference. With some little modification that plan was adopted, and the result was an application on the part of the Conference, in 1878, to his Royal Highness the Prince of Wales, to suggest to the Prime Minister the appointment of a small scientific Commission for ascertaining those facts, which they were now told still required to be made known. The application was made, but through various circumstances was put aside, and nothing had been yet said which did not tend to show the weighty nature of the application. And he would venture to submit whether it would not be a worthy outcome of the present proceedings to repeat the recommendation of the former Conference, and endeavour to obtain further distinct and definite information as to the subject of water supply. The contrast that existed between the information, or rather want of information, on this subject, in this country and on the Continent, was anything but creditable to us. They owed something to the Ordnance Survey, and they owed much to several gentlemen who had devoted themselves to this subject. It was impossible to touch the subject at all without acknowledging what they owed to Mr. Symons for the information he had collected with regard to the rainfall. That information had been collected, in the first instance, by his unassisted efforts, and afterwards by the efforts of an unpaid and disinterested body of fellow workers, which were an honour to the country, but possibly not so much an honour to the Government that such a duty should be left on the shoulders of private individuals. The Blue-books which had been issued by the different Commissions contained a mass of information, and so did the proceedings of the Institution of Civil Engineers. But when they turned to other countries, a very different state of things was to be found. The Italian Government published, in a form accessible at a small cost to every landowner, information as to the flow, both in summer and winter, and all the other particulars of every river in Italy. But if we turned to our own books and proceedings, there was an absolute absence of this fluviometric information which in Italy was at the command of everybody. He need not point out how important it was to the engineer and landowner, or to any one who had to keep off floods, or seek for water, to possess all this information; and therefore it was not merely as an academical demand, but as a matter of practice, that this knowledge was required. Many of them were aware of the present condition of the Thames, and he apprehended, from instructions recently given by the Board of Trade, that they would shortly be in possession of the actual summer flow of the Thames during July. The lowest account of the flow was that of Mr. Harrison, who put it at 309 million gallons per day. Mr. Bateman put it at 350 million gallons as the summer flow, for days and days together. But the question was whether, with a long series of dry years which might naturally be expected to follow the long series of wet years we had had, a constant supply of 350 million gallons could be anticipated. On the other hand, the demand was constantly increasing. The quantity pumped in July, last year, by the five metropolitan water companies, exceeded 75 million gallons per day; and considering that in the Valley of the Thames, not including that of the Medway, there were now something like seven millions of inhabitants, who require 225 million gallons a day, that was making an unpleasant approach to the 350 millions of possible flow. In forty or fifty years, those seven millions would have increased to something like 14 millions, and the 225 million gallons required now would be from 400 to 500 millions. It was tolerably clear, therefore, that it was desirable to know all that was to be known about the sources and the behaviour of the Thames. With regard to dummy wells, it was a local question how far any individual well might absorb a flood, but as to the general idea, he thought all would agree it was a feasible and good one. There was one point to which he would call the attention of practical men which had not yet been touched upon. The Valley of the Thames and Medway included an area of something like 6,000 square miles, or 5,000 for the Valley of the Thames alone, and of this, according to the figures, something like 4,000 miles was a permeable area, of which 2,000 were chalk and 2,000 miles sand and gravel—a true water-bearing area. The great object of the Geological Survey was to avoid wasting flood water. The natural storage of this water was the pervious water-bearing beds, and the importance of the information suggested as to the percolation from the surface was no doubt very great. They had the facts of the rainfall, and of course they could get nothing more than the rainfall. About fifteen inches evaporated in the course of the year, which would leave only eleven inches to be dealt with in the Thames Valley, of which it was supposed two or three ran down the River Thames. But in whatever mode the water got into the water-bearing strata, there was no doubt it escaped from it very irregularly. It escaped at the lowest lip of the basin, and if a thorough knowledge of the basin were obtained, it occurred to him it would be possible to raise the lip, and place a regulating sluice there, and by that means, to store one, two, or three years of rainfall in these water-bearing strata, to be drawn upon as required, and so keep up the flow of the Thames.

Mr. BALDWIN LATHAM said, with reference to the escape of water from the outcrop of the chalk formation, it was quite clear that all round the escarpment of the North Downs a very small quantity flowed away in the opposite direction to the dip of the strata, which was towards London; in fact, immediately under the chalk there was the upper greensand, which all along the escarpments was worked, at various quarries, both for building and fire-stone; and the level of the water in those quarries varied with the level of the water in the overlying chalk formation; and although there appeared to be the chalk marl intervening between the upper greensand and the chalk, he did not think it was of such an impervious nature as to prevent direct communication between the waters of the two strata. In fact, it was clearly shown where the chalk marl came to the surface all along the foot of the escarpments of the North Downs, there were no ditches or streams all along the formation, and all the rain equally disappeared there as it did over the chalk itself; therefore, practically for all water supply purposes, the chalk, with the chalk marl and upper greensand, might be taken as one stratum. There were immense fluctuations in the quantity which was stored from year to year in these formations. In March, 1883, they had one of the largest quantities of water stored in the chalk of the North Downs and South Downs which had been known for many years, and yet at the end of 1883 they had one of the lowest water periods. That was a thing which had hardly ever occurred before—going from extreme high water to extreme low water in a single year. The maximum probably exceeded the minimum by ten times, and, therefore, when considering the water supply of a particular district, the minimum must be borne in mind, and either the average or the total capacity, seeing there were these immense fluctuations in the quantity of water which were common to all geological formations. The same thing occurred in the new red sandstone, the permian beds, and the oolite, in all of which he had carried on observations for some years. It was absolutely certain, therefore, as Mr. Lucas had pointed out, that a future water supply for underground sources must depend upon correct hydro-geological surveys. When the quantity of water was known, and they could show the yield over certain years, and what area of strata was required to supply a definite quantity of water, there would be nothing to do but to make careful observations in order to get a sufficient supply of water. The question of compensation would naturally crop up, and to his mind there was not the slightest doubt that a single drop of water could not be taken from any of these porous strata without interfering with the flow in some adjoining stream. It seemed, therefore, to be a matter of great injustice that power should be given to water companies to sink wells and abstract water to the injury of those who had property, and often very valuable property, in the water supply, without compensation. The hydro-geological experiments which had been made would tend to show that these areas which were affected contributed their supplies to different rivers, and when it was essential to the public advantage that supplies of water of this character should be procured, it was only right that those who were injured should be properly compensated. With reference to Mr. De Rance's proposition as to the means of storing water in porous strata, of course there were great difficulties in the case of elevated strata, but there were other circumstances in which water might be stored in that way. In the course of his investigations, he had received the most valuable contributions from General Hyde, of the Indian Railways Department, who stated that in Peshawur, from time immemorial, it had been the practice in the rainy season for the natives to cut channels from the water source to the wells so as to fill up the gravelly strata underneath the more impervious surface stratum, and when the wells were filled in that way they were closed, and only opened in the summer time, so that they had at that period an abundant supply of water which had been cooled by coming in contact with the earth at the time at which it was stored. Therefore, what might appear to be a new idea, was really one of extreme antiquity. The whole question of water supply was one of the greatest importance with regard to the public health, and it behoved them, especially in seeking for these underground supplies of water, to take care that they were sought for at points not liable to contamination. Many underground sources of water supply were polluted to a frightful extent; and really the cause of his undertaking these investigations was the repeated outbreaks of typhoid fever in the district with which he was especially connected. Having been able to collect statistics for some fifty years back, he could say with confidence that there was the most marked parallelism between the state of the underground water and typhoid fever. Not only so, but these statistics showed very clearly that there appeared to be a ten years' periodicity in low water times. One of the lowest water periods in this country occurred in the cholera year of 1854; another very low water period occurred in 1864, and another in 1874; and two years ago he predicted, as the result of investigations, that there would be a low water period this year. There was not a shadow of doubt in his mind that over a large portion of England we should have the water lower this year than it had been for years, and the consequence would be that the diseases which followed those periods were likely to be more rife than they had been for some time past.

Mr. W. SMARTT said he understood that the water at Birkenhead was contaminated in a very serious manner, and knowing that a patent was applied for not long since, for a method of draining land in a particular manner into the chalk, he thought it was hardly advisable to go to any great expense in taking water from the chalk, seeing that there was a danger of its being seriously contaminated. Laws might be passed to prevent the passage of drainage from houses into it, but if the level of the water under London were lowered to any great extent, it was quite possible to cause a flow back from the lower part of the river. For instance, there was said to be a fault in the chalk at Woolwich, and on a former occasion it was stated that the water supply at that place was frequently contaminated from that cause. There were also faults under the Thames, and if the water were lowered, there would be a flow back which might not be noticed for a considerable time, and eventually the whole body of the chalk water might become contaminated. There could be no doubt that the water was absorbed by the chalk beyond the amount absorbed in the first instance, for having placed a piece of chalk in water, and allowed it ample time for absorption, and then placed it in a vessel where it remained for some time, he found that not a particle of water ran out. His opinion was that water should be taken from the springs along the course of the river, whilst it was still pure. The water could be obtained at a depth of 30 or 40 feet all the way up the valley of each river, and it might be taken out of the chalk or other porous strata. It was shown that about half of the chalk district about London was covered with an impervious stratum, though the surface might be pervious, as it was reasonable to suppose it would be, because all the marsh land was flat, showing it was formed from sediment washed down from the hills, and being washed down gradually, it must necessarily be more or less porous, and contain a large quantity of water. With regard to swallow holes, it had been stated at a former meeting that there was a passage in Lincolnshire extending some miles under land, and out to sea.

Mr. JOSEPH QUICK, jun., said, referring to the statement of a previous speaker as to the condition of the Thames being at present so extremely low, that only 350 million gallons a day passed over Teddington Weir, he knew that information to be perfectly accurate. The question he wished to ask was, why advantage was not taken of the enormous quantity of water which flowed at other periods over the weir, and which, so far from being useful, was, on the contrary, a very serious detriment to navigation? If those responsible for the water in the Thames stored up the winter floods, they might thereby regulate the flow throughout the year, and the condition of the river would be much improved, with advantage not only to those who took from it, but to those who lived on the banks. With regard to the case of the River Alyn, he had the misfortune to be opposed to Mr. Robinson before the Parliamentary Committee, but he certainly thought Mr. Lucas went a little too far in saying that the decision of the Committee formed any precedent for future cases, and that mill owners were not to be compensated for water of which they were deprived by water companies or others. The circumstances were quite exceptional, but the Committee did not lay down any precedent to prevent mill owners in future cases asking for water compensation.

Mr. W. B. KINSEY desired to corroborate Mr. Baldwin Latham's remarks with regard to the question of periods of drought. From his own investigations he found that ten years ago there was a drought, and again ten years before that, and there was the same drought now. He could also concur in what he said about the water flowing against the dip of the upper greensand. He was now carrying out works in the neighbourhood of Petersfield in the upper greensand, where the facts fully bore out what had been stated.

Mr. W. A. RICHARDSON said he had heard it stated with great surprise that the wells at Birkenhead were polluted. The water at Liverpool was taken from boreholes in the red sandstone, 450 to 460 feet in depth, and the water was frequently analysed, and was considered to be the best and purest in the kingdom.

Mr. LUCAS, with reference to the case of the River Alyn, produced a section showing the exact state of the case, and remarked that what he said in the paper was that it would affect similar cases. The section showed that the water flowing down the slanting strata sank into the limestone and ran a quarter of a mile underground in a course that was not known, and it was on that ground that the Committee refused compensation. Of course rivers which had no such underground course, would not be affected.

The CHAIRMAN then proposed a vote of thanks to the four gentlemen who had read the papers, which was carried unanimously, and the Conference adjourned for a short time.

Mr. Symons's paper was then read.

Mr. E. K. BURSTAL thought Mr. Symons had made out a very strong case indeed for limiting to some extent the period to which water rates should be absolutely unalterable. They had been accustomed to consider that the three driest consecutive years were one-sixth less than the average, but he now showed that they were one-fifth less; and as the difference between one-fifth and one-sixth was considerable when dealing with very large quantities, that was a sufficient reason why some such suggestion as his should receive serious consideration.

Mr. LIGGINS wished to point out the great importance of using rain gauges. Some thirty years ago he spent a month in Santa Cruz, and there he found the rain gauge was the first thing which interested the manager of an estate when he got up in the morning. The next year he visited his own estate in the island of Antigua, and found only two rain gauges in a whole group of islands; but in consequence of what he had seen in the Danish islands, he interested all his friends, from the Governor downwards, in introducing the system. The result was that every estate in the island from that time had constantly used the rain gauge with great satisfaction. The same course had since been adopted in Barbadoes, and he only wished the farmers of England were as enlightened as the planters of those islands, and would see the importance of having rain gauges on every farm in England. He was quite sure they would be pleased with their week's work when they came to tabulate it, and would find the benefit of the information thus obtained. When there were such divergencies as were indicated on the map, there was a clearly proved necessity that, in every district, they should know what they might expect, so as to guide them as to the desirability of commencing the various agricultural operations.

Sir ROBERT RAWLINSON, C.B., remarked that the rain gauge only afforded part of the information, and that a very imperfect part, of that which was necessary for the engineer in pursuing his practice. The rain gauge recorded the rain that fell into it; it did not record the evaporation that took place outside of it. In this country a season might have a rainfall which should take place in a certain order, and which would register in the rain gauge a certain quantity of water, but scarcely any of that water would have been available for the engineer. For instance, in this country, after a continuance of dry weather, a heavy shower on the mountainous districts in Wales, or elsewhere in the kingdom, would do very little for the engineer, because $\frac{9}{10}$ of the water would go back into the atmosphere before it got down into any stream to feed a reservoir. That was a fact which young engineers should know. If in the mountains of Wales, for instance, a rainfall of $2\frac{1}{2}$ inches took place in a week, and then stopped, there would be no feeding water for an engineer's reservoir. Then, if an interval of dry weather should take place, and another $2\frac{1}{2}$ inches of rainfall during a week (which would be a tolerably heavy fall) the engineer would have no feed into his reservoir. He could mention one instance where, on the east coast of England, a reservoir which he had himself constructed was run dry, and for 20 months continously there was no rainfall in that district which was capable of feeding it. Those were important facts which young engineers must take into account.

Mr. MACKNIGHT, with regard to Mr. Symons's reference at the end of his paper as to legislation being very desirable on the subject, said that gentleman had not told them in what direction the legislation he desired should proceed. For his own part he considered that a great deal of injury had been done to the country and to the public interests by premature and rash legislation on these subjects. He thought a great deal more information was required on scientific points before such attempts were made. In Scotland, in various sanitary matters, a great deal of harm had been done by premature legislation, where persons holding particular views on matters of scientific observation had influence enough to get legislation passed in those directions, and it had then turned out that instead of doing good it had done a great deal of harm. A great deal more information should be before the public and scientific societies before such attempts were made, and he deplored the fact that the country should be allowed to suffer from premature sanitary legislation.

A vote of thanks for the paper was then passed.

Papers were then read by E. Bailey-Denton, Edward Easton, and James Mansergh.

Sir ROBERT RAWLINSON said the suggestion of Mr. Easton with regard to supply by meter for large consumers and trade purposes was one of great interest, not only to the public of London, but to the outside public generally. The whole point would turn on the possibility of supplying a reliable meter cheaply, when he did not think a system of supplying water by meter would be objectionable. The great abuse at present in the supply of water for domestic use, under high pressure, was the intolerable waste which took place, which made it almost impracticable to keep up a supply of water at a moderate cost. In the metropolis the supply was equivalent to about 32 gallons per head of men, women, and children, and it needed no great reasoning powers to see that there must be in that vast supply a great deal of waste, for no such quantity could be used legitimately. Some of it the tenant was not liable for, being lost by leaks in the mains; some was lost by leaks in the service pipes, but a great deal was lost by having fittings out of order, and services deliberately left open to flow during the night. That tended to prevent a constant service, and, therefore, he should not object personally to seeing water sold by meter. In another paper the word "pure" had been applied to certain gathering grounds, such as the great moorlands of the country, which were supposed to give a pure supply of water, but this was a great mistake. There was no pure source of supply, as when water came in contact with the earth, even on the mountains of Scotland, which gave a very soft water, they were covered with vegetation up to their summits, and were inhabited by different animals and birds, and whatever the value of that water might be as soft water—and it had its value—for domestic purposes it was very dangerous, especially to strangers. People coming from England to the highlands of Scotland, were almost certain for the first few weeks, if not longer, to be attacked by diarrhœa. He spoke practically, because he and his family had suffered from it; when he was down at Ballater, some time ago, he spoke to the commanding officer at the station where the military were brought down when the Queen was in Scotland, and he learnt that invariably when the soldiers were brought there one-half of them suffered from the softness of the water, and something it contained, which was washed from the mountains. The medical officer also told him that strangers were frequently obliged to leave the district on account of the effect that the water had upon them. A great deal was said against water taken from the Thames, and he was not going to advocate impure water or hard water, but he had had to study the question as a practical engineer, in some respects philosophically, and as it concerned his own health. He had lived three times in districts supplied with what was termed pure soft water, and his experience there had made him very glad to get back again to so stigmatised polluted Thames water. Even for washing, for which soft water was so much prized, he had more pleasure in washing in London water than he had in the lake waters, for if you used soap—and you could not clean yourself thoroughly without it—you had the greatest possible difficulty in keeping sponges and things about the toilet table clean, because the soft water would not easily take the soap out. You might get water from tube sinkings, and deep wells, but you did not then get pure water. The late Dr. Angus Smith—and no one had paid more attention to the qualities and character of water than he had—said that if you gave him the analysis he could tell the stratification the water came from; and, on the other hand, if you gave him the stratification he could predict the character of the water which would come from it. And that must be so, because water as it fell from the clouds was soft water, the purest water in nature, and it was a powerful solvent. It dissolved and combined with any of the salts that it came in contact with. He often regretted that persons travelling in Africa, or in any country not previously traversed by civilised man, that they did not describe the appearance of the rivers and lakes more particularly, and mention whether the water was brown, or what character it had. If you saw a river running bright and sparkling, you might put it down as coming from a limestone source; if it were running bright and brown, it came from a primitive source, slate or granite. Of course when rivers were in flood and turbid, you could not predict anything about them. Water to be used for domestic purposes required special care in treatment and in storage. When a river is the source, the water must be filtered; as from the Thames, the Ganges, and the Nile. Deep well water, from chalk, new red sandstone, or from the oolites, must be stored in covered reservoirs; as if exposed in open reservoirs to sunshine and air, such waters become polluted to a worse degree than river water filtered.

Mr. Edwin Chadwick, C.B., said sanitary science had still to be applied to the instruction of engineering science in this matter of water supply. Originally, he did not object to soft water supplies, for in the then state of knowledge it was stated that the main infusion to which they were liable was from the peat, and a certain amount of tannin, which was not thought particularly injurious; but subsequent experience had shown there were further objections, and he did not think Sir Robert Rawlinson had stated them sufficiently broadly. Very soft waters, the surface washings of moorlands, were in use in Manchester, in Glasgow, and also in Dublin. He had received particular results of the soft water in Glasgow for nearly three months, and found the infusion of peat rendered it unfit to drink, as it produced dyspepsia. In Manchester, the peat-tainted water had the same effect, and he believed the same occurred in Dublin. In Manchester, it not only produced dyspepsia, but had such an action on lead piping as to lead to a large amount of lead poisoning. There was no doubt that in those places the water was not fit to drink during a certain portion of the year. He found that in Glasgow it was customary at some hotels to use glasses coloured, so as to conceal the colour of the water which was supplied. In the face of such experience, what was to be said of the proposal to bring to London 200 gallons per head of peat-tainted water—which for two or three months in the year was not fit to drink. At that time, Clark's process had not got farther than the reduction of hard water to 8°, but now it could be reduced to 4 or $3\frac{1}{2}$, and in those localities, such as Canterbury, where first hard spring water had been thus softened, it produced the finest water possible, which delighted the consumers not only for drinking, but for all domestic purposes. He looked forward to the time when the supply of water would be reduced as it was in Manchester, Sheffield, and other places, to some seventeen gallons per head per day. It might certainly be reduced by half, and if that were accomplished, it would reduce the intakes very materially, and also the establishments of the water companies, and this would be further aided by the chalk sources being utilised. It should be remembered that the Board of Health, some years ago, directed an examination of the spring supplies near the metropolis, and it was found that some forty million gallons of water could then be drawn from perennial springs in the Surrey sands quite free from every objection, in fact free from the greater amount of impurity which was collected by rain water. The consumption then was not more than eighteen gallons per head of population, and it was demonstrated in various ways that fully ⅗ths of the water now pumped into London was actually mischievous, supersaturating the subsoil with additional rainfall, and he believed that evil was still going on, and would continue until the supply was put on a public footing. As to the qualities, they depend mainly on its aëration, which the stomach test, and not chemistry, determined. Water direct from spring sources in chalk was highly potable; taken from cisterns in which it has stagnated, it was charged with bad town air, taken from a slum in which it has been kept, it was charged with the foul air of the slum. Chemistry does not analyse such air, but the stomach does. The prisoners of Millbank Penitentiary had their supplies of water changed from a river source to a spring source, and the medical officer showed that the change was attended by a great improvement in health. Death-rates were adduced to show differences in the qualities of water; but the fact was general that the people of the wage-classes drank, not water, but beer and tea: only children drank water. Not engineering, but sanitary science took cognisance of the principle of circulation against stagnation. In none of the papers did he find any due recognition of the conditions of stagnation which made good supplies bad, and bad supplies worse; in none was there any recognition of the effects of self-cleansing house drainage, which discharged sewage fresh and undecomposed, in conditions which fed fish, and the conditions of stagnation and putrescence which killed fish.

Mr. Bischof said the germ theory had been referred to in one of the papers, and it almost appeared as if the authorship of that theory were imputed to Dr. Frankland. He was sure if that gentleman were present he would be the first to disclaim that idea; he had simply adopted that theory as being the one most in accordance with observed facts. He was under the impression that Mr. Mansergh's paper must have been written some time ago, or he should have expected him to go a step further, and refer to the memorable discovery, by Dr. Koch, of the comma or cholera bacillus. He did not go so far as to consider it finally proved that this bacillus was actually the cause of the cholera, but he thought it extremely likely that the further researches of Dr. Koch and other scientific men would prove that to be the case, and then, perhaps, Dr. Tidy's incredulous gaze might behold the germ itself.

Mr. Maxwell said he wished to refer to a passage in Mr. Denton's paper in which he said that the deficit of the present year would have been more severely felt had it not been, in some measure, counterbalanced by the excessive rain which occurred during the last seven years, which left a balance to be carried over. But as far as his experience of underground water went, he did not consider that they had a bank to fall upon, or that the rainfall in previous years affected the present in the slightest degree. In the waterworks with which he was connected in the neighbourhood of Hull, which was a supply from the chalk, the wells followed very nearly the average rainfall of the three previous months. Thus, in considering their present supply, he had to look at the rainfall of April, May, and June, and depend entirely upon it. Certainly, so far as the water which fell on the Yorkshire wolds was concerned, it found its way into the Humber and German Ocean, and they never could keep any stock. Mr. De Rance had advocated dummy wells, which should be fed in rainy seasons to keep up the reservoirs for dry seasons, but he was satisfied that, in his district, they would be no use. He had a peculiar instance of that three years ago, when there was a heavy snowfall about February. The water in the shafts came up as a rule at a temperature of 50°, but in the June of that year it fell to 46°, which he could not account for until it occurred to him that it was owing to the snows, which lay a long time on the ground and then gradually melted. Mr. Latham had referred to the rapidity with which the water level fell last year, which again was an illustration of there being no storage of previous years to fall back upon. Last year, in June, there were 30 ft. of water in the bottom of his shafts, in July it fell to 20 ft., and in September to 7 ft. This year it came down, in May, to the same level as it was last year in August, simply because after January, which was a wet month, there came February, March, and April, exceedingly dry. He was quite satisfied that the rain of previous years was not stored up as had been suggested.

Mr. E. K. Burstal said he was sorry to differ from Mr. Easton with respect to the supply of water by measure, but his experience of ten years in the management of large works led him to a totally opposite conclusion, mainly on account of the expense. Taking a town of 100,000 inhabitants, one meter would be required to nearly every house, and supposing there were five persons to each house, that would require 20,000 meters, the cost of which, including fixing, would be £100,000. At 5 per cent. that would mean an annual charge of £5,000, and he knew that an inspector could not possibly look after more than 1,000 meters, so that £500 more must be added for their wages, and £5,500 was a large sum to charge on such a town. Now the saving, he calculated, would not be as much as £500 a year. When he took charge of the Oxford Waterworks about five years ago, he had a similar experience to what he previously had at Derby. Oxford was using 42 gallons of water per head per diem, but he had now brought it down to almost exactly 20. A few nights ago, being desirous of learning more particularly the quantity of water used at different hours of the day, he had the whole town supplied from the service reservoir which he had carefully gauged, and found that from 12 o'clock at night to 4 o'clock in the morning, when no water was really used, for there were no manufactories there, the quantity wasted was equivalent to 6 gallons per head. He could safely say, therefore, that 14 gallons per head only was used, and 6 gallons wasted. He had already reduced it from 42 gallons to 20 gallons per head, by means of two inspectors, who had various other duties to perform. That was in a town with a population of 45,000. At Derby, with 75,000 population, he had three inspectors, and if that could be done, he thought there was no necessity for the enormous expense which would be incurred by introducing meters. Meters for measuring water were very different to gas meters. With gas you had a pressure of inches, but with water there was pressure from 150 feet to 200 feet, which made it very difficult to keep any instrument absolutely in order, and there were always disputes with reference to them. The only meter which he knew of which was a good type of a positive meter was Kennedy's, but the great objection to that was that it often let the water pass through it day after day without registering it at all. He certainly had had one in use ten years, which was never touched except to oil it, and at the end of that time it was as perfect as at the beginning; but he had had them in other places where they were often source of annoyance. Parkinson's was very good, but it was only a low-pressure meter. Siemens's was also good, but the public did not like an inferential meter; and, in fact, there was no meter at present which would really answer the purpose, and he was quite certain their introduction would be very distasteful. In London, a reduction in the quantity consumed could easily be brought about, and the companies would be the first to co-operate, but it was necessary for the public to assist; and, unfortunately, at the present time, any one who could oppose the water companies in the police-courts and elsewhere was the popular man, and probably that would be so until the whole of the water companies were transferred to some public authority, and then it would be the old story of Stockton and Middlesbrough over again.

Mr. JABEZ HOGG remarked that London was a very exceptional city to deal with. It was useless to point out what had been done by provincial towns, and this constituted a very serious impediment in the way of procuring a better water supply. In the first place, it would not do to ask the Government to sanction any scheme which would make London dependent on one source of supply; and, therefore, the proposal to bring water from Wales, or from a long distance, was out of the question. If there were an aqueduct bringing water from Wales, what would happen to London if some of the dynamite people determined to cut off the supply; besides the danger there was the enormous expense. Then there came the question of how could we get a better supply than that from the Thames and Lee, for he apprehended no one would say that either of those rivers afforded London a pure and wholesome supply of drinking water; the late discussion in the press made this appear impossible. The water companies had also been accused of taking more water than they should take, thus leaving the river-bed in an exposed and dangerous state; exclusive of this there were a million inhabitants living on the banks of the Thames, and he was surprised the Thames Conservancy should adhere to the statement that the water was comparatively pure, and free from pollution. It was said, indeed, that twenty-one towns situated on the banks were still continuing to pour sewage into the Thames. That was a statement which could hardly be denied. They certainly did not pour the whole of their sewage into the river, but great portion of it found its way, secretly or openly, into the Thames. If any one would go up the river with him, he could point out innumerable inlets where sewage water made its way into the river, in spite of the efforts of Conservators.

Mr. E. K. BURSTAL said that was not the case above the intakes of the London water companies.

Mr. JABEZ HOGG said it could not be controverted that the Thames was miserably polluted above the intakes of the water companies. He would not throw blame upon the Conservators; they did their best; it was simply impossible to divert the sewage of the immense population residing on the banks of the Thames; and even taking it that the sewage went through a sewage farm, or was submitted to the A B C process, the effluent water must pass to the Thames, and was dangerous to health—not always dangerous, but supposing two or three cases of cholera were to occur high up the stream, and the dejections sent into the river, there would be the extreme danger of everyone becoming affected by cholera who might partake of the water. It had been said that the present deficient supply of the Thames might be supplemented by impounding underground water; indeed, one of the water companies obtained a considerable quantity of spring water from the gravel and subsoil, but he denied that this was pure water. With regard to the Lea, there was a letter in the *Times* that morning stating that it was shamefully polluted, the sewage farms on its banks sending in effluent sewage, most dangerous to health, and this could be seen by anyone at the trouble to go up the river. He contended it was impossible for London to look any longer for a supply of drinking water to the Thames or the Lea; there should be an immediate resort to deep well water, which could be had in unlimited quantities from the chalk, where it had been stored up for ages. It was said, however, this water was too hard; it was no doubt discreditable to rich companies to send hard water to their customers without softening it by a process which could be carried out at a small cost in their reservoirs. He considered it a great discredit that a rich company, like the New River Company, should, after sinking deep wells into the chalk, pump a very large quantity of good spring water into a river exposed to pollution, and send it on, open canal fashion, to London, or otherwise keeping it in large open reservoirs where it may become stagnant, and men and dogs may drown. It was impossible to purify such water as that, and convert it into pure and wholesome water such as the companies engaged to supply. The water he drank had 16 degrees of hardness, which was sufficient to produce a large amount of calculous, a disease which he believed was very much on the increase, and besides which it did damage, and marred all domestic arrangements. Mr. Easton had spoken of the damage done to water by cisterns, but he contended that much less damage was done in that way than was alleged. He had gone very carefully through all the poor districts of St. Giles's, and visited house after house to see the condition of the cisterns, and he found that it was less due to the condition of the cisterns than to the quality of the water sent into them. He had just had his cistern cleaned out, and found a very small deposit in it; but of course his remarks applied to covered cisterns, and not to the uncovered cisterns found in some of the poorer houses. It was impossible, with the short supply of water the companies gave, for the poor people to do without cisterns altogether. He was often without water on Sundays, because a short supply of fifteen or twenty minutes daily was thought sufficient by the company.

The CHAIRMAN said he must say a word in support of Mr. Easton's statement with regard to the cisterns. He thought Mr. Hogg would have to inform himself a good deal more with regard to the real condition of cisterns in London, before speaking so decidedly as he seemed inclined to do.

Captain E. BURSTAL said he had only just come into the room, but had heard some astounding remarks, and he was quite sure Mr. Hogg must have been very much misinformed as to the real condition of the River Thames above the intakes of the water companies. That afternoon he had deposited in both Houses of Parliament a report for the year ending December, 1883, signed by the Chairman and himself, which no doubt would shortly be published, when it would no doubt be seen that there were but two towns on the banks of the Thames which passed any pollution into the river. One of these towns was Staines, and they were now beginning to do what they had had notice to do some time ago, and, what they had been prosecuted for not doing namely, adopting some system to deal with their sewage. The other town was Henley, from which a very small quantity of sewage found its way into the river, but however small it might be, it was the duty of the Conservators to arrest it, and do everything they possibly could to prevent any pollution, and every source of pollution which had been found above the intakes of the water companies had been stopped.

Mr. HOMERSHAM said he had seen sewage from the outfall at Windsor, of a most disagreeable nature, coming into the Thames. The fact was, every drop of liquid sewage now went into the Thames; he agreed it had passed through some treatment, but if anybody contended that urine, one of the most deleterious matters that could go into water, was thereby purified, he was grossly mistaken. The sewage was purified to some small extent; but to say that no sewage entered the river, when the whole of it went in except some solid matter, was not correct. He should like to ask particularly about Reading as well as Windsor.

Mr. E. K. BURSTAL said he was the engineer who carried out the Windsor sewage arrangements, and after the precipitating process, the whole effluent was passed through land.

Mr. WALKER said he was manager of the Reading Waterworks, and had a great deal to do with the sewage works of that town. The sewage did not go into the River Thames. Reading had expended over £300,000 in diverting the sewage of the town from the Kennet, which was one of the principal tributaries of the Thames. But while Reading had done that, the sewage of Newbury, sixteen miles above the intake of the Reading Waterworks, went into the Kennet, and from thence might find its way into the Thames. From what had passed that day, he felt quite at a loss to know what would be the best source of supply—one recommended getting it from the chalk, and then they were told the water was too hard, and if they got it from the rivers, that was too soft. With reference to the sewage of Reading, he had simply to say that it had not gone into the Kennet for the last seven years.

A GENTLEMAN asked where it did go to?

Mr. WALKER said it went to the "Manor" Farm, and the effluent flowed into the Kennet.

Mr. ROBERT SUTCLIFF said Mr. Denton, in his paper, mentioned some supposed disadvantages attending the adoption of tube wells, namely, that if an accident happened to the pump, the supply was stopped until it was replaced, and that if the supply was insufficient, another well had to be constructed. As these points were important to the system which he had the honour to be connected with, he wished to say a word or two upon them. With regard to the first, if a pump got out of order in an ordinary dug well, as a rule, another pump must be put up in its place, but in a tube well that could be done in a few minutes. With reference to the supply running short, he could mention one town (Watford) in which sometime ago they doubled the supply, their dug well having got into the very position which it was supposed the tube wells might get into, and not giving a sufficient supply; they put down a single tube well of 8½ inches, and that gave double the supply previously obtained. In reality, having to add other tube wells has really in many cases been an advantage. Sometimes people would say they did not want to incur a great outlay at present in order to provide for future possibilities, and by having a tube well they could have a supply requisite for the present which could be added to as it was wanted. If more water were required, all they had to do was to sink two or more tube wells, and couple them to the existing arrangement. Being at the present time engaged in some ten deep artesian borings, he might make a remark on the general question. There seemed to be a great difference of opinion as to whether water, after it was purified, was prejudicial or not, but he always felt that he would very much rather have water which had not been contaminated, even if the contamination were afterwards removed. His idea was to get the water pure, and keep it pure, not to allow it to be contaminated, and then put it through a process of purification, which seemed to him objectionable and contrary to common sense. On the banks of the Thames, in many places, the sources which supplied the river were beautifully pure, and though he did not approve of shallow sources as a permanent supply, yet, temporarily, an enormous quantity of pure water might be found on the banks of the Thames, which went to add to its volume. In one case, even at Gravesend, within a stone's throw of the river, which was then in a most disgusting state, having put down a tube well, he had water which was analysed, and pronounced to be as pure as that of Loch Katrine. There was a vast body of this water flowing towards the Thames, and if it could be taken temporarily, it would save the water companies a great expense in filtration. This reminded him of the manner in which water was filtered. He did not know whether any of the water companies had tried passing the water up instead of down, but it seemed to him very objectionable to let all the stuff they were trying to prevent passing, be caught on the surface of the filter-beds, and let all the other water go through that. He thought the right system was adopted by one of the filter companies, in which they made all the water pass upwards through the filter, so that any sediment which might be deposited was left at the bottom, and could be easily removed.

Captain DOUGLAS GALTON, C.B., F.R.S., with reference to the observation of Mr. Hogg that cisterns were not objectionable, said, if one thing seemed to have been better established than any other with reference to the water supply, it was the danger of cisterns. He did not say that cisterns might not be kept clean, but the general plan was to leave them for weeks, months, or years, without being cleaned, and then it was undoubted that however pure might be the water put into them, it would become contaminated. All who had studied sanitary matters had come to the conclusion that if possible a constant supply was the best thing to obtain, and that such a supply would obviate the necessity for house filtration. Those impurities which were now obtained in London water were chiefly owing to the method of storing it.

Mr. HOGG said what he wished to imply was that the water supply was so short that the cisterns were drained dry every day, and therefore there could be no sediment.

Mr. CHADWICK said, living at Richmond, he had seen water running from market gardens into the river in enormous quantities, the colour of coffee, and he had gone to take a bath there, and found the water absolutely smell of manure. Many people forgot that it was not sewage alone, but the surface washings from lands heavily dressed with manures, which polluted the rivers.

Mr. EASTON said he laid so much stress on the evils of the cistern system because, when he investigated the water supply in 1877 and 1878, an immense mass of information was got from the Metropolitan Board which would have been laid before a Select Committee if the Bill had not been stopped at the second reading, and very conclusive evidence was obtained as to the filth in the cisterns. Five of the ablest chemists in England, with the Chairman at the head of them, were engaged for three or four months, not only investigating the quality of water supply in the mains of the different companies, but the mud which they took out of the cisterns, and however difficult Mr. Hogg said it was to find any deposit, he could assure him there was an ample supply of taint from all parts of London—not only from the poorer class of houses, but they found it in places where it certainly ought not to have been found, and where, if the people took proper care of the cisterns, it certainly would not have been found. With regard to the people generally, it was their misfortune that the cisterns were in such a condition; it was a consequence of the intermittent supply that this filth would accumulate. He might add that they were investigating not with a view to prove that the water in the mains was the best, but on behalf of the Metropolitan Board of Works, who had a rival scheme, so that, if they had any bias, it was to show that the water in the mains was bad.

Mr. MACKNIGHT said there had been a great deal of discussion in Edinburgh on this question of cisterns. The Water Trust were under the necessity of bringing in a very large supply of additional water, and it so happened this was from the Moor Foot Hills, ten or twelve miles south of Edinburgh, where there were no springs; and there were loud complaints on the part of the artisans of its impurity. The Water Trust in defence got up a cry about the state of the cisterns, but they were completely beaten. Most of the houses in Edinburgh were what are called self-contained, and all had separate cisterns, which the owner took care to keep in good order, but the bad water sent into them left a deposit. All chemists knew very well that if water had certain mineral ingredients in it, after standing a short time, it would leave a deposit, but that was due to the water, not to the cisterns.

[The Conference then adjourned.]

Mr. WHITAKER writes:—There having been no time for the authors to reply to the points raised in discussion, I send the following note on what fell from Mr. Baldwin Latham, and from Mr. Kinsey, in regard to the chalk marl on the south of London and near Petersfield, allowing of the passage of water between the chalk above it and the upper greensand below. In my paper the suggestion that another colour might have to be added to those already used on my maps to separate the chalk marl from the rest of the chalk, is not of universal application; but refers only to those parts where the chalk marl is so clayey as to be practically water-tight and not water-bearing. The district in my mind was not that on the southern side of the London basin, but that on the northern side, where, for very many miles in Hertfordshire, Bedfordshire, Cambridgeshire, and part of Norfolk, this basal part of the chalk is so impermeable as to throw out water from the permeable bed of hard and somewhat sandy chalk that overlies it. The outcrop of that permeable bed, known as the Totternhoe stone, and which has been largely used in building, is marked by a line of springs, the occurrence of which has determined the site of the many villages to be found along the base of the chalk hills from Hertfordshire to Cambridgeshire. The conditions here are clearly different from those that hold on the southern side of the London basin; but I doubt if in the latter district the chalk marl everywhere allows the passage of water through it, and evidence in this direction is given by the experimental drift-way of the Submarine Continental Railway, near Dover, which, driven through chalk marl, was practically dry. To show, however, the varying nature of this bed, as regards water, we need only cross the Channel, to the corresponding experimental works of the French Company, where many springs were met with in the chalk marl. At Dover the only fluid found was champagne, and it is said that this was dry!

Miscellaneous.

*EDUCATION IN ENGLAND.**

The building in which we are assembled marks a new departure in English education. Like most good things in England, it is the splendid result of local munificence, of local effort to satisfy a want long felt, at last acknowledged. The *genius loci* will, I hope, impart itself to the Conference, and it too will, I trust, show us new channels of enterprise, and give to our thoughts on many subjects a new starting-point. We are not here to codify a system of education. We are aware that toleration of opposite views is the first result of a liberal education—that nothing could damage education more than fanatical adhesion to preconceived notions. In England, hitherto, we have been hospitable to every possible method of education, and we do not intend to ostracise any. The Standard School, which all other schools are forced to follow, is a despotic institution which will not meet with favour in England. I crave your indulgence for a few remarks on some of the burning questions of the day. If science is a constant inquiry into the causes and probable effects of the phenomena by which we are surrounded, it follows that we can never allow the process of inquiry to remain dormant. Constant observation of the various forces which are operating is the main element of education. The development of the powers of observation, to satisfy an ever-expanding curiosity, is at the root of every system of rational education. How to observe, and what to observe, in the past and in the present, is the ever-recurring function of education through life. Apply the test to the humblest and to the most exalted professions, you will see that the test does not fail. The agricultural labourer, whose work is of the most uninteresting description, will be efficient or inefficient exactly in proportion as his faculty of observation has been developed. Nature will teach him something every day of his life, if he has been taught how to watch her workings. It is the same for the astronomer; observation is to him the first necessity. In primary education this truth is more and more recognised, and drawing as well as elementary science and manual work are being put in their proper place. Belgium is moving vigorously in that direction, following, with reference to manual work, Sweden, where the *slöjd*, or school of domestic industry, may well claim our attention. Two French Ministers of Education, M. Bardoux, and the present Premier, M. Ferry, have given their verdict in favour of the extreme importance of drawing. Sweden also contributes to

* Opening Address by Lord Reay, at the International Conference on Education, at the Health Exhibition August 4th, 1884.

gymnastics that efficiency of training which—as we are so near to hygienics—I need only indicate with a word. The monopoly of the three R's is doomed, and the enthronement of the three D's—drawing, drill, adroitness—approaching. The primary school must not degenerate into a mere workshop. I do not agree with the Procureur-Général de la Chalotais when he complained of the subversive influence of the Jesuits in teaching children to read and write who ought only to learn how to handle a hammer or a plane. In pleading for rational being substituted for mechanical methods, I simply desire to arouse those inquisitive tendencies which in many cases now are deadened; to make the primary school, not the early grave of individuality, but an attractive spot where the productive use of leisure as well as of the hours devoted to work, coupled with the surroundings of prints and flowers, shall give pleasure to the boys and girls who frequent it. I need not say how important the invaluable report and recommendations of the Royal Commissioners on Technical Instruction are, and none more so than those bearing on agricultural education, to the effect that "in rural schools instruction in the principles and facts of agriculture, after suitable introductory object lessons, shall be made obligatory in the upper standards"—as it is in Ireland—and "that encouragement should be given, by way of grants, to practical works on plots of land attached to such schools." Agricultural education is considered in certain quarters as a luxury. I may be allowed to use the strongest expressions to deprecate this extraordinary error. At the present moment the future of rural society is a great problem. The bearings of this problem on society in general are obvious. The land question is in all countries one of paramount importance. *Ad nauseam* we are told that land is a limited quantity, and then almost immediately afterwards we are told that, for that reason, it should be made common property. The deduction to be drawn from that palpable axiom seems to me an entirely different one, namely this—that we should throw into the management of land the highest possible skill. Gold is a rare commodity, therefore you only give it to a skilled artisan; on the other hand, the management of the soil, which raises a host of scientific and economic considerations of the utmost delicacy, is left in most cases to those who have not had any training in science or in the technicalities of agriculture. Farming is a pursuit which requires in these days the utmost skill and versatility. The fact is admitted, not by mere theorists, but by the most practical agriculturists in every country. We used to hear a great deal of the practical soldier as opposed to the academic soldier; but since recent wars we hear a great deal less of the former, though I do not wish that often great character to become extinct. So it is in the agricultural world. Three years of depression have been the death-knell of unskilled farming. The notion of farming—of estate management—not requiring previous technical education, is quite as absurd as entrusting H.M. ironclad *Inflexible*, with its complex machinery—a floating laboratory—not to a scientific officer like Captain Fisher, but to the skipper of a Yarmouth fishing smack. I shall not inflict any statistics to-day on you; but I should like to know what the loss was resulting from unskilful agriculture? Transform agriculture into a skilled pursuit, multiply men like Lord Walsingham, and we shall probably hear as little of the wish to reduce the surface of the globe to encampments of squatters as we now hear of a division of commercial navies, which are also a limited quantity, which cannot be expanded indefinitely. Not to be misunderstood, I should like to point out that, in this case also, science will not rob the people of enjoyment, but add to it. My friend, Sir John Lubbock, has insisted on forestry being taught. How much of enjoyment has been lost by the wanton destruction of forests and the neglect of planting forests? The preservation of Epping Forest answers this question. By how much could the consumption of milk be increased if dairy farming were conducted on scientific principles? How are you to feed humanity in the next century, if population continues to increase at its present ratio? How are you to stem the tide of immigration to the large towns? Only by giving to the rural districts that sense of pride which their inhabitants can only have if they realise that they are members of a body which commands universal respect, like the army and the navy, whose scientific branches have, in recent years, made gigantic progress You see that, in this respect, as in most other respects, I do not agree with Voltaire when he wrote to De la Chalotais, "I am grateful that you disapprove of learning for agriculturists. I, who am an agriculturist myself, do not want *savants* for that purpose." We do want *savants*, and I am happy to say that the University of Edinburgh has recognised this; but, in addition, we want trained agents, trained farmers, and trained farm labourers, just as much as we want trained merchants, trained manufacturers, trained mechanics, trained foremen, trained artisans. Through technical education we must recover ground lost since the Middle Ages, when, in Italy at all events, an artisan was an artist. There is some injustice in the favourable view we entertain of our enlightened century, as compared with the dark times which have left those splendid monuments of art. The great controversy about the relative merits of the gymnasium and of the realschule has not yet invaded England. Is it because the classical school enjoys a sense of perfect security, or is it because the Technical Instruction Commissioners have only sounded the first note of alarm? One thing is certain, we shall have to make up our minds for a large increase of schools with a modern curriculum. What is called the perfect school, which embraces every branch of learning, would certainly never meet with favour in England. It would only lead to ancient and modern languages and science being all equally badly digested by the pupils. Such programmes, if approved by the Whitehall

Inspectors, would, ere long, attract the notice of sanitary inspectors of the Local Government Board. The only chance of anything being taught thoroughly would be, not the efficiency of all, but the inefficiency of some of the teachers. This was illustrated in a German gymnasium, where the director, on being asked how it was that the Latin of his pupils was so satisfactory, replied, "Oh, because we are fortunate enough to have a very inefficient mathematical master." The exclusion of the study of the ancient languages does not mean the exclusion of the study of the institutions of ancient Rome and Greece. It is a fair question whether a student of German, reading German authors on the literature and institutions of Greece and Rome, will not have a deeper insight into their character than the youth who has been victimised to write hexameters. Will Mr. Warre make the study of German compulsory for all Etonians, as the Bishop of Chester recommends? Will he put a stop to classics in all cases where the mind shows no capacity for their profitable influence? I do not go so far as Herbert Spencer, who quarrels with the sculptor of the Discobolus because, unfamiliar with the theory of equilibrium, he placed him in a position which must cause him to "fall forward the moment the quoit is delivered." I do not believe that the Discobolus will cease to be admired by those who are versed in the laws of equilibrium, by German staff-officers, for instance, because Moltke approves of a scientific education in preference to a classical training. There is a great deal of truth in Thiers' apprehension when he said—"At a time when religious convictions are weakened, if the knowledge of antiquity also became faint, we should have become a society without moral links with the past, exclusively acquainted and busy with the present—a society ignorant, lowered, only fit for mechanical industries." I also agree with M. Saint Marc de Girardin, "that if we were to clear out of our brain all the ideas we have received from the Greeks and Romans, we should be frightened how little remained." But the spectacle of Claude Bernard, the founder of French physiology, working in a cellar of the College de France, and shortening his life by the martyrdom inflicted on him through the absence of a laboratory, is quite as potent an educational factor as the philological research which culminates in the restoration of the original text. A lawyer ignorant of Roman law, a theologian ignorant of the Greek Testament, an artist without classical training, seem to me imperfectly educated; but then an architect, an engineer, a doctor, not trained in science are equally unsound. The whole contention is simply one of possibilities. The hatter of a great statesman lately told him that his head had grown larger within the last ten years. We are told that a French physiologist has come to the conclusion that in generations who, from father to son, have constantly used their brain, an enlargement of the skull has taken place, which, in ten centuries, would make a difference of six millemetres. The power of expansion is therefore limited, and we must have bifurcation; and if we give a variety of instruction in both schools by the teaching in both of modern languages and history, which cannot be neglected, we shall find a common ground for those who take up science and those who take up classics. Not a mere smattering of "Allgemeine Bildung" is the aim of English education; it has alwas striven after thoroughness—"non multa sed multum." The bifurcation is rendered necessary by the very fact that a combination of both curricula would damage them both. If we are to give secondary education of any value to a large part of the population, this is the only way of doing it, because they cannot afford to waste time on classics. The complaint is as old as Montaigne, who in his day bewails the fact of the great number of people whose mental growth was stunted by the inordinate desire to learn overmuch. By education you do not want to enervate, but to strengthen, the will of the individual, and to give to his character a manly independence. The highest culture, undoubtedly, is found among the representatives of the classical school. It would be sheer ingratitude not to recognise that to it we owe writers like Newman, theologians like Lightfoot, orators like Gladstone, statesmen like Goschen, poets like Browning, artists like Alma Tadema, historians like Lecky, metaphysicians like Flint, essayists like Lowell, biographers like Trevelyan, critics like John Morley, not to mention names equally illustrious among the living and the dead, here and abroad. The numbers of authors, poets, orators, and artists must inevitably be limited, as Goëthe tells us:—

> Wer in der Welt Geschichte lebt,
> Wer in die Zeiten schaut und strebt,
> Nur der ist Werth zu sprechen und zu dichten.

The study of the ancient world is undoubtedly one capable of attracting the noblest instincts; but what are you to say to those who, having attained a mere smattering of Greek and Latin, either turn their backs on all further self-education, or swell that literary proletariate which, good for nothing, declaims hollow theories or panders to bad taste? The great bulk of the nation is not intended to speak and write, but to work, and must therefore be trained to satisfy the requirements, not of ancient Rome and of ancient Athens, but of society as at present constituted, with its extraordinary development of international relations. It is the realschule which makes it possible for young Germans to write letters in three or four languages besides their own, and to fight their way into the offices of our merchants at Manchester and at Bombay. Michael Chevalier said of the Ecole Centrale des Arts et Manufactures—"If it were not in existence, it would be necessary to create it, as the complement of the treaties of commerce." We have too long neglected that side of our educational system, forgetting that such schools are much more likely to benefit the greater number of those who frequent them than classical schools, which only benefit a select few. But if you have admitted that one type of secondary school is as impossible as one type of primary school or one type of university, you have recognised another great truth—namely that you cannot centralise your education. The needs of nations, of localities, of individuals, are so varied that it is impossible to draw up one code. It will be unnecessary for me to remind this audience of the utter failure to assimilate English, Scottish, and Irish education, though perhaps not everybody here would be prepared to consider this a satisfactory phenomenon. But let us ask our French friends whether they are satisfied with centralised machinery. What does Pasteur say? How does he answer the question, "Pourquoi la France n'a pas trouvé d'hommes supérieurs au moment du péril?" As follows:—"While Germany was multiplying its universities, and establishing among them a most salutary emulation; while it was surrounding their masters and doctors with honour and consideration; while it was creating vast laboratories furnished with the best instruments, France, enervated by revolutions, always occupied with sterile aims at a better form of government, gave only a heedless attention to its establishments of higher education." The late eminent Dumas, one of the eight inspectors of superior instruction in the Uuiversity, speaks not less positively. "If the causes of our marasmus appear complex and manifold, they are still reducible to one principle—administrative centralisation, which, applied to the University, has enervated superior instruction." A professor in the Faculty of Medicine, Loraine, boldly says:—"We demand the destruction of the University of France, and the creation of separate universities." The Germans do not centralise; there is no "Reichs Ministerium" for education at Berlin. Ask Döllinger whether he would sanction the destruction of autonomy in matters of education in the various States of Germany. My friend Sir Lyon Playfair assures us—"A free country like England will not tolerate State unity in education, any more than it has tolerated it in any region of her politics." Notwithstanding this gratifying assertion, he must allow me to look with considerable suspicion upon his conception of a Minister of Education. I am told that Herbert Spencer on one occasion maintained the opinion that we might, perhaps, be all the better for absence of education, leaving it to the friction of life to develop individual powers. This is an extreme view; but it is more human than that of our poet Gascoigne, who says, "A boy is better unborn than untaught." Adventurous and enterprising men, though uneducated, have done great things. The tyranny which would compel the human race to be educated on identical lines seems to me to have nothing human in it at all; and I am quite certain of this, that our empire can only be maintained if we give free scope to the greatest variety of methods of education. The French Canadian, the settler in New Zealand, the Parsee in Bombay, the ryot in the Deccan, the Scottish bursar at Aberdeen, the Connemara peasant, are all entitled to have that system of education which will develop on national and historical lines the strongest features of their race, though none of them may be able to compete for the Hertford scholarship. If every nation were to give full play to the variety of talents which it contains, instead of trying to press their schools into one mould, we should hear less complaints of want of originality. Are the universities to take cognisance of the technical part of education, or are they to take no part in this great movement? If the universities train our statesmen, our doctors, our lawyers, our clergy, our literary and our scientific men, I can see no reason why they should not also give us the highest engineering, artistic, financial, commercial, and agricultural skill. Why should the great Institute which gives us its hospitality to-day not form part of the University of London of the future? The idea of a university is not to grind a certain number of individuals in a certain limited number of studies, and then to invite them to write down answers to printed questions. The idea of a university is to supply the highest wants of a nation in every direction, not in one. "Discite vitæ non scolæ." If the best scientific teaching is to be represented at the universities, and if technical education in its most advanced stage is to obtain it, why not at the university? It is a gratifying fact to me, as Rector of the St. Andrew's University, to be able to recall the fact that in the organisation of that university after the Reformation, one of the three colleges was to devote itself to teaching dialectics, mathematics, including arithmetic and geometry, cosmography, astronomy, and natural philosophy. After attending this course for three years, and passing a successful examination, the student "shall be laureat and graduat in philosophy." I do not forget that a university is not merely a place for professional training, but for the highest research. I prefer the German system, where both objects are united, to the system which has obtained in France, where the Collège de France and l'Institut Pratique des Hautes Etudes overshadow all the universities from which they are separated, though, we must recollect, the two professional schools, "l'Ecole Normale et l'Ecole Polytechnique," have given to France its most eminent *savants*. This question is a question of division of labour. Huxley and Ray Lankester will not grudge lecturing to those who are capable of benefiting by their teaching. The important element in university training is that those who attend the lectures should be quite fit, by previous training, to follow the lectures; that the lectures should be given by the most learned men, and should have a stimulating influence on those who attend them. Any pupil of Jowett's will agree to this proposition. You will, of course, have to graduate your lectures for those who intend to give up their lives to study, and for those who wish to enter on a profession; but the best teaching will be at the disposal as well of the one class as of the other. The object is not to burden the men who are the highest representatives of learning, but to increase the number of those who come under their influence; to make the influence of the university felt in a wide circle. That is, I know, the object of the best men at our universities; and I may, perhaps, couple the name of Professor Stuart with these efforts. What you want is to reduce the necessity of artificial intermittent examinations, by increasing that unremitting self-examination which is the natural result of constant attendance at the best teaching. An examination can never become a corrective of indifferent teaching, and I had rather not answer the question whether it is an unerring test of the results of good teaching. I can only say that I was glad lately to be told confidentially, by one of the most eminent men engaged in the higher education of France, that he held very heretical views on the subject of examinations. The task of the universities is to collect as great a number of eminent men as they can find. The triple task of these men will be, firstly, to fill every profession and every walk of life with men who will be able to grapple with the problems they have to face, because they have been taught what is implied by scientific method; secondly, also to reproduce, as it were, themselves by training new leaders of future generations; and, thirdly, to add to our intellectual capital by research. I am opposed to the professors at universities degenerating into what M. Renan has stigmatised as "amuseurs publics," who give entertaining and brilliant lectures. The class-room of a professor should only be filled with the flower of the youth of a country, but that flower should be recruited from all classes of the community. The luxury of idleness alone ought not to be tolerated at a university; every other luxury, in the way of bursaries and scholarships, should at once be absorbed. I say this in London, where we have this variety, but where we keenly feel the want of the "Alma Mater" which will gather these wandering orphan lecturers. Let us hope that the next Conference will be welcomed by the chancellor of a teaching university in London. I do not wish the universities to stand in solitary grandeur, remote from the life of the people. An eminent Radical statesman said to a professor who was putting in a good word for the existence of other agencies than the mere impulse of the multitude—"It is the like of you who are worse than Peers." The remark was significant. The French aristocracy is destroyed. The French University retains its ancient lustre. Science is never sensational, but from its very nature progressive, because always constructive, and using, not wasting, the materials of the past, to build the future on a solid foundation. A cynical plutocracy and an uneducated democracy both are inclined to be wasteful and destructive; both are inclined to set up shams. Science cannot set up shams, but invariably destroys them. The patient, the cautious attitude of true science, in dealing with obstacles to progress, will not always suit the impatient and often generous impulses of democracy. One of the great dangers of the future is a collision between these two forces. How can we prevent it? Only by giving the democracy confidence in the aristocracy of science —an aristocracy which is self-made, and can only perish with science itself. It is an independent aristocracy, because the moment science becomes servile it loses its *raison d'etre*. Its labours are the main causes of the prosperity which is enjoyed by the people, and of the greater prosperity which is in store for them if they listen to the voice of wisdom. The notion of equal comforts for all—*le régime des appetits*—has nothing but a ruinous collapse of civilisation to commend it. The antidote to these poisonous precepts is to be found in the extension of university teaching. Its administration should be on a large scale. Emerson was not far wrong when he wrote—"We shall one day learn to supersede politics by education." Those who are painfully aware, by the fulness of their knowledge, of the greatness of their ignorance, will have to inculcate that greatest of all lessons to those whose ignorance draws pictures of a future paradise, in which *à priori* theories will secure universal happiness. In such an earthly paradise, I am afraid, the tree of knowledge would be sought in vain. The doctrine of human fallibility is not impugned by scientific progress, but rather the reverse, when we think of the darkness from which we are only just emerging. Faraday gave expression to this conviction when he said—"Society is not only ignorant as respects education of the judgment, but it is also ignorant of its ignorance." Such a complex machinery as modern society, with its manifold wants, makes the organisation of education more complex every day. Not by centralisation, not by programmes, not by circulars, not by examination papers, not even by lavish expenditure alone, will success be attained. What is wanted is that public spirit, that strong conviction in every man, woman, and child, that education is a privilege; that the more education a man has, the more he is to be respected. Does it exist? Yes; you will find it among the scattered population of the Highland glens of Scotland and of Switzerland, along the canals of the Netherlands, in the forests of Germany. It is a precious heritage. To increase it is our object. The great Chancellor of the German Empire once compared the struggle for gold between the central banks of Europe to a struggle among individuals for a blanket of insufficient size. The same process is at present going on in the various States of Europe with reference to education. We are all struggling for golden wisdom, with this great difference, that the gold we bring to the surface at once becomes the property of all. The discoveries of the biological marine station at Naples can be tested at St. Andrew's, and the scientific work done at Strasburg can be utilised in Edinburgh. Science cannot render men equal. The princes of science constitute a separate order, and when we enjoy the pleasure of contemplating or reading the works of genius, we cannot help admitting our own inequality. A nation ceasing to reverence its great men is on the decline. Inequality is a law of nature; but so is liberty, and liberty is incompatible with equality. But if education alone makes liberty possible, by learning its uses and preventing its abuses, it also teaches us to be generous. The best educated man will also have the widest sympathies. The best educated people will also be the people which cements peace and goodwill among nations.

TECHNOLOGICAL EXAMINATIONS.

The Report, by Mr. Magnus, on the 1884 Technological Examinations of the City and Guilds of London Institute, has just appeared.

A considerable increase is shown in the nnmber of candidates at the recent examination, as compared with that of the previous year. In 1883, 2,397 candidates were examined, of whom 1,498 passed. In 1884, 3,635 were examined, of whom 1,829 passed. There is also shown an increase in the number of centres at which the examinations have been held.

From the returns received at the office of the Institute in November last, it appears that 5,874 persons were receiving instruction, with a view to these examinations, in the registered classes of the Institute. The number of students at the corresponding period of the previous year was 4,052, this being 585 in excess of the number in 1882.

Of the candidates who received instruction in the registered classes of the institute, about one-half presented themselves for examination; of the remaining candidates who came up, some had received instruction in colleges the professors in which do not accept payment on results, whilst others had supplemented their workshop practice by private study.

This year, as last year, Glasgow heads the list of centres from which the largest number of candidates have passed, the number being 139, as compared with 123 in 1883. Of the other centres, Manchester sent up 115 successful candidates, as against 76 in the previous year; Bolton 98, as against 117; Bradford 90, as against 51; Leeds 70, as against 64 (50 coming from the Yorkshire College as against 43); Preston 59, as against 46.

In carpentry and joinery, which was added this year to the examination progamme, 369 candidates were examined, of whom 125 passed. Nottingham sent up this year, for the first time, 19 candidates in lace manufacture, of whom 13 succeeded in satisfying the examiner.

Examinations were held this year in 43 subjects, as against 37 in 1883, the only subjects included in the programme in which no examinations were held being the mechanical preparation of ores and salt manufacture.

Practical examinations were held this year for the first time in weaving and pattern designing, and in metal pattern work.

Of the 23 candidates for honours who, besides undergoing a written examination in pattern designing and weaving, sent up specimens of their work, 13 succeeded in obtaining a certificate. In metal plate work, two candidates presented themselves for honours, but neither succeeded in obtaining the institute's certificate. In all subjects of examination, the honours certificate of the institute is intended to be regarded as a diploma of proficiency, and is awarded in those cases only in which the candidate shows a sound theoretical and practical knowledge of the subject.

The percentage of failures on the results of the examinations in all the subjects has increased from 37·5 in 1883 to 49·7 in 1884. This increase in the number of failures is due to many causes, prominent among which is the want of skill in drawing, and of previous science teaching on the part of the candidates. In many subjects, too, there is still experienced the serious want of competent teachers, which it is hoped will, to some extent, be remedied when the central institution is in working order.

The large accession to the total number of candidates is due mainly to the increase in the number of candidates in cloth and cotton manufacture, in weaving, and in mechanical engineering, and to the addition of the subject of carpentry and joinery to the programme.

"Looking at the general results of the examination," Mr. Magnus says, "the large increase in the number of students under instruction, and of the candidates who presented themselves for examination, may be considered satisfactory, as indicating the more general desire of artisans, and of those engaged in manufacturing industry, to take advantage of the opportunities now offered to them of receiving technical instruction. At the same time, the larger proportion of failures consequent upon this accession of candidates, the majority of whom are already familiar with the practice of their trades, but possess a very imperfect knowledge of the application thereto of the principles of science, shows the need that still exists of improved and of more systematic technical instruction for those who are employed in factories and workshops.

"Although the Royal Commissioners on Technical Instruction have spoken encouragingly of the facilities now offered to artisans of obtaining in evening classes good scientific and technical teaching, it would appear that the number of persons engaged in manufacturing industry who avail themselves of the Science and Art Classes under the Department is still comparatively small, and that the proportion of children who learn drawing in the public elementary schools is, as yet, inconsiderable. These causes, doubtless, prevent our artisans from deriving the full advantage of the technical classes now organised in different parts of the kingdom."

THE CHANNEL TUNNEL.

At the invitation of Sir. E. W. Watkin, Bart., M.P., and the directors, some members of the Society's Council and other gentlemen visited the Channel Tunnel works on Saturday, the 2nd inst. Amongst the party were the Duke of Buckingham, Sir Frederick Abel, Sir Frederick Bramwell, Sir Joseph Bazalgette, Lord A. S. Churchill, General Cameron, Captain Douglas Galton, Sir R. Rawlinson, Mr. Andrew Cassels, Colonel Webber, Mr. Brudenell Carter, Mr. J. B. Eads, Mr. Henry Doulton, Mr. Alfred Carpmael, Mr. Owen Roberts, Mr. B. Francis Cobb, Professor Dewar, Mr. J. R. Crampton, Mr. H. Trueman Wood, Mr. Myles Fenton, and Mr. Shaw.

The party inspected the works and the boring machine, which, by permission of the Board of Trade, was set to work for a few minutes experimentally. At the luncheon which followed, a few toasts were drunk.

Sir FREDERICK BRAMWELL, whose health was drunk as consulting engineer of the Tunnel, said he could scarcely trust his temper or his good manners, after a visit to the great work they had seen that day, the progress of which had been arrested. When one considered that the proposition was that the military power of England and the scientific power of England were incapable, in the event of war, of doing away temporarily with a couple of holes 14 ft. in diameter, and twenty miles in length, he was ashamed of it, and it was positively scandalous, for a scare of that kind, that one of the most important works in the world should have been stopped. It had been authoritatively said, "We shall be glad to see you do the work, but you cannot," and now that they had shown that they could carry it out, they were not allowed to. They had spent a large sum of money, and the French on their side had been induced to spend a large sum, and now the work was stopped, not for any reason, but for the most groundless scare that ever disgraced a nation.

Short speeches were also made by the Duke of Buckingham, Lord Alfred Churchill, Sir Frederick Abel, and others of the guests.

CANE AND BEET SUGAR.

By G. BUCHANAN.

(Continued from p. 818.)

In Germany, 12½ cwts. of sugar beets were formerly assessed to make 1 cwt. of crystallised or grain sugar, equal to a yield of 8 per cent. But now, owing to improved cultivation and manufacture, it is believed that in good years, 1 cwt. of sugar is obtained from 11 cwts. of roots, being a return of 9 per cent. In France, not more than 5½ per cent. of grain sugar is made from beets containing 10 per cent. of saccharine matter. About 2 per cent. is procured in the form of molasses, and of what remains, rather more than 1·3 per cent. is given up in the pulp to the farmers. The losses in manufacture will account for the rest. In Demerara, 12 cwts. of canes, with an assumed extraction of 66½ per cent. of juice, make 1 per cent. of grain sugar, equal to a yield of 8⅓ per cent. In Jamaica, the exports, on an average of the five years before mentioned, with the sugar made by the small settlers, which is mostly consumed on the island, show a production of less than one ton of sugar per acre, or a yield of 5 per cent. But on many of the estates, it may be noted, a large proportion of rum is made, Jamaica rum fetching more money than the rum of other places. In Martinique, 13 cwts. of canes, with an extraction of 65 per cent. of juice, are taken to make 1 cwt. of sugar, giving a return of 7·62 per cent. The yield, however, at one of the usines, as the works are called, with an extraction of 77·94 per cent., is stated to have been 8·91 per cent. of grain sugar. In other words, 11¼ cwts. of canes made 1 cwt. of sugar, a result as good as it is perhaps exceptional to have accomplished. The theoretic out-turn gives, nevertheless, a greater yield. For instance, taking the sugar in the canes to be 18 per cent. and the juice 90 per cent. of their weight, the amount of sugar in the juice is found to be 20 per cent. Then $11\frac{1}{4} \times \frac{20}{100} = 2\frac{1}{4}$ cwts., of which an extraction of 77·94 per cent. is 1¾ cwts. And this, allowing for the change of a fourth of the sugar into molasses, shows a loss of one-third of a cwt. in every cwt. manufactured. No account is made of the juice abandoned in the megass from inability to get it, or the loss would appear considerably more. But take the exponent 1 to 13 as a better index of the proportionate production of sugar to cane in good mills. Then $13 \times \frac{20}{100}$ as before = 2·60 cwts., the full contents. And if 85 per cent. of juice be extracted, we get 2·21 cwts. of sugar and molasses. A result that is tantamount to a loss by the ordinary mode of manufacture of cwt. per cwt. In such a case it becomes a pertinent question, how to avoid this loss. In practice there must of course be some waste, and unripe and damaged canes will also cause a destruction of sugar. Yet as it is possible to get the sugar in the beet with a discount of little more than 1 per cent., it cannot be thought a thing impossible to obtain it from the cane without the forfeiture of as much almost as is made. And it is evident that, if the pressing mill has failed to do it, the diffusion process gives promise of greater success. In the Louisiana trials diffusion used only 9⅗ cwts. of canes, when the mill took 13¾ cwts. to make 1 cwt. sugar and molasses, equal to a yield of 10·37 and 7·27 per cent. respectively. At Aska works the yield is much larger, amounting to from 13 to 14·8 per cent., and more than has been obtained by the mill anywhere. It has been objected to the diffusion process that an excess of molasses is produced, and the first run of diffusion in Louisiana showed an excess of 6·79 per cent., the proportion being—

Diffusion .... 50·43 sugar, 49·56 molasses.
Mill .... 57·22 „ 42·77 „

But in the second run of diffusion there was no excess, the proportion being—

58·48 sugar, 41·51 molasses,
or 1·26 per cent. less than the mill.

It will be noticed how large was the quantity of molasses made both by the mill and diffusion, caused probably by the weak character of the cane juice, which does not always ripen successfully in that region. Whether there would be a continued diminution of the amount, the nearer diffusion was brought to perfection in working, it is hard to tell.

Since the failure of the process in Louisiana, the attention of the planters has been given to the better grinding of the canes, by adding to the 3-roller mills in use a 2-roller mill of greater strength and capacity. But seeing what has been done at Aska by diffusion, it may be fairly concluded that the ratio would be decreased. Less than one-third of the product manufactured there is molasses, the proportion on an average of the three years before cited being—

Sugar, 68·06; molasses, 31·93,

and hitherto they have been working the process in wooden vessels made in the country.

To recapitulate, the comparative production may be approximately shown thus:—

	Sugar.	Molasses.	Pulp and Begass.	Loss.	Total.
Diffusion..Germany ......Beet, 11 cwt. make 1 cwt. sugar..........	9·09	2·00	0·70	1·21	13
Mill......France .... „ 18 „ 1 „	5·50	2·00	1·32	1·18	10
„ ......Demerara ......Cane, 12 „ 1 „	8·33	3·00	4·66	2·01	18
„ ......Martinique .... „ 13 „ 1 „	7·69	2·75	5·00	2·56	18
„ ......Full extraction.. „ 13 „ 1¾ „	13·46	2·54	1·00	1·00	18
Diffusion..Aska .... „ 10½ „ 1 „	9·45	4·45	1·30	2·80	18

This Table illustrates the superior skill and enterprise displayed by the beet sugar manufacturers, and their success in dealing with materials of an inferior natural character, in the competition with cane sugar. It does not, however, give a full statement of the case between the beet and the cane, nor does it show how utterly the cane sugar producers have failed to turn to profit the advantage afforded them in the relative yield of the two plants. If the growth of an acre of canes gives a crop of 20 tons, it would, at the rate of 1 to 13, afford a yield of 1½ tons of sugar, or by a full extraction of the juice, 2¾ tons per acre, and the produce of an acre of beets of the richer sort being only half that quantity, or 10 tons, the yield of beet sugar cannot be put higher than 18 cwts., or at the very most, one ton per acre. Now, comparing the great productive capacity of the cane with the largest return obtainable by skilful management from the beet, it would not be too much to say that it will be a reproach if a continuance of the present state of things should be allowed. The sugar planter, not generally well-found in means, may certainly see it to his advantage, when harvesting his large crops of cane, to make a small extraction of the juice, acknowledging to himself that, as was said of old, "He is a fool who knows not how much more the half is than the whole." But if the planter is content to take what he can and not what he may, and expedite his work, the impolicy of this waste, and the need of a reform in the practice, will be recognised by the merchant and the refiner. The coming-in of beet sugar upon us like a flood is not a desirable thing to contemplate by anyone interested in the prosperity of cane sugar making, and it is only by aiding the development of this great source of wealth which the country now holds in neglected possession that the invasion can be met and stayed. In any remedial measures to be taken, the first thing is, as directed in an analogous case of some note, to "catch the hare," that is, to obtain from the cane a saccharine fluid not only as pure and rich as possible, but in as large a quantity as may be shown to be practicable. The further operations of concentrating the juice and refining the sugar are, it will be admitted, of secondary importance. It is proved the sugar is there, in the cane, and is procurable in a greatly increased amount. The call, then, for improvements in the manner of manufacture will not, it may be hoped, when sustained by the Society, be uttered in vain.

(To be continued.)

Correspondence.

PATENT FUEL IN FRANCE.

Briquettes cannot be treated as a new manufacture in France. In 1828 I saw coal dust prepared under that name in small cakes in an hotel at Lille, where they made a hot fire in an English style of grate.

HYDE CLARKE.

32, St. George's-square, S.W.,
26th July, 1884.

Obituary.

CHARLES MANBY.—Mr. Charles Manby, F.R.S., the Honorary Secretary of the Institution of Civil Engineers, died on the 31st ult., at the age of 80 years. He was born in February, 1804, and was the son of Mr. Manby, the founder of the Horsley Iron Foundry. He was originally intended for a soldier, but soon gave up the idea of a military career, and began to study engineering in his father's workshops. In 1835 he came to London, and then for four years practiced the profession of a civil engineer in partnership with Mr. H. H. Price. In 1839 he was appointed Secretary of the Institution of Civil Engineers, and this post he held till 1856, when he became Honorary Secretary, Mr. James Forrest, the present holder of the office, succeeding him as Secretary. On his retirement he was presented with a service of plate, and a sum of two thousand guineas, a portion of which sum he asked might be devoted to the foundation of an annual premium which should bear his name. Mr. Manby became a member of the Society of Arts in 1853, and maintained his connection with the Society until 1880, when advancing years and ill-health caused him to resign.

General Notes.

POPULAR EDUCATION IN AUSTRALIA.—The New South Wales Minister for Public Instruction says, in a recently published report, that there are very few children in the Colony who do not for some period of each year receive instruction, either in schools or at home. The greater number of exceptions are amongst children from 12 to 14 years of age, whose labour is of value to their parents. Many of these, however, especially those in the country, learned to read, write, and cipher before they left school. In places where State Schools are opened for the first time, it might be supposed that the children to attend them had previously been without schooling, but in most cases the necessity for a school in any locality has been caused by a recent movement of population thereto from other settlements, and the children when enrolled are generally found to have been at school elsewhere.

PATENT FEES.—The Board of Trade, with the consent of the Treasury, have made the following modification in the manner of paying certain fees prescribed by the Second Schedule of the Patents, Designs, and Trade Marks Act, 1883:—In the case of patents granted before the commencement of the said Act, a patentee who has paid the prescribed fee of £50 before the end of four years from the date of his patent may, in lieu of the prescribed fee of £100, payable before the end of seven years from such date, pay the following annual fees:—Before the end of the seventh year from the date of the patent, £10; eighth, £10; ninth, £10; tenth, £15; eleventh, £15; twelfth, £20; and thirteenth, £20. This alteration came into operation on the 1st of this month.

POSTAL BUSINESS IN AUSTRALIA.—The estimated number of letters posted for delivery within New South Wales during the year 1883 was 31,258,300, as against 25,737,300 for 1882; the number of letters posted for delivery in the Australian Colonies and New Zealand was 1,401,900, as compared with 1,202,600 for 1882; and the number of letters posted for foreign dispatch was 585,200, as against 498,300 for last year. The total number of letters posted in the Colony during 1883 was 33,345,400, as compared with 27,438,200 for last year. The number of newspapers posted in the Colony was 18,344,500, as against 16,970,100 for 1882. The total number of parcels, &c., was 1,435,900, as compared with 1,087,400 for 1882. The total number of post cards was 259,400, as against 222,800 for 1882. The increase in the number of letters posted is at the rate of about 21 per cent., in the number of newspapers about 8 per cent., in the number of packets about 32 per cent., and in the number of post cards about 16 per cent. The average number of letters posted in 1883, in proportion to the population of the Colony, is estimated at 38 to each person.

SORGHUM EXPERIMENTS.—Experiments with the amber cane have been made by Professor Failyer, of the Kansas Agricultural College. Beginning when the sorghum seed was in the state of stiff dough, and making an analysis at intervals of three to five days until three weeks after the seed was ripe, Professor Failyer found that the quality of the juice increased until perfect maturity of the stalk, and that the maximum contents of cane sugar remained the same while the cane stood in the field. It was further shown that the middle portion of the stalk is far richer in crystallisable sugar than the ends, and that the reverse is the case with the glucose. This difference in favour of the central portions of the stalk increases as the sorghum seed hardens and then declines slightly. The quantity of juice yielded by these parts varies also, being an average of about 44 per cent. for the extremities, and about 55 per cent. for the middle portions. For making syrup, it will pay to use the whole stalk exclusive of the lower joint and of the extreme top. But it is pointed out that in sugar making it will frequently happen, on account of the inferiority in the cane from immaturity or other cause, that the tops and butts should be worked separately for syrup, using four or five central joints for making sugar.—*Times.*

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PLANT LABEL COMPETITION.

The judges appointed by the Council of the Society of Arts to examine the plant labels submitted in response to the offer of prizes have reported, after careful testing of the labels, that, while among those sent in there are many of considerable merit, there are none showing such distinct advance as to deserve the award of either of the prizes offered. The prize of £5, offered by Mr. G. F. Wilson, F.R.S., was for a wooden label treated with some preservative preparation, and the additional prize of £5 5s. offered by Mr. E. G. Loder, was for the best permanent border label suitable for private gardens.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS USED FOR COINAGE.

By W. Chandler Roberts, F.R.S.
Chemist of the Royal Mint; Professor of Metallurgy, Royal School of Mines.

Lecture IV.—Delivered April 7, 1884.

We have now to consider the means adopted to secure accuracy in the weight of coins issued from the Mint, and to examine the questions connected with the loss in weight sustained by coins during their circulation. Before the invention of coined money, the precious metals circulated by weight. Examples of such currency are presented by the gold and silver "talents" of the Schliemann collection, which bear a definite relation to the Babylonian "mina;" and so completely has the spirit of this method of circulation by weight been retained, that the best definition we possess of coins represents them as "ingots, of which the weight and fineness are certified by the integrity of the designs impressed upon the surfaces of the metal."*

Rice Vaughan,† whom I have before quoted, has some interesting remarks on this point in the section of his little work devoted to the consideration "of coining moneys without distinction of weights." He says the proposition is, "that there should be coined no pieces of a certain [*i.e.* definite] weight, either of gold or silver, but that, the allay being certain, the weight should remain uncertain; all money now currant should be valued by a certain weight." For example, every ounce of silver should be valued at five shillings, and every ounce of gold at such a proportion as shall be thought most equal. He points out that, among other incidental advantages, this plan would prevent the "culling, washing, and clipping" of money, that is, its fraudulent reduction in weight; but on the other hand, the objection would be, as he says, "the extreme molestation which the people should receive in the practice of it, when every man should be bound to carry scales in his pocket, and upon every little payment be bound to weigh their money." Few people at the present day bear in mind that this is precisely what, in the case of the gold coin, the existing law requires them to do, for the Coinage Act of 1870, now in force, directs, in Section 7, that "where any gold coin of the realm is below the current weight provided by this Act, every person shall, by himself or others, cut, break, or deface such coin tendered to him in payment, and the person tendering the same shall bear the loss." Compliance with this demand would, of course, render it necessary for each individual, who has reason to expect the tender of a sovereign, to carry scales and weights, as well as shears to cut such pieces as should be found to be deficient in weight.

It will be well for us to examine—1st, what degree of accuracy as to weight the law requires in pieces issued by the Mint; and 2nd, how long gold coins may be expected to circulate without incurring the "extreme penalty of the law." The law takes the same view of coins as is expressed in Butler's "Erewhon" with regard to humanity, and considers defective organisation and decrepitude in a coin to be criminal, and punishable by "cutting and defacing." Mr. John Biddulph Martin, whom I shall again have occasion to quote, well

* Stanley Jevons, "Money," p. 57. 1876.

† "A Discourse of Coin and Coinage," p. 214. 1675.

observes, "We are wont to speak of the life of a coin, but whereas the term 'life' is in all other cases associated with a period of growth, of maturity, and of decay, in this instance the process is one of degradation only."

The first schedule of the Coinage Act of 1870 prescribes the weight at which each coin shall be issued; it also defines the lowest weight at which the gold coins may be permitted to circulate, and it sets forth the "remedy" of weight—that is, the range above or below the exact standard within which the issue of coins would be legal. The silver and bronze coins, being merely tokens, have no "least current weight," but are withdrawn from circulation, and re-coined, when they become defaced by wear. The standard weight of a sovereign is 123·27447 grains, the remedy is $\pm$ 0·2 of a grain, and the least current weight, 122·5 grains. In the case of the half-sovereign, the standard weight is 61.63723 grains, the "remedy," $\pm$0·1, and the least current weight, 61·125 grains. In order to ensure that the coins issued from the Mint shall be well within the remedy allowed by law, it is necessary to adopt in practice a still more minute margin, or allowance for unavoidable error. The "working remedy" adopted in the Mint in the case of the sovereign, is therefore fixed at 0·17 of a grain, instead of the 0·20 which the law allows, and the weight which denotes whether a sovereign is or is not within the remedy, is represented by a piece of wire of fine gold, 0·1355 of an inch in length, and 0·018 of an inch in diameter, and weighing 0·17 of a grain. It will be obvious that the possibility of restricting the weight of coin within such narrow limits, entirely depends on the degree of accuracy which may be attained by the process of rolling the strips of metal from which the discs destined to form the finished coin, are cut; and we have already seen, in the first lecture, that in the case of the fillet prepared for the manufacture of the half-sovereign, a variation of $\frac{1}{20000}$th of an inch above or below the accurate thickness, or a range of $\frac{1}{10000}$th of an inch in the thickness of the fillet would cause the rejection of the coin, on the ground of excess or deficiency of weight. The question then arises—Is it not possible to supplement the operation of rolling by some mechanical operation, conducted on the blanks themselves, in order to bring them within a closer approximation to the exact weight. The problem has long proved an attractive one in Mints, but the earliest suggestion I can find for securing absolute accuracy in weight, occurs in the "Records of the Scotch Mint,* from which it appears that J. Acheson claimed, in 1597, to have discovered a method of making coins so that none shall be "ane grane heavier or lichter nor another."

On the Continent it is very generally the practice to adjust blanks by the aid of a file, the weighing being performed by hand; the process is, however, open to the objection that the marks of the file are never quite obliterated when the blanks are struck into coin, and the same objection applies to most of the machines that remove a fine shaving of metal from the surface of the blank. An additional objection to such a mechanical adjustment of blanks arises from the tendency, in Mints where it is adopted, to produce "too heavy" blanks in the rolling and cutting departments, as it is impossible to adjust blanks which are too light. Some years ago, Mr. J. M. Napier † devised for the Indian Mints an automatic machine of great beauty, which first ascertains how much it is necessary to cut from each blank in order to reduce it to the standard weight, and then removes the necessary amount of metal and no more. The initial cost of such machinery is, however, considerable. Another machine, having the same object in view, has been devised by Herr Seyss.‡

Chemical aid has not been wanting in the attempt to solve the question of the adjustment of blanks. In 1849, M. Diereck, Director of the Mint in Paris, endeavoured to substitute a chemical for a mechanical treatment, by submitting the heavy gold blanks to *aqua regia*, which, it was anticipated, would bring them within the prescribed limits of accuracy, by dissolving away metal. The results were not satisfactory, and the attempt was abandoned.

Having myself attacked the question in 1870, I may, perhaps, be permitted to refer to the results which attended my experiments. It was found that gold, alloyed with copper, might be removed from heavy blanks with singular regularity by means of a suitable solvent, aided by a battery. The blanks were arranged in a frame of wood, and submitted to the action of a solution of cyanide of potassium, the heavy blanks forming the dissolving pole of the battery. The process was not used in the London Mint, as it became evident that

* "Records of the Coinage of Scotland," by R. W. Cochran-Patrick, Esq., M.P. 1876. Introduction, p. clx.

† Patent, No. 108. 1866.

‡ "Dingler's Polytechnisches Journal," ccxlv 61; plate 6. 1882.

it could not replace the present system, under which finished coins alone are weighed, and the manufacture of good coin only is paid for. The late M. de Jacobi, one of the earliest workers in the field of electro-metallurgy, visited my laboratory while the first experiments were in progress, and we discussed the possibility of re-depositing the metal removed from the heavy blanks on those that were too light, the problem being to obtain a tenacious film.

I was greatly interested to find, long after my experiments were made, that an eminent firm of electrotypers had suggested officially that the worn gold coins in circulation could be restored to the legal weight by the electric deposition of a film of gold on the surfaces. The process was, introduced into the Bombay Mint, in 1873, by the late Mr. L. G. Hines, who transferred the metal dissolved from the heavy blanks to blanks which are too light, the latter being by this means raised to the prescribed weight. Its importance in mints where its use is possible may be gathered from the fact that, in the Indian mints, no less than 1,300 tons of silver were converted into coin in one year (1879), so that the saving effected by its use must be considerable.

Whether or not a method for adjusting the blanks be adopted, the finished coin must be weighed before it leaves the Mint, and this, as before stated, is the great obstacle to the introduction of the electro-chemical method into the English Mint. In former times the weighing was effected only in bulk, but more recently, individual pieces have been weighed in this country. I have already pointed out that the weighing may be effected by hand, and this method is very generally adopted on the Continent and in America, where each operator is provided with a delicate pair of scales.

In the Mint of this country, very beautiful automatic machines are used, for a full description of which reference may be made to the "Encyclopædia Britannica."* [The general nature of the appliance was made clear by the aid of a model.] The balance was originally devised in 1851 by the late Mr. William Cotton, of the Bank of England, and has since been improved by the officers of the Mint, and by Mr. J. M. Napier, who has secured several patents in connection with this machine.

In the Vienna Mint, a balance devised by Herr Seyss is employed, which depends upon a somewhat different principle. The beam resembles that of an ordinary balance, with pans suspended from it; one pan contains the weight, and a slide brings forward the coin to the other pan; the depression of the beam produced by a heavy coin brings the balance pan opposite one of several slits, the lowest slit corresponding with the extreme depression of the beam produced by a very heavy coin. The pan is then momentarily fixed, and the coin is allowed to pass away into the slit against which it stands. If the coin is very light, the pan which contains it will rise and stand opposite the highest of the series of slits.

* Ninth edition, art. "Mint."

The life of a coin, after it leaves the Mint, may now be traced, and it will be seen that the conditions of its existence are far less severe in modern than they were in ancient times. The actual wear to which coins are subjected may, no doubt, be rougher at the present day than in the past; but, on the other hand, they are not subject, to anything like the same extent, to ill-treatment from enemies in the shape of clippers and sweaters.

It is difficult to overrate the importance of some system of protecting the edge of the coin against fraudulent treatment, and it is hardly less difficult to understand, at the present day, the extent to which the ill-shapen hammered coins were tampered with. The earliest protection seem to have been afforded by a circle or beaded ring on the surfaces of the coin, and that such circles have been used from early times, is proved by the fact that many Greek coins bear them. Attention is specially directed to the outer circle in an enactment of King Henry VII., which provides that "every piece is to have a circle about the utter part thereof, and also that all manner of gold hereafter to be coined shall have the whole sculptuie without lacking any part thereof, to the intent that the King's subjects might have perfect knowledge, by that circle or sculpture, when the coins were clipped or not." No protection, however, is as efficient as the addition of letterings or devices round the edge of the coins. I have already stated in the first lecture that the practice of marking the edges was adopted, for another reason, in Roman times in the case of the *Nummi Serrati*, mentioned by Tacitus.

Coins may be fraudulently reduced in weight by the action of a solvent aided by a battery, but there is reason to believe that the practice is only carried on to a very limited extent.

Removal of metal by drilling holes and filling them up by base metal has sometimes been resorted to, and the Mint Museum contains interesting examples of American coins which have been sawn so as to leave two thin flat discs, which have subsequently been soldered over a disc of base metal, the precious inside of the coin having been removed. It has been proposed to make the American gold double-eagle dish-shaped, in order to render the centre so thin as to prevent this method of falsification. In mediæval times, tampering with the coin caused the gravest anxiety, and was punished with dreadful severity.

In 1381, the first equivalent of the modern Royal Commission on the Coinage met, and the following was the evidence, or rather were the recommendations, of the individuals who took part in it. Richard Leyc advised that the practice of clipping the gold coin could only be checked by a proclamation directing individuals to weigh coins when they took them, and Richard Aylesbury, a goldsmith, also held that gold pieces which had been reduced by clipping should be universally weighed by those who received them.* I will take only a few more historical instances of instructions as to weighing the coins tendered to individuals. The Mint Records† contain a copy of a proclamation given in the 17th year of King James I., which states that the people, instead of refusing such light gold moneys as were without the remedies * * * * do now for the most part accept in payments, indifferently and promiscuously, all such coins whatsoever tendered unto them, without weighing," which shows that the practice of weighing the coin had been adopted, and was falling into disuse. In 1619, the person who tendered the gold coin was instructed to give twopence for every grain the coin was light, and individuals were directed to brand every piece abnormally light by striking a hole through it, returning such pieces to the owners thereof, thus re-affirming a proclamation made in 1587 by Queen Elizabeth, which directed that the defective coins should be "stricken through and cut into pieces." In 1632, it is stated that "in and about London and Westminster, people carried scales in their pockets, to weigh gold on all occasions."‡ I mention these facts to show that the directions of the present law

* Ruding, vol. i., p. 240.

† Record Book, vol. i., p. 56.

‡ Ruding, vol. i.. p. 386

(Coinage Act, 1870) as to the cutting and defacing of worn coin, rest on ancient precept.

The condition of the silver currency in the end of the 17th century may be gathered from the statement of Lowndes, who computed the amount of all the silver moneys coined in the reigns of Queen Elizabeth, James I., and Charles I., at £15,109,476. Writing in 1695, and allowing for the sums coined in the reign of Charles II., James II., and William and Mary, he did not consider that the silver circulation consisted of more than £5,600,000, of which only £1,600,000 was heavy;* and he further pointed out, as the result of careful weighing of the coin in bulk, that the weight of "the moneys commonly currant are diminished near one half." Not, it must be remembered, merely by legitimate wear, but by the fraudulent practice of "clipping," from which, I believe, modern coinages suffer to a hardly appreciable extent.

It is now necessary to consider the conditions affecting the circulation of a metallic currency, more especially as regards its power of resisting legitimate wear. An experimental inquiry conducted by the officers of the Mint towards the close of the last century, showed that $78\frac{1}{10}$ of the shillings then in circulation were required to make a pound weight, which should have been represented by 62 shillings; eleven years later, $82\frac{9}{40}$ shillings weighed a pound. With regard to the gold coinage, the Mint officers found, in 1807, that 1,000 guineas withdrawn from circulation, had lost 19s. per cent. in value. Parcels of 300 sovereigns, coined in each of the years 1817-21-25-29, were weighed by the officers of the Mint in 1853, and the results proved that they had sustained an average rate of wear of 0·047 grains per annum.

The rate of wear, in the case of gold coins, is dealt with by Jacob;† but we owe an authoritative determination of the annual rate of wear of the gold coin to the late Professor W. Stanley Jevons, F.R.S.‡—formerly assayer of the Sydney branch of the Royal Mint, and subsequently Professor of Political Economy at University College, London—who brought to the consideration of the question an acute intellect and perfect knowledge of the conditions which govern the metallic currency. He proved, as the result of an exhaustive inquiry, that "just about eighteen years' wear will reduce a

* "Essay for Amendment of the Silver Coins," p. 105 1695.

† "The Precious Metals," vol. ii., p. 168. 1831.

‡ *Journal of the Statistical Society*. 1868.

sovereign below its point of legal currency;" and he shows conclusively that the average rate of wear per annum of the sovereign is 0·043 grains, which led to the conclusion that, at the time he wrote, 1868, "31·5 per cent. of the whole of the sovereigns in the kingdom are now no longer of legal currency." He estimated the annual average wear of the half-sovereign at 0·069 grains. Mr. Martin * has since repeated and extended Professor Jevons's inquiry. He has greatly added to the value of the work by bringing it down to the present time; and his researches, which deal with no less than 105,364 sovereigns, confirm, in a remarkable manner, the average rate of wear deduced by Professor Jevons, who adopted a different method of calculation. It may safely be assumed, therefore, that any sovereign which has been in circulation more than eighteen years has been reduced to a point at which it is not legally current, and should, therefore, be withdrawn from circulation, in order that it may be re-coined.

The questions now present themselves—Can this average rate of wear be diminished? Is the form of the coin well adapted to enable it to resist wear; and is it possible to adopt a more durable alloy for our gold coinage? First, with regard to the form; no doubt a sphere which contains the maximum weight in the smallest surface is better adapted than a disc to resist the abrading influence of friction, and it follows, therefore, that the Siamese money, which is nearly globular, will retain its weight longer than any other coin now in circulation.

A short cylinder is the geometrical form which, next to the sphere, presents the smallest surface for the greatest weight, and, consequently, in order to reduce the wear of coins to a minimum, their thickness should be equal to their diameter. Such a form would present many inconveniences; but, on the other hand, coins should not be made too thin, and much may be gained by even a small approach to theoretical requirements. A good practical rule for calculating the most useful diameter of a coin from its weight is given by the following formulæ:—

$$D = P \sqrt[3]{G}$$

D = Diameter in millimetres.
G = Weight in grammes.
P = A certain number found by experiment.

* *Journal of the Institute of Bankers*, June, 1882.

Take the cube root of the weight of the coin, multiply by the number for the particular coin, and this gives the most suitable diameter in millimetres. The value of P for all kinds of gold coins is 11·3.

I have thought it advisable to make the above reference to the matter, although it is not likely that the form of our coins will ever be greatly modified. The mean thickness of the coin does not differ much from the initial thickness of the blank, because in virtue of the "flow" of metals, to which allusion has already been made, the portions of metal diminished in thickness are about balanced by the raised part of the device. Sharp new coins do not wear much more rapidly than old ones, as is shown by the experiments of Professor Jevons and Mr. Martin, that is, the rate of wear of coins at different periods of their career is fairly normal. There is no doubt that a coin in high relief becomes disfigured much sooner than one in low relief, as the unity of a design is greatly impaired by the loss of a prominent feature, and the lovely Renaissance works in low relief [now before you] present a much better appearance after prolonged circulation than their classical predecessors, which are almost lenticular in form. The power of the metal to resist, not wear, but deformation by impact, therefore demands attention, and from this point of view a soft metal is far less useful than a hard one. Coins of lead, for instance, have been found, in experiments to which reference will be made presently, to become rapidly defaced, and reduced to the state of mere blanks, when submitted to mutual action in a revolving drum. Coins of pure gold also become rapidly defaced, although their weight is but little reduced by such treatment. As has already been pointed out, the reason for using an alloy instead of pure metal is the greater durability of the former, and accurate experiments on this point have not been wanting. Their history may be briefly stated as follows:—In 1792, the unfortunate French Statesman Clavière * proposed that pure metals should be used for coinage, and that they should be current by weight. The Académie des Sciences was consulted on the subject, and experiments made by this distinguished body† showed that while the pure metals were rapidly reduced in weight by friction, the addition of even a small amount of base metal had a notable effect in enabling

* "Traité des Monnaies," par. P. F. Bonneville. p. xxiii. 1806.

† "Annales de Chimie" (1793), tome xvi., p. 230.

the metals to resist abrasion by wear. In 1798, the Privy Council appointed a committee "to take into consideration the state of the coins of this realm," and they directed Mr. Henry Cavendish, F.R.S., and Mr. Charles Hatchett, to ascertain experimentally whether the loss of gold coins by wear was "occasioned by any defect, either in the quality of the standard gold, or the figure or impression of the coins." The result was an elaborate investigation, conducted by Mr. Hatchett,* on the "comparative wear of gold," the results of which have since been frequently quoted, and have, in fact, become classical. Hatchett operated both on unstamped blanks and on discs struck by dies, which produced small "rounded prominences, regularly disposed over the surface of the coin." Such blanks, or coined discs, were arranged in two frames, so that the flat surfaces of the metal could rub against each other when the frames were pressed together. Each frame was moved rapidly backwards and forwards by suitable mechanism, the path of each frame being at right angles to the other. The discs were in this way subjected to mutual friction, and the gearing was so devised that while one frame was moving with its greatest velocity, the other was at the extremity of its path, the result being that the coins were prevented from moving always in the same line. The numbers of "revolutions" or contacts of the pieces varied from 20,680 to 229,000. He also used a cubical box of eight inches, in the side, in which the coins were made to revolve; and the discs were also rubbed on a table covered with either flour, fine chalk, or metallic filings, fixed in isinglass. Hatchett's main conclusion was that the "extraordinary loss which the gold coin of the kingdom is stated to have sustained within a certain limited time, cannot, with even a shadow of probability, be attributed to any important defect in the composition or quality of the standard gold."† He further observes "that the experiments on the various alloys of standard gold (that is gold standardised with various metals) concur with established practice and opinion to prove that only two of the metals, viz., silver and copper, are proper to be employed in the reduction of fine gold to standard for the purpose of coin." Notwithstanding the care and skill employed by Hatchett in conducting his experiments, some of his deductions appear to demand confirmation. The subject possesses additional interest

* Phil. Trans. Roy. Soc., 1803, p. 43.

† Loc. cit. p. 190.

at the present time, because it is probable that much of the light gold coin now in circulation will soon be withdrawn; and it has therefore been considered advisable that Mr. R. A. Hill, Superintendent of the Operative Department, and myself should resume an investigation on the relative wear of coins of different metals and alloys, which was begun by one of us during the Mastership of the late Mr. Graham. After several preliminary experiments, in which a sliding motion was given to pieces of metal along a smooth surface of oak, we satisfied ourselves that revolving the pieces in a box represents more faithfully the kind of friction to which coins are subjected in the varying conditions of their circulation, and this view was fortified by the opinion of the late Professor Jevons. We addressed ourselves mainly to ascertaining whether the alloy used for the British gold coin, the standard of which is 916·6 is, or is not, more durable than the alloy of 900 fine, which is so widely used by other nations; and we are satisfied that the experimental evidence proves, as regards rate of wear, that there is not much to choose between standards 916·6 and 900. On the other hand, differences in mechanical treatment, resulting from a heavy as compared with a light blow, or in thermal changes produced by annealing, exert greater influence on the rate of wear than the small variation in composition comprised between the limits 900 and 916·6. We agree with the view taken by M. Feer-Herzog* that differences of wear of coins of these two alloys is very slight.

Our experiments are in progress, but the results hitherto obtained are published in the Mint Report for last year.†

The use of aluminium has often been suggested for the manufacture of subsidiary coins, this metal being known to possess the great tenacity when equal volumes of it and other metals are compared. We have been much interested to observe that coins of aluminium, especially if they be alloyed with about 2 per cent. of nickel, are very durable, as are also coins of pure nickel; but in one case the durability results from toughness, and in the other from hardness.

There is one other point in connection with the gold currency to which I would now direct your attention. The Coinage Act of 1870 fixes the remedy on each individual piece, and

* See "Enquête sur la question Monétaire" (Paris, 1792), vol. i., p. 344.

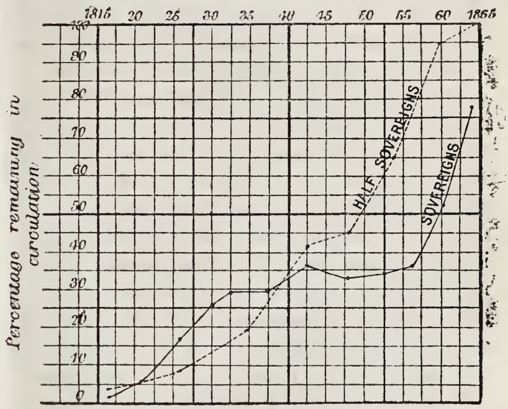
† Fourteenth Report of the Mint, p. 45, 1883.

not, as was the case formerly, on the pound weight of the coin. The object of this provision is to prevent the "culling" the heavy pieces, which would be a profitable transaction if the inequalities of weight were considerable. The heavy pieces so selected might either be exported or used in the arts, and the annals of the coinage abundantly indicate the extent to which the practice was carried on in former times. A notable case occurred in 1637,* when the Attorney-General charged several persons before the Star Chamber with "culling out the weightiest coins, and with melting down his Majesty's moneys into bullion;" and, on examination, it appeared "that between the years 1626-1631, one Timothy Eman culled £500,000 a-year, which yielded £7,000 or £8,000 of heavy moneys yearly, and in five years he melted down £15,000, his profit therout amounting to £100." Another offender was Violet, whose name deserves mention, as his work "An Appeal to Cæsar" contains so much curious information as to the export of bullion.†

I regret to say that the practice of culling is not absolutely unknown at the present day. Professor Jevons stated in 1868, that he "received overwhelming evidence that this picking and culling of the coinage, as it used to be called, is practised as an ordinary business transaction by all banks which need to make remittances to the Bank of England," in order, that is, to avoid the loss which would be entailed if light coin were sent to the Bank, where it would be cut and the deficiency charged for. "It will thus be apparent," Professor Jevons adds, "that there exists a regular system, whereby the older coins are continually returned into the hands of the public, and the new heavy coins alone are returned to the Bank of England, or to those who would melt or export them."

The amount of gold actually in circulation is estimated to be £100,000,000, but the coinage returns show that the amount of sovereigns and half-sovereigns issued since 1816, when their coinage was begun, is £247,521,429. What, then, has become of the 147 millions not in circulation? The coinage returns show that between the years 1864-83, £57,492,842 in sovereigns were coined. A considerable proportion of these have been exported never to return. The following figures, which I offer with some hesitation as they may not be rigidly accurate, show that, while during the same period sovereigns were exported and imported, the excess of exports over imports was no less than £25,991,445, or a yearly average of £1,299,572.

With regard to the disappearance of gold coins from circulation, Professor Jevons has some observations of extraordinary interest. He says it appears "that of the sovereigns coined in 1817-19, not more than one-fiftieth part remain in circulation; and the proportion rises until, between the years 1840-1858, it is about one-third." He suggests in his paper that these curves should be plotted graphically, and this I have done.*



Gold coins in circulation.

In both cases there is an elevation in the period 1840-45, arising probably from the recoinage of the years 1841-43, when £14,000,000 of gold coin were called in and redistributed in an unusual manner, so that more than a common proportion became fixed in the circulation. The most important peculiarity of the numbers is the very small increase which takes place in the proportion of sovereigns preserved between the years 1832 and 1854; this indicates that there is a residuum of coin which is no longer subject to be exported or withdrawn, like the rest of the circulation; for if the proportions of coins exported were taken indifferently, the curve would rise as rapidly as is the case with the half-sovereign curve, those coins not being liable to exportation.

It will be evident, therefore, that in tracing the analogy between the life of a coin and ordinary vital phenomena, we are abruptly checked by observing that the "fittest" coins are not

* Ruding, vol. i., p. 389.

† "An Appeal to Cæsar,' by Thomas Violet, of London. 1660.

* Since the above was written the late Professor Jevons' "Investigations in Currency and Finance" has been published, and this valuable work also gives similar curves.

those which survive as the fittest; that is, the heavy ones drop out of the struggle of active circulation they were created to sustain, and are either exported, or exist as part of a "hoard" of coin. It may, of course, be urged on this ground, that a full-weight coin, issued to the public without charge, is not the fittest to retain its place in circulation, and that a small amount of metal lost by wear really tends to its preservation.

With that Darwinian problem, I must bring these lectures to a close.* You have seen the great change and depreciations through which the "alloys used for coinage" have passed in times gone by, but there is no probability that in this country similar changes will take place in the future, and I cannot find better words to offer you than a quotation from Professor Jevons, whose perfect grasp of the question of metallic currency enabled him to realise its difficulties in a way few of us are able to do. He points out that, in times past, the rulers of nations have been the most notorious false coiners and depreciators of the currency; but that now "the danger lies quite in the opposite direction—that popular governments will not venture upon the most obvious and necessary improvement of the monetary system without obtaining a concurrence of popular opinion in its favour; while the people, influenced by habit, and with little knowledge of the subject, will never be able to agree upon the best scheme."

I can say with Rice Vaughan that "my scope was not to render the reader able to find out the fittest course to govern this matter of money and coin, but able to judge of what should be propounded by others;" but we need no longer fear the state of things described by him when he says "that for want of that ability the wisest states and the greatest Councils of Christendom, for many ages, have been abused by mysterious names and perplexed subtleties of Mint-men."

CONFERENCE ON WATER SUPPLY.

The following are some of the papers read at the Conference of the Society of Arts on the Water Supply, held at the International Health Exhibition on Thursday and Friday, July 24th and 25th:—

* Since the above was written, I find that Mr. J. B. Martin incidentally pointed to this analogy in a paper read before the Institute of Bankers in March last.

WATER FOR DOMESTIC USE.

By S. C. Homersham, M.Inst.C.E.

Water for domestic use, and for distribution through pipes into dwellings in cities, towns, villages, and other places, should be derived from sources that afford adequate quantities at all seasons, characterised as being:—

1. Wholesome for drinking, for culinary and for other uses.
2. Soft without having the power to dissolve or injure lead, and well adapted for washing the person, for use in baths, and for use with soap.
3. Of a normal uniform temperature at its source equal to the average of the climate for the year, which in England differs but little from 50° Fah.
4. Well aërated, holding in solution eight or more cubic inches of gases per gallon, namely, about two of oxygen, six of nitrogen; agreeable and refreshing when drunk.
5. Clear, transparent, colourless, bright, and, when seen in large bulk, pure blue, the natural colour of uncontaminated water.
6. Unable to cause a deposit or fur in the utensil in which it may be heated or boiled.
7. Free from organisms, animal or vegetable, living or dead, and any matter in suspension.

Water in its natural or normal condition characterised by all these seven qualities may be abundantly obtained in some portions of the globe. It abounds in parts of Brazil, in parts of New South Wales, and doubtless in other places. Such water, however, is not abundant in the United Kingdom.

Here it is difficult to find a source that will yield a considerable quantity of soft water associated with the other six named qualities; or to find a source that will yield an abundant quantity of soft water associated with qualities 1, 3, 5, 7.

Water, inland, is all derived from rains that fall on the surface. Land, composed at or near its surface of sand, gravel, chalk, and some other limestone, absorbs nearly all the rain that falls upon it and stores in its pores the greater portion below ground. Other land, consisting of clay, granite, millstone, grit, and other impervious rock, absorbs hardly any of the rain or snow that falls upon its surface. For the most part it flows off the land into valleys, and forms brooks, rivers, or floods. Sometimes the rivers or floods are collected in natural impervious hollows or basins, thus forming natural lakes.

Sometimes artificial hollows or reservoirs, or lakes, are constructed in valleys to catch and impound river and flood water, to supply or feed canals, or to be stored for domestic use. Thus the sources from which water can be obtained for the supply of a population, or for manufacture, or other uses, are—

1. Brooks, rivers, and natural or artificial lakes. These may all be called surface waters.

2. Springs that often naturally issue from the sides of valleys into brooks or rivers, and other subterranean water stored in the pores of rocks below ground may be collected above ground or by means of wells, bore holes, and underground adits or tunnels. Such water may all be termed subterranean or spring water. Water, however, whether surface or spring, is all derived from rain falling on land, mostly on uplands or hills. All brook, stream, or river water, ultimately finds its way by gravitation into the sea through uncovered channels, or rivers, that may be seen, and are often navigable, providing inlets and outlets for vessels from the land into the ocean, or from the ocean inland.

All deep subterranean water also ultimately finds its way into the ocean, through subterranean pores, fissures, or channels, often penetrating to great depths before doing so. Thus, at present, a bore-hole at Richmond, in Surrey, derives a supply from the surface carried down to a depth of more than a quarter of a mile below the surface of the ocean. The water from this bore-hole will naturally rise to an altitude of more than 120 feet above Ordnance Datum, or the mean level of the sea.

As a rule, for domestic uses, subterranean or spring water is greatly to be preferred to river or surface water, more especially when it is derived from certain beds of sand, as then the water often possesses the whole of the seven characteristics before described. Large quantities of subterranean water, however, are derived from the chalk formation in the south and south-east of England, and in Yorkshire, and used for the supply of urban and other populations. Thus a considerable portion of inner and outer London, and numerous towns situated on or near the chalk formation, are supplied by subterranean water absorbed by the chalk. Aylesbury, Brighton, Canterbury, Charlton, Deal, Dover, Greenwich, Gravesend, Hull, Margate, Plumstead, Ramsgate, Tring, Woolwich, and many other places, are entirely supplied by spring or subterranean water obtained in this way from the chalk formation. This water has five out of the seven characteristics I have mentioned, but is wanting in two, namely, softness and non-ability to deposit fur when boiled. By a simple process, however—invented by the late Dr. Clark, and described in a paper read before the Society of Arts on the 14th May, 1856—both the quality of hardness and the power to deposit fur when boiled are got rid of. The process is a simple one, and has now been in practical use for more than a quarter of a century with great success. Water so treated is greatly admired and valued by those who are supplied with it.

Surface water, whether derived from brooks, rivers, or lakes, though the latter be natural or artificial, is usually soft, and less liable to deposit a fur when boiled than most spring or subtaranean water. On the other hand, it is not well adapted or so wholesome for drinking; (3) it is cold in winter and liable to freeze in distributing pipes; warm in summer, and (7) pervaded by numerous living organisms.

(5.) It is not always clear and bright without being filtered (2) and dissolves lead.

Thus, in these most important respects, spring or subterranean water is to be preferred to river, lake or surface water. Those who care to follow this subject more in detail, will find both the quantity and quality of spring or subterranean water, fully discussed in a paper I read before the Society of Arts, on the 31st January, 1855.

It is obvious, also, that all brook, river, or lake water is liable to be greatly contaminated by becoming mixed with faded blossoms and fallen leaves; by mud, mainly composed of decaying vegetable matter and pervaded by numerous living organisms; by manure from off the land; by the excreta of fish, animals, and man, both liquid and solid washed into it, and more especially in times of floods; by the action of frost and other contaminating causes that it would be difficult or impossible to prevent. Indeed, streams and rivers, in a greater or less degree, must always remain the sewer of a district, and the means by which surface washings are conveyed t the ocean.

All river, lake, or surface waters, mor especially in warm seasons of the year, are found to be pervaded by minute livin organisms, vegetable and animal, none of which are found in uncontaminated spring water.

A paper read by Mr. Jabez Hogg, before the Society of Arts, on the 12th May, 1875, will be read with interest by those who care to pursue the subject.

In the Parliamentary Session, 1852, a body of householders deposited plans, and applied to Parliament for powers to supply a large portion of London with softened spring water at a very moderate charge for drinking and personal ablution, thus leaving the old established companies who supplied the Thames water to continue the supply of such water for watering roads, for flushing sewers and closets, and for other gross purposes. At that time, however, the Water Companies had great influence in the House of Commons, so much so, that the Government of the day, very much, as I know, to their regret, felt themselves obliged to exert their influence to prevent the powers sought being granted, in order to secure the passing of a Government measure affecting Imperial interests.

As respects the metropolis, no physical difficulties exist to prevent the whole of the four millions of souls inhabiting the inner and outer circle from being copiously supplied with uncontaminated softened spring water, possessing all the seven characteristics I have named. Indeed, a considerable portion of the inner and outer circle is already supplied with uncontaminated spring or subterranean water, though not (2) of a soft character or (6) free from depositing a fur when boiled.

It is not from want of ability to supply the metropolis most abundantly with subterranean or spring water possessing all the seven characteristics that the inhabitants are not so supplied. The want of an uncontaminated supply to the greater portion of the inhabitants mainly results from want of the necessary technical information among these who have to put up with the present supplies.

Such Conferences and discussions as these we are now concerned with cannot fail to afford much useful information to many, and it is to be hoped will ultimately result in securing a more wholesome, a softer, and a cheaper supply carried into the dwellings of the mass of the population.

SOFTENING OF WATER.

By Baldwin Latham, M.Inst. C.E., F.G.S., F.R. Met. Soc., &c.

Introduction.

From the remotest period of antiquity, of which we have any record, the art of softening water for the purposes of washing and cleansing, appears to have been known and adopted. Long anterior to the invention of soap, of which the elder Pliny gives us the earliest account, as having been first manufactured by the Gauls, caustic alkali derived from wood ashes, and from natural earths, was used as a lye. The process of making an alkaline lye was mentioned by Aristophanes (434 B.C.), and also by Plato (348 B.C.). We have also a record in the volume of Sacred Writ, in Jeremiah ii. verse 22, "For though thou wash thee with nitre and take thee much soap." The Hebrew word *borith* used in this passage is stated by authorities to refer to the vegetable lye of potash, but in another passage of Sacred Writ, Malachi iii., verse 2, where reference is made to "fuller's soap," the Hebrew word *nether* is there believed to apply to a mineral lye or soda. The people of Egypt were known to use mineral alkali and ashes of plants for the purpose of making a lye for washing from an early period, as recorded by Pliny.

Nitrum, a natural lixivious salt which is found in many southern countries, was well known, and was used for washing at a very early period. Certain plants, too, the juice of which is of a saponaceous nature, were used in early days, instead of soap. Meal and many kinds of seeds and bran were also used in connection with washing operations. The urine of various animals kept until it became stale, and alkaline was used in eastern countries, at a very early period; and in the Avesta, special directions are given for cleansing and purifying with the urine of the sacred cow. Pliny, in his "Natural History," states that if water be nitrous or brackish, or bitter, if some fresh barley meal is put into it, that within two hours it will be so amended and sweet, that a man may drink thereof; and a translation made from Pliny, by Dr. Philemon Holland, in 1634, goes on to recount that the same operation of sweetening water may be effected by a kind of chalk which is found in the Island of Rhodes; and a description of clay which is found in Italy will do the same. Pliny, who died A.D. 79, records the manufacture of soap as being composed of tallow and ashes, the best being made of goat's suet and beechwood ashes. That the amount of mineral matter in water, as affecting the conditions of health, was studied at a very early period, is known from the fact that the hydrometer was probably first used for the purpose of ascertaining the quality of the water used for dietetic purposes. Although the principle of the hydrometer has been ascribed to

Archimedes, there is no record of this instrument having been made by him. The earliest record, according to Beckmann, appears from a correspondence between Synesius and Hypatia, the latter of whom was assassinated, A.D. 415, in which Synesius states that he found himself so ill that he proposed to use the hydrometer, and requested Hypatia to at once procure one for him. The mode of strengthening ordinary lye by the addition of lime was known in the time of Paulus Ægineta, a physician who flourished either in the 3rd or the 7th century.

Soap is mentioned by Geber in the second century, and at a later period is frequently referred to by Arab writers, as being used not only for detergent purposes, but also for external application.

Soap is very largely used, or rather wasted, in many places in the present day for softening water. It is now well understood that no useful effect in washing is produced until sufficient soap has been used to soften the water.

For the purposes of this investigation, water may be divided into two classes, hard and soft. *Hard water* is a water which contains salts of lime, magnesia or iron, and sometimes an amount of free carbonic acid. A hard water, commonly considered, is one that destroys soap in washing, while a soft water is one that does not destroy soap. A *soft water* may derive its properties from an absence of earthy salts, or it may have become soft by reason of the presence of certain alkaline salts in the water, notably the salts of soda and potash.

Hard waters may be divided into two classes, those which are permanently hard and those which are temporarily hard. It is often found that a single sample of naturally hard water partakes of both these properties. A water which is said to be be temporarily hard becomes soft by boiling, as the hardness is due to salts of magnesia or lime dissolved in the water by the agency of carbonic acid, or due to the presence of this gas in a free state in the water. Under either circumstances, the effect of boiling the water a sufficiently long time is to drive off the carbonic acid gas, and a natural softening of the water takes place from the absence of this gas, and the earthy salts that have been held in solution by it in the water.

Water that is permanently hard derives this property from the presence of the same salts as under water temporarily hard, but instead of being combined with carbonic acid, they are combined with sulphuric acid, and to soften water that is permanently hard requires very different conditions than is the case with waters that are only temporarily hard.

The qualities of a good drinking water have been described as :—

1st. Freedom from vegetable and animal matter.

2nd. Pure aëration.

3rd. Softness.

4th. Freedom from earthy mineral or other foreign matter.

5th. Coolness and delivery at the minimum temperature.

6th. Lucidity or clearness.

7th. Absence of taste and smell.

Although many authorities insist that for the sake of health a soft water is beneficial, on the other hand, there are those who contend that there is no evidence whatever to show that even a hard water had any influence upon health. It is clear, so far as the health statistics of this country are concerned, that if anything the results come in favour of persons inhabiting districts having hard waters. On the other hand, it has been thought that particular diseases which affect particular localities, such as cretinism and goitre, are due to certain salts of magnesia, which have been found in the waters of the district. Some waters which are of remarkable softness, in which the softness is due to the presence of certain alkaline salts, especially those of soda, may be quite unfit for drinking purposes. A type of this water is found in the well supplying the Trafalgar-square fountains, as it is stated by some authorities that the large amount of soda contained in it, if taken habitually, acts medicinally upon the kidneys. It is also unfit for washing, as the water is liable to destroy certain colours, and stains glass. It is said to be unfit for bathing, as the soda combines with the oily matter of the skin, producing a roughness and liability to chapping. Water, however, which is naturally soft, or which has been softened by means of a process like Dr. Clark's, which does not add any new element to the water, has great advantages for many purposes, it prevents incrustation of steam boilers and household utensils, it results in a saving of fuel, less wear and tear in washing linen, and in the labour of cleansing; it saves soap in all washing and cleansing operations, the water cleans better, and gives a better colour to linen, and it is also stated to lead to greater economy in tea-making and brewing, but whether this is correct or not is very doubtful, as water used for such purposes is always boiled, and when used in that state should be as soft as softened water.

The processes which have been used both in ancient and modern times for softening water may be comprised under the heads of Boiling, Chemical Processes, Distilling, Exposure, Freezing.

Softening by Boiling.—Pliny, in his "Natural History," states that water that hath been once sodden, that is boiled, is far better than that which is raw. There is little doubt that the boiling of water, both as a means of reducing its hardness, and also to effect its purification, was very extensively practised in ancient times, and the practice of boiling water is still carried on amongst some of the older nations, such as China and parts of India, with the greatest possible advantage, both from an economical and from a sanitary point of view. The Emperor Nero (A.D. 50 to 68), both boiled water for drinking purposes, and subsequently cooled it in glass vessels to which snow was externally applied. The effect of boiling water is to liberate the carbonic acid which holds certain alkaline salts in solution, and on the liberation of the acid these salts are precipitated, and forms the coating which furs our kettles, accumulates in our boilers, blocks the circulating pipes of our water-heating apparatus, and is often a source of danger, and always of expense. The effect of boiling water, in order to soiten it, can only be secured when this operation is sufficiently prolonged. The Commissioners appointed to inquire into the chemical properties of the water of the metropolis in 1851, made some experiments on the effects of boiling an artificially prepared hard water containing 13·5 grains of carbonate of lime per gallon, and it was found to decrease in hardness from 13·5° to 11·2° by being heated to the boiling point; after boiling for five minutes, it was reduced to 6·3°, for fifteen minutes to 4·4°, for thirty minutes to 2·6°, and for one hour to 2·4°, so that the softening effect does not take place at once, but a prolonged boiling is required in order to produce the greatest degree of softening. In order to get rid of the temporary hardness of water, sharp boiling for not less than twenty minutes is requisite, but boiling water does not remove the hardness occasioned by the salts which are neutral; in fact the permanent hardness of the water is increased by boiling, as all the water evaporated leaves a concentration of the neutral salts in the remaining water. It has also been shown that the alkalinity of water is more after boiling than when softening has been produced by an alkaline salt such as lime, but both have the effect of reducing the hardness to about the same degree. This increase of alkalinity after boiling is attributed to the concentration of the neutral salts consequent on the loss by evaporation. The temporary salts held in solution by water are precipitated by boiling, and it is these precipitated salts which cause the furring of kettles, hot-water boilers, steam boilers, and hot-water pipes, and have led to the adoption in certain cases of means either for retaining the salts in solution in the water or of preventing their deposit in steam boilers, but as a rule with only partial success.

Chemical Processes of Softening Water.—In a paper read before the Literary and Philosophical Society of Manchester in 1781, by Thomas Henry, F.R.S., a description is given of a mode of preserving sea-water by means of quick lime, in which the author pointed out that the earthy base of magnesia was precipitated in sea-water by lime, and its place taken by a calcareous salt. He also referred in this paper to the well known action of quick-lime on common water as a preservative. The effect of the lime, doubtless, upon the sea and fresh water was to induce abundant precipitation, which dragged down with it certain organic impurities, and as a consequence the water remained free from putrefactive influence afterwards, as was clearly shown in the course of his experiments.

The first patent for purifying water by chemical agency in this country was taken out in 1838, for precipitating by muriate of zinc and salts of soda, the latter salts precipitating the zinc from the water, leaving the water in a purified state.

In 1841, Dr. Thomas Clark, of Aberdeen, took out a patent for his well-known and beautiful process for softening water, and which has, more or less, been the basis of all other patented processes of this description which have been adopted since that period. Dr. Clark thus describes his process, in a paper published in the *Journal of the Society of Arts* of the 16th May, 1856:—

"In order to explain how the invention operates, it will be necessary to glance at the chemical composition and some of the chemical properties of chalk, for, while chalk makes up the great bulk of the matter to be separated, chalk also contains the ingredient that brings about the separation. The invention is a chemical one for expelling chalk by chalk. Chalk, then, consists, for every one pound of sixteen ounces, of lime nine ounces, carbonic acid seven ounces.

"The nine ounces of lime may be obtained apart by burning the chalk, as in a lime kiln. The nine ounces of burnt lime may be dissolved in any quantity of water not less than forty gallons. The solution would be called lime water. During the burning of the chalk to convert it into lime, the seven ounces of carbonic acid are driven off. This acid, when uncombined, is naturally volatile and mild; it is the same substance that forms what has been called soda water when dissolved in water under pressure.

"Now, so very sparingly soluble in water is chalk by itself, that probably upwards of 5,000 gallons would be necessary to dissolve one pound of sixteen ounces; but by combining one pound of chalk in water, with seven ounces additional of carbonic acid —that is to say, as much more carbonic acid as the chalk itself contains—the chalk becomes readily soluble in water, and when so dissolved is called bicarbonate of lime. If the quantity of water containing the one pound of chalk with seven ounces additional of carbonic acid were 400 gallons, the solution would be a water of the same hardness as well water from the chalk strata, and not sensibly different in other respects.

"Thus it appears that one pound of chalk, scarcely soluble at all in water, may be rendered soluble in it by either of two distinct chemical changes; soluble by being deprived entirely of its carbonic acid when it was capable of changing water into lime water, and soluble by combining with a second dose of carbonic acid, making up bicarbonate of lime.

"Now, if a solution of the nine ounces of burnt lime, forming lime water, and another solution of the one pound of chalk and the seven ounces of carbonic acid, forming bicarbonate of lime, be mixed together, they will so act upon each other as to restore the two pounds of chalk, which will, after the mixture, subside, leaving a bright water above. This water will be free from bicarbonate of lime, free from burnt lime, and free from chalk, except a very little, which we keep out of account at present, for the sake of simplicity in this explanation. The following table will show what occurs when this mutual action takes place:—

Agents.			Products.	
Bicarbonate of lime in 400 gallons	Chalk	16 oz.	= 16 oz. of chalk	= 2 lbs.
	with carbonic acid	7 oz.	= 16 oz. of chalk	
Burnt lime in 40 gallons of limewater ...		9 oz		

"A small residuum of the chalk always remains not separated by the process. Of $17\frac{1}{2}$ grains, for instance, contained in a gallon of water, only 16 grains would be deposited, and $1\frac{1}{2}$ grains would remain. In other words, water with $17\frac{1}{2}$ degrees of hardness arising from chalk, can be reduced to $1\frac{1}{2}$ degrees, but not lower.

"These explanations will make it easy to comprehend the successive parts of the softening process.

"Supposing it was a moderate quantity of well water from the chalk strata around the metropolis that we had to soften, say 400 gallons. This quantity, as has already been explained, would contain one pound of chalk, and would fill a vessel 4 feet square by 4 feet deep.

"We could take 9 ounces of burnt lime made from soft upper chalk; we first slack it into a hydrate by adding a little water. When this is done, we would put the slacked lime into the vessel where we intend to soften, then gradually add some of the water in order to form lime water. For this purpose at least 40 gallons are necessary, but we may add water gradually till we have added thrice as much as this; afterwards we may add the water more freely, taking care to mix intimately the water and the lime water or lime. Or we might previously form saturated lime water, which is very easy to form, and then make use of this lime water instead of lime, putting in the lime water first and adding the water to be softened. The proportion in this case would be one bulk of lime water to ten bulks of the hard water.

"It is of importance that the lime, or lime water, that is the softening ingredient, be put into the vessel first, and the hard water gradually added, because there is thus an excess of lime present up to the very close of the process, and this circumstance is found to render the precipitatation of the carbonate of lime produced in the process more easy.

"But what you will wish to know now is, by what mark is the conductor of the process to find out when there is enough of water to take up the last of the excess of lime, so as to be enough, but no more.

"This is done by what has been called the silver test, the only test necessary to the operator after the process is fairly set a-going. This test is a solution of nitrate of silver, in twice distilled water, in the proportion of an ounce per pint. In making use of the silver test with ordinary waters, we get a white precipitate; but if the water have in it a notable excess of lime water, there is a light reddish brown precipitate produced; but if the excess be very slight, we only get a feeble yellow precipitate. The way we make use of the test is to let two or three drops of it fall on the bottom of a white tea cup; then add the water somewhat slowly; then, if there be the slightest excess of lime, a yellow colour will show itself."

It may be here mentioned that a more delicate test than the silver test for ascertaining if there is an excess of lime in the water, consists in using a solution of cochineal, the natural colour of which is yellowish red, which is turned violet in the presence of alkalies; and other agents are now used to show, by distinct colour, or its absence, if there is an excess or not of lime in the softened water.

According to Dr. Clark's scale, 1° of hardness means that there is one grain of chalk in a gallon of water. According to the scale introduced by Dr. Frankland, in the sixth report of the Rivers Pollution Commissioners, parts per 100,000 are used, or one grain of chalk in 100,000 grains of water, so that it is necessary, in considering the reports of the Rivers Pollution Commissioners, to bear in mind this difference of degrees of hardness. To reduce the hardness to parts per gallon, or to the Clark scale, it is necessary to multiply by 7 and divide by 10.

Hard water decomposes soap. The amount of soap ascertained by Dr. Clark to be wasted before softening the water, is equivalent to 2 ounces for each degree of hardness for every 100 gallons. Dr. Clark introduced a soap test, or a means by which a solution of soap is made to at once indicate the degree of hardness of a water. When pure chalk is burnt into lime, one pound is converted into 9 ounces of lime, and this quantity is soluble in 40 gallons of water. Beyond this, lime is not soluble in water, so that clear lime water always possesses a known composition. This amount of lime is equivalent to 98·43 grains per gallon. As one particle of lime will remove $\frac{16}{9} = 1·777$ of chalk, it follows that $98·43 \times 1·777 = 174·9$, or the number of gallons of water 1° of hardness which one gallon of lime water will soften. In practice, however, while theoretically 175 gallons of water of 1° of hardness may be softened by one gallon of lime water, owing to the impurities in the lime, probably not more than 130 to 150 gallons would be softened, so that, to arrive at the amount of lime-water necessary to soften hard water, if we divide 130 by the degrees of hardness according to Clark's scale, it will, generally, roundly represent the number of gallons of water which can be softened by one gallon of lime water.

It is found in practice that neither by boiling nor by the lime process can all the hardness which is termed "temporary hardness" be removed; in fact, a small quantity of chalk, to the extent of one part in 50,000 parts, is soluble in water, and still remains in solution after the process. In practice, however, 10-11ths of the whole of the temporary hardness may be moved by the lime process. In carrying out the Clark process, the lime water is usually applied, owing to the fact that it is a standard liquid containing a known quantity of lime, although cream of lime is sometimes used with advantage. Large tank space is required to carry out the Clark process, three tanks ordinarily being required, one for filling up, another for drawing down, and a third in reserve while cleansing is going on, and each tank should hold a day's supply.

It is a point of importance to know that the salts of iron may be readily removed by the application of lime. This the author found in the case of a water works at Horsham, where the water was so highly charged with iron, that everything it touched was discoloured; but by the application of lime the whole of the iron was removed. It should also be noted that the process has a marked effect in removing organic matter from water. This was shown by the Rivers Pollution Commissioners and by the analysis published by Prof. Wanklyn, especially in the marked diminution in the amount of albuminoid ammonia. The great objection raised against soft water has been its liability to produce lead poisoning; but the consensus of opinion is that water softened by the Clark process is not liable to attack lead, which is a point of very considerable importance in favour of the process.

Dr. Clark's process was first carried out by the Woolwich and Plumstead Waterworks Company, where it was shown that the water was successfully softened from 23° to 7°. These works were subsequently bought by the Kent Waterworks Company, and the process of softening the water was discontinued. An experiment was also made at the Chelsea Waterworks Company's works, the result of which is set forth in the following Table:—

THAMES WATER AT THE CHELSEA WATERWORKS.

1851	Degrees of Hardness.		REMARKS.
	Before liming.	After liming.	
February 24	14·0	4·5	The river was in good condition. The mixing was completed in 10 hours.
March 1	14·1	3·75	The river was in good condition. The mixing was completed in 9¾ hours.
" 18	10·5	5·0	The river was in flood, and the flood tinge was retained after liming.
" 22	11·6	4·8	Recovering from flood. The yellow flood tinge not removed.
April 17	15·5	3·6	The river in an average condition.

In the course of experiments made in softening various waters, it was observed that, if the water was at all tinted, the softening process did not clear it; but there was a tendency for the matters separated to remain in suspension in such water, so that it was considered expedient, in softening river water, that the water should be filtered until quite bright before it undergoes the softening process.

It may be here mentioned that, in 1852, a patent was applied for (W. B. Bowditch) to treat water with clay and alkali, and subsequently filtering.

Mr. Phillip H. Holland, M.R.C.S., late Inspector to the Burial Act Office, suggested, as an addition to the Clark process, the use of oxalate of ammonia or soda, to further reduce the hardness of the water after treatment by this process. The use of carbonate of soda for softening water has been known throughout the whole country by tea-makers from an early period. This salt added to water acts on the bicarbonate of lime and magnesia, and precipitates chalk and carbonate of magnesia. It also decomposes the sulphates of lime and magnesia, precipitating the lime and magnesia, while the soda remains in solution, so that the permanent hardness of the water is reduced by the use of this salt. The Rivers Pollution Commissioners of 1874 state, in their sixth report, with reference to the use of carbonate of soda, that "the hardness of water is almost exclusively caused by the presence in solution of the bicarbonates and sulphates of lime and magnesia. These salts are all decomposed by carbonate of soda, slowly in the cold, but rapidly when the water is hot, insoluble carbonates of lime and magnesia being deposited or precipitated as a fine mud, whilst soluble bicarbonate and sulphate of soda are formed." The process, however, of using soda is much more expensive than the ordinary lime process, about 4¾ times as much soda being required to produce the same results as in the case of lime. An old receipt for softening water, and useful for some domestic purposes, is as follows:—Dissolve 6 lbs. of pearlash or subcarbonate of soda in a gallon of soft water, boil the solution, and when boiling add 2 ozs. of soap, and stir until all the soap is dissolved. When this solution is added to water to be softened, the carbonate of soda and the soap combining with the salts producing both temporary and permanent hardness, form an insoluble compound by the combination with the soap, which coagulates and rises to the surface of the water, and may be skimmed off.

As any of the earthy alkaline earths may be used instead of, or in addition to, lime, it is not surprising that, since the date of Clark's patent, numerous patents have been taken out for softening and purifying water in which lime, in combination with other alkaline earths, have been proposed. For example:—

In 1849, Mr. John Horsley took out a patent for the use of calcined or caustic barytes, phosphate of soda, oxalic acid, or preparations of these substances.

In 1850, lime, in combination with chloride of barium, was patented.

In 1852, hydrate of potass and hydrate of soda, clay, and alkalies were the subject of separate patents.

In 1853 and 1854, hydrate of barytes, and hydrate of strontia formed the subject of patents.

In 1855, a patent was taken out for a powder containing oxalate of ammonia, peroxide of manganese, and charcoal.

In 1856, silicate of soda, in combination with carbonate of soda, was patented.

In 1856, bicarbonate of soda, and oxalic acid, in crystals, were again proposed to be used.

In 1856 and 1857, carbonic acid was proposed to be introduced in conjunction with hydrate of lime.

In 1860, bicarbonate of soda, and silicate of soda were again twice patented.

In 1862, the ordinary lime process was repatented.

In 1863, the use of chloride of barium was patented.

In 1865, hypermanganate of potash, carbonate of soda, alum and neutralised aluminite, or a solution of iron was proposed; and in another patent, sequi-sulphate of alumina was proposed as a means of purifying water. In another patent taken out in 1865 the use of soda and lime is again patented.

In 1866, a patent was taken out by a Mr. J. W. Tobin for an improvement on the Clark process for mixing the lime and filtering.

In 1866, the use of chlorine and permanganates, in combination with any alkaline earth, was patented.

In 1867, a patent was taken out for a preparation in a portable form, consisting of marsh mallow, linseed, bran, starch, gum, or any softening emollient, for the purpose of softening water for ablution purposes.

In 1868, the use of barytes was again patented, and the precipitate removed in vessels of a cellular form.

In 1869, the use of steam applied to water as a means of softening it was patented, the particles subsiding on shelves arranged in a vertical vessel.

In 1872, unslaked lime and sulphate of soda were patented as a means of purifying water.

In 1873, the lime process, in conjunction with a mixing and filtering arrangement, was patented; also lime, carbonate of soda, chloride of barium, or other reagent in conjunction with filtering.

In 1874, the treating of water with lime and carbonate of soda in combination with filtration was proposed.

In 1875, the lime process pure and simple, and in combination with other reagents and filtering, was patented.

In 1876, the lime process in combination with filter presses was first patented by Mr. Porter

In 1877, the use of oxide of magnesia and basic carbonate of magnesia was proposed; also the use of a carbonate of potassa, silicate of soda, and nitre cake, used separately or combined.

In 1878, a patent was taken out for combining bicarbonate of soda with the lime process, and filtering upon the Porter-Clark plan.

In 1879, Mr. Porter took out an additional patent for carrying out automatically the softening and purifying of water. In the same year phosphoric acid and phosphate of lime were proposed as a means of softening water.

In 1880, the means of automatically carrying out the softening process, and adjusting the quantities by means of an arrangement of ball valves in a cistern, was patented.

In 1881, Mr. Porter took out a further patent for the automatic regulation of the supply of the solution of lime.

In 1881, Mr. Atkins took out a patent for treating water with lime, and subsequently filtering through a specially constructed filter.

In 1882, an apparatus for softening and clarifying water was proposed, in which sloping shelves in a vertical vessel were used, the water entering the bottom of the vessel and flowing off at the top; or concentric cylinders overflowing from one to another might also be used with the same object.

In 1883, Messrs. Gaillet and Huet's apparatus for softening water was patented, consisting of sloping and V shaped shelves in a vertical vessel, the water entering at the bottom and flowing out at the top.

The use of steam and caustic soda was also patented.

A patent was also taken out for the use of phosphate of soda, and an apparatus for measuring the water and lime to be used in the softening process.

Modern Inventions for Softening Water.—The modern inventions for carrying out the Clark process may be described as the application of machinery to the saving of time, space, and labour. Of those in general use, dealing with them in the order of date, the Porter-Clark process comes first. In the ordinary Clark process, lime water, in known quantity, is first admitted into a tank, to which the water to be softened is added. However, in some cases, the lime water and the hard water are allowed to flow in together into the tank, but it was considered by Dr. Clark to be an advantage, in carrying out his process, for the hard water to be brought into contact with an excess of lime water in the first instance, which was led into the tank before the water to be softened was added. In the ordinary Clark process, not less than 16 hours were required for the softening and subsidence of the matters separated from the softened water. In the Porter-Clark process, instead of allowing the particles of carbonate of lime to separate and subside, a brisk agitation is maintained, so that these particles remain in suspension to permit chemical reaction with the lime, and the purification of the hard water which, when completed, is passed onward to filter presses, where the carbonate of lime adheres to the filtering cloth. The subsequent operations of filtering through the deposit on the cloth then takes place, and the water is passed away at once in fit state for use, so that the process is continuous in its action, and may be carried on just as quickly as water can be pumped from a well, provided the apparatus is of sufficient capacity to allow time for the water to remain in contact with the lime in passing through the machine. The lime in this case is passed through horizontal cylinders, which are termed lime churns, and is constantly churned up with water, and the lime water so made is, by suitable arraugements, allowed to mix with the ordinary water in proper proportions, after which it is again agitated. Mr. Porter has also an apparatus by which, instead of using ordinary filter presses, he can use filter frames, and where power is not available, he also suggests a means of working the process without such power. In some cases the power obtained from the pressure of the water is utilised for working the apparatus. An apparatus of this description may be seen at the Camden Town locomotive sheds of the London and North Western Railway, and the apparatus may also be seen at work within this Exhibition.

The Atkins Process is also a modification of the Clark process, by which the space formerly required is reduced. The lime is put into a vessel where lime water is formed, and this water is allowed to mix in its proper proportion with the water to be softened in a specially arranged mixing vessel, after which it passes into a reservoir of small dimensions. From this reservoir it is conveyed to filtering vessels which contain a special arrangement of filter, consisting of a series of chambers mounted upon a central hollow shaft, these disc chambers being covered with prepared canvas, npon which the deposit of chalk, &c., adheres, and through which the softened water filters. The filters are cleansed by means of revolving brushes. The apparatus does not require power to maintain it while at work, the only power used being that necessary to give motion to the brushes when the apparatus is cleansed. The system may be seen at work at the Henley-on-Thames Waterworks, and at other places.

In the Process of M. Maignen, a powder is used which the inventor calls "Anti-calcaire." This powder is made of variable composition, in order to suit the special characteristics of the water to be treated, the ingredients used for ordinary hard water being lime, soda, and alum in suitable proportions. In the apparatus, which is at work at the International Health Exhibition for softening water for some of the breeding tanks, the water entering the apparatus gives motion to a water-wheel, which in its turn works an arrangement for distributing a given quantity of the softening agent, and causing it to pass into the water. The water is then allowed to subside in a small tank, and is eventually filtered through filters covered with asbestos cloth, the basis of the filter being similar to that of the "Filter Rapide." A part of the carbonate of lime and magnesia deposited from the water adheres to the filtering surface, and the softened water filters through it. The apparatus may be seen at work in this Exhibition.

The Process of Messrs. Gaillet and Huet.—In this process, which was patented in February, 1883, the patentees make use of certain known agents, the patent itself applying to the apparatus used for the purpose of producing the results after the chemicals have been applied. The agents they propose are lime and caustic soda. Whenever the water contains organic matter, they use salt of alumina or iron in addition. Iron, however, is not recommended in any case where the water is required for washing purposes. The apparatus consists, virtually, of a series of tanks in duplicate, in which the chemicals are mixed, and these enter a vertical pipe in proper proportion to the water to be softened, and which communicates with the bottom of an upright chamber divided by a series of sloping shelves, through which the water gradually works upwards in a zig-zag path. These shelves slope in one direction, and are of V shape, so that as the deposit takes place it accumulates at one point, at which there is an opening ordinarily closed by a tap, and when any tap is open the deposit on the sloping shelf communicating with it is washed out. The apparatus appears to be extremely simple in its design, but its efficiency has yet to be tested, although it is at work at Messrs. Duncan's, Victoria Docks, where the water is reduced from 24° to 6°, and the Thames water is reduced from 16° to 2°.

Purification by Distilling.—It is not necessary to devote any large amount of attention to the question of purifying water by the process of distillation. The process is one which has been used from remote periods in order to produce absolutely pure water, and during the last forty years very great improvements have been adopted in order to bring this process into more general application in connection with the purposes of water supply. The difficulty of obtaining absolutely pure water is practically exemplified by this process, for in attaining this result, unless the water is distilled some two or three times, and every time a large proportion of the residue is discarded, pure water cannot be obtained. In the case, however, of water distilled for dietetic purposes, it is not necessary to carry out the process to the extent required in procuring water for some chemical purposes. It has generally been considered that distilled water lacks æration, and on this account it has been strongly recommended that it should be filtered. The great improvements in the process of distillation are due to Dr. Normandy, whose first patent, taken out in 1851, has been improved upon by many subsequent patents. The process has been adopted with the greatest possible advantage in many of our ocean steamers, and the preservation of the health of the crews and passengers visiting countries liable to the ravages of epidemic disease is, in a great measure, due to the use of this process. It is generally believed by many high sanitary authorities that if this system were adopted at malarious stations, one of the largest channels by which infection is disseminated would be effectually closed. Dr. Macnamara states that on our ocean steamers, "as a general rule, condensed sea water is employed for drinking purposes which, although it may not be always very palatable, must obviously be free from all chance of choleraic contamination;" and this is one of the great safeguards to Europe against the spread of cholera.

Softening by Exposure.—The exposure to the air of water containing salts which are held in solution by carbonic acid causes a loss of carbonic acid. Water of deep wells which has been in contact with chalk and other rocks often contains free carbonic acid by exposure, especially under the inequalities of diurnal temperature, the original charge of ground air is got rid of, and pure atmospheric air takes its place. On exposure to air, hard waters are especially liable to develop vegetable growth. A few days' exposure of very hard water in the summer time will soon develop green confervoid growth, and so soon as this growth takes place, carbonic acid is rapidly used up by it, so that the bicarbonates in the water are soon converted into simple carbonates, and are precipitated. Water, therefore, exposed to air undergoes a chemical metamorphosis; the bicarbonates of lime and magnesia are converted into carbonates, and are precipitated, and it is in this way that exposure assists in softening water.

Softening by Freezing.—Pliny, speaking of the quality of water and of the controversy going on in his time amongst physicians as to the use of water, says that some people preferred rain water above all others, because it is the lightest. He also says that some prefer "snow water before that which cometh down in showers; and the water of ice dissolved before the other of melted snow," and he goes on to say that the rain, snow, and ice are all lighter than those which spring out of the earth, and ice amongst the rest far lighter than any water in proportion. Ice taken from hard or other impure waters, if found to be perfectly crystalline and free from air bubbles, will produce, on melting, a water as soft as that of distilled water. If, however, the ice contains air bubbles or cavities of any description, such water will not be entirely pure. Some years ago the author made an extensive series of experiments upon the degree of purity which might be arrived at by freezing water, when it was shown that the act of freezing may be carried to such an extent as to produce, in the remaining water, a precipitation of the salts in solution, but ice frozen upon very superficial water was found liable to have the impurities frozen in it which adhered to the under sides of the ice, and which became embedded in it by subsequent freezing, but water which has been largely deprived of air by boiling or exposure, upon being frozen, if perfectly crystalline, will produce absolutely pure water. Several patents have been taken out with a view to freezing sea water so as to furnish a supply of fresh water on board ship, but such processes will not compete, from an economical point of view, with the process of distillation.

Geological. — The geological formations which furnish water of a quality suitable to be softened are those of the dolomitic or magnesian limestone, which gives great hardness to water, for while salts of lime render water hard and troublesome in washing, those of magnesia cause the water to curdle, and render it considerably more disagreeable for washing and ablution. The mountain limestone, which is ordinarily of an impermeable nature, does not yield water of such a hard quality as those of the magnesian limestone. The waters of the oolite and chalk are chiefly hard from what has been termed temporary hardness, that is due to the presence of bicarbonates of lime and magnesia in the water, which may be got rid of by boiling, or by the lime process. The waters of the new red sandstone and Permean beds vary considerably in hardness; many of them have a considerable permanent degree of hardness, but there are none of them which may not be softened to a great extent by the adoption of the lime process, while this process, in combination with the other alkaline earths, such as soda, when the water is not intended to be used for dietetic and washing purposes, will still further reduce the hardness of these waters.

The surface wells of the country, usually sunk in drift covering various geological formations, furnish water of various degrees of hardness. Scarcely any such wells yield a soft water, and in most instances, when these wells are sunk in populous places, in addition to their natural hardness, the waters are highly polluted, and such waters ought never to be used for dietetic purposes, unless they are first boiled.

ON THE DETECTION OF SEWAGE CONTAMINATION BY THE USE OF THE MICROSCOPE, AND ON THE PURIFYING ACTION OF MINUTE ANIMALS AND PLANTS.

By H. C. Sorby, LL.D., F.R.S.

By studying with the microscope the solid matters deposited from the water of a river, the previous contamination with sewage can usually be detected without any considerable difficulty. If the amount be serious, the characteristic particles of human excrement can easily be seen; and even if it is small, and has been carried a long way by the current, it can usually be recognised by means of the hairs of oats derived mainly from the droppings of horses, which resist decomposition for a long time, and are not consumed as food by minute animals. I, however, do not propose to enter into detail in connection with this part of my subject, but specially desire to call attention to the connection between the number of minute animals and plants, and the character of the water in which they live, and also to their influence in removing organic impurities.

For some time past I have been carefully ascertaining the number per gallon of different samples of river and sea water, of the various small animals which are large enough not to pass though a sieve, the meshes of which are about $\frac{1}{200}$ part of an inch in diameter. The amount of water used varies from ten gallons downwards, according to the number present. By the arrangements used there is no important difficulty in carrying out the whole method in a satisfactory manner. I confine my remarks entirely to general mean results.

The chief animals met with in fresh water are various entomostraca, rotifera, and the worm-like larvæ of insects. I find that the number per gallon and per-centage relationships of these mark, in a most clear manner, changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase in the total number per gallon, or by an alteration in the relative numbers of the different kinds, or by both. All my remarks apply to the warm part of the year, and not to winter.

It is known that entomostraca will eat dead animal matter, though probably not entirely dependent on it. I have myself proved that they may be kept alive for many months by feeding them on human excrement, though they soon died without it. If the amount of food in any water is small, not many of such animals can obtain sufficient; but, if it be be abundant, they may multiply rapidly, since it is asserted that in one season a single female cyclops may give rise to no less than four thousand millions of young. In stagnant muddy ponds, where food abounds, I have fouud an average of 200 per gallon. In the case of fairly pure rivers the total number of free-swimming animals is not more than one per gallon. I, however, found that where what may be called sewage was discharged into such water the number per gallon rose to twenty-seven, and the per-centage relationships between the different groups of entomostraca were greatly changed. In the Thames at Crossness, at low water, the number was about six per gallon, which fell to three or four at Erith, and was reduced to less than one at Greenhithe.

There is, however, a very decided limit to the increase of entomostraca when the water of a river is rendered very impure by the discharge of too much sewage, probably because oxygen is deficient, and free sulphide of hydrogen present. Such water is often characterised by the great number of worm-like larvæ of insects. Thus, in the Don, below Sheffield, in summer, I found the number, per gallon, of entomostraca only about one-third of what it is in pure waters; whilst, on the contrary, the number of worm-like larvæ was more than one per gallon.

Now if the minute free-swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities. The number of the excrements of entomostraca in the recent mud of such rivers as the Thames is most surprising. In one specimen, from Hammersmith, I found that there were more than 20,000 per grain; and the average number at Erith, in August, 1882, was above 7,000, which is equivalent to about 200,000 per gallon of water at half ebb, from the surface to the bottom. This enormous number must represent a very large amount of sewage material consumed as food; and though, as in the case of larger animals, a considerable part of their excrements no doubt consists of organic matter capable of putrefaction, yet there can be no less doubt that the amount entirely consumed in the life processes of the animals is also great.

As named above, I kept cyclops alive for many months by feeding them on human excrement. It is thus easy to understand why, when they abound in the Thames, the relative amount of human excrement is very considerably less than in the winter, when their number must be much smaller.

We thus appear to be led to the conclusion that when the amount of sewage discharged into a river is not too great, it furnishes food for a vast number of animals, which perform a most important part in removing it. On the contrary, if the discharge be too great, it may be injurious to them, and this process of purification may cease. Possibly this explains why in certain cases a river which is usually unobjectionable may occasionally become offensive. It also seems to make it clear that the discharge of rather too much sewage may produce relatively very great and objectionable results.

Though such comparatively large animals as entomostraca may remove much putrefiable matter from a river, we cannot suppose that, except incidentally, they remove such very minute objects as disease germs, but it would be a subject well worthy of investigation to ascertain whether the more minute infusoria can, and do consume such germs as a portion of their food. If so, we should be able to understand how living bodies, which could resist any purely chemical action likely to be met with in a river, could be destroyed by the digestive process of minute animals. Hitherto I have had no opportunity for examining this question critically, but have been able to learn certain facts which, at all events, show that it is well worthy of further examination. It is only during the last month that I have paid special attention to the number of the larger infusoria, and various other animals of similar type, met with per gallon in the water of rivers and the sea, which can be seen and counted by means of a low magnifying power. At low water in the Medway above Chatham, in the first half of June, the average number per gallon has been about 7,000, but sometimes as many as 16,000. Their average size was about $\frac{1}{1000}$th inch. Possibly the number of still more minute forms may be equally great; but, even if we confine our attention to those observed, we cannot but conclude that their effect in removing organic matter must be very considerable; and judging from what occurs in the case of larger animals, those 1 th of an inch in diameter may well be supposed to consume as food, particles of the size of germs. Up to the present time, I have however collected so few facts bearing on this question, that it must be regarded merely as a suggestion for future inquiry.

So far, I have referred exclusively to the effect of animal life. Minute plants play an important part in another way. The number per gallon of suspended diatoms, desmids, and confervoid algæ is, in some cases, most astonishing, and they must often produce much more effect than the larger plants. As far as I have been able to ascertain, their number is, to some extent, related to the amount of material in the water suitable for their assimilation and growth. In the mud deposited from pure rivers their numbers is relatively small, but in the district of the Thames, where the sewage is discharged, I found that in summer their number per grain of mud at half-ebb tide was about 400,000, which is equivalent to above 5,000,000 per gallon of water. This is two or three times as many as higher up or lower down the river, and, out of all proportion, more than in the case of fairly pure rivers like the Medway. Their effect in oxygenating the water must be very important, since, when exposed to the light, they would decompose carbonic acid, and give off oxygen, under circumstances most favourable for supplying the needs of animal life, and counteracting the putrefactive decomposition so soon set up by minute fungi when oxygen is absent.

Taking then, all the above facts into consideration, it appears to me that the removal of impurities from rivers is more a biological than a chemical question; and that in all discussions of the subject, it is most important to consider the action of minute animals and plants, which may be looked upon as being indirectly most powerful chemical reagents.

ON THE CHEMISTRY OF POTABLE WATER.

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1.—Sources of Water Supply.

The water of most towns is derived, as is well known, from one or other of three typical sources, constituted respectively by springs, or streams, or lakes, this last named source being taken to include not only natural lakes, but also those huge artificially formed reservoirs, in which the surface water collected from more or less extensive gathering grounds, is retained by means of embankments, and stored up for distribution to consumers. Although some streams, indeed, are fed largely by springs, and some lakes are little else than local expansions of streams or rivers, still a general distinction in character between supplies derived from the three just spoken of typical sources, is, on the whole, broadly recognisable; and this, notwithstanding the fact of the considerable differences in composition manifested by individual spring waters, derived from different springs or wells, by individual stream waters, derived from different streams or rivers, and by individual lake waters, derived from different lakes or reservoirs. Despite the marked preference of a few authorities for some one variety of source to the exclusion of the others, the majority of engineers have come to recognise each variety as having its own characteristic excellencies and concomitant defects, and are accordingly ready to avail themselves, in different cases, of whatever kind of source is rendered by local circumstances most available and suitable for the particular town to be supplied. From all three varieties of source alike, numerous large populations have been furnished for generations past, with an abundant, and, as the result has shown, with a satisfactory and wholesome supply of water; although, indeed, in a few special instances, supplies from all three varieties of sources alike have, in different ways and under exceptional circumstances, proved detrimental to the health, and even, in certain cases, fatal to the lives of some among the population supplied. All three varieties of source have, under the best advice of the time, been continually resorted to from the earliest period of water supply undertakings, nearly three centuries ago, down to the present day. Thus, while the youngest of the companies supplying London has obtained its supply, since 1862, wholly from deep wells sunk in the chalk, the new works for the supply of Liverpool and Manchester respectively, which may both take rank among the greatest hydraulic undertakings of the century, are intended to introduce and distribute river water in the one town and lake water in the other. All experience, indeed, goes to show that the supply of excellent water is not confined to its supply from any single variety of source; and that for the purpose of water supply, there are alike good wells and bad wells, good lakes and bad lakes, good rivers and bad rivers. Just, moreover, as the best of river waters or lake waters will fall short in regard to an excellency characteristic of well water, so will the best of well waters fall short in regard to an excellency characteristic of lake water or river water. The comparison of the one sort with the other sorts of water must be made as a whole. To select arbitrarily the special good point of one sort of water as a standard, to the neglect of the countervailing good points of other sorts, and to measure the quality of the other sorts solely in reference to this selected standard, is clearly the conduct rather of an advocate than of a judge.

2.—Purity of Water.

Water, as conceived of by the chemist, is a definite compound of 100 parts by weight of oxygen, united with 12·5 parts by weight of hydrogen. So exceedingly difficult is it of production, even if it ever has been produced in an absolutely pure state, that it may be regarded rather as an ideal than a real chemical substance. All natural water, besides the matter, never entirely absent, which it holds in suspension, is a solution of various mineral matters, of various organic matters, and of various gases in the ideal water, or protoxide of hydrogen, of the chemist. Of the different kinds of foreign substance habitually or exceptionally present in natural water, some kinds are beyond question prejudicial, and in particular cases highly prejudicial; most kinds are simply innocuous; while not a few kinds, as saline matter in moderate proportion, and more particularly dissolved aerial matter, are positively beneficial. Looked at, however, from a strictly chemical point of view, any matter whatever foreign to the ideal chemical compound, water, constitutes an impurity of the natural water in which it occurs, whether this foreign matter be a prejudicial or a beneficial constituent, whether it consist of sewage matter, by which the water is fouled, or of healthful oxygen, by which it is aerated. The chemist uses the word pure, not in the sense of opposite to nasty, but much in the way it is often used in ordinary language, to express the exclusion from one thing of anything else, whether better or worse. Thus, we talk no less familiarly of pure rubbish or pure dross than of pure gold. We speak of pure nonsense as readily as we speak of pure truth, irrespective of the circumstance that the nonsense would be benefited, though to the prejudice of its purity, by its contamination with a few grains of sense. So chemists speak of pure water, irrespective of the circumstance that, for all the needs of life, the water is benefited, though to the prejudice of its chemical purity, by the presence both of its dissolved gases, and of a proportion of dissolved saline matter. Chemists, then, are in the habit of using the word "purity" to signify oneness of chemical nature. Accordingly, in the eyes of a chemist, the matter, for example, of an old copper penny would have its degree of purity equally lowered by the same addition made to it of any kind of other matter, whether of base metal, like tin, or of noble metal, like silver, or even gold. Similarly, in the case of natural water, the small proportions of other substance existing together with the main substance, protoxide of hydrogen, interfere with the oneness of its chemical nature; or, in other words, constitute the natural water a mixture of substances, instead of being a single substance, which is alone looked upon by the chemist as a pure substance. It follows, that the water of the chemist is one thing, the water of nature another. The ideal water of the chemist is a single substance; the water of nature, like the air of nature, is a mixture of substances. Just as this last is a variable mixture of the pure chemical substances—nitrogen, oxygen, water vapour, carbonic acid and ammonia, with traces of various other kinds of matter, so is the water of nature a variable mixture of the pure chemical substances—protoxide of hydrogen, common salt, saltpetre, gypsum, limestone, carbonic acid, nitrogen, and oxygen, &c., together with various kinds of organic matter. Air, from which the minor constituents of atmospheric air have been carefully abstracted, is sometimes spoken of as purified air; but air, deprived in this way of its so-called impurities, is absolutely incapable, in relation alike to animal and vegetable life, of fulfilling the functions of an atmosphere. The substitution of such purified air for actual atmospheric air would mean the cessation on the earth's surface of all life as it now exists. Similarly, with regard to natural water, some of its minor constituents we know to be essential, others of them we have reason to think advantageous to the fulfilment of its functions in nature. Bearing in mind, indeed, the interaction everywhere of life and the conditions of living, we can scarcely doubt that the actual mixed substance, water, is better suited to supply the wants of our daily life, than the ideal unmixed substance would be; and, further, we have no reason whatever to look upon this ideal substance as furnishing a standard of excellence, to which it is desirable that our daily supply should, as far as practicable, and in all respects, approximate. What we really desiderate is not chemical purity, but hygienic freedom from anything hurtful. In some water, as in some air, an objectionable constituent may be met with; but in the case neither of water nor air, is there any presumption on the score of wholesomeness, in favour of a single substance as such, rather than of a mixed substance as such. The presumption is indeed the other way. No one desires unmixed oxygen, or even oxygen and nitrogen free from commixture with the minor constituents of our native air; so neither is there any reason to desire unmixed protoxide of hydrogen, freed from the minor constituents of wholesome natural water. It is clearly open to a chemist, addressing himself to chemists, to speak of the constituents of ordinary water, other than protoxide of hydrogen, as impurities in the water; provided of course that he is consistent, and includes the desirable dissolved gases of the water among its impurities and as contributories to the sum total of its impurity. It is also open to a chemist, addressing himself to chemists, to make a comparison of different natural waters, in respect to the relative proportions of their total impurity, or of their saline impurity, or of their calcareous impurity, or of their organic impurity, or of their aerial impurity, &c. But it is not, I take it, open to a chemist addressing the general public, to speak as a chemist of some particular selected constituent, characteristic of the class of natural waters derived from one kind of source, as an impurity, and to leave it to be inferred by the general public that because this constituent is, in a strict chemical sense, an impurity, it is therefore a something nasty and unwholesome, and that the class of waters in which it is more especially met with are, in proportion to the extent of its presence, nasty and unwholesome. The general public do not know that the chemical impurity of a water may be good or bad, noxious or innoxious, desirable or undesirable, wholesome or unwholesome. They are unaware that no scale of wholesomeness or desirableness can be inferred from a scale of chemical purity, with respect to some particular constituent stigmatised as an impurity, until it has been established by evidence that this particular chemical impurity is of an unwholesome or prejudicial character. It is a mere dialectic artifice, and not a very worthy artifice, to use the word impurity in a strictly scientific sense, with intention to have it accepted in a popular sense as bearing a meaning which, scientifically, by no means belongs to it.

3.—Organic Matter of Water.

The saline matter of water is a useful expression to denote the sum of the dissolved mineral constituents, and the organic matter of water a useful expression to denote the sum of the dissolved organic constituents of natural water. The saline matter of one water is not necessarily, or yet commonly, identical with the saline matter of another water; nor is the saline matter of the selfsame body of water necessarily identical throughout its entire extent, or from one period of time to another. The same holds good with regard to the organic matter of water. It is a different thing in one water from what it is in another; and may be different in the same water from place to place and from time to time. But just as there is a character or nature more or less common to the usual varieties of dissolved saline matter, so also is there a character or nature common, within certain limits, to the usual varieties of organic matter met with in potable water. So far, a certain parallelism holds good between the saline matter of water on the one hand, and its dissolved organic matter on the other. But in many important particulars the parallelism fails. Thus the saline matter occurs, for the most part, in appreciable proportion, say from $\frac{1}{100}$ to $\frac{1}{20}$ of a per cent. It is constituted of definite chemical substances, possessed of well-determined properties; and its amount is capable of estimation with all desirable accuracy—with considerable accuracy by direct weighing, and with yet greater accuracy indirectly, by the separate estimation of its several constituents. The dissolved organic matter of potable water on the other hand, never amounts to more than an exceedingly minute proportion, say from $\frac{1}{5000}$ to $\frac{1}{1000}$ of a per cent.; what are its separate constituents, and what their chemical nature, is almost, if not wholly, unknown; its amount is moreover incapable of direct determination, and the different means for its indirect determination are far from satisfactory. Chemists are capable, however, thanks to Dr. Frankland, of determining with a considerable degree of accuracy, the quantity of carbon that exists in any water, in the form of organic matter. Evidently, if all organic matter contained the same proportion of carbon, a determination of the organic carbon present in any water would be tantamount to a determination of its organic matter. But in reality the proportion of carbon existing in different individual varieties of organic matter has, on the contrary, a very wide range of variation. Still, it would appear, from such imperfect investigations as have been made, that the proportion of carbon existing in the organic matter of water—that is to say, the mean proportion of carbon present in the whole of the several individual constituents of the organic matter, taken together—is not subject to any such considerable range of variation, and that it may, without risk of serious error, be valued at about 40 per cent. Disregarding then for the moment the consideration of the nature of the dissolved organic matter present in natural water, and confining attention only to its quantity, it may be taken as admitted that the determination of the organic carbon in water is an absolute, and more then fairly accurate determination; that the organic matter of water is in a general way proportionate to the amount of its organic carbon; that the amount of organic matter may accordingly be represented by some multiple of the organic carbon; and that for purposes of comparison, at any rate, this multiple may be taken provisionally as 2·5, corresponding, of course, to the occurrence of 40 per cent. of carbon in the organic matter.

The inquiry next presents itself as to what, on the basis of these propositions, is the quantity of organic carbon, and consequently of organic matter present in the three classes of water derived respectively from each of our typical varieties of source. Speaking generally, it may be said that the proportion of organic matter is decidedly least in spring or well water—that is to say, if we limit our attention to such waters only as would be taken for town supply, for there are, of course, foul well waters, in which the amount of organic matter is in excess of anything ordinarily met with in the water of lakes and natural rivers. As between lake sources in general, and river sources in general, it is not easy to assign the order of seriation. The proportion of organic matter found in different lake waters is, on the whole, more uniform than the proportion found in the waters of different rivers. Accordingly, while in some river waters the proportion of organic matter is somewhat higher, there are other river waters in which it is very considerably lower than the proportion commonly present in lake water. On the whole, it would seem that river water in general must take precedence of lake water in respect to the smallness of its proportion of dissolved organic matter, subject, however, to the observation that the proportion of this constituent is more variable in river water—that it is liable to a greater range of variation, both as between the water of one river, and the water of another, and as between the water of the same river at different seasons. In order to give some idea of the quantities of organic carbon, and consequently of organic matter, present in the water, furnished from different varieties of source for town supply, I have made an abstract of the results set forth in the Registrar-General's monthly reports for the last year and a-half, beginning, that is to say, with the report for January, 1883, and ending with the report last made, for June, 1884, in respect to the supplies of London, Birmingham, and Glasgow. I have resorted to the reports of the Registrar-General, in part, because they alone furnish the results of a regular series of analyses of the water supplied to other towns than London; and, in part, because, with regard to London, I have, for the purpose of this address, preferred to bring before you the results of analyses for which I am not in any way responsible. There is not, however, any appreciable difference between the mean results for the period obtained by Dr. Frankland, on the one hand, and by my colleagues and myself on the other, in respect to the composition of the London waters examined by both of us.

The five Thames waterworks companies, as is well known, take their supply from the river at Hampton, Ditton, and Molesey. They furnish just under 50 per cent. of the total supply of the metropolis. The East London Waterworks Company take their supply from the River Lee, some distance below Ware. Their subsiding reservoir at Walthamstow has the enormous area of 222 acres, equal to that of a good-sized lake. The company have power to take in addition ten million gallons of water daily from the Thames at Sudbury. It is but seldom, however, that they resort to the Thames at all; and very rarely indeed to the extent of more than one-quarter of the daily amount they are privileged to obtain. Substantially, the water of the East London Company is water from the Lee. The New River Company take somewhere about four-fifths of their supply from the Lee, above Ware, and the remaining one-fifth from Chadwell springs and a series of deep wells sunk in the chalk. The East London and New River Companies jointly, furnish about 44 per cent. of the total supply of the metropolis. The Kent Waterworks Company take their water entirely from deep wells in the chalk, and furnish from this source rather more than 6 per cent. of the total supply of the metropolis. The water supplied to the town of Birmingham by the Corporation, is taken from various sources, lake or reservoir, stream and well, but in what relative proportions I am unable to say. The water supplied to the town of Glasgow by the Corporation, is taken, as is well known, from Loch Katrine. The underneath table shows the actual quantities of organic carbon, expressed both in parts per 100,000 and in grains per gallon, and the estimated quantities of organic matter in grains per gallon, present in these six several supplies of water, as determined by monthly analyses of the waters conducted during the last year and a-half.

MEANS OF EIGHTEEN MONTHLY ANALYSES, 1883-84.

Source.	Proprietary.	Organic Carbon.		Organic Matter.
		Parts per 100,000.	Grains per gallon.	Grains per gallon (estimated).
Chalk Springs	Kent Company	·047	·033	0·083
River Lee and Springs..	New River Company	·089	·062	0·156
Mixed	Birmingham Corporation ..	·132	·093	0·231
River Lee	East London Company	·139	·098	0·245
Loch Katrine..........	Glasgow Corporation	·147	·103	0·257
River Thames	The Five Companies	·164	·115	0·286

It will be seen that the organic matter of the Kent Company's water, which is a spring water, is under one-tenth of a grain per gallon; that the organic matter of the New River Company's water, which is mainly a river water, is considerably under two-tenths of a grain per gallon; that the organic matter of the East London Company's water, which is a river water, that of the Birmingham Corporation's water, which is a mixed water, and that of the Glasgow Corporation's water, which is a lake water, are alike about two and a-half tenths, *i.e.*, a quarter, of a grain per gallon; while the organic matter of the Thames Companies' supply of river water is under three-tenths of a grain per gallon. It is to be noted, however, that, although the average proportion of organic matter in the Thames-derived water supplied to London, is a little in excess of that in the Birmingham and Glasgow Corporations' supplies, the excess is entirely due to the effect of the winter floods. Comparing the results in the summer nine months, March to September, 1883, and March to June, 1884, the proportion of organic matter in the Glasgow Corporation's supply is somewhat in excess of the proportion found in the Thames supply, the number of grains of organic matter, being for the Thames-derived water ·22, and for the Glasgow water ·25 grain per gallon. Similarly, the organic matter of the East London Company's water, during the summer months, falls appreciably below that of the Glasgow Corporation's supply at the same season of the year,—the season, that is to say, during which a high character of water is considered to be more especially demanded. The above statements, as to the particular fractions of a grain of organic matter ordinarily present in a gallon of different kinds of water, serve to convey some idea of the always exceeding smallness of the quantity. A better notion, however, of the minuteness of even the highest proportions of organic matter found, say, in any London water, is afforded by stating the results in another way. Thus, if we suppose for an instant that the Thames companies' water, instead of containing under three-tenths of a grain, contained seven-tenths of a grain of organic matter per gallon—a maximum which has been occasionally approached in the supply of one or other of the Thames companies at a period of flood—even this exceptional proportion would but correspond to the presence in the water of exactly the thousandth part of one per cent. of organic water. Whether or not, variations within the limit of such a small proportion of dissolved organic matter present in potable water, ranging from about the one-thousandth part of one per cent. exceptionally met with in a Thames-derived water, down to the eight-thousandth part of one per cent. habitually met with in a chalk-spring water, are matters of any real significance, must obviously depend on the character of the dissolved organic matter present in the different waters. It will suffice for the present to observe that, so far as mere quantity of organic matter is concerned, the water supplied to London from the Thames and Lee takes, on the whole, precedence of the highly reputed, and deservedly reputed, water furnished to Glasgow; as, doubtless, it will take precedence of the water about to be furnished to Manchester.

As regards range of variation, it is noticeable that, while the mean proportion of organic matter present in the summer supply of the Thames Companies, as calculated from the average of forty-five analyses reported to the Registrar-General, is ·22 grain per gallon; and the mean proportion present in the yearly supply, as calculated from the average of ninety analyses, is ·28 grain per gallon; the proportion in one particular sample of water out of the ninety samples analysed, fell to ·17 grain, in two samples it rose to ·50 grain, in one sample to ·53 grain, and in yet another sample to ·60 grain; but that in no one sample out of the ninety did it reach the maximum of ·70 grain per gallon, so as to constitute the thousandth part of 1 per cent. of the water. It happens similiarly in nearly all natural waters, that while the absolute variation in the proportion of organic matter present at different times is almost infinitesimally small, the relative variation is, on the other hand, strikingly large. Thus, the proportion of organic matter present in the Glasgow Corporation's lake water at different times varies as 1 to 2; that in the Kent Company's spring water, in the East London Company's water, and in the Thames Companies' water, varies as 1 to 3 or $3\frac{1}{2}$; that in the New River Company's water varies as 1 to 4; and that in the Birmingham Corporation's water varies as 1 to 7; but the larger range of variation in the water of these last two supplies is dependent, doubtless, on the circumstance of their being mixed supplies, constituted of unequal proportions of their several contributories at different times. In the official phraseology with which we are so familiar—phraseology of but little meaning, though the words are strong—it would be said that while the degree of "pollution by organic impurity" of the Glasgow water is twice as great at one time as at another, the degree of "pollution by organic impurity" of the Birmingham water is seven times as great at one time as at another. The large extent of relative variation thus noticeable in respect to the organic matter of water, is common, as might be expected, to those other of its constituents, which also exist absolutely in very small quantity, and is, indeed, almost a consequence of the smallness of their absolute quantity. A somewhat parallel comparison may be adduced in the case of personal wealth. We know that while the wealth of a capitalist will, for the most part, vary only by a small percentage from month to month, the whole fortune of a beggar, his utmost riches being a matter of no consideration, may vary manyfold in the course of a day, although by the absolute amount of only a few halfpence put into or taken out of his ragged pocket.

4.—General Considerations.

So far, attention has been directed to the organic matter of potable water, solely from the point of view of its quantity. A much more important inquiry, however, has reference to its nature or quality. But this is too large and important a matter to be taken up at the fag end of an address, limited strictly to the duration of a short half-hour. That the organic matter of potable water is constituted, in the main, of dissolved, unorganised, and non-living matter, does not admit of question. Anything like an adequate discussion, however, of the origin, nature, and possible hygienic influence of this main portion of the organic matter, could not but involve a very long story. It may suffice here to say that, having regard to its origin and nature, and to the minuteness of its proportion, the presumption against any unwholesomeness attaching to its presence is very strong. To what extent living and organised matter may be also present; how far such living organic matter may include a something capable of developing zymotic disease; and, admitting all this, how far the liability of different waters to contain more or less of noxious living organic matter is related to the varying amounts which they contain of innoxious non-living organic matter, are questions far more difficult of solution. They are questions on which, in the present imperfect state of our knowledge on the subject, it behoves every one to speak with caution; but in my own view, having regard to what is observed and recorded respecting the health of differently supplied populations, and to what little is known of the natural history of disease-producing organisms, the preponderance of evidence does not, I think, favour an alarmful answer. Other persons, however, are of a different opinion. But the address which I have been asked to read at this Conference, is on the chemistry of potable water; and my concern to-day is solely with the chemical aspect of the subject. It is not from biologic or pathogenetic inquiries, but from the results of the chemical analysis of the water supplied to London—from the mere determinations of the quantity of its organic matter—that its wholesomeness is month after month, by suggestion, impugned. On this point I join issue altogether. Further, it seems to me an abuse of chemistry, that a chemist, who on other than chemical grounds may, rightly or wrongly, have satisfied himself of the unwholesomeness of a particular water supply, should state and summarise the results of his analyses in such a fashion as to make it appear that the unwholesomeness, which he really infers on other grounds, is deducible from the results of his periodical chemical examinations. It is well understood that a statement, of which the verbal accuracy cannot be challenged, may, nevertheless, be far from a warrantable statement. It may convey a *suggestio falsi*, and include a *suppressio veri*. Such I take to be the case with the statement, paraded month after month, in what is an official, and should be a scrupulously impartial report, as to the relative "amounts of organic impurity" contained in individual samples of metropolitan water, compared with a particular decennial average amount present in the Kent Company's water,—a standard, by-the-bye, of which the value is known and used only by the reporter, whose comparison, accordingly, it is impossible to check. This monthly statement suggests, I take it, the notion that spring water is the proper type of what river water, or at any rate of what metropolitan water, should be—a notion entirely without foundation, and discordant with the reporter's own strong recommendation of lake water for the supply of London. It further suggests the notion that the desirableness and general wholesomeness of different waters are inversely proportional to their relative "amounts of organic impurity," irrespective of the origin and nature of this so-called impurity,—a notion equally devoid of foundation. On the other hand, the statement in question suppresses the fact that spring water, lake water, and river water, have each their special characteristics, excellencies, and defects. It suppresses the fact that the so-called "previous sewage contamination" of the standard spring water is as relatively high, as its "amount of organic impurity" is relatively low. It suppresses the fact that the "amount of organic impurity" in the metropolitan river supply, though threefold or fourfold that present in the spring water supply, is nevertheless almost infinitesimal in absolute quantity. It suppresses the fact that the "amount of organic impurity" in the highly reputed Loch Katrine supply is, during the summer months, in excess of, and is on the average of the year substantially identical with, the summer and yearly amounts respectively present in the metropolitan river supply. It further suppresses the fact that the head waters of the Thames, by the time they reach Lechlade, about 22 miles only from their source, and 120 miles above the Companies' intake, have exchanged their character of spring water for that of river water, and irrespective of urban contamination, contain an "amount of organic impurity" identical in quantity with, and chemically undistinguishable in kind from, that met with in the river water at Hampton. I dispute altogether the notion, suggested by the mode of statement adopted in the monthly reports made to the Registrar-General, that the relative unwholesomeness of the Kent Company's water, the New River Company's water, and the Birmingham Corporation's water, was, during the last eighteen months, approximately as the numbers 1, 2, and 3; or, in other words, that it was in the proportion of the 8-hundredths, the 15-hundredths, and the 23-hundredths, of a grain of dissolved organic matter per gallon, present in the three supplies respectively. I contend, further, that the New River Company's water would have been no more wholesome or unwholesome respectively, if, instead of actually containing 15-hundredths of a grain of organic matter per gallon—this organic matter being chiefly of vegetable origin, and a product of ordinary fluviatile life—it had contained, like the Kent Company's water, as little as 8-hundredths of a grain, or, like the Birmingham Corporation's water, as much as 23-hundredths of a grain of organic matter, the absolute variations of a tenth of a grain or so of such dissolved organic matter per gallon, being too small to have any real hygienic importance whatever.

If it were indeed the fact that the dissolved organic matter of potable water, taken as a whole, is of such a nature that, in the proportions in which it is met with, it is capable, on occasions, of developing and spreading epidemic disease, it is manifest that no plea, based on the actual smallness of its proportion, would be of any avail to save it from hopeless condemnation. It is manifest also, on this assumption, that the determination of the variations in the proportions of organic matter present in a water, notwithstanding the minuteness of even the maximum proportion, would be a determination of the highest significance; and further, that any information furnished in intelligible language to the general public, as to the results of a comparison of different waters with one another in regard to their respective proportions of organic matter, would have an extreme degree of interest and value. But all this is based on the hypothesis that the dissolved organic matter of water, or at any rate the dissolved organic matter of some water, taken in its entirety, is a noxious constituent of the water, capable, in proportion to its quantity, of setting up epidemic disease; a view, it need scarcely be said, which is sustained by no sort of evidence, and supported by no weight of authority. If, indeed, the organic matter of water were really of this noxious character, the conclusions above set forth, with regard to the propriety and value of a comparison of waters with one another in respect to so noxious a constituent, would be undeniable. But if, on the other hand, the minute proportion of dissolved organic matter met with in potable water is constituted mainly of innocuous vegetable extractive, with a trace or more of innocuous animal extractive; and if, at the same time, this organic matter does not affect in any appreciable degree the taste, or colour, or appearance of the water, clearly all variations in the amounts present in potable water, that fall within the limits of an exceedingly minute proportion, are matters of no consideration whatever; and this whether they be variations in the proportions existing in different waters, or variations met with in the same water at different times. And the same conclusion would hold good, even if the organic matter of water, while constituted in the main and at most times wholly, of innocuous extractive, was, nevertheless, liable to include at other times a sub-proportion of an effectively noxious agent; unless, indeed, it could be shown that the liability of different waters to contain this noxious agent was in proportion to their relative amounts of dissolved organic matter—a proposition so preposterous as never to have been seriously put forward. Whether or not there exist any good grounds for calling in question the excellence and wholesomeness of the water, supplied to probably the healthiest great city in the world, is another matter

Speaking as a chemist, I represent that there are no chemical grounds for such a contention. In support of this position, I would call to mind that the last Royal Commission on Water Supply, after hearing very varied evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial; and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial. Their conclusion on the general question is expressed in the following words :—" Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the companies is not generally good and wholesome."

[This paper was not complete at the meeting of the Conference, and Dr. Odling, therefore, only read the first portion, and the conclusions at which he had arrived.—Ed.]

Miscellaneous.

CANE AND BEET SUGAR.

By G. Buchanan.

(*Concluded from p. 909*)

Worthy, however, as the cane must be acknowledged to be of receiving our exclusive attention, it is yet fortunate that there is at hand in the beet an ancillary sugar bearer to which, when stinted in the supply of cane, we can turn for the relief of our wants. And deserving the sugar beet (it is a mangel wurzel) is to be called " scarcity root," considering how large a quota it furnishes to meet the requirements of our greatly increased consumption, the needs of which would, with cane alone, have caused ere now a sugar famine. According to the Board of Trade returns, the imports of sugar into this country amounted in the year 1882 to 1,130,267 tons, of which more than a third, or 395,915 tons were beet sugar. But the unrestrained admission of this portion of the supply is objected to by the home trade, and strenuous endeavour has been made to restrict the importation of beet, by the imposition of a countervailing duty of £2 per ton, which, as was shown before the Select Committee on sugar, would suffice to equalise the foreign bounties given to the exporters. That the claim has not been conceded is scarcely surprising; the wonder is that it was ever made. The rules of free trade have never been shown to be so considerate of the growers of corn or sugar, as to give reason to suppose they would be indulgent to the second-hand traders in the same products, the millers and melters. And an artificial bar of this kind put up in the way of beet sugar would be surmounted by the manufacturers improving their machinery, and adopting new processes to extract all the sugar possible from the saccharine of the root. The diminution in value by the tax would be compensated by the augmentation in quantity of the sugar; when the controversy would begin again, and a cry be raised to have the barrier made higher. A surer way to stop the influx of the objectionable commodity would be to lower permanently the price. The present low quotation prevailing in the sugar market will, doubtless, lessen for a time the production of beet on the Continent, but so soon as the demand overtakes the supply, and prices rise, the cultivation will be followed up and extended. One-half the time and pains that have been taken in an unavailing opposition to the foreign bounties on beet, would, if given to the introduction of improvements in cane-sugar making, have furthered the object of the planters and refiners more effectually. And that without injuring the consumer, who, when provided with better and cheaper cane sugar, could have no cause to complain of the displacement of beet sugar from the market. But it almost seems as if our people had lost a great deal of their relish for the sweet cane, and had more liking for the unsavoury beet. For instead of applying skill and money to the development of cane sugar works in the Indies, the habitat of the plant, the manufacture of sugar from beetroot is to be commenced in this country. A former attempt to make sugar in Suffolk failed, and it may be doubted if the present trial will be more successful in meeting foreign competition. As although home-grown beet will have a considerable advantage over that from abroad in the saving of freight, &c., the humidity of our climate is almost as great a natural disadvantage. In Germany the wet bulb thermometer shows 2 to 3 degrees more cold than here, indicating the air to be less damp, which is conducive to more richness of sugar in the root. But the depreciation in value from over production is a greater discouragement to beet sugar, for if it was unable, as supposed, to bear the burden of a tax of £2, how can it endure the fall, as reported, of £4 in the market. This decline must be a very serious thing for the growers, and yet sugar can scarcely be said to be too low in price, compared with other articles of food, if the equivalents of their value for food are considered. The natural effect of low prices is to stimulate consumption, and seeing how extensively sugar is employed in the diet of the people, it is for the public benefit that it should be cheap. If the beet-sugar manufacturers have no margin left for working on with profit, and cannot eke out the failing price with a fuller quantity of sugar from the root; the cane-sugar makers are not in the same evil plight. Their situation compares favourably with that of their rivals, and they may look forward with hope and conviction that cane-sugar planting can be made to pay well, although the day of such high dividends as 30 per cent. on the capital employed be past and gone.

ANALYSIS,—COMMERCIAL SUGAR.

	Moisture. Per cent.	Ash.
1. Dutch crushed	·068	·003
2. Clyde crystals	·130	·010
3. German granulated	·062	·118
4. French centrifugal	·118	·061
5. London crystals	·071	·003
6. Paris loaf	·050	lost.
7. German crystals	·077	·063

THE SUGAR CROP.

Cane sugar taken from the figures of export and production in the Blue-books, &c.

	1872.	1882.
Bahamas	219	nil.
Jamaica	30,220	34,553
St. Christopher (1)	5,525	11,828
Nevis (1)	1,682	4,010
Antigua (1)	5,645	12,810
Montserrat (1)	1,349	2,071
Dominica (1)	3,070	3,540
St. Lucia (2)	6,031	6,581
St. Vincent (1)	8,530	7,717
Barbados (1)	33,412	46,674
Grenada	4,217	1,477
Tobago	3,384	2,517
Trinidad	46,023	55,326
Demerara	76,146	124,101
Honduras, Belize	2,203	2,572
Penang and Singapore	12,100	15,750
Mauritius	110,065	113,738
Natal (3)	7,096	11,950
Queensland (3)	3,762	19,051
Fiji	nil.	684
Louisiana (3)	55,958	134,486
Cuba	660,000	574,364
Porto Rico	94,262	83,566
Philippine Islands	91,109	143,227
Martinique (4)	37,344	50,865
Guadeloupe (4)	39,279	46,387
Cayenne	227	nil.
Reunion	36,164	33,959
Johanna, Comoro Isles (5)	?	1,671
Java	206,193	291,031
Surinam	10,584	9,253
St. Thomas, for St. Cruz (6)	4,514	?
Madeira (3)	830	1,161
Cape Verdes (7)	150	25
Brazil	139,459	110,878
Argentine Republic (3)	?	17,000
Peru (8)	6,696	?
Mexico	nil.	1,289
Guatemala (9)	607	?
Salvador	?	605
Nicaragua	?	292
Colombia	126	75
Venezuela (9)	642	?
Dominican Republic	795	10,777
Hawaiian Islands	7,587	46,495
Siam	6,060	600
Egypt	22,892	25,260
Madagascar	nil.	249
Total	1,782,607	2,060,565

(1). Packages nominally the same. Taken hogshead 17 cwt., tierce 12 cwt., cask 9 cwt., barrel 2 cwt. Jamaica and Demerara hogshead 18 cwt. Louisiana hogshead 1,250 lbs. (2). Year 1880. (3). Production. (4). Year 1881. (5). Imported into Mauritius. (6). Caret. (7). Turned attention to distilling rum. (8). At rare intervals a ship is despatched with cargo sugar. (9). Exports do not include sugar.

Beet sugar taken from the figures of production in Lichts' Circular.

	1872.	1882.
France	335,000	393,269
Germany	189,000	644,775
Austro Hungary	162,000	411,015
Russia	90,000	308,799
Belgium	72,000	73,136
Holland	25,000	30,000
Total	873,000	1,860,994
Total, both sorts	2,655,607	3,921,559

Correspondence.

MR. SORBY ON THE DETECTION OF SEWAGE CONTAMINATION BY THE MICROSCOPE.

The short space of time allotted to the discussion of the several groups of papers, read at the Society of Arts Water Supply Conference, precluded me from making a few remarks on Mr. Sorby's paper on the "Detection of Sewage Contamination by the use of the Microscope." I, therefore, venture to put what I intended to say in the form of a communication. As the material constituents of all potable river waters must rather be studied biologically or physiologically, than under low powers of the microscope or chemically, to become of any value, it is obvious that Mr. Sorby's examinations of the coarser and more palpable contaminations of water will, under any circumstances, be of little moment. It is the minuter forms of organic life with which medical men are much concerned, and which are known to be of vital importance as matters of hygiene. These are only discernable by using high powers, and their effects on health and life are only seen by applying the "physiological test." But as Mr. Sorby seems to attach importance to his investigations, it will be as well to inquire if these can be followed to any useful purpose. "The chief animals," he says, "met with in fresh water are various entomostraca, rotifera, and the worm-like larvæ of insects;" and he finds "that the number of these per gallon, and per-centage relationship of these, mark in a most clear manner the changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase on the total number per gallon, &c." In another paragraph, however, a contradiction to this proposition occurs. He says, "a very decided limit to the increase of these forms of animal life takes place when the water of a river is rendered very impure by the discharge of too mnch sewage in it. Thus in the Don below Sheffield, I found the number per gallon of entomostraca only about one-third of what it is in pure waters." This latter statement is, certainly much nearer the truth than the former; it agrees with my own observations and that of others. Most certainly the minute animals enumerated by Mr. Sorby have a decided preference for water uncontaminated by sewage; they are in truth the denizens of lake water, shallow pools, and bogs, in short, of all water abounding in water plants. Moreover, the late Dr. Baird, who wrote an elaborate and valuable "Monograph on the Entomostraca," found most of the species he describes in standing waters of a fairly pure nature. In summer, when the temperature of lake and river waters is much augmented, entomostraca, "minute animals and plants," increase and multiply enormously—I may say alarmingly—since they have often been known to produce serious outbreaks of illness and numerous deaths. For instance at Dorpat, and Boston, America, the lake water supplied to these towns for drinking, became so much infested by entomostraca that whole communities suffered severely from choleraic diarrhœa, and dysentery, and numbers of young children died from these diseases, thus becoming deleterious rather than salutary.

I doubt much whether "the minute animals" enumerated "eat dead animal matter," if they can obtain a sufficient supply of living vegetable matter. I have more frequently found their stomachs filled with the spores of unicellular plants, and their ova sacs glued to the under surface of such weeds as duckweed. Nevertheless, it is quite possible, "to keep them alive for a few weeks or months by feeding on human excrement," as Mr. Sorby did, but we must not lose sight of the fact, that even sewage excremental matter is generally composed of two-thirds of vegetable tissue, while a too concentrated form of sewage as that of Crossness will kill even entomostraca, the water there being found to "contain only six per gallon, and at Erith three or four per gallon." The rotifera are also denizens of water unpolluted by sewage.

Mr. Sorby has omitted to include among his "minute animals," the *gordiaceæ*. The Thames mud—hair-worm, cannot fail to attract considerable notice from its blood red appearance in the mud banks of the River Thames. This genus belongs to the *entozoa*, and although it revels in sewage excrement, is dangerous both to man and animals. As the embryos escape from their eggs, they rise to the surface of the water in millions, to be swallowed by the lower animals when they come to drink, or by insects, in the bodies of which they are developed into parasites of a deleterious nature. Mr. Sorby will, I am sure, admit that investigations which have only "extended over a month" are insufficient to warrant his conclusion, that, "if the minute free swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities."

JABEZ HOGG.

1, Bedford-square,
August 6th, 1884.

Obituary.

SIR ERASMUS WILSON.—Sir Erasmus Wilson, late President of the Royal College of Surgeons, died on Friday, the 8th inst., at his residence, The Bungalow, Westgate-on-Sea. He was born in 1809. He studied anatomy and medicine in London and at Aberdeen, and became a member of the Royal College of Surgeons in 1831. He was made a Fellow of the College of Surgeons in 1843, member of the Council in 1870, and President in 1881. In 1869 he founded the chair and museum of Dermatology in the College of Surgeons, and was elected the first professor. He also instituted the chair of Pathology in the University of Aberdeen. Having amassed considerable wealth by his practice and his medical works, he gave his money away for charitable objects with great liberality. He erected a chapel and new wing to the Sea Bathing Infirmary at Margate, he built the master's house at the Epsom Medical College in 1872, and restored the church of Swanscombe, Kent, in 1873. Her Majesty conferred the honour of knighthood on Mr. Wilson in 1881, after he had been the means of bringing "Cleopatra's Needle" to England. Sir Erasmus became a member of the Society in 1861, and served on the Council in 1878 and 1879.

RICHARD GARRETT.—Mr. Richard Garrett, of Saxmundham, who had been a member of the Society of Arts since 1868, died on the 30th ult., at the age of 55. When only 14 he became apprentice assistant to his father at the Leiston Works, Suffolk. On the death of his father, in 1866, he became senior member of the Leiston firm. It is stated in a memoir of Mr. Garrett, in the *Engineer*, that he devoted his life to the construction and development of the thrashing machine. He also devoted much attention to the improvement of the portable steam-engine. He was elected a member of the Institution of Civil Engineers in 1877.

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FRIDAY, AUGUST 22, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

"*OWEN JONES*" *PRIZES*, 1884.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereon in prizes to "Students of the Schools of Art who, in annual competition, produce the best design for Household Furniture, Carpets, Wall-papers, and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal.

The following is a list of the successful candidates:—

1. Sidney G. Mawson, School of Art, Cavendish-street, Manchester—Designs for calico printing.
2. Alfred G. Weatherstone, West London School of Art—Design for the side of a dining-room, and decoration of a ceiling.
3. Charles B. Aylward, South Kensington School of Art—Designs for carpets.
4. Mary Lloyd, School of Art, Dublin—Design for wall decoration.
5. Marie H. Burghardt, School of Art, Cavendish-street, Manchester—Design for calico printing.
6. Albert E. Godwin, School of Art, Macclesfield—Design for silk hanging.

Proceedings of the Society.

CONFERENCE ON WATER SUPPLY.

The following papers complete the list of those read at the Conference of the Society of Arts on the Water Supply, held at the International Health Exhibition on Thursday and Friday, July 24th and 25th. The report of the second day's discussion will be printed in the next number of the *Journal*.

WATER DISTRIBUTION AND DUAL SUPPLY.

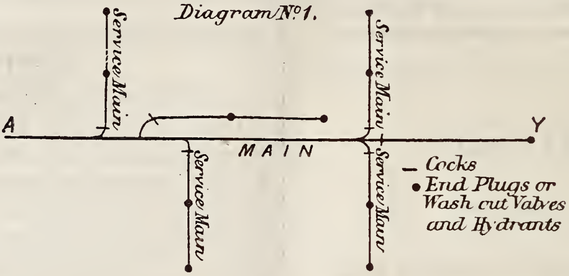
By Col. Sir Francis Bolton.

In former times it was customary to lead water through aqueducts to public fountains, whence it was taken by water carriers to those consumers who could afford to pay for it, while the poorer classes fetched the water from the fountains for themselves; and this system still exists in certain large cities abroad, such as Constantinople and Venice. In some towns, indeed, even in ancient times, this primitive mode of delivering water was found insufficient for the better class of houses. In luxurious Pompeii, for instance, which was destroyed A.D. 79, a very complete system of distribution appears to have existed by means of pipes, which delivered the water direct to the houses. This mode, however, was by no means general, the inhabitants of most cities contenting themselves, as above mentioned, with the services of water carriers.

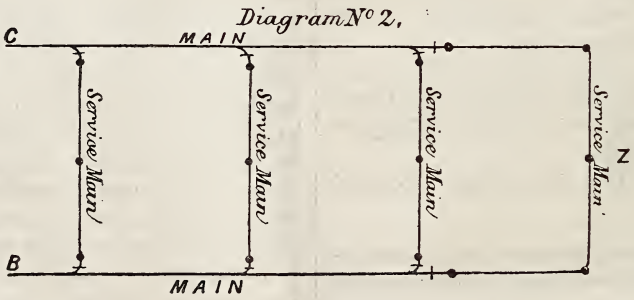
A very noticeable want in connection with those towns which derive their water supply from public fountains is that they are, for the most part, without any sewage system, and the evils arising from this serious drawback may be readily imagined, although it is not the object of this paper to describe them. On the other hand, it should be mentioned that the difficulty of carrying large quantities of water in such towns to the houses separately has, from time immemorial, been remedied to a certain extent by the construction of public baths, and other public conveniences for the general health and benefit of the inhabitants.

The mode of distribution which may now be said to be almost universal is by means of cast-iron pipes, and as far as our knowledge goes, in the present state of hydraulic engineering, this system may be considered perfect. Towns are divided into districts, according to position and level, and in each district mains are laid, usually following the course of the principal streets. From these mains service pipes supply all the streets within the area. Each service pipe is provided with a cock at the junction with the main, and a wash-out valve at the other end, fire-plugs or hydrants being inserted at convenient distances, usually about 100 yards apart. In those districts which are supplied on the intermittent system, the service-pipe cocks are opened and closed at certain ntervals; but where the plan of "constant supply" is adopted, they are always left open, except in case of accident, or during repairs.

On reference to Diagram No. 1, showing part of distributory mains on this system, it will be seen that the water, on entering the service pipes, enters as it were a *cul de sac*, where, unless there is a large draught or consumption, it is apt to remain practically stagnant, thus allowing the impurities held in suspension to be deposited on the sides and bottoms of the pipes. It is for this reason a wash-out valve is placed at the end, which, if opened sufficiently often, allows the impurities to be washed out; but if this precaution is neglected, the impurities accumulate, and when a sudden call is made on the service pipe, find their way to the consumer.



By having no "dead ends," as shown in Diagram No. 2, this difficulty is obviated, as the water is continually circulating in all directions. This arrangement is of great advantage where there is constant supply, as in case of accident at C, the main, B, would supply the service pipes entirely, whereas if an accident occurred at A (Diagram No. 1), the whole district beyond would be without water until the repairs were completed. It has the further advantage that should a fire occur at Z (Diagram No. 2), both mains, B and C, would supply that and the adjoining hydrants, whereas a fire occurring at Y (Diagram 1), would only have the water passing through the one pipe. Equal facilities occur for washing out the service pipes, if found necessary, by closing the cock and opening the adjoining hydrant.



The pipes should be of iron, of good tough quality, as, if the metal is brittle, difficulty is found in cutting the holes to receive the house service pipes; 2 in. pipes are usually cast in 6 ft. lengths, 3 in. to 12 in. 9 ft. lengths, and 12 in. and upwards, in 12 ft. lengths. In order to ensure uniform thickness, the pipes are generally cast upright, and socket downwards; and to prevent oxidation of the interior, they generally either receive a coating of lime inside, or are dipped whilst hot into a mixture of pitch, oil, and tar, which is usually known, from the name of the inventor, as Dr. Angus Smith's composition. The protection of the interior of the pipe is particularly necessary if iron is used in the filtering medium, as otherwise the water becomes distinctly chalybeate if the consumption is slow.

The mode of connecting the pipes together is by slipping the spigot end of one pipe into the socket of the next, and then making the joint. Diagram No. 3 shows the ordinary method of joining pipes. No. 1 is the ordinary "yarn and lead" joint, and No. 2 the "turned and bored" joint. In No. 1 the best white yarn is caulked in to a depth of about 2½ inches, and the rest of the space run in with soft lead, which is afterwards well set up or caulked one-eighth of an inch within the rim of the socket. The chief point to be observed is that no part of the yarn should find its way into the interior of the pipe. In No. 2, the turned spigot is simply brushed with cement or paint, and pushed home into the bored socket. The extra space is sometimes run with lead and sometimes left. The most approved modern system is to run the joint solid with lead without the yarn, a strip of drawn lead being inserted in the bottom of the socket in lieu of yarn.

For connecting the service mains suitable cast-iron branches are introduced. The cocks used for regulating the flow of the water consist of a door, which is raised or lowered by means of a screw worked from the surface, as shown in Diagram No. 4. For the purpose of supplying water in case of fire or other emergency, openings are left in the mains, which are closed in some old waterworks by wooden plugs, but in all recently constructed ones by hydrants, which are undoubtedly to be preferred. The description of these, however, properly belongs to the section treating of the supply of water for extinguishing fires, and a full account of the various forms in use will be found in the special paper on "Water Supply for Fire Extinction," by Mr. J. H. Greathead, C.E.

Diagram No. 3

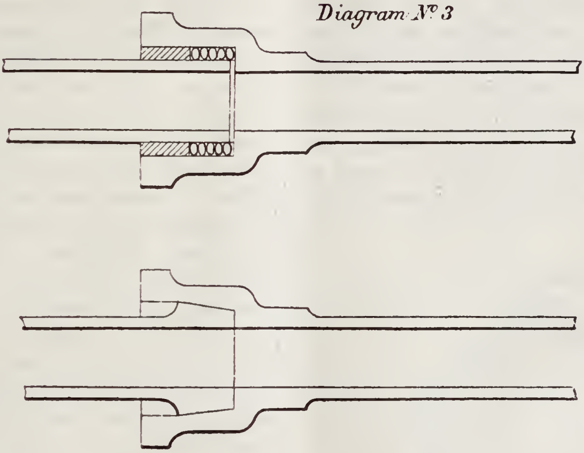
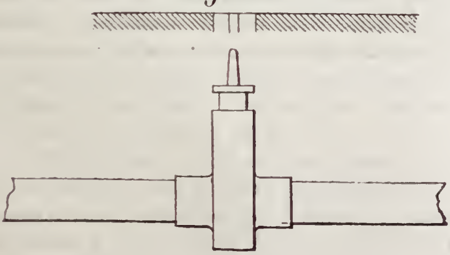


Diagram No. 4.

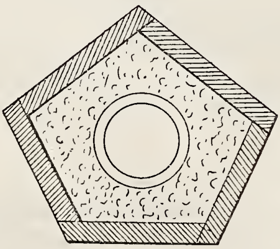


Each house is connected with the service pipe or main, by a pipe called the "house service pipe," the connection being made by means of a ferrule screwed into the main. The house service pipe is generally of lead, but as some waters have a chemical action upon this metal, drawn-iron pipes, either glazed, galvanised, or otherwise protected, are substituted. Where the system of "constant supply" prevails, an apparatus is used in order to avoid inconveniencing the consumer, which enables the ferrules to be inserted while the main is still charged and under pressure.

The depth at which mains should be laid varies according to circumstances, but may be taken in temperate climates to be from two to three feet from the surface of the ground to the top of the pipe. In colder climates the mains should be laid at sufficient depth to escape the action of frost, which, generally speaking, does not extend below four to five feet. When mains are laid at this depth, the cost of laying as well as making house connections and effecting repairs is considerably increased. When the temperature of the water varies considerably at different seasons, the length of main is affected. Where "socket joints" are used, little damage is done, but with "turned and bored joints" it will generally be found in autumn that some tightening up of the joints is necessary, unless special provision is made for the contraction that then takes place.

Where pipes are carried across openings they should be protected from the changes of temperature, which can conveniently be done as shown in Diagram No. 5, in which the pipe is shown enclosed in a wooden casing, the circular space being filled in with felt, sawdust, or other non-conducting material. In laying mains across bridges, great care should be taken for their protection. It will often be found that there is not sufficient depth from the surface to the arch or girder of the bridge to allow of the pipes being laid; when this is the case, it is convenient to carry the mains on cantilevers at the side of the bridge, the pipes being enclosed in a casing of wood or other material, as shown in Diagram No. 5.

Diagram No 5



In new bridges it is generally arranged to leave sufficient space for a subway below the footpaths; this, as a rule, is a very convenient way, as it allows of repairs being effected without interfering with the ordinary traffic.

The system of distribution hereinbefore described refers mostly to the distributing pipes within the town. In some exceptional cases, owing to local circumstances, wooden pipes, similar to those which were used before the introduction of iron pipes, are still used, and in places where freight and carriage are difficult, pipes formed of sheet iron or steel can, owing to their lightness, be more economically used than those of cast iron. Pipes have been made of paper prepared with bitumen and several other substances, but have not been proved able to withstand the severe tests to which water pipes are subject. Where the pressure is very great, as for instance where water is distributed for hydraulic power, the pipes are cast of extra thickness, and a "faced" flange joint with an india-rubber ring inside a recess, into which a projection on the next pipe fits, is sometimes substituted for the socket joint.

The construction of the aqueduct conveying the water from the source to the distributary mains varies with circumstances. If the water is conveyed under pressure, one of iron is necessary, and preferably of cast-iron, which, being laid under the surface of the ground, is better in all respects (apart from cost) than any other. The pipes are so placed as to follow pretty closely the undulations of the ground, an emptying valve being fixed at the bottom of every fall, and an air escape valve at every summit. When large quantities of water, however, have to be conveyed, aqueducts of masonry, brickwork, or concrete have to be adopted. These, unlike pipes which can be made to follow the inequalities of the ground, have to be laid to a regular gradient. Provision is made for draining such aqueducts, and overflows are placed along their length to prevent damage in case of the flow of water being interrupted. All aqueducts of masonry, &c., should be covered, but this is not always possible when they are of large size. Size, indeed, renders the covering less necessary, provided precautions are taken to prevent the infiltration of land drainage, as the large quantity of water flowing down is less liable to be affected the by sun, while the conduit, being uncovered, can be easily and completely cleansed at all times.

The cross section varies with the materials employed; those of brickwork and concrete being generally of an oval or circular form, whilst those of masonry are usually constructed with a rectangular section, and when covered, are sometimes arched over, and sometimes covered with slabs. For the aqueducts, tunnels often have to be made through hills, and conduits over valleys. These latter, when there is sufficient head of water available, are usually crossed by syphons of cast-iron pipes. When, however, the head of water cannot be spared, the aqueduct is carried across the valley at the regular gradient, and supported by piers of masonry, or other suitable material. In this case, the aqueduct is sometimes continued in masonry, brickwork, or concrete, or a trough or tube of wrought iron is substituted. This trough is sometimes made of pipes of sheet iron or steel, riveted together throughout the full length of the crossing, and suspended and braced by wire cables or rods, similarly to a suspension bridge.

One of the most important of modern aqueducts is that bringing the water of the River Vanne to Paris, the length of which is about 90 miles, with 23 syphons of wrought-iron pipes.

The chief points to be observed in the designing of a complete distribution should be—(*a*) that the water, which before entering the mains is in its purest state, should be delivered to the consumer in a similar state, and suffer no contamination on the way; (*b*) that the mains should be of sufficient area to allow an ample quantity of water to pass to meet all contingencies; and (*c*) that a constant circulation should be maintained of about 3 ft. per second, so as to prevent any deposit taking place.

Dual Supply.

In the case of many large towns, an abundant supply of water of inferior quality is found in close proximity, while further off, but still within reasonable distance, a limited supply of better water exists. In considering such cases, it often becomes a question as to the advisability of adopting both sources of supply, the latter for drinking purposes, and the former for domestic and manufacturing uses. In the opinion of the writer, a system of dual supply is not practicable for domestic purposes, but only for municipal or manufacturing requirements. In cases where water is used for power, a dual supply may also be considered indispensable, as the great pressure necessary for its economical use for this purpose is undesirable for a domestic supply. Again, a separate supply for municipal purposes can be used for road watering, sewer flushing, fires, &c., without affecting the domestic supply. In most manufacturing towns the factories are grouped together, and require large quantities of water at a very cheap rate, which, supposing the water is not used in any way for alimentary purposes, can often be supplied from sources sufficiently pure for purposes of manufacture, although the water may be unfitted for household consumption. Such a supply exists at Roubaix, in France, where the cheapness of the water contributes to the prosperity of the town.

Paris also is supplied in the same manner, there being a double set of mains in the streets, one for domestic purposes, and the other for street watering, &c. The supply of potable water, however, is limited, and in time of drought has to be supplemented by water drawn from the Seine.

A dual supply for domestic purposes would entail a considerable extra outlay on the construction of works, as a double line of mains would be necessary in every street, and the cost of most of the house fittings would be doubled, as they would have to be in duplicate. Another objection is the probability that the excellent quality of the water supplied for potable purposes would cause the quality of the other to be little considered, and the latter might deteriorate, or become subject to great contamination. Consumers, bearing this in mind, would probably use the purer water almost entirely. In ordinary times, this might not be of much consequence, but in times of drought it might be serious. This difficulty, it is reported, has just occurred in Paris, which, as just stated, is supplied under this system, and where now, in the heat of summer, with the cholera possibly approaching the town, the drinking water is said to be failing, so that nearly all the supply will have to be taken from the other source, the Seine. Unfortunately, this water is not as carefully filtered and aërated as it would be if it were usually used for domestic purposes, and it may consequently prove a source of danger and disease.

When only one supply exists for domestic purposes, means are generally taken to render it as pure as possible, either by efficient filtration, or by such other means as may be found necessary. Should such water not be considered of a sufficiently high standard of quality, a pure source is selected, and the old one abandoned; when this is impossible, the use of household filters becomes universal.

When the Chelsea Water Company first moved their intake to Ditton, in carrying out the works an extra reservoir was constructed, and extra mains were laid for supplying unfiltered water for road watering and other purposes; but in practice this arrangement was found to be no saving, and to possess no advantage over supplying filtered water for these purposes, so it was discontinued, and now none but filtered water is supplied.

It may be contended that if water were sold by meter, the difficulty of supplying the two kinds of water for domestic purposes would be overcome, inasmuch as the extra cost of the purer water would prevent its excessive use, and so conduce to its conservation and the greater use of the inferior water. This argument, probably, would prove fallacious, as the servants who use the water are unaffected by any such considerations.

It might, further, be urged that the inferior water should only be laid on to the closets, and that the supply to them should be independent of the general domestic supply. This arrangement would leave the remainder of the domestic supply to be furnished by the better water. Baths even would have to be supplied from it, for when it is remembered that they are very frequently supplied with hot water from an apparatus from which water is drawn for other purposes, it will be seen that it would be practically impossible for them to be connected with an inferior supply. Apart from special cases, in which water is distributed under great pressure for power, and under smaller pressure for ordinary consumption, only one plan of dual supply seems feasible, which, however, from the necessity for duplicate mains, &c., must necessarily be costly, though it might prove advantageous in many respects if carefully worked out. The writer would hesitate to advise such a scheme, except under exceptional circumstances. It is that the domestic supply should be entrusted to a company selling water by meter, and the general supply (including supplies to closets) should be in the hands of the municipal authority, and paid for by a general rate levied on all property. In addition, the municipal authorities would receive payment for any water they might dispose of for manufacturing purposes. It will be seen that, under this arrangement, the municipal authority would have under its control waterworks (supplying fairly good water it must always be presumed) for supplying closets, road and public garden watering, sewer flushing, fire extinguishing, and to sell for manufacturing purposes. The company which supplied water by meter for domestic use, and for those manufacturing purposes for which pure water is indispensable, should also be under the supervision of the municipal authorities.

Such a system as the above would probably only be found worthy of consideration in the case of a town which possessed a supply of good water, but of so limited a quantity that the rapid growth of the city rendered an increased supply indispensable, and where there was an inferior supply near, which could be made available at small cost. By these means the consumption of the pure water would probably be reduced to such an extent as to be available for a much larger population, and at the same time, from the fact of the municipal authorities controlling the house drains, closets, and flushing supplies, an improved sanitary condition might result. It is, however, not easy to imagine a town in such a position.

Rain water, as it falls, is in a comparatively pure state, and if proper measures are taken to preserve the surplus falling in wet seasons, and to keep it from contamination, it will generally be found that the rain falling in each watershed is amply sufficient to supply the whole of the inhabitants dwelling in their districts. If any scarcity exists, it is owing, generally speaking, to the want of proper care, or to the fact that the district is so subdivided under different authorities, that joint action for the proper conservation of the rainfall is impossible.

MODE OF DISTRIBUTION, WITH SOME REMARKS ON DUAL SUPPLY.

By Henry J. Marten, M.Inst.C.E.

Until comparatively recent times no attempts were made to afford what we now term "a domestic supply," that is to say, a supply of water distributed to and available within each house for general domestic purposes.

The large supplies of fine water introduced into the principal cities of ancient times, by means of the magnificent aqueducts of which there are many remains to this day, were directed, so far as distribution is concerned, to the supply of public baths and fountains, and possibly here and there to the supply, for similar purposes, of a few of the private residences of the wealthy classes.

A house to house supply, such as we have in modern times, was unknown and undreamt of. The supply for domestic purposes had to be obtained by the occupants of the houses either from the public fountains, or from the streams flowing from them, or was supplied in detail by water carriers, somewhat after the fashion in which milk is now supplied from house to house. Although, according to Pliny, the ancients were aware that water under pressure rises to the height of its source, little practical advantage was taken of the knowledge of this fact. Water under pressure was occasionally conveyed for some distance through stone or earthenware tubes or in leaden pipes. The two former were, however, difficult to be kept tight, and the latter were not only very expensive, but, at an early period of their history, were found to act deleteriously on the water flowing through them. Although, therefore, immense volumes of water were frequently brought into ancient cities, as into Rome, where, according to Strabo, "whole rivers flowed through the streets," and where the total quantity so delivered probably exceeded three hundred gallons per diem to each inhabitant, there was practically no distributed domestic supply.

The inhabitants of modern London, therefore, although only furnished with a supply per head equal to one-tenth of that which used to flow into old Rome, are, nevertheless, infinitely better off than the ancient Roman, because the thirty gallons supplied to the modern Londoner are delivered exactly where he requires it, "upstairs, downstairs, or in my lady's chamber," and the supply is at all times available by the mere turning of a tap. We have here a good illustration showing how various combinations of applied science, united to the practical skill of modern times, have resulted in a tenfold economy, coupled, at a moderate estimate, with a tenfold advantage to the water consumer.

If modern London were supplied in the same wasteful and unscientific manner as ancient Rome, the quantity of water required for the purpose would exceed in volume the average flow of the River Thames at Kingston, and whilst this immense volume of water would be rushing from public fountains, and down open channels made for the purpose in the streets, the inhabitants would be totally without the comfort and advantage which they at present enjoy of a domestic supply delivered under pressure into each of their houses.

Coming to modern times, the distribution of a domestic supply dates back from the time of Peter Morice, who, in 1582, erected waterworks for the supply of the City of London by means of pumps actuated by water-wheels placed in the first two arches of old London-bridge. He appears to have distributed the water under pressure through leaden pipes, but it is probable that a few years later these were replaced by wooden pipes, which, as early as the year 1628, were being laid down by the New River Water Company. These wooden pipes consisted of the trunks of elm trees, cut into lengths and bored longitudinally to an internal diameter of from 6 to 12 inches, in accordance with the internal pressure they were required to withstand. In the parts of the town lying at the lower level (where the pressure would be greatest), the diameter of the bore would be 6 inches, so as to leave a considerable thickness of wood between the inside of the bore and the outside of the tree. In the higher parts of the town, and near the reservoirs, where the pressure would be less, the bore would be gradually increased to 12 inches in diameter, a less thickness of timber being required in those parts. The joints of these wooden pipes were made by forming one end of the tree into a conical shape, and hollowing out the other to correspond; the several lengths, when laid, being then driven one into the other.

These wooden pipes, however, proved very defective, as the loss by leakage was estimated at not less than one-fourth of the whole quantity flowing through them. From decay and other causes they required also to be renewed on the average about once in every twenty years; and consequently, as at one time the New River Company had 400 miles of these pipes laid down, they had to take up and renew upwards of twenty miles in length each year.

Owing also to the small diameter of these wooden pipes, where they had to bear any amount of pressure, more than one line—and in one case no less than nine lines—of pipes had to be laid side by side in the same street, in order to furnish the requisite supply.

When we reflect on the fact that at this period London was almost entirely without under drains, we may be able to form some slight idea of the terrible amount of moisture with which the foundations and basements of the houses adjoining these lines of leaky pipes must at all times have been saturated, and the disturbance which the constant repair and renewal of these pipes must have occasioned to the roads.

Bad, therefore, as matters are at the present time in London and other large towns, from the disturbance of the streets for such repairs, we of the present generation may congratulate ourselves upon the fact that, notwithstanding we now have gas-pipes, sewers, and underground electric wires in addition to water-pipes laid under the streets, the annoyance which we suffer from street disturbance is as nothing compared with that which our ancestors must have had to put up with in this respect.

There are no records to which the writer has access showing whether, in these early times, the supply for domestic purposes was on the constant or the intermittent system, nor whether the water was delivered at the ground floor of each house only or at a higher elevation. With wooden distribution pipes, such as these described, it would be very difficult to have a proper service of stop or shut-off valves, even if an efficient stop-valve for working under pressure were then invented. The frequent stoppages for repairs would necessarily assimilate the arrangements for supply to those of the intermittent system, which involves the necessity of having tanks, butts, or other capacious receptacles for the storage of water in each house.

In the early part of the present century, cast-iron mains began to be substituted for wooden water-pipes, and by the year 1820 the whole of the wooden pipes belonging to the New River Company had been removed and replaced by cast-iron ones. The substitution of cast iron for wood introduced a new era into the art of water distribution, as much higher pressures were rendered available, and leakage was materially reduced. The early cast-iron pipes, although made of the finest cold blast metal, were very rough productions. They were all cast horizontally, and in numerous cases, owing to the imperfection of the machinery, they were far from being either cylindrical or concentric, and thus were frequently thicker on one side than the other. They often, therefore, gave way when exposed to the working pressures they were called upon to sustain, the methods of testing them, previous to their being laid, being primitive and inefficient.

The first cast-iron distribution pipes were made with flanges, on the same principle as the ordinary cast-iron pump trees. These flanges were fastened together with bolts and nuts, the joint being made between the flanges, with an iron ring covered with tarred yarn or flannel. This method, however, soon had to be abandoned, as, owing to the expansion and contraction of the pipes consequent on the changes of temperature in the water passing through them, the flanges were frequently torn off, and hence stoppages for repairs were numerous.

This defect was overcome by the introduction of the spigot and socket pipe. The early joints of these pipes were made by driving soft wood wedges into the sockets, which were made wide for the purpose. When the wedges had been driven into the sockets as far as was considered prudent, the ends projecting beyond the sockets were cut off, and a few small iron wedges were then driven into the wood for the purpose of giving a final tightening. These joints were found to be a great improvement on the previous system of flanges; but as the wooden wedges became saturated with water, they expanded, and frequently burst the sockets. This led to the abandonment of the system of jointing pipes with wooden wedges, and to the adoption of the plan of filling the back part of the socket with yarn tightly rammed in, and then running the remainder of the socket full of molten lead, which on cooling was caulked up, and so made a tight and permanent joint, capable of withstanding the full pressure to which the pipe might be subject, and, at the same time, of allowing for expansion and contraction without leakage.

This method, for the first time, gave those reponsible for the distribution of water under pressure the advantage of having at command continuous distributing tubes of any length, and practically water-tight under any ordinary pressures.

The lead joint, as above described, with variations only for reducing the weight of lead used, or for adding to its security against being blown out by back pressure, has remained a permanent institution, a bar of lead being occasionally substituted for the molten metal.

In some cases, the old-fashioned method of jointing the wooden pipes has been imitated in their cast-iron successors, by turning a conical end to the spigot, and boring the socket, so that, when fitted together, the pipes practically joint themselves without any other stopping.

With the introduction of cast-iron pipes, and greater pressure, the system of intermittent supply became more completely developed and established.

Under the intermittent system, the supply of water was not constantly laid on, as is now almost universally the case. The arrangement was to turn on the water from the principal main into the subsidiary distribution pipe, in any particular street, for an hour or an hour and a-half a day; during which time all the people in that street had to draw and store a sufficient supply for the remainder of the twenty-four hours.

This system, with which the public were long content, ultimately fell into disfavour. Its inconveniences were great; the water was, as stated, only turned on for a very short time; the system necessitated the employment of a large number of turncocks, whose sole business it was to go round the districts to turn the water on and off. The intermittent system was also injurious on sanitary grounds, as it freqnently happened that the vessels in which the water was stored were exceedingly foul, in consequence of putrifying sediment left in them from previous supplies, and the stored water itself was apt to become impregnated with poisonous gases rising through the waste or overflow pipes of the cisterns which were connected with the sewers.

The sanitary defects thus inherent in the intermittent system were the fruitful source of disease and death, and early engaged the attention of the Board of Health presided over by the late Earl of Carlisle, and of which Mr. Edwin Chadwick, C.B., was the earnest and indefatigable secretary. After much inquiry the Board came to the conclusion that these evils could be remedied by the adoption of the constant supply system, which had been introduced at Nottingham by Mr. Thomas Hawksley, past president of the Institution of Civil Engineers, and was in successful operation there on a large scale.

Under the "constant" system, the supply is kept on the whole 24 hours, so that anyone, at any time of the day or night, by simply turning a tap in the house, can obtain a supply direct from the main without the intervention of any intermediate storage vessel.

When the proposition for affording a supply on the constant system was first broached by the Board of Health, it was met by a storm of opposition, some engineering advocates of the old system going so far as to allege that it would be a sheer impossibility to carry out the constant system, on account of the uncontrollable waste that would result from having the water always "on," and because, as there was no guarantee that everybody would not be drawing water at the same time, the main pipes would in consequence have to be of enormous magnitude compared with those necessary under the intermittent system, under which system it was alleged the supply could be more judiciously and economically manipulated.

The controversy on this question raged with great vigour from 1845 to 1850. About that time Sir Robert Rawlinson, C.B., having occasion to visit Wolverhampton in connection with a local inquiry under the Board of Health, asked the writer, who had then recently converted the supply of that town from the intermittent to the constant system, and who at the moment had the means of doing so with great accuracy, to institute some experiments with a view to ascertain what, under the constant system, was the actual rate of consumption at each hour of the day. As the result of these experiments, the writer found that, so far from all the people drawing from the mains at the same time, the highest rate of consumption was only about two and a-half times the total daily supply; that is to say, that the main and distribution pipes under the constant system should be of a capacity sufficient to supply two and a-half times the ordinary daily consumption. Now, as under the intermittent system it was the practice to make the mains and distribution pipes of sufficient capacity to supply four times the ordinary daily consumption, these experiments proved that, so far from larger mains being required under the constant system, they might actually be made of smaller capacity than those required for the intermittent system. It was also shown that, with proper fittings in the houses, the consumption of water under the constant supply system was actually less than that under the intermittent system.

These facts being reported by the Board of Health, and afterwards given in evidence by the writer before a committee presided over by the late Sir James Graham, and confirmed also by similar results in other cases, brought the controversy to a close in favour of the constant supply system, which is now almost universally adopted, and under which 263,904 out of the 671,888 houses in the London district are now supplied, as stated in the able and interesting report for May, 1884, of Colonel Sir Francis Bolton, C.E., Official Water Examiner under the Metropolis Water Act, 1871.

The introduction of the system of constant supply brought about other advantageous changes in the method of distribution. Under the intermittent system the water lay stagnaut in the distribution pipes for at least twenty-two out of the twenty-four hours each day, and before the introduction of filter beds these pipes were practically small settling reservoirs in which the sediment accumulated, and which sediment, when the water was turned on, was driven with the first rush, in a semi-putrescent state, into the household storage receptacles.

Under the intermittent system, but little attention was paid to fittings in the houses, as neither those supplying the water nor those receiving it troubled themselves much about waste, which in each case did not last more than an hour or an hour and a-half each day.

Hence taps, ball-cocks, house supply pipes, and other internal fittings were old-fashioned and defective almost beyond description.

With the advent of the constant system, new descriptions of fittings were introduced to prevent waste, and to meet the requirements of the greater pressures at which the water then began to be delivered.

It may be safely affirmed that the constant system has brought about an extraordinary change for the better in all domestic water fittings; those now in general use displaying an amount of skill, ingenuity, and good workmanship far superior to anything ever before known.

Under the intermittent system the distribution pipe necessarily had a "dead end" in each street, because the water requiring to be daily turned on or shut off, the pipe could only be connected at *one* end with the feeding main, leaving the other end isolated or "dead." The water near these dead ends became very foul from stagnation, and consequently the dead end required to be frequently washed out. This was effected by drawing a wooden plug fixed in a branch at the end of the distributing main. When this plug was drawn, it was not at all uncommon to see the water spouting out from it tinted with all the colours of the rainbow, from dark purple to the lighter tints, and emitting a most offensive odour, for when the water was shut off, it frequently happened that the distributing pipe was drained by a discharge at some low lying part of it, and it then became filled with an atmosphere drawn through ground full of gas reek.

Under the constant system these evils, including those resulting from dead ends, are done away with; the distributing pipes being now constantly under pressure, no gas reek or other impurities can enter them, and being connected at each end of the street with the adjoining mains, there is a constant circulation throughout the whole system, whereby stagnation is prevented, as the water is always on the move towards the point of greatest consumption.

Very great improvements have also been made under the constant system, in the construction of the sluice valves for shutting off the water for repairs at any particular point. Under the intermittent system, the sluice valves were only made to shut against the pressure from *one* side, whilst they are now universally made to shut against the pressure coming from either side or in any direction. These valves, which are called "double faced," are the invention of Mr. James Nasmyth, so well known in connection with the steam hammer. The writer, then an articled pupil to the late Mr. Wicksteed, Engineer to the East London Water Works, had the privilege of assisting Mr. Nasmyth in preparing the first rough drawing of these "double faced" sluice valves; and he well remembers the instantaneous rapidity with which that great mechanician not only grasped the point to be attained, but within an hour had so completely solved the difficulty to be overcome, that whilst alterations have been made in minor details, no practical improvement has been effected in that first design of his.

The method of connecting the house services with the main pipes has also undergone a great improvement. In early times the connection was made by driving a brass ferrule into a hole chipped or drilled through the main pipe. These ferrules were apt to be dislodged, and frequently blew out, and the fixing of them obliged the water to be shut off from the whole street during this occasionally tedious operation. These connections are now made by screw threaded ferrules, tapped securely into the pipe by an instrument which obviates the necessity for any stoppage of the supply to other houses whilst the operation is being performed.

The arrangements also for the supply of water for fire extinction, have been very greatly improved since the introduction of the constant supply system. In former times, in the event of a fire, the first thing was to find the turncock to turn the water into the main. This done, the old wooden plug had to be knocked out, often a work of time and difficulty; and then until all the empty tubs and tanks were filled up in the street there was practically very little pressure at the plug, and the supply was consequently scanty for some time. Thus most precious moments were lost. Now, on the contrary, the fireman goes to the nearest hydrant, inserts his standpipe, turns on the water from the constantly charged main pipe, and in a much less time than it previously took to call the turncock, he has a stream of water pouring into or over the burning building at the rate of 200 or 300 gallons a minute, and under a pressure sufficient to knock a strong man down at a distance of fifty yards from the nozzle of the fire-hose, and that without the intervention of any fire-engine.

Another little machine which has proved itself to be of great value in connection with constant supply, is the "Waste Water Detector," invented by Mr. Deacon, the engineer to the Liverpool Corporation Waterworks. This machine indicates and registers the flow of water passing through any particular pipe at any moment of time, and by its agency all undue waste and leakage are easily detected and traced. Thus the modern appliances in connection with distribution, if properly used and directed, are now nearly all that can be desired.

Except in very special cases, the writer is not an advocate for the "Dual System," that is a system under which two classes of water are introduced, into a town; the one for dietetic purposes, and the other for washing, street watering, sewer flushing, fire extinguishing purposes, &c. The dual system necessarily involves the laying of a duplicate set of mains, and the fixing of a duplicate set of house fittings, with all the attendant annoyance and expense.

There may be cases where the circumstances are so peculiar as to make the dual system a necessity, and then the difficulty must be faced; but generally it will be found cheaper and better to manipulate the supply so as to make sure that none but water of a high class shall ever enter the mains, and so as to effect the whole work of distribution by one set of pipes and fittings.

WATER SUPPLY FOR FIRE EXTINCTION.

By J. H. Greathead, M. Inst. C.E.

When it is considered how vast is the havoc wrought by fire every year, and that we depend upon a supply of water, in all cases, to prevent much greater ravages, the importance of this subject will be at once recognised.

In London alone, it has been calculated on reliable data that the destruction of property in 1882 amounted to at least 2¼ millions sterling, and last year it was probably more; and it has been stated by a very good authority, Mr. Edward Atkinson, of the Boston Manufacturers' Mutual Insurance Company, that the losses by fire in the United States and Canada, in the five years ending January 1st, 1879, amounted to 82½ millions sterling, while the cost of insurance companies and fire departments in the same period, amounted to 55,000,000 more, or together to an average of 27,000,000 sterling per annum.

It is difficult for the mind to grasp such figures; the last, however, is about equal to the whole rateable annual value of the metropolis.

If such losses as these were inevitable, it would be of little profit to refer to them, but it is because I believe them to be to a large extent preventable, that I have ventured to bring the subject of water supply for fire extinction before you.

In the remarks which I am about to make, I purpose to refer largely to the case of this metropolis as being likely to add additional interest to the general subject, and because the reasoning which applies to this will apply in a greater or less degree to all other similar cases.

It may be useful at once to define what are the requirements necessary to be fulfilled in a water supply for fire extinction purposes.

In order to reduce, as far as possible, the destruction of life and property by fire, the fire extinguishing service should have at hand—

(1) A copious supply of water.
(2) In close proximity to the property.
(3) Easily accessible.
(4) Having sufficient and reliable pressure.

In nearly all cities the water supply has been introduced and distributed without reference to the fulfilment of these conditions. The quantity of water required for the extinction of fires is so infinitesimal as compared with the quantity required for all other purposes, that, except where the conditions have been naturally favourable, the water service has been introduced devoid of some at least of the qualities necessary to fit it for fire purposes. The result, in such cases, has been that mechanical contrivances have had to be provided in order to make good whatever deficiencies existed in the supplies, and dwellers in cities have become familiar with fire-plugs and fire-engines.

There are, however, some cities in this country where, the conditions having been favourable, the authorities having control of the water supplies have wisely availed themselves of Nature's gifts.

The most notable instances are those of Glasgow, Dublin, Liverpool, and Manchester. In all these cases the water supply is almost entirely by gravitation, and the result is that over the greater and most important parts of the cities there is a good pressure, and a copious supply of water which has been made easily accessible by the introduction of numerous hydrants in close proximity to the property in each place. Here, then, we have, as nearly as may be, in four of the most important cities of the United Kingdom, a fulfilment of the necessary conditions (as to water supply) for fire extinction.

An ordinary hydrant may be shortly described as a stop-cock on a water-pipe or main, to which hose may be attached for fire extinction, or other purposes. If for fire extinction, without the intervention of a fire-engine, the hose will, at its other end, be provided with a branch and nozzle. Upon opening the stop-cock, the water from the main, or pipe, will issue from the nozzle as a jet. The height of the jet will depend upon the pressure in the main, the quantity of water available, the length of hose employed, and the size and shape of the nozzle.

A fire-plug is a wooden plug driven tightly into a socket or opening in a water pipe under the road. When water is required for fire extinction the plug is withdrawn, and the water issues from the opening, either into the street, where it is usually received by a portable tank, or into a stand pipe inserted in place of a plug. It is obvious that plugs cannot be used where the supply is constant with a good pressure, and they have not been placed upon the constantly charged mains (the best existing supply for fire extinction) in the metropolis. Several forms of hydrants, and a fire plug and stand pipe, may be seen in the Water Companies' Pavilion in the Exhibition.

In order to obtain a good jet from a hydrant, it is necessary that the pressure of water at the hydrant, while flowing, should be about 65 lbs. per square inch. This will provide for overcoming the friction of the water in passing through an average length of hose, and will give a jet about 80 feet high from an inch nozzle. From the elaborate reports of the chief officer of the Dublin Fire Brigade, which he has kindly furnished to me, it appears that all the fires in Dublin, except those extinguished by small hand pumps, are put out by jets direct from the hydrants, and that the prevailing pressure is about 60 lbs. per square inch.

So much has been written and said about hydrants, and the advantages to be derived from their use, during the last twenty years, that it is hardly necessary for me to discuss their merits as compared with fire-plugs. It is generally conceded that in all cases, whatever the water supply may be, whether constant or intermittent, high pressure or low, hydrants are superior to plugs as a means of letting the water out of the pipes. But it has been contended that so long as it is merely a question as between hydrants and plugs, the advantages of the former over the latter are not sufficiently great to justify any large expenditure upon them. When, however, the question becomes one as between hydrants and fire-engines, a wider view becomes necessary. Hydrants with a constant and copious supply, and good pressure of water, are recognised as being incomparably better agents for extinguishing fires than fire-engines, and the result of the introduction of hydrants into Manchester may be given in illustration. Mr. Bateman, the eminent engineer of the Manchester Waterworks, has stated publicly on more than one occasion, that the introduction of hydrants with a good pressure of water has resulted in a reduction of the losses from fire in Manchester to a small fraction (viz., one-seventh) of what they were before the introduction of the hydrants. And according to the report of Captain Tozer, the superintendent of the Manchester Fire Brigade, the amount of property destroyed has only averaged 4·3 per cent. of that at risk during the last ten years, while it will be seen presently that in places having no efficient hydrant services the losses are many times greater.

In Liverpool, the fire brigade is a branch of the police. The water supply is mainly by gravitation from reservoirs (from 400 to 600 feet above the low parts of the town), and there are numerous hydrants. There are 3 steam and 14 manual fire-engines. The population in 1881 was 548,650, and the area is 8¼ square miles. Of the 180 firemen, 170 do regular police duty. The annual cost of the brigade (average of three years, 1880-1-2) was £5,325, or £9 14s. per 1,000 of the population. The average annual number of fires in the same period was 219, but the loss by fire was not ascertained.

In Glasgow, there is a good supply of water by gravitation; there are about 5,000 hydrants, and the majority of the fires are extinguished direct from the mains. There are 3 steam and 17 manual fire-engines. The 66 officers and firemen are supplemented by an auxiliary force of 52 policemen. The area of the city is 9½ square miles, and the population in 1881 was 510,816. The cost of the brigade to the ratepayers in 1882 was £5,266, or £10 6s. per 1,000 inhabitants; while the annual average loss from fire in the same period was £110,000, or about £215 per 1,000 of the population.

In Manchester, the supply is also by gravitation from reservoirs at a considerable elevation

(200 feet to 600 feet above the Exchange), and there is a constant high pressure supply. There are about 17,000 hydrants in the city and suburbs. Two steam and five manual fire-engines are retained, but are seldom used. The population in 1881 was 341,500. The area of the city is 6¾ square miles, but the fire brigade extend their operations beyond the city. There are sixteen stations, and the annual cost to the ratepayers for the fire brigade is £3,547 (on an average of the three years, 1880-1-2), or equal to £10 8s. per 1,000 of the population. The average estimated annual value of property destroyed in those three years was about £80,000, or about £235 per 1,000 of the population.

In Dublin, the supply of water is again by gravitation, and the pressure varies from about 40 lbs. to 80 lbs., being generally 60 lbs. when the water is flowing through the hydrants. There are numerous hydrants, and though there are 2 steam and 3 manual engines they do not appear to have been used in the three years (1880-1-2), within the city. The brigade consists of 32 officers and men. The population in 1881 was 249,602, and the area of the city is 6 square miles, but the operations of the brigade are not confined to that area. The average annual cost of the brigade for expenses and wages (for the three years 1880-1-2) was £3,286, or about £13 3s. per 1,000 of the population. The estimated value of property destroyed averaged £31,144 per annum, or about £125 per 1,000 of the population.

In Birmingham, the whole of the water supply is pumped, therein differing from the cases already referred to; but a system of fire hydrants has been recently introduced. The population (average of 1882 and 1883) is 411,690, and the area 13 square miles. The fire brigade consists of twenty-seven officers and men, and there are two stations and eight police stations, with apparatus. One steam and five manual fire engines are retained, none of which were used for fire extinction in 1882, and engines were used twice only in 1883. The total water supply is 11½ million gallons daily, with a pressure of 40 lbs. to 60 lbs. per square inch. The annual cost of the fire brigade to the ratepayers (average of 1882 and 1883) is £3,250, or £7 18s. per 1,000 of the population while the average annual loss in the two years was £10,931, or £26 11s. 8d. per 1,000 of the population, and this loss was equivalent to 3 per cent. only of the value of the property "at risk."

In Paris, the water supply is partly pumped, and partly by gravitation. Street hydrants have, to some extent, been introduced. In certain cases, where the pressure is sufficient, they are used without the intervention of fire-engines, but the water supply is not such as to admit of this being done generally. It is intended, however, to increase the number of hydrants to 8,000, and ultimately to make them universal, and to dispense with fire-engines. The total daily supply of water is about 82 million gallons. The population is 2,269,000, and the area 29 square miles. The fire-brigade, numbering 1,743 officers and men, is an armed force lent by the Minister of War for the special service, and it is not called out for purposes of war. There are 11 barracks, 10 steam fire, and 80 small stations in addition to 40 look-outs, and there are 12 steam and 80 manual fire-engines. The annual cost of the fire extinguishing service is £86,600 (average of two years, 1883 and 1884), or about £38 3s. per 1,000 of the population, but this cost does not include the rent and repairs of the barracks, quarters, &c., which belong to the Prefecture of the Seine. The estimated annual average losses for the three years, 1880, 1881, and 1882, were £431,300, or about £122 10s. per 1,000 of the population.

Having now described the operations, and their results in cities having efficient hydrant services, I propose to direct attention to some of the more important of the cities having no such services, and more particularly to New York and London.

In New York, the water supply is very copious, but it has not sufficient pressure for fire purposes without the intervention of fire-engines. Hydrants have, to some extent, been introduced, and it is stated with benefit, as permitting more speedy access to, and preventing waste of, the water. The total supply is, according to the report of the fire department, about 100 million gallons daily; the population in 1880 was 1,206,300, and in 1881 probably 1,240,000. The area served by the fire brigade in about 39 square miles. In 1882, there were 50 engine company and 19 hook and ladder company stations, besides lookouts, fuel depôts, and store houses. There were 57 steam fire, but no manual engines. In the period 1880-82 the average force was 939 officers and men, and the average annual expenditure was £288,190, or £230 8s. per 1,000 of the population. In the same period the average annual fire losses were £880,000, or about £710 per

1,000 of the population. The quantity of water used by the fire-engines was about 40,000,000 gallons annually in the period 1880-2, or about 1-900th part of the total supply.

In London, the whole of the water supply is pumped, and the average pressure is quite inadequate for fire extinction without the intervention of fire-engines. A large number of observations were made all over the metropolitan area by the Board of Works, in 1876, and it was found that the average pressure was only about 30 lbs. per square inch, when there was no extraordinary draught on the pipes, such as that required for fire extinction. And it is not surprising that this should be so. The pressure given by the water companies is that required by statute, or, otherwise, by the customers of the companies, and even if they desired to do so it might be doubted whether, in the words of the Select Committee of 1876-7, the companies would be "justified by their constitution in incurring expenditure for fire purposes," for which purposes alone would it be necessary for them to increase their pressure.

The quantity of water delivered for all purposes is sufficient to meet the demands for fire extinction. There are, according to Captain Shaw's reports, very few cases of short supply, and constant supply is being gradually extended voluntarily by the water companies. Hydrants have been put down by the Corporation throughout the City, and connected directly by branches with the constantly charged mains of the New River Company, and they have on several occasions been found useful, though the pressure is not such as to admit of fire-engines being dispensed with in all cases. A few hydrants have also been recently introduced by the Metropolitan Board of Works in other parts of the metropolis.

In the matter of pressure, however, as already stated, the general metropolitan water supply is undeniably deficient. There is a copious supply of water, in close proximity to the property to be protected, but it cannot be brought to bear upon a fire without the intervention of fire-engines.

The population of the metropolis, in 1881, was 3,814,571, and the Metropolitan Board of Works area is about 121 square miles, including the City's one square mile. There are 55 land fire stations, 12 street, 127 fire-escape, and 4 floating stations; and the brigade consists of 588 officers and men. The annual average cost of the fire brigade for the three years 1880-2, was £99,880, or £26 4s. per 1,000 of the population. It is somewhat difficult to arrive at the value of the property destroyed by fire in the metropolis, but a calculation based upon the contributions of the insurance companies to the support of the fire brigade, and upon evidence given by Captain Shaw and others before the Select Committee on the Fire Brigade, in 1877, would make it appear that in 1882 the value of insured and uninsured property destroyed by fire was probably considerably in excess of 2¼ millions sterling, or about £588 per 1,000 of the population. As compared with the efficiently hydranted places already referred to, it will be seen that the cost of the fire-extinguishing service, and the fire losses, are very high in London. This will be made very apparent upon an inspection of the appended Table A, which gives, in addition to the cost of the fire services and fire losses in the several places referred to, a statement of what the cost and losses would be in the metropolis, were the rates of cost and loss the same as in the other places.

It will be asked why the metropolis should have been allowed to remain year after year subject to the preventible drain of wealth indicated by these figures. The reply is that, the past and existing state of things have not been submitted to in ignorance or willlingly, but the difficulties surrounding the subject in the metropolis have been practically insurmountable.

More than twenty years ago, the Select Committee on Fires in the Metropolis directed attention to the extraordinary facilities for extinguishing fires then existing in Liverpool, Manchester, and Glasgow, and to the efficiency and small cost of the fire services in those places; and more recently, in 1876-7, the Select Committee on the Metropolitan Fire Brigade, having heard evidence as to the advantages of the hydrant systems referred to, recommended that hydrants should be put down in the metropolis at once wherever a constant supply was given, and that the water supply should be improved so as to give constant service everywhere, and increased pressure. But it was found that to comply with these recommendations a permanent expenditure of £337,000 per annum beyond the cost of the fire brigade would be involved. Of this annual sum about £150,000 represented the increased cost of pumping alone; and since the quantity of water required for fire purposes is infinitesimal as compared with the quantity supplied for all other purposes, it is obvious that this expenditure of power, if the whole had to be pumped to the requisite height, would be out of proportion to the result obtained. I have made a calculation, based upon the relative quantities, and upon the evidence given before the Committee, from which it appears that for the purpose of discharging water through a hydrant upon a fire in this way, about 170 horse-power would be required for every gallon of water thrown. And there would be the attendant disadvantages that all the house fittings would have to be altered and strengthened, and the mains and pipes would have to be taken up, and relaid of greater size and strength, and at enormous inconvenience to the householders and the traffic in the streets; and the pressure would, in the greater part of the metropolitan area, be inconveniently great. This proposal also involved the great disadvantage that it could not be carried out until the water companies should have been ranged under one control.

As long ago as 1862, the late Mr. James Easton, who held the view that no satisfactory supply of water for fire extinction with constant high pressure could be secured in connection with the ordinary domestic supply, proposed to lay down a completely new set of mains to be used exclusively for fire purposes, but the cost would have been enormous. His estimate was £72,000 per square mile, and his proposal only extended to forty square miles of the metropolis. This area alone would have involved an annual cost for interest and working expenses of £150,000. A somewhat similar proposal, but with the addition that the water was to be taken from the chalk formation at about 15 or 20 miles from the centre of London, instead of from the water companies' mains, as was proposed by Mr. Easton, and that the supply was to be used for potable and culinary purposes after being pumped to the greatest attainable elevation in order that it might have sufficient pressure for fire extinction purposes, was put forward by the Metropolitan Board of Works, on the advice of Sir J. Bazalgette, Sir F. Bramwell, and Mr. Edward Easton, in 1877. It was estimated that the introduction of this system of hydrants would have resulted in an annual saving of £60,000 in the existing expenses of the fire brigade. This scheme, involving a dual supply to every house, was taken to Parliament, but was withdrawn; and in their annual report of 1878, the Board said that they "came to the conclusion, in view of the disfavour with which the scheme appeared to be regarded by most of the local authorities of the metropolis and others, not to bring it before Parliament again in the following session." Looked at purely from a fire extinction point of view there is one great objection to all the proposals that have been hitherto made, viz., that owing to the great variations of level in the metropolis, there would, in many localities, be insufficient pressure, while in others the pressure would be excessive.

In any water supply for fire purposes, it is certainly desirable that the pressure, in addition to being sufficient, should also be moderately uniform in the hose, whatever may be the elevation of the locality. This uniformity is practically obtained at present by the use of fire-engines, but with the great drawback that the power requisite for giving the pressure is not available on the instant that the occasion for its use is discovered. The diagram B on the wall illustrates among other things the result of the vigorous efforts made by the fire brigade to reduce this evil to a minimum. It shows that since the year 1870, when Captain Shaw first began to publish the distances travelled by his engines—the distances run have increased from 11 miles to 34¼ miles (in 1882) per fire. The number of journies made has increased from 8,000 to 29,000, and the total distances run from 22,000 miles to 66,000 miles in the year.

According to the evidence given before Sir H. Selwyn Ibbetson's Committee in 1877, the fire-engines were then only used for pumping at about one-fifth of the fires. If that was still the case in 1882, then it follows that for each time the engines were used for pumping upon a fire they must have run on an average 172 miles.

When it is considered under what unfavourable conditions, and how uselessly the journeys are often made, some idea may be formed of the superiority of a system of hydrants where the power as well as the water is always on the spot ready for instant application. The same diagram illustrates also another feature of the fire brigade service, viz., the growth of its cost from the commencement of the old fire-engine establishment in 1833. It will be seen that the growth has been, and is very rapid as compared with the growth of the population. In the first year of the Metropolitan Board of Works' administration of it, the cost of the brigade was under £41,00; in 1882 it was £106,552, or an increase in the period of sixteen years of 160 per cent., while the population increased only 28 per cent., and the number of fires 44 per cent. And in the year 1883, the cost had further increased to over £115,000. It must not be supposed for a moment that this increase is to be regarded as unnecessary under existing conditions. The cost of the London Fire Brigade is, thanks to Captain Shaw's admirable organisation, still small as compared with some other unhydranted cities. In New York, as already stated, the cost is very much greater for less than a third the population and area. There the average annual cost for the three years, 1880-3, was over £288,000, and it appears to be growing almost as rapidly as that of London, though on the other hand the population there is growing more rapidly. Paris, also another practically unhydranted city with half the population, spends proportionately more than London for fire extinction.

The question of the cost of fire extinction, again, is not the sole consideration; behind that there is the question of fire loss, or the destruction of property by fire, and the loss of life. Putting aside the last and highest question as being one not altogether dependent upon the extinguishing service, I propose now to direct attention to the question of fire losses as affected by the absence or presence of efficient hydrant services.

In describing the hydranted cities, I have already given the fire losses in four of them, viz., Glasgow, Manchester, Dublin and Birmingham, in accordance with the published estimates, and I have shown that the losses are—in Glasgow £215, in Manchester £234, in Dublin £125, and in Birmingham £26 11s. per 1,000 of the population. In the case of New York, the losses are published in detail, and amount to about £710 per 1,000 of the population, as compared with £588, the loss in the metropolis, as estimated by myself.

The Table A has been prepared in accordance with the facts I have stated; but in order to give the figures a practical bearing in the case of the metropolis, I have added two columns which give the costs and losses of a place having the population of London, at the same rates as each of the places considered. It will be seen that the annual cost of extinction by hydrants, if it were at the same rate as Liverpool, Glasgow, Manchester, and Birmingham, would be from £30,000 to £40,000; and at the same rate as Dublin, £50,000; while if it were at the same rate as New York, the cost would be £886,000, instead of £99,880, the average annual cost in London in the years 1880-2.

The diagram H (shown on the wall) has been prepared from Captain Shaw's table, already referred to, and it seems to place the value of efficient hydranting in a very striking light. From the table referred to have been plotted the figures, giving the cost of the fire brigades in a number of important towns at the date of the compilation of the table (in 1877). The cost in the hydranted cities, viz., Glasgow, Liverpool, Manchester, and Dublin, has been shown in red. The blue line shows the cost in a number of American cities. Paris and London, having populations respectively twice and over threefold as great as New York, are not shown, but from the table and the remarks upon it, it will be gathered that in both those cases the cost would be far above the rates shown by the red colour, which has been extended to embrace a place of the size of New York.

In the foregoing remarks, I have simply taken population as the basis of comparison between the several places. And I do not pretend to say that there are not exceptional considerations apart from the question of water supply, such as areas, character and proximity of buildings, habits of people, and so on, which would, and no doubt do, materially influence results, but the distinction between the hydranted and unhydranted places is so broad and marked where the places are of such different characters on the one hand as Glasgow, Liverpool, Manchester, and Dublin, and on the other hand as London, New York, Paris, and Birmingham, that it must appear to all that the absence or presence of efficient hydranting far outweighs any other consideration.

It now remains for me simply to add that, having for some years devoted much study to the subject, I believe that, notwithstanding all the difficulties, only the chief of which have been adverted to here, there are methods—or perhaps I ought rather to say there is a method—by which such cities as London, New York, and Paris may be efficiently hydranted at a comparatively small cost, and practically with very trifling inconvenience, which method I have already described in papers read at the last meeting of the British Association, and before the Institution of Mechanical Engineers.

It is, however, impossible, within the limits of a single paper, as must be sufficiently obvious, to discuss the whole question; I, therefore, content myself on this occasion by advancing the proposition that efficient hydrants form, as far as our experience goes, the only effective weapon with which fire brigades can successfully cope with fires.

APPENDIX.

TABLE A.—ANNUAL COST OF FIRE EXTINCTION, AND ANNUAL AMOUNT OF FIRE LOSSES. IN SOME HYDRANTED AND UNHYDRANTED CITIES.

Average of 3 *years*, 1880, 1881, 1882.

	Population, 1881.	Area Square Miles.	Cost of Fire Brigade.	Cost of Fire Brigade per 1,000 Inhabitants.	Cost of Fire Brigade of Metropolis at same rate.	Loss.—Property destroyed by Fire.	Loss.—Property destroyed by Fire per 1,000 Inhabitants.	Loss of Property in Metropolis at same rate.
* HYDRANTED.								
			£	£ s.	£	£	£ s.	£
Liverpool	548,649	8·28	5,325	9 14	37,000	—	—	—
Glasgow	510,816	9·55	5,266	10 6	39,290	110,000	215 7	821,542
Manchester	341,508	6·7	3,547	10 8	39,670	80,180	234 16	895,644
†Dublin	249,602	6·0	3,286	13 3	50,200	31,144	124 16	476,050
Birmingham, 1882-3	411,689	13·15	3,250	7 18	30,115	10,931	26 11	101,287
* UNHYDRANTED.								
London	3,814,571	121	99,880	26 4	99,880	2,242,400	587 19	2,242,400
New York	1,240,000	39	288,190	232 8	886,490	880,000	709 14	2,707,150
‡Paris, 1883-4	1,269,023	39	§86,600	§38 3	145,500	‖431,300	‖192 10	734,300

* The term "hydranted" and "unhydranted" indicate the presence or absence in each place of a complete system o hydrants which are used for fire extinction without the intervention of fire engines.

† The cost of the Fire Brigade has been reduced from £3,616 in 1880, to £3,053 in 1882.

‡ A large number of fire hydrants have been put down, and some have been used without the intervention of fire engines, but the average pressure is not such as to admit of this being generally done.

§ Average of 1883 and 1884, exclusive of rent and repair of quarters, barracks, &c.

‖ Average of 1880, 1881, and 1882.

REMARKS ON THE DISTRIBUTION OF WATER.

BY JOSEPH QUICK, JUN., M.Inst.C.E.

Next to the importance of securing a supply of water of good quality for the requirements of a city or town, is that of its distribution, for however superabundant the source may appear to be, the advantages to be derived from its use, and the number of those whom it may benefit, must necessarily be in a great measure dependent upon the way in which it is distributed.

The author does not propose to enter here into the question as to the works necessary to bring an ample supply of water into a city or district, but assumes, for present purposes, that such works have been well executed, and that properly proportioned distributory pipes have been laid, and service reservoirs or other means provided for affording a supply of water at high pressure throughout the district to be supplied.

The history of the water supply in England is eminently instructive, as showing not only the various phases through which it has passed as refinement and sanitation have advanced; but also as proving the absolute necessity of proper control being exercised with regard to its distribution.

Not to weary my hearers with unnecessary detail on this point, it may suffice to refer to the discussions which have taken place during past times, as to the relative merits and practicability of the systems known as "intermittent" and "constant" supply respectively.

It is within the author's recollection when it was the exception, instead of being, as it is to-day, the rule for towns in England to enjoy the advantages of constant supply; but up to this moment there are many instances, notably in the metropolis itself, where the intermittent supply still, either wholly or partially, prevails.

It is hardly necessary to explain that by "constant" as opposed to "intermittent" supply, the author refers to the difference between the mains and house-service pipes being always charged with water, so that it can be drawn off direct from the main at any hour of the day or night by the consumer, instead of, as on the intermittent system, the supply being only turned on for a limited time, varying from half-an-hour to two hours per day, during which time any receptacles, cisterns, &c., provided by the consumer, have to be filled, and suffice for use until the operation of refilling them is repeated on the next and subsequent days.

Of the advantages of the constant supply for domestic purposes, independent of its being immediately in case of fire, it is almost needless to speak, especially for the poorer class of houses in cities and towns, whose only receptacle frequently consists of a dilapidated and uncovered water-butt, the water in which is exposed to all the evils of contamination from the atmosphere and other sources. No one who has travelled by the railway in any part of London can have failed to observe, in the crowded districts traversed, innumerable instances of this kind, which are amongst the most prolific causes of disease amongst the lower classes of the population. It is, indeed, little short of a crime on the part of those responsible for this order of things, that human beings should be compelled to obtain their drinking water from such contaminated receptacles; and it is doubly wrong that, after the suppliers of water have done all in their power to improve, by filtration and other means, the quality of the water, and to prevent its pollution at its source, it should, after delivery to the consumers, be allowed to thus become deteriorated in quality, and a source of danger to health.

One of the great advantages offered by the constant supply system, as already stated, is to abolish the necessity for any of these miserable receptacles; and it is difficult to imagine a greater blessing, or one more conducive to sanitation, than the introduction in their place of water direct from the water mains to the consumer's tap.

Although the author has alluded thus prominently to the evils attendant upon the butts so frequently found in the dwellings of the poorer classes, it is not to be supposed that the evil is limited to them; on the contrary, in some houses of the best class, where cisterns are employed, the same evils, although in a minor degree, prevail. The author feels justified in asserting, as the result of upwards of twenty years' day-to-day experience in connection with the water supply of London, that the periodical cleansing of cisterns, from which it is impossible to exclude a certain amount of dust and dirt, even in first-class houses, is the exception rather than the rule, and that, in a large per-centage even of the better class of dwellings, a further serious evil arises in consequence of the over-flow pipes from such cisterns communicating direct with the drains, without the intervention of a proper trap, thus allowing the foul gases from the drains to communicate with, and thereby contaminate, the water in the cistern.

The obvious question arises, under the above circumstances, why the constant supply is not universal throughout the length and breadth of the land? This is a question which has puzzled many a Parliamentary Committee, and although it has made great progress, it is still but imperfectly understood. The difficulty has usually been ascribed to either the inability or unwillingness of the water authorities to adopt it, on the score of expense; and this argument has frequently been brought forward as one of the reasons in favour of the transfer of the management of the water supply from private companies to a public body; but, on closer investigation, and to the few professionally familiar with the subject, it is apparent that the real difficulty is not to be attributed to this cause, which would have been almost equally difficult to cope with had the water supply been under public instead of private control.

The real difficulty in effecting the change of system consists in having to graft it on to the old state of things, which involves the re-arrangement of the various pipes, taps, closet apparatus, &c., in the houses in such a manner as to prepare them to receive the constant supply, and at the same time prevent waste of water.

It was a long time before the absolute necessity of stringent regulations to prevent waste was understood or appreciated, except by those immediately conversant with the practical everyday working of waterworks; but eventually it became evident, even to those most clamorous for the new system, that the enforcement of such regulations was absolutely necessary to ensure its successful working.

When once this was officially recognised and admitted by Parliament to be indispensable, the necessary powers were granted, both to the metropolis and in the provinces, of which the latter afford some instances of a highly successful result, both in the changing of the system from intermittent to constant supply at the same time, and the effecting of a large reduction in the quantity of water required, after providing an ample supply for all purposes to the inhabitants.

The author may mention as an example, the town of Portsmouth and surrounding districts of Portsea and Southsea, where the Water Company supply a population of 140,000, occupying 27,545 houses, of which a large number are of a very small class. The company was established in 1857, and until the year 1876 the supply was intermittent throughout the borough; but in 1873 an Act of Parliament was obtained, under the advice of the author's firm, entitling them to make the necessary regulations to prevent waste, and these regulations were sanctioned by the arbitrator appointed, Dr. Pole, F.R.S., in April, 1876.

It will be seen by these regulations that while ample power is given to the company to require waste preventing apparatus to be used, the company are restricted from requiring alterations of fittings until the existence of such waste is actually proved; the effect of this has been to necessitate more frequent inspection, and to some extent to cause delay in introducing the new system; nevertheless, the activity of the company's resident engineer, Mr. H. Smith, was such that in March, 1880, or within four years from the official approval of the regulations, the constant supply was given to the whole borough, and has continued without interuption to the present time. Owing, however, to the very extensive supplies for trade and public purposes, and for the use of her Majesty's Dockyard given by the company, the actual supply for all purposes still amounts to 30 gallons per head per day; but there is every reason to believe that by the means the company are still taking to detect cases of waste, as hereafter described, the consumption will be still further considerably reduced.

Probably the extent to which waste of water exists is best tested by asking the question—"What is the quantity really required per head per diem," and comparing it with the quantity actually supplied to any particular town or district; the answer to the former will of course depend upon local circumstances; for instance, in a manufacturing town, or one where unusually large quantities of water are required, for Government establishments, breweries, or trades requiring considerable supplies, the consumption per head per day will be much greater than in a purely residential town or district. When new waterworks are being constructed for a district, it is usual to estimate for works calculated to supply thirty gallons per head per day; but this is not because in well-regulated works the consumption reaches to that quantity, but to provide for a maximum supply being at hand during the driest season of the year, when the consumption is at its greatest. This quantity, however, is in many cases exceeded, notoriously so at Glasgow and New York, while in London it amounts to upwards of 28 gallons per head per day. But as examples of what it should be where proper regulations to prevent waste are adopted, it has been incontestably proved (by Mr. Ayris, M.Inst.C.E.) that in the case of Norwich and Sheffield, that a supply in the former case of 15 gallons, and in the latter of 18 gallons per head per day suffices for all wants, domestic and otherwise. It is evident, therefore, that by a proper system of supervision, and the enforcement of the use of proper waste-preventing apparatus, the supply may be kept, under ordinary circumstances, within the above limits, without in any way stinting the supply.

Another notable case is that of the city of Amsterdam, where the author's firm constructed the works. The supply is constant, and there are no less than 1,137 trade consumers supplied by meter, but the total consumption per head per day, for all purposes, even in the hottest seasons, does not exceed 14 gallons. This company, unlike the London Water Companies, had the great advantage of prescribing proper fittings from its commencement, in 1856; and this circumstance, combined with the fact that the w.c.'s are not connected with any system of main drainage, accounts for the small quantity of water supplied, which, however, is ample for the wants of the inhabitants, notwithstanding the notorious fact that the consumption of water for washing purposes, in Dutch households, is abnormally large.

The most fertile sources of waste of water, and yet the most easily preventible, are those from the w.c., and the overflow pipe from cisterns, which frequently leads direct to the drain; the former is remedied by the employment of a service box placed between the supply pipe and the w.c. ; and the valves for the ingress and egress are so arranged, that before the latter is opened, the former must be closed, so that no direct communication can take place between the main and the w.c. itself. The waste from the overflow pipe is avoided by breaking the connection between the pipe and the drain, by converting the overflow into a warning pipe, fixed in such a position that whenever an overflow or waste of water takes place, it can be seen by an inspector from the outside of the premises ; or it is so arranged as to flow into some inconvenient place ; in either case it insures the cause of waste being speedily discovered and the cause removed.

The "detection" of waste is more difficult than its prevention; for whereas the latter can, when once discovered, be checked or stopped by well known simple mechanical contrivance (*e.g.*, those above referred to and described in Clauses 11, 12, and 20 of the Portsmouth Water Company's regulations annexed hereto), it must be remembered that only a certain portion of the apparatus for conveying the water from the main to the house is exposed to the view of the inspector of fittings on behalf of the water authority; for instance, it frequently happens that, especially in certain soils, the service pipes are defective, and certain leaks may exist and remain undiscovered for years; the waste of water from this cause the author believes to be much greater than that usually attributed to it, and he believes much of it to be due to the employment of wrought iron service pipes of inferior strength and quality. Many (hundreds of) instances could be quoted where such pipes have been found, after only a few years' use, to be decomposed from the outside, leaving the fibres of the iron stretched like violin strings, and barely holding together; imperfectly made joints or connections, or careless workmanship, or broken pipes from unequal subsidence, are also causes of underground leakages. To ascertain their extent and position forms an important feature in any thorough system of water inspection.

Until a few years since, the detection of underground or concealed waste of water by scientific or semi-self-acting means was comparatively unknown, but since the advantages of the constant service system have been more generally acknowledged, and the absolute necessity of preventing water waste admitted, much attention has been paid to the subject, and reliable mechanical means are now available for detecting, isolating, or concentrating at any particular point or district any waste that may be going on. The instrument known as "Deacon's Waste Water Meter," the invention of Mr. G. F. Deacon, M.Inst.C.E., is at once not only a waste detector and localiser, but also a self-acting silent registrar of the exact extent and amount of the waste at any particular spot. A detailed description of that instrument was given in a paper read by Mr. Deacon at the Society of Arts, on May 17th, 1882; it is therefore unnecessary to repeat it here, further than briefly to describe it as a self-acting registrar of the velocity at which the water is passing through it any moment, the result being registered by a diagram on a sheet of paper, placed on a drum worked by clockwork. This instrument is so sensitive that, in the words of the inventor, "in a main supplying 3,000 or 4,000 persons, the opening of a single tap is shown by a sudden fall in the line, and the quantity per hour by the difference in the flow before and after the opening; if the closing of the tap is shown, the duration of the flow is obvious also."

The extent to which waste has has been reduced in Liverpool and other large cities by the employment of this meter, is matter of notoriety in the waterworks world; the author begs to add his personal testimony to the advantages gained by its use at Portsmouth, as shown in the table on page 961.

Waterworks authorities have now, therefore, at their command both the means of detecting waste, and, having detected it, of requiring proper waste-preventing apparatus to be used, *i.e.*, assuming that they possess the necessary statutory powers; in cases where such powers do not exist, their necessity is so obvious that there is but little difficulty in obtaining them from Parliament, under proper restrictions. In the case of the metropolis, the necessary regulations were determined by a committee appointed by the Board of Trade, in 1871, and the operation of the clauses in the Metropolis Water Act, 1852, requiring the London water companies to furnish constant supply, which had lain dormant since that time, at once commenced, and considering the Herculean proportions of the districts included within the radius which those companies supply, great progress has been made. From 52,265 houses receiving the constant supply, in 1873, the number have increased as follows:—

1874	59,281
1875	70,160
1876	75,016

1877	97,343
1878	122,242
1879	138,624
1880	160,674
1881	185,076
1882	203,443
1883	226,376

Hitherto the author has only dealt with the supply as affecting private consumers, whose use of the water is presumably limited to domestic purposes. We have now to consider the question also of the supply to manufacturers, and those cases where water is consumed for other than domestic purposes.

The introduction of water meters, for the purpose of measuring the quantity of water actually supplied to any consumer, has materially simplified the mode both of supplying and charging for water employed for manufacturing, or purposes other than domestic. Formerly, it was exceedingly difficult to form an accurate idea of the quantity used, especially at public institutions or large works, where frequent inspection was almost impracticable; re-surveying of premises, to ascertain whether additional supplies were being used, and the alteration of the annual charge for water, was a source of perpetual disagreement between the suppliers and the supplied. The water meter has, however, put an end to this, and proved equally advantageous to all parties interested. By its introduction an enormous amount of waste of water has also been detected, in many instances, to a large extent. One notorious case occurred in the metropolis. At a well-known popular restaurant, the water company having erected a meter, the quantity registered as passing it was so enormously in excess of the amount previously paid by the proprietor, that he naturally complained to the company. The meter was thereupon tested, but found to be accurate. Unconvinced, however, the proprietor threatened to have the supply cut off, and to resort to a very fine spring which he had in the basement of his premises. He commenced operations accordingly, only to find that the "very fine spring" consisted of a leakage from a broken pipe, which had been, doubtless, running for years, and which of course, accounted at once for the abnormal consumption recorded by the meter.

As regards the most desirable water meter to be used, it is so large a question as to be worthy of a distinct paper. Speaking generally, however, those in practical use may be divided into three classes:—

No. 1. The low pressure meter.
No. 2. The inferential meter.
No. 3. The positive meter.

The disadvantage of the low-pressure meter, which is constructed much upon the same principle as the gas meter, the quantity being measured by the filling and emptying of compartments in a revolving drum, is that it must of necessity be fixed at (or rather above)

BOROUGH OF PORTSMOUTH WATERWORKS COMPANY.

TABLE SHEWING RESULTS OF USE OF DEACON'S WASTE WATER METERS.

District.	Number of services.	Estimated Population.	Date of fixing Deacon's Meter.	Reduction per head in Daily Supply.	Total Reduction per day.
				Gallons.	Gallons.
Queen-street	217	1,085	October, 1882	3	3,255
Daniel-street	626	3,130	September, 1882	13	40,690
North-street	550	2,750	June, 1882	3	8,250
Charlotte-street	1,100	5,550	November, 1882	12	66,600
King's-road	796	4,776	May, 1883	12	57,312
Fratton-street	857	4,285	July, 1883	9	38,565
Greetham-street	512	2,560	"	9	23,040
St. James'-street	530	2,650	May, 1882	24	63,600
Hanover-street	360	1,800	April, 1882	18	32,400
Havant-street	227	1,135	June, 1882	14	15,890
Broad-street	252	1,260	January, 1882	43	54,180
Barrack-street	125	625	February, 1882	25	15,625
Warblington	420	2,100	"	28	58,800

the highest point where the supply of water is required, thus making it more expensive to fix, in consequence of the extra length of service pipe required, and more difficult of access for inspection; it also affords the opportunity to the consumer of fraud, by making connections to the pipe between the main and the meter; and although this latter may not be considered in the great majority of cases an objection, it is at any rate not desirable that the opportunity should be given. On the other hand, there are many instances in which—especially where large quantities of water are supplied in bulk into a large reservoir from one community to another—this meter may be applied with peculiar and especial advantage.

The second, or inferential meter (usually known as Siemens's meter), is based upon the principle of the re-action turbine, or Barker's mill, and is set in motion by the passage of water through it, the velocity of rotation being checked by veins, or plates, projecting from the revolving drum.

The author has some thousands of these meters now at work under his charge, and, taken as a whole, their accuracy is surprising; it is quite true that, under very exceptional circumstances, *i.e.*, when the water is drawn off in minute quantities (or the capacity of the meter is much greater than its work), a certain quantity can be passed without registration; but in practice this does not take place in any appreciable extent, except in the case of large sized meters, as, if the draw-off outlet is reduced to such an extent as to affect the working of the meter, the quantity passing is so small as not to reach the minimum annual water rent which the consumer is usually bound to pay, even if the consumption has been below a certain amount. These meters have the advantage of being moderate in price, compact, and liable to a comparatively small amount of wear and tear.

3. The positive meter, of which there are many varieties—*e.g.*, Kennedy's, the Manchester, and Tylor's—measures, as its name implies, the actual quantity of water displaced by one or more pistons, which are themselves worked by the pressure of the water. These meters are, however (with the exception of Tylor's), more expensive and more bulky than the inferential meters; they are, in fact, machines, and require the attention of machines; at the same time, under proper management, they are not liable to get out of order, nor more costly for repair. At one waterworks which the author designed, every house is supplied by a Kennedy's water meter, at a price per 1,000 gallons; a minimum rent being paid to the Water Company, proportionate to the size of the premises supplied.

In the foregoing remarks the author has endeavoured, he fears somewhat imperfectly, to compress within the limits assigned to this paper a synopsis of the various primary points in connection with the distribution of water. Were he to have attempted to go into detail, the paper could have been materially extended, but he trusts that he has said enough to draw the attention not only of those connected with water and water supply who are already aware of the difficulties of the subject, but of those who are the recipients of the water supply provided for them at so much outlay, foresight, and trouble, to the very great importance of preventing the waste and misuse of so valuable an element. It is a notorious fact that all the available watersheds are being gradually occupied, and that year after year witnesses large communities being compelled to go to long distances for additional supplies of water. Glasgow to Loch Katrine, Manchester to Thirlmere, Liverpool to Vyrnwy, and the metropolis itself bound in the near future to resort to other sources as auxiliary to, or even possibly in substitution of, a portion of its present supply, all afford instances of this necessity; and hence the question of economy in the consumption of water is one the importance of which cannot be overrated. By all means let every individual, rich or poor, use abundantly all that is necessary for every legitimate purpose, but beyond this let them be equally careful that no waste shall be allowed. This is not only a duty of the consumers to the suppliers of water, but to their fellow-men, and while all who neglect it will deserve the reprobation, the gratitude of the community will be eminently due to those who will not allow one of the greatest blessings afforded to us to be diverted from its career of usefulness and benefit to humanity. To an audience like the present, largely composed of brother professionals, the author is aware that a great deal contained in this paper will not be new; but, on the other hand, there are, doubtless, those amongst the visitors to whom the subject is wholly or partially foreign, and he wishes this paper to be regarded not so much as a scientific as a practical paper, addressed to the community at large on an important domestic subject, in which every man has a direct interest.

ON THE PURIFICATION OF WATER BY IRON ON A LARGE SCALE.

By W. Anderson, M. Inst. C.E.

In January, 1883, in a paper on the Antwerp Waterworks, read at the Institution of Civil Engineers, I described the application of Professor Bischof's method of filtration, through a mixture of spongy iron and gravel, to the purification of the waters of the River Nethe. The eighteen months' additional experience gained has shown that, so far as the purification of the water is concerned, Professor Bischof's process leaves little to be desired, but the working of the system has been costly, and the area of land required, as well as the quantity of iron necessary has, in the case of the Antwerp water at any rate, proved very much beyond the inventor's expectations.

The increased demands of the town rendered it necessary to extend the arrangements for purifying the water, and it became my duty to advise the directors of the company on the best means of doing this.

The extension of Professor Bischof's method would have involved so great an outlay, that after trying, unsuccessfully, many experiments on direct filtration through unmixed iron at high rates of flow, I determined to adopt a plan first suggested to me, some years ago, by our chairman, Sir Frederick Abel, of agitating the water to be purified with iron instead of attempting to filter it. The object, in either case, was to expose the water as much as possible to an extended surface of iron, consequently any plan by which the iron could be made to keep itself clean by rubbing against itself continually, would seem to be a more rational way of attaining this object, than of trusting to a partial filtration through a more or less spongy material.

The obstacle to trying Sir Frederick Abel's method at a much earlier date, was the belief entertained by Professor Bischof that a contact of about 45 minutes was necessary to ensure complete purification, and any such time would be fatal to mechanical means of performing the work. The late Professor Way, and Mr. Ogston, it is true, had shown that with very finely divided iron the effect was much more rapid, but there was still a doubt about its permanence.

In the autumn of last year, a revolving cylinder, 4 ft. 6 in. in diameter, and 5 ft. 6 in. long, was adapted to try Sir Frederick Abel's system. It was fitted with inlet and outlet pipes, and with shelves or ledges for scooping up the iron, raising it to the top of the cylinder, and then letting it fall through the water.

At first I began to run water through at 12 gallons per minute, which gave a contact of about 45 minutes, but I found that at this rate the water was very heavily charged with iron; I gradually increased the quantity to 30 gallons per minute, and then found that 1·20 grains of iron were dissolved per gallon, or about twelve times more than experience at Antwerp showed to be necessary. The flow was increased to 60 gallons, and even then 0·9 grains per gallon were dissolved.

The experiment looked so hopeful that I fitted much larger pipes to the apparatus, and having made some other dispositions connected with maintaining a uniform distribution of iron in the cylinder, and preventing it being washed away by the comparatively rapid current that would be possible, I sent the "Revolver," as it came to be called, to Antwerp, where it was put to work at the end of last February, and has continued to operate ever since.

The head available for forcing the water through the "Revolver," is, at Antwerp, limited to 5 feet, but by fitting very large pipes, I have managed to get 166 gallons per minute through; this gives a contact of about $3\frac{1}{2}$ minutes, and is so amply sufficient, that I feel sure that, even for the waters of the Nethe, much less time will be adequate.

The charge of iron is about 500 lbs., and the quantity taken up by the water, including impurities and very fine iron washed away, during a run of 33 days, was 0·176 grains per gallon.

By making suitable arrangements, and choosing a favourable time with respect to the demands of the town, we were able to obtain samples of water that have been purified by the "Revolver" only, and after proper exposure to the air, followed by filtration through one of the large sand filters, the result obtained has been that the colour was very little different from distilled water, the free ammonia was reduced from 0·032 grains per gallon to 0·001, and the albumenoid ammonia from 0·013 grains to 0·0045.

The "Revolver" turns at the rate of about $\frac{1}{3}$ revolution per minute, and requires scarcely appreciable power. The area occupied by apparatus for dealing with 2,000,000 gallons per day is 29 feet by 24 feet, and it can be introduced into any existing system of filters, for by enlarging the in and outlet pipes to a suitable diameter, a head of some 12 inches will suffice to pass the water through.

It can easily be arranged so as to be used or not, as the state of the water to be purified may warrant, and the consumption of iron being only about 20 lb. per million gallons, is quite an insignificant expense. It will be found to remove all colour from water, whether caused by peat or clay, and will facilitate the action of sand filters by the peculiar curdling effect the iron has on the impurities.

During the experiments made at Erith, it was noticed that considerable quantities of gas collected in the upper part of the "Revolver." On collecting this gas, it was found to extinguish a lighted taper instantly, and on analysis was found to contain only 8 per cent. of oxygen.

It was observed from the first, that the animal and vegetable life which was so abundant and troublesome in the natural waters of the Nethe, lying over the spongy iron filters, had quite disappeared in the water, otherwise in exactly the same circumstances lying over the sand filters, and I always supposed that this was due chiefly to mechanical filtration through the spongy iron having separated all the germs, spores, and seeds which come to life above it. But during the recent hot weather it has been found that the water from the "Revolver," though it contains all the impurities of the natural water, has been modified by the action of iron to such an extent that neither animal nor vegetable life is apparent over the sand filters. Without presuming to draw very wide inferences from this fact with reference to the action of iron upon organisms connected with disease, it may, at least, be pointed out that the absence of visible life in water treated by iron on a large scale confirms, in a great measure, the experiments of Dr. Frankland, Dr. Voelcker, Mr. Hatton, Professor Bischof, and others. It is due to the last named gentlemen to state that to his persistent advocacy the introduction of iron as a purifier is mainly due. It must be borne in mind that the system does not depend on filtration only, but, first, on a process of exposure to iron, which decomposes the organic matter, and kills living organisms; and, secondly, on simple filtration, which merely separates the noxious matters which had been previously attacked by the iron. The waters of the Nethe are exceptionally bad, and heavily charged with impurities, so that the test both of Professor Bischof's and Sir Frederick Abel's systems has been very severe.

Miscellaneous.

EDINBURGH FORESTRY EXHIBITION.

In his preface to the catalogue of the Indian Section of this Exhibition, Sir George Birdwood writes, "it may be said that Forest Conservancy in India originated in Edinburgh." Denudation of the earth's surface of its forest covering was first brought under general notice at the meeting of the British Association held in Edinburgh in 1850. Special reference was then made to the uncalled-for destruction of forests in India and America, and a committee was appointed to consider "the probable effects, in an economical and physical point of view, of the destruction of tropical forests." The committee presented an exhaustive report in the following year, in which they drew attention to the wasteful and uncontrolled destruction of forests going on; to the fact that this was checked by proper forest conservancy; and recommended the preservation and maintenance of all indigenous forests, the institution of forest surveys, and the working of the forests on well-devised plans. The discussions to which the report gave rise led directly to the organisation of the Indian Forest Administration for local governments in 1855, and for the whole Indian empire in 1862.

Previously, in 1846, Dr. Gibson had been appointed Conservator of Forests in the Presidency of Bombay, and in 1848, General (then Major) F. C. Cotton urged on the Madras Government the necessity of taking steps to preserve the forests from further denudation by the reckless wastefulness of native contractors.

The engineers required for forest conservancy in India have been sent to foreign schools of forestry at the cost of our Government; and in 1882, the Council of the Society of Arts transmitted to the Secretary of State for India a memorial in which they impressed upon the Indian Government the necessity for the establishment of a department for the teaching of forestry in the Royal Engineering College at Cooper's-hill.*

In the Paris Exhibition of 1867 there was a special pavilion devoted to forestry, and the Russian Government followed with an Exhibition of forest products at Moscow. At the Paris Exhibition of 1878 a still larger display was made. The present Exhibition is largely due to the initiative of the Scottish Arboricultural Society, the members of which, being anxious to establish a forest school in Edinburgh, after the model of those in France, Germany, and other European countries, thought that the scheme might be furthered by the formation of a special Exhibition. The suggestion was made in the autumn of 1882,

* The memorial is printed in the *Journal* for July 14, 1882 (p. 879). For Colonel G. F. Pearson's paper on "The Teaching of Forestry," see *Journal* for March 3, 1882 (p. 422).

and was received with public favour. An executive committee was appointed, with the Marquis of Lothian as chairman, and Mr. Cadell, late of the Indian Forest Department, as secretary. There was at first some difficulty as to the site. West Princes-street gardens were decided upon as being in the centre of the city, beautiful in themselves, and affording the most admirable scope for both indoor and outdoor displays. But the Town Council refused permission, and eventually the extensive grounds of Donaldson's Hospital, situated in the western outskirts of the city, were chosen. The preparation of the plans were entrusted to Mr. Robert Morham, the city architect, and the buildings were erected by Messrs. Wm. Beattie and Sons, at a cost of over £5,000. The design consists of a great nave, 630 ft. in length by 50 in breadth, intersected near each end, and in the centre by transepts 138 feet long by 50 feet broad. Over the intersection of the central transept with the nave is a lofty dome, and at the corresponding intersection of the eastern and western transepts the roof rises in octagonal pavilions. The building is of wood, and is lighted from the roof and by windows in the gables of the nave and transepts. Adjoining the northern divisions of the transepts, and at right angles to them, are large annexes, the central one 200 feet long, and those at the two ends 150 feet each in length. The grounds attached to the building cover a space of eight acres, and have been planted with specimens of coniferæ and ornamental shrubs. There are also in the grounds several châlets, summer houses, &c., and sheds for the machinery in motion.

Before proceeding to notice the special contents of the Exhibition, it may be well to set down a few particulars as to what has already been done for the study of forestry. The forestal decrees of the Middle Ages in France were wise, but they were seldom enforced, and it was Sully who first recognised the importance of forests as a source of national wealth, and promulgated laws to restrain reckless clearances. It was not, however, until the present century that scientific forestry was first taught. Hartig founded his school at Dillenburg, in Nassau, in 1800; and Cotta followed in 1812 by founding a school at Thorandt. In 1820, colleges were established in the chief German states; and in 1824, the great Forest College was established at Nancy. The chief countries of Europe (with the exception of Great Britain) have all schools of forestry, and Dr. Hough has been commissioned to organise one for the United States. Professor Sargeant, of Harvard College, estimates that at the present rate of cutting and consumption of timber, the whole of the great forests of the United States will be cleared in little more than a quarter of a century. He fortifies this opinion by stating that no less than ten thousand million cubic feet of white pine are required for present needs per annum, and that the total annual value of the timber consumed for fuel, constructive purposes, and in the arts, is two hundred millions sterling.

The following are the forestal statistics of the chief countries of Europe. Russia has forests extending to 527,426,510 acres, or 42·38 per cent. of her whole territory. Sweden has 40,636,883 acres of forest, or 40·43 per cent. Baden, 1,337,767 acres, or 35·90 per cent.; Austria, 23,284,174, or 31·39 per cent.; Wurtemburg, 1,494,147 acres, or 31·22 per cent.; Hungary, 19,425,600 acres, or 28·24 per cent.; Prussia, 20,047,014 acres, or 23.35 per cent.; Norway, 17,290,000 acres, or 22·30 per cent.; Switzerland, 1,905,407 acres, or 18·64 per cent.; France, 20,641,953 acres, or 15·79 per cent.; Belgium, 1,073,452 acres, or 14·82 per cent.; Italy, 9,031,310 acres, or 12·34 per cent.; Holland, 486,229 acres, or 6 27 per cent.; and Denmark, 364,474, or 4·25 per cent. But the United Kingdom is less than the least of these. The ratio of woods to the total acreage is 3·7 per cent. Ireland has 328,473 acres of woodlands, or 1·62 per cent. of its total area; Scotland, 734,490 acres, or 3·7 per cent.; and England, 1,325,765 acres, or 4 per cent.

On the other hand, the supply required by this country is enormous. The value of forest products imported into Great Britain is little short of 50 millions sterling. Of this sum about 20 millions are spent for timber alone. Our largest supplies are drawn from British North America, the United States, Sweden and Norway, Russia and Germany. These consist chiefly of fir logs or deals; but we receive teak from Bengal and Burmah; mahogany from Honduras, British Guiana, and Mexico; rosewood, walnut, and satin-wood from the United States, Brazil, and Turkey; and logwoods from Hayti and St. Domingo. £182,000 are expended in the imports of living trees and shrubs from foreign countries, ranging from Belgium to Japan, and £57,500 for tree and garden seeds. Sufficient has been said to show the importance of forests in every point of view—climatic, agricultural, economic, and commercial.

Apart from timber, the forest products are numerous and valuable. Take, for instance, the importation of fruits and nuts alone; these are valued at nearly eight millions. Palm and cocoa-nut oil sent from the West Coast of Africa, India, and the islands of the Pacific, is worth more than a million and a-half; olive oil, from Italy, France, Portugal, Spain, and Turkey, nearly a million. Caoutchouc, is imported from Brazil, Africa, India, &c., to the value of nearly three millions; and gutta percha is got from the East Indies to the value of over half a million. Again, take Peruvian bark, from which quinine is made: nearly two millions are paid to India and Brazil for it, whilst four millions sterling are sent to India for dye-stuffs. Gums to the value of a million and a-quarter are imported from Egypt, New Zealand, India, and Brazil; and turpentine and pitch, valued at a million and a-half, are used in Britain from the forests of the United States, Russia, Germany, and France.

A CENTURY'S PROGRESS IN TANNING.

The *Halle aux Cuirs*, one of the leading organs of the French leather trade, calls attention to the fact that in 1765 the Society of Arts awarded a prize to Mr. John Eldridge, for the discovery of a practical method of tanning with the sawdust and shavings obtained from oak wood.* In 1768, Lavoisier used oak leaves, but their general employment was restricted by their strength for tanning varying with the period of the year and the variety of tree from which they are obtained. Swelling by means of sulphuric acid was introduced by Seguin, who was entrusted in 1792 with the furnishing, in as brief a delay as possible, of a large quantity of leather for military purposes. In 1804, Lawrence utilised Seguin's idea, and in 1823, Spilsbury devised the acceleration of tanning processes by forcing the tanning decoction through the skins to be treated. In 1826, Knowles improved upon this idea with his method. In 1833, Leprieur introduced the employment of vats of graduated force, but immersed the skins, as an initiatory process, in a bath of acetate of lead. In 1837, Herapath, of Bristol, employed the plan of sewing the skins together, and passing them between pressing-rollers. In 1841, Robert Warington used carbonate of potash and carbonate of soda for removing hair, and oxalic acid for swelling. In 1849, Hibbard introduced the process of removing hair with potash and lime. In 1850, Felix Boudet suggested the employment of alkaline sulphurets and sulphuret of lime as substitutes for orpiment. In 1854, Derruys, of Brussels, commenced to use decoctions of cutch for tanning. In 1854, Preller first used the method which results in the production of "crown leather." In 1855, Belfond made the first experiments in mineral tanning by means of iron, the process having already been called attention to by Knapp. In 1860, the use of chromate of potash in tanning was patented by Clark. In 1879, Professor Putz, of Passau, indicated the possibility of tanning by means of alum and albumenoid substances. The most recent invention is the chrome process of Heinzerling, which would seem, however, not to have been adopted by the tanning industry.

General Notes.

Carrara Marble.—The total production of the marble quarries of Carrara last year was 173,593 tons, of which 115,644 tons were rough blocks and 57,949 tons sawn or worked. The exportation in 1883 amounted to 147,188 tons, showing a decrease on that of the previous year of 10,782 tons, and an increase of 24,383 tons on that exported in 1881.

* See Dossie's "Memoirs of Agriculture," vol. i., p. 226.

Antwerp International Exhibition, 1885.—The Lords of the Committee of Council on Education have received information, through Her Majesty's Principal Secretary of State for Foreign Affairs, that the International Exhibition at Antwerp, of which a notice was inserted in the *London Gazette* of the 15th July, 1884, will be a national and governmental undertaking, under the immediate patronage of His Majesty, the King of the Belgians. The President of the Exhibition will be His Royal Highness the Count of Flanders, and the Vice-President, the Minister of Agriculture, Industry, and Commerce. The committee will consist of 450 members, and the Belgian Parliament will be asked to vote a sum of money for the Commission. The State will nominate the jury, and regulate its functions.

The Crefeld Silk and Velvet Industry.—The following interesting statistics have been issued regarding the above industry:—

(1.) Amount of Trade.

	1881.	1882.	1883.
With—	£	£	£
Germany	1,419,397	1,594,948	1,502,173
Austria-Hungary	52,962	55,222	46,090
England	1,048,046	969,225	1,115,283
France	240,022	336,815	382,127
Other European countries	178,821	191,471	166,849
Extra European countries	887,180	1,048,673	1,116,674

(2.) Consumption of Raw Material.

	1881.	1882.	1883.
	Tons.	Tons.	Tons.
Raw silk	431½	456	416
Schappe	215½	274½	360
Cotton	940	1,024	870

(3.) Wages Paid.

	1881.	1882.	1883.
	£	£	£
Weaving	799,453	8[illegible]8,699	955,983
Winding	94,463	107,741	101,255
Warping	42,574	42,785	44,176
Dyeing	223,982	238,693	227,973
Finishing	101,659	115,827	97,806

(4.) Looms Employed.

(*Average number, including master weavers, workmen, and apprentices.*)

	1881.		1882.		1883.	
	Hand.	Power.	Hand.	Power.	Hand.	Power.
Velvet and velvet tissues	15,716	—	17,812	299	21,770	651
Velvet ribbon (fast edges)	240	—	541	72	1,003	159
Tissues	16,125	—	16,425	460	12,690	657
Ribbons	45	—	58	25	80	—

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Proceedings of the Society.

CANTOR LECTURES.

FERMENTATION AND DISTILLATION.

By Professor W. N. Hartley.

Lecture I.—Delivered Monday, May 12, 1884.

Introduction.

The process of fermentation, which is carried out on a vast scale in breweries and distilleries, is one which has for its object the manufacture of alcoholic products, or of alcohol in a more or less concentrated form. Though generally this branch of manufacture is associated with the preparation of alcoholic beverages, nevertheless, alcohol, pure and simple, is an article of commerce which is daily becoming of greater importance as a material employed in the technical applications of organic chemistry, it being *par excellence* the solvent of organic substances. It dissolves essential oils, and such solutions constitute the perfumes of commerce. It dissolves resins, and upon this its value as applied to the manufacture of varnishes and pharmaceutical preparations depends. Products of its transformation are the articles known as vinegar, chloroform, chloral, ether, and certain fruit essences. Converted into ethylic iodide, it is an agent used to produce violet and green dyes from magenta red. Mixed with ether, it dissolves nitrated cotton wool or pyroxyline, and the product is collodion. It is a preservative of fruits, and of anatomical preparations and natural history specimens.

As numerous and varied as its applications are the sources whence it may be derived; thus, for instance, it may be manufactured from—

(1.) Wine, beer, perry, cider.

(2.) Sugar-cane, beet-root, carrots, milk-sugar, maize-stalks, and Chinese sugar-cane.

(3.) Fruits—as apples, cherries, figs, rhubarb, grapes, dates, mountain-ash berries, melons, and gourds.

(4.) Molasses of cane and beet-root sugars, marc of grapes, refuse of grain and honey, and milk.

(5.) Roots and bulbs, beet-root, carrots, potatoes, and dahlia roots.

(6.) Cereals—rye, wheat, barley, maize, oats, and rice.

(7.) Leguminous and other seeds—as peas, beans, lentils, chesnuts, horse-chesnuts, buck-wheat, millet, and black millet.

(8.) Various substances containing saccharose, glucose, glucosides, pectosine, fibre—as sawdust, paper, straw, hay, haws, osier-peelings, moss, rags, and cotton-waste.

(9.) Carob or locust beans.

(10.) Daffodil roots (*Asphodelus bulbosus*).

(11.) Coal gas.

The processes ordinarily carried out in the preparation of alcohol depend upon the following facts: most vegetable substances contain sugar, starch, or some other substance easily converted into a fermentable sugar by the action of a constituent of malted grain called diastase, or by the action of dilute mineral acids. The sugar produced by either means is readily resolved by vinous fermentation into alcohol and carbonic acid.

These operations involve three distinct phases, namely:—1. *Mashing*, or the preparation of a saccharine fluid. 2. *Fermentation*, the conversion of sugar into alcohol. 3. *Distillation*, or separation of the alcohol from water.

Two kinds of spirit are manufactured on a large scale in Great Britain and Ireland, viz.:—

a. Spirit from grain.

b. Spirit from potatoes.

The Preparation of Mash from Grain.

Grain spirit is obtained from a mash prepared from either wheat, rye, barley, maize, or a mixture of two or more of these cereals. It has been found that when more than one kind of grain is used, there is a larger yield of alcohol than from one kind only. Thus, a mixture of wheat and barley, or barley and maize, or rye and barley, give a better result than any one of these materials used singly.

It is not necessary that all the grain should be put through the process of malting.

The first operation consists in grinding the grain to a fine meal, a process which is the more important the harder the nature of the grain, as it is necessary that the meal be thoroughly moistened with water, in order that the starch granules which it contains may swell and burst, and so become soluble.

The meal which is to be infused is mixed with a certain proportion of malted barley, which amounts to one-seventh or as much as one-fourth of the unmalted grain.

The malt is grain which has been allowed to germinate rather more freely than such as is employed in the brewing of beer, and it is dried at a temperature of from 40° C. = 104 F. to 60° C. = 140° F. This special preparation contains a larger proportion of the active principle called diastase, and saccharification thus proceeds more rapidly than with ordinary malt. In order to prevent the liquors being too dilute, it is necessary to employ as little water as possible in the preparation of the infusion, termed technically the mash. The temperature of the water is from 50° C. = 122° F. to 60° C. = 140° F., the mashing being carried out in large iron vessels, each holding as much as 10,000, or even 25,000 gallons. The meal is kept in operation by rotating arms, as in the operation of brewing. The weight of water represents about one and a-half times that of the grain used. The addition of boiling water is made little by little, till the whole attains a temperature of 65° C. = 149° F. or 70° C. = 158° F. This temperature is maintained, the vessels being covered, and the malt which is added in the course of two or three hours, at first converts the whole of the dissolved starch into a sugar termed maltose, and a gummy substance known as dextrin; but when the action is completed, the liquid contains maltose only.

The mashing processes carried out in breweries and distilleries differ in this respect, that, whereas it is of importance to the brewer that a clear wort should be the result, the malt, which is the only grain used, is crushed, but not finely ground; the simple crushing instead of grinding of the malt prevents the complete saccharification of the starch, a portion of dextrin remaining in the sweet wort. The distiller aims at the complete conversion of the starch into fermentable sugar, the clearness of the infusion being of little consequence. With this object, the grain is finely ground, after carefully sifting off all dust, stones, and seeds, such as those of the dock and black rape, and as little water as possible is used beyond that necessary to complete the saccharification of the starch, and the conversion of the sugar into alcohol by fermentation.

Mash has generally an agreeable odour, something like that of newly baked bread, and a sweet taste. The proportion of water does not exceed three and a-half to four times that of the solid matter in solution. When the saccharification process is complete, the mash is cooled down as rapidly as possible to a temperature favourable to fermentation, 23° C = 73° F., either by passing it through refrigerating backs or by the addition of a certain quantity of very cold water. Saccharification is frequently, if not invariably, now carried out by the use of steam, as both the temperature and the proportion of water can be better regulated than by other modes of heating the liquid. In France and Belgium, Lacombe's macerator is much used. This consists, essentially, of a closed copper vessel containing an agitator, into which the meal, the green malt, and the warm water are introduced; at the end of fifteen or twenty minutes steam is blown into a double bottom, which raises the temperature gradually to 65° C = 149° F. After a period of from half to three-quarters of an hour, the contents of the macerator are again agitated, and more steam delivered, and this operation is continued for three or even four hours. When the saccharification is complete, cold water is made to circulate through the double bottom in place of steam, in order to cool the mash. The mash is then run off, and the vessel rinsed with a little warm water, the rinsings being added to the mash.

The formation of a small quantity of lactic acid (the acid of sour milk is lactic acid) during maceration, appears to be rather advantageous than otherwise; and it has been stated that the addition of phosphoric acid, and about 2 per cent. of beer yeast, renders the subsequent fermentation process more energetic and more complete, which in turn results in a larger yield of alcohol. The liquid portion of the mash, the saccharine fluid, may be withdrawn previous to fermentation, and the solid matter of the grain, which abounds in the nitrogenous principles, fatty matters, and phosphatic salts, so necessary as a mineral food both for plants and animals, has proved to be an excellent food for cattle.

Sometimes the solid matter, or draff, is allowed to remain with the liquid extract until the fermentation process is completed. The use of mash which has been separated from the draff is advantageous, on account of the greater facility of obtaining a regular fermentation. Frothy fermentation, which is a great source of annoyance, is caused by the presence of nitrogenous substances, which are, for the most part, removed with the draff. In breweries it is necessary to separate the yeast from the beer, and this is dried by pressure in a filter-press from which it comes out in cakes about two inches thick. It is not necessary in distilleries to separate the yeast from wash previous to distillation.

The proportions of extractive matter and of draff yielded by a satisfactory saccharification when operating on different cereals, are the following:—

	Extractives.	Insoluble Matter.
*100 parts of maize	70	30
,, ,, rye	65	35
,, ,, barley	60	40
,, ,, oats	42	58

Mixtures of rye and barley yield 63·25 per cent. of extractive matters.

The Composition of Barley.

	In 100 parts.	
*Starch	65·43	parts.
Nitrogenous substances	16·25	,,
Dextrin	6·63	,,
Fat	3·08	,,
Cellulose	7·10	,,
Ash, &c.	3·51	,,
	100·00	

*The ash contains in 100 parts—

Potash	17	parts.
Phosphoric acid	30	,,
Silicic acid	33	,,
Magnesia	7	,,
Lime	3	,,
	100	

The Preparation of Mash from Potatoes.

Potatoes consist of about 28 per cent. of dry substance, 21 per cent. of which is starch, 2·3 per cent. albuminous matters, and 72 per cent. water. It is of great importance, in calculating the expected yield of alcohol, that this water be taken into account. Thus 100 parts of potatoes, yielding 20 per cent. of starch, give 17·3 per cent. of extractive matter to the mash; if to this be added five parts of barley malt to effect saccharification, this yields three parts of dry malt-extract, and from these materials the yield of alcohol has to be calculated. In making a thick mash, therefore, the proportion of water to be added must depend upon the large quantity of water in the potatoes, which varies between 68 and 80 per cent. Sometimes the malt amounts to as much as 10 per cent. It will thus be seen that it is essential, for the purpose of getting the best possible yield, to ascertain the quantity of starch in the potatoes.

* "Wagner's Chemical Technology."

Fresenius and Schultze have devised a simple plan for ascertaining the proportion of starch, and of solid matter insoluble, contained in potatoes; it depends upon observed facts relative to their density. Potatoes, carefully washed, are weighed, first in air and then in water, the less the loss of weight in water, the greater the proportion of starch.

The treatment of potatoes consists in (1) washing and cooking, (2) crushing or mashing and mixing with malt, (3) the saccharification and cooling of the mash.

The washing is effected in a cylindrical cage, inclined at an angle of about three or four degrees, to the horizontal position, and nearly half immersed in water. A rotatory motion given to the cage rolls the potatoes over and over in the water, all earthy matter falling through the bars into the tank of water below. This arrangement is imperfect, as it does not separate stones of large size. To effect this, a spiral of arms, fixed to a central axis, placed longitudinally in a water trough, carries the potatoes forward with a screw-like motion, while stones sinking immediately remain undisturbed. The potatoes are carried upwards by an endless chain and buckets and delivered thereby into the boiler to be steamed. The potatoes are cooked in a vessel, by means of steam, and are allowed to fall on two toothed hollow cylinders, 2 ft. in diameter, which, revolving in opposite directions, crush and mash them. The crushed potatoes, which are hot, are mixed in a copper with 5 per cent. of crushed malt, and 25 per cent. of water, at the ordinary temperature. The temperature of the liquid rises, but care should be taken to prevent it exceeding 62° C. = 144° F. to 65° C. = 149° F. The copper is covered, and the maceration is allowed to continue for two or three hours, during which period complete saccharification of the starch is effected. Sometimes the pasty mass is too tenacious, and in such a case rollers on the bottom of the copper are set in motion to crush and divide it, in order to permit the diastase to act on all the starchy matter.

Preparation of Mash by Sulphuric Acid.

This mode of saccharification, first recommended by Leplay, is carried out in the following manner. The raw potatoes are converted into pulp, which is thrown into a large vessel containing water. The starch cells separate and settle to the bottom mixed with the cellular tissue of the pulped potatoes. The supernatant liquid containing the albumenous matter of the potatoes is syphoned off, otherwise it would interfere with the action of the sulphuric acid. While this operation is in progress, the required quantity of dilute sulphuric-acid is heated in another vessel by steam pipes, and the washed raw potato starch is added to this in small quantities at a time. The boiling is continued for about five hours, that is, until the whole of the starch as well as the dextrin is converted into sugar. The liquid is run off through a strainer into another vessel containing chalk, which neutralises the excess of acid. The gypsum settles down, and the liquid is transferred to a fermenting vat.

The Chemistry of the Process.

Starch and sugar both belong to a group of substances of complicated structure, known as the carbo-hydrates. The simplest of them, grape sugar, contains no less than 72 parts of carbon, united to 10 parts of hydrogen, and 80 parts of oxygen, in all making a free and independent particle of matter known as sugar, having a relative weight 162 times as great as the lightest particle of its constituents. The hydrogen and oxygen in all of them are in exactly the proportions which will form water, hence they may be easily decomposed with the production of carbon and water. By heating starch, this change is effected; it is charred or carbonised, and much water separates. By mixing sugar with oil of vitriol the carbon is set free, water being withdrawn from the substance by the action of the powerful acid. Cellulose or woody fibre, if moistened with sulphuric acid and moderately heated, is resolved into carbon and water.

The carbo-hydrates as a class are divisible into three groups, each with a generic formula representing the composition of the group, thus:—

I. The Amylose, or Starch group. $nC_{12}H_{20}O_{10}$	II. The Saccharose, or Cane-sugar group. $C_{12}H_{22}O_{11}$	III. The Glucose, or Grape-sugar group. $C_6H_{12}O_6$
Starch	Saccharose	Lœvulose
Dextrin	Maltose	Dextrose
Gum Arabic	Synanthrose	Inosite
Cellulose	Melitose	Sorbite
Lichenin	Melizitose	Arabinose
Mucin		Eucalyte
Tunicin		Dambonite
		Bornesite

By a comparison of the above formulæ, a close relation between the groups will be noticed; thus, by adding the elements of water, H_2O, to a member of the first group, we obtain a member of the second, and by performing the same operation in the second, we obtain two members of the third group:—

$$\frac{C_{12}H_{20}O_{10} + H_2O}{C_{12}H_{22}O_{11}} \qquad \frac{C_{12}H_{22}O_{11} + H_2O}{C_{12}H_{24}O_{12} = 2\,C_6H_{12}O_6}$$

The wide distribution of starch in the vegetable kingdom enables us to prepare it from a variety of materials, such as potatoes, wheat, barley, oats, or rye, or to obtain the products of its transformation without the preliminary process of separation from the other constituents.

For the benefit of those who are not conversant with the use of such formulæ as those descriptive of the carbo-hydrates, I have prepared a series of illustrations, consisting of weighed amounts of carbon and of water contained in tubes of the same diameter, so that the length of the columns of carbon and of water represents the proportional weights of those substances in the molecules, or, more correctly speaking, obtainable from them.

The integral particle of starch, called the molecule, consists of n times $C_{12}H_{20}O_{10}$ where n is intended to represent a certain whole number. By C we understand twelve parts by weight of carbon, the smallest portion of that substance which can enter into combination; H represents in the same way one part by weight of hydrogen; and O, in like manner, sixteen parts by weight of oxygen. Hence, the smallest particle of starch which can have an independent existence will weigh at least three hundred times as much as the smallest particle of hydrogen which enters into its constitution. These smallest particles of the constituent substances are termed atoms, because they are indivisible proportions; hence we learn from these symbols that the atom of carbon weighs twelve times as much as an atom of hydrogen, an atom of oxygen sixteen times as much. Now, in order to illustrate the *relative* quantities of these three kinds of matter entering into the molecules of the carbo-hydrates, we may compare the following weights:—12 grains of charcoal and 18 grains of water represent the symbols $C\,H_2\,O$, or formic aldehyde; 72 grains of charcoal and 108 grains of water represent the grape sugar group, six times formic aldehyde; while 144 grains of charcoal and 198 grains of water express in a sufficiently close manner the cane-sugar group.

When tabulated, the numbers appear thus:—

Parts by weight.

$$\left.\begin{array}{l} C = 12 \\ \text{Water}\left\{\begin{array}{l} H_2 = 2 \\ O = 16 \end{array}\right\} 18 \end{array}\right\}\text{Formic aldehyde.}$$

Parts by weight.

$$\left.\begin{array}{l} C_6 = 12 \times 6 = 72 \\ \text{Water}\left\{\begin{array}{l} F_{12} = 12 \\ O_6 = 16 \times 6 = 96 \end{array}\right\} 108 \end{array}\right\}\text{Glucose.}$$

Parts by weight.

$$\left.\begin{array}{l} C_{12} = 12 \times 12 = 144 \\ \text{Water}\left\{\begin{array}{l} H_{22} = 22 \\ O_{11} = 16 \times 11 = 176 \end{array}\right\} 198 \end{array}\right\}\text{Saccharose.}$$

The Properties of Starch.—Starch in mass forms a perfectly white powder, insoluble in cold water. The powder consists of granules which differ in size, for instance, in potatoes they are about $\frac{7}{1000}$ths of an inch, and in wheat about $\frac{2}{1000}$ths of an inch in length. Under the microscope they exhibit a series of concentric markings, the nucleus of which, termed the hilum, lies a little to one side. In polarised light, starch granules show a dark cross, the point of intersection of which coincides with the hilum. If starch granules are crushed in cold water, a small portion of the interior, called granulose, is dissolved; addition of iodine-solution causes the precipitation of fine-grained pellicles of a blue colour. Starch granules, when ground with fine sand, yield a solution of granulose. When starch is placed in water at 55° C = 131° F. the larger and more watery starch grains become soluble, or swell up and form a paste. In small grains, which are of denser material, the conversion into paste commences, according to Naegeli, at 65° C = 149° F. This difference of behaviour of different varieties of starch granules is well observed in the case of barley, which swells at 99° F, and maize starch at 122° F. In these operations, the interior watery parts swell first, the outermost layer scarcely at all; it bursts and remains for a long time recognisable by means of iodine as a pellicle. This effect can likewise be caused by the action of a cold solution of alkali, such as potash or soda. The volume of starch grains may increase 125-fold, and so much fluid can be absorbed that the swollen grains contain only 0·5 to 2 per cent. of solid starch. If the proper proportion, of, say, 1 of starch to 8 of water has been employed, the swelling and bursting of the starch granules yields a paste which gelatinises on cooling. According to Lippman, the behaviour of different varieties of pure starch is shown in the following table:—

THE GELATINISATION OF STARCH.

	Granules swollen	Gelatinisation commenced.	Gelatinisation completed.
	° F	° F	° F
Barley	99·5	135	144
Maize	122	131	144
Rye	113	122	131
Potato	115	137	144
Rice	129	137	144
Wheat	122	149	153
Buckwheat	131	155	160
Sago	—	151	158
Arrowroot	151	151	158
Portland arrowroot	122	137	144
Horse chesnut	126·5	133	137
Chesnut	126·5	137	144
Acorn	135	171	190

Starch in certain grains, as, for instance, maize, is mixed with oily and fatty matter, which retards gelatinisation until this is removed by steaming; or gelatinisation may be effected by heating under pressure.

In 1813, Stromeyer discovered that starch, whether dry or in the form of paste, is deeply coloured by iodine. A liquid containing about $\frac{1}{500000}$ its weight of starch paste, strikes a blue colour. If the starch be not in the gelatinous condition, a much larger quantity of iodine is required to cause this reaction, and the colour appears with comparative slowness. According to Sonstadt, dry starch absorbs 3·2 per cent. of iodine (*Chem. News*, vol. 28, p. 248) which will bear drying at 120° C = 248° F. Soluble starch which will not gelatinise may be prepared by long continued boiling of starch paste, or by dissolving starch in boiling acidulated water, The latter preparation, after neutralisation of the acid and evaporation, yields a substance granular, and without structure, which is insoluble in cold water, but capable of being dissolved at 50° C. = 122° F. (Musculus, Comptes Rendus, vol. 78, pp. 1413-17.)

It has been shown by W. Naegeli that starch is a mixture of several modifications of the same substance, or of several substances of a very similar character. When treated with acids not too concentrated, that portion which is coloured blue by iodine, and preponderates in the softer parts of the starch, is dissolved, and a portion is left to which iodine imparts a yellow colour. This latter is only slowly changed by acids or boiling water. It still possesses the structure of granules, and its hardest part seems to be identical with, or nearly related to, cellulose. The modifications coloured blue and yellow by iodine are capable of changing gradually into each other, and forming others, which take with iodine, a violet, red, or orange colour. Potato starch contains much of the blue, but little of the orange, there being most yellow. In wheat starch there is less yellow, hardly any blue, but much violet and reddish violet. When boiled with water the quantity of the blue modification increases. On boiling yellow starch with water for a long time the greater part dissolves, and the solution gives with iodine a violet colour. Now it is evident that the operation of mashing is to obtain either a solution of starch or a starch paste, the addition to this of malt-extract and the maintenance of the liquid at a temperature of 60° C. = 140° F. being intended to convert the starch into sugar.

The Change of Starch into Sugar.

In 1811, Vanquelin discovered that starch, when heated strongly, can be converted into a gummy substance completely soluble in water. Kirchof likewise at the same time discovered that sulphuric acid largely diluted with water was capable of transforming starch into a crystallisable sugar, and in 1814 he further observed that the same change could be effected by the albumen of grain which was rendered especially active by converting the grain into malt. The gummy substance discovered by Vauquelin was afterwards proved by Vogel, in 1812, to be producible by the action of sulphuric acid on starch, and in 1823 it was examined and fully described by Biot and Person, who gave it the name of dextrin on account of its property of powerfully rotating a ray of polarised light to the right hand.

If the flour of wheat, and especially of rye or any other of the cereals, be mixed with twenty times its weight of water, and be submitted to a temperature of 75° C. = 167° F., it yields a thick paste, which after the lapse of a few hours, becomes a thin fluid with a very sweet taste. It is evident that, as we have added no chemical reagent to effect this work but water, and water alone, the change must be caused by some substance present in the grain, because if the starch be first separated from the other constituents of the grain it is unable to undergo such a transformation. This saccharifying action was discovered by Payen and Persoz to be due to the presence of a nitrogenous body which they named diastase. In the course of this change, the starch of the flour attaches to itself a definite proportion of water, and in consequence of this the constituent atoms become re-arranged, so that there is first produced a mixture of sugar and dextrin, and finally sugar only. The same formation of sugar occurs in the germination of corn, hence the sweetness of malt. All the starch contained in wheat, rye, barley, oats, &c., becomes converted into sugar during the development of the germ. I have stated that when flour is used the saccharification is completed after a few hours; but if, instead of plain flour and water, an aqueous extract of ground malt be used, the same change will require no longer a period than a few minutes. So long as the starch and the diastase are separated, the former remains unchanged, but when they come into contact the change begins instantly. Many plants with woody stems are found in the autumn, containing starch which remains unaltered, but with the renewed activity of life in the spring this is transformed into sugar. In explaining the change of starch into sugar, it is necessary to bear in mind that the starch is not first converted entirely into dextrin, and this subsequently entirely into sugar, nor is the product either dextrin or sugar, because the fact is that dextrin and sugar are produced simultaneously in equivalent quantities, until finally the dextrin itself becomes sugar. Strong experimental evidence was given by Musculus in 1860 to show that this was the action of dilute sulphuric acid on starch; and it was subsequently proved by Mr. O'Sullivan that this was the action both of sulphuric acid and of diastase. Mr. O'Sullivan, in a series of papers in 1872 and 1876 (Chemical Society Journal, vol. xxv., p. 572; xxix., p. 479; xxx., p. 125), has further proved that the sugar produced from malt, grain, or starch, either by the acid or diastatic conversion, is not of the nature it was formerly supposed to be. Although in common with the leading members of the glucose group, it has the property of giving a fine orange-coloured precipitate of sub-oxide of copper with what is known as Trommer's test, it should not on this account be classed as a glucose. Two researches, that of Saussure, published in 1819, and another of Dubrunfant, in 1847, dealt with facts concerning this sugar. The latter chemist prepared it and examined its properties, recognised its distinctive character, and called it maltose.

Maltose, its properties. — Composition $C_{12}H_{22}O_{11}\cdot H_2$. This is a sugar belonging to the saccharose group, obtained by heating starch with dilute acids, or by the action of diastase. If a syrupy solution of maltose be extracted with boiling alcohol, and the alcoholic solution be allowed to stand for some days, maltose crystallises out in hard crusts of acicular crystals containing water of crystallisation in accordance with the formula $C_{12}H_{22}O_{11}\cdot H_2O$. The difference between maltose and glucose is chiefly in the rotatary power and the power of reducing cupric oxide.

Whereas a given quantity of dextrose will reduce 100 parts of copper solution, prepared after the method of Fehling, maltose reduces only 66 parts, or two-thirds the usual quantity. Lactose, a well-defined crystalline sugar reduces 70 parts. This latter substance appears to be isomeric with maltose and saccharose, that is to say, it has the same composition and the same molecular weight, but different properties.

Dextrin, its properties. — Starch is convertible into dextrin—1st, by the action of diastase on starch-paste; 2nd, by the action of dilute sulphuric acid; 3rd, by heating the dry substance to a temperature of 200° C = 322° F.

British gum, or commercial dextrin, is prepared by moistening starch with water containing 2 per cent. of nitric acid, allowing it to dry in the air, and converting it by heating to 110° C. = 230° F. It is a clear yellow powder easily soluble in water. A strong solution of this is frequently sold as gum mucilage. It differs from starch paste in not being coloured blue by iodine. From glucose and maltose it differs in not being reducible by Fehling's solution. It is converted into sugar by diastase. Its rotatory power on polarised light has led to its fraudulent use for the purpose of "correcting," or masking the left-handed rotation of glucose mixed with cane sugar. It has already been mentioned that dextrin gives no blue colour with iodine, but it would be incorrect to say that it gives no colour at all; and it would be equally incorrect to say that it always yields a colour reaction. The fact is, there are several kinds of dextrin, two of which give a brown tint with iodine, these are termed erythro-dextrins; and seven others, which give no colour, are termed achroo-dextrins. Mixtures of these with soluble starch give a violet colouration. That a series of such substances has been proved to exist, depends upon their varying power in respect to the rotation of a polarised ray, and to the reduction of solutions of copper oxide.

The change which takes place when starch-paste is altered by malt extract varies with the temperature, but it is always dependent upon an attachment of water to the starch molecule, and a splitting up of the latter into maltose and a kind of dextrin. Three differing proportions of dextrin, accompanied in each case by maltose, have been recognised by Mr. O'Sullivan as the result of such changes of the starch molecule. The first is producible at any temperature below 63° C. = 145° F., the second between 64° — 68° and 70° = 147° — 155° F., the third between 68° and 70° C. = 155° and 158° F. At 70° C. = 158° F., the activity of the transforming agent is destroyed.

In the year 1878, Musculus and Gruber, and in 1879, Brown and Heron (Jour. Chem. Soc., vol. xxxv. p. 653), recognised the formation of a variety of dextrins differing in molecular weight, but otherwise of the same composition. At the same time, the latter chemists confirmed the views previously expressed by O'Sullivan, relative to these modifications being the result of the action of heat on the transforming agent, and not due to the splitting up of the starch molecule previous to its further change. There are three achroo-dextrins varying in optical properties, and in their power of reducing copper oxide solution, and there are at least four well-defined molecular transformations of starch.

1. The most stable form of dextrin, and the best defined transformation, is that which results when malt-extract acted on starch at a temperature not exceeding 60° C. = 140° F.

2. The next point coincides with the disappearance of the iodine reaction for erythrodextrin when starch is heated with malt-extract to 66° C. = 150° F.

3. That is the most strongly marked reaction which is obtained with malt-extract heated to

75° C = 167° F., or when rendered alkaline with carbonate of soda, and heated to 66° C. = 150° F.

4. The highest stable transformation is effected with a very slightly alkaline malt extract heated to 66° C. = 150° F.

Musculus and Gruber, as also Brown and Heron, regard the constitution of soluble starch as that of a polysaccharide, or a molecule built up of a number of saccharose molecules, which became intimately united or connected by the elimination of the elements of water. In accordance with all ascertained facts, the simplest formula representing the molecule of soluble starch must be 10 $(C_{12}\,H_{20}\,O_{10})$.

Adopting the mode of illustration employed in the case of the sugars, we may represent the starch molecule by about three ounces of charcoal and four ounces of water, more strictly speaking, by carbon 1,440 grains, and water 1,800 grains. By placing the water in tubes of the same bore, and cutting the charcoal into pieces with the same sectional area, we see by the different lengths of the water tubes and carbon sticks the different relative sizes of the molecules of starch; the dextrins and sugars, and the reactions ensuing upon the addition of water to the starch molecule, are easily demonstrated to you by placing on the right hand the representatives of starch and water, and on the left those of erythro-dextrin and maltose.

With this view we may regard the varieties of dextrin as derived by successive assimilations of water and the divisions of the molecule into two parts, namely, maltose and a dextrin, thus:—

Soluble starch. Water. Maltose.

(1) $10\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Erythro-dextrin α

$9\,(C_{12}\,H_{20}\,O_{10})$.

Erythro-dextrin α. Water. Maltose.

(2) $9\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Erythro-dextrin β.

$8\,(C_{12}\,H_{20}\,O_{10})$.

Erythro-dextrin β. Water. Maltose.

(3) $8\,C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin α.

$7\,(C_{12}\,H_{20}\,O_{10})$.

(4) $7\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin β.

$6\,(C_{12}\,H_{20}\,O_{10})$.

(5) $6\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin γ.

$5\,(C_{10}\,H_{20}\,O_{10})$.

(6) $5\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin δ.

$4\,(C_{10}\,H_{20}\,O_{10})$.

(7) $4\,(C_{12}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin ε.

$3\,(C_{10}\,H_{20}\,O_{10})$.

(8) $3\,(C_{10}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin ζ.

$2\,(C_{10}\,H_{20}\,O_{10})$.

(9) $2\,(C_{10}\,H_{20}\,O_{10}) + H_2\,O = C_{12}\,H_{22}\,O_{11} +$

Achroo-dextrin η.

$C_{10}\,H_{20}\,O_{10}$.

Maltose.

(10) $C_{10}\,H_{20}\,O_{10} + H_2\,O = C_{12}\,H_{22}\,O_{11}$

Unmistakeable evidence has been obtained by Messrs. Brown and Heron of the transformations effected in equations (2), (3), (4), and (8); with less certainty experimental evidence of equations (5) and (6) has been obtained. The most soluble form of dextrin is that which results from equation (8).

Maltose is the only sugar produced by the prolonged action of malt-extract on soluble starch.

According to the researches of Baszwiz ("Zeitschrift für Spiritusindustrie," 1879, p. 321), the most advantageous temperature for mashing for distillation is 112° F., the yield of sugar being the greatest in the shortest period of time. The influence of temperatures somewhat higher than this can be illustrated by the following figures:—

	Temperature of mash rising to		
	140° F.		149° F.
Yield of maltose, per cent.	80·9	..	41·3
,, dextrin ,,	19·1	..	58·7
	100·0	..	100·0

Below 140° nearly double as much sugar is produced as between 140° and 149°.

Hitherto, the temperature employed (149°) has been too high, though in the production of sweet wort for brewing this temperature may be suitable because complete saccharification is not desirable. These conclusions are in accordance with the facts demonstrated by Brown and Heron, that at 122° F. the proportion of albumenoids coagulated in malt-extract was 19 per cent.; at 140° F., 53·5 per cent.; at 150° F., 67·4 per cent.; and at 169° F., 80·8 per cent.; while at 176° to 178° F., all albumenoids are precipitated. We thus see that in the mashing of grain the process consists of (1) the preparation of a solution of starch paste, (2) the saccharification of the starch by the addition of malt. In the first operation any convenient temperature may be employed, but in the second, as low a temperature as 112° F. is that most favourable.

CONFERENCE ON WATER SUPPLY.

The following is a report of the discussion on the papers read at the Conference of the Society of Arts on the Water Supply, held at the International Health Exhibition on Friday, July 25th. Sir FREDERICK ABEL, C.B., F.R.S., in the chair:—

The CHAIRMAN, in commencing the proceedings, said the outcome of the previous day's discussion showed that there was agreement, at any rate, on some important points. All agreed that the water supply was derived from rainfall, though perhaps, with the exception of Mr. Jabez Hogg, who spoke of the illimitable supplies stored in the chalk. The importance of the systematic observations introduced by Mr. Symons, and the value of the data derived from those observations as indicating the relative abundance or scarcity of the supply of water in different districts, and their relation to the population of the districts, were also unanimously recognised. In connection with this matter very useful information had been supplied by Mr. Topley, Mr. De Rance, and Mr. Whitaker, and the maps prepared by the latter gentleman promised to be extremely valuable. There could be no doubt that a combination of careful hydrogeological surveys, with a study of rainfall observations throughout the country, would serve to enlarge our knowledge with regard to the conditions to be fulfilled for securing an efficient water supply to different parts of the kingdom. It was only natural that the discussion with regard to the sources of supply should gravitate towards the larger towns, and more especially towards the supply of water to London, which had been of late a question of such serious controversy. Mr. Bailey Denton, however, in his interesting communication, had referred more especially to the supply of rural districts or small communities; and it might be hoped that the disinclination of local authorities, to which he referred as having stood in the way of progress, was rapidly disappearing. There could be no question that the country generally was now thoroughly alive to the necessity for obtaining for all communities, large or small, as pure a supply as could be obtained. In connection with this subject, Mr. Denton gave interesting information with regard to the application of tube wells; he might say that in connection with military matters he had had considerable experience of the usefulness of such wells, and so long as it was not necessary to apply power in connection with them, and a moderate supply only was required, their use would be attended with very considerable advantage. With regard to large towns, there was also a consensus of opinion to the effect that in order to ensure as pure a supply of water as possible, it should, if practicable, be obtained at its source, rather than after it had been more or less polluted by passing along streams and receiving surface drainage or still more objectional matters in its course. With the exception of Mr. Hogg, he also thought they were all impressed also with the fact that the necessity not only for having water pure, but for keeping it until used in a perfectly pure condition, gave rise to a wide spread objection to intermittent supply, and to the consequent necessity of having tanks in houses, in which the water inevitably became more or less polluted. It was somewhat remarkable that Mr. Hogg, in his search for the minute animalcules on which he based such important conclusions, should have entirely overlooked the grosser impurities which everyone else found in the cisterns. With regard to the supply from wells, Mr. Baldwin Latham had directed attention to two or three important points; for instance, to the necessity, in estimating the quantity to be derived from such a source, for ascertaining what was likely to be the minimum supply from those wells, and regulating the number of wells accordingly. There was no question that this might be a matter of considerable difficulty for water engineers to meet. He had also directed attention to an incidental point, which, as he (the Chairman) had pointed out, the Conference could hardly deal with, but which it was impossible to keep entirely out of sight, viz., the influence of wells in reducing the supply of water to streams in their neighbourhood, and the consequent questions of property which would arise. Upon the question whether the water supply should be taken from rivers or wells, there were great differences of opinion. Some believed that, although it would be most desirable to have water absolutely pure, yet there were considerations weighing somewhat strongly in favour of obtaining water from convenient streams, as high up the source as practicable, and to apply, in connection with such supply, the most efficient means of mechanical, and, if possible, chemical purification. Others took a somewhat poetical view with regard to the supply from deep wells, and utterly ignored the possibility of any contamination of such water, and seemed to think that you had only to sink any number of wells as close together as they could be placed conveniently, to obtain any amount of water to supply a town of any size. Those were points upon which differences of opinion would always exist until the matter was put to a practical test on a large scale. Again, many, in referring to the hardness of the water, said that companies had no business to give hard water; that they had only to adopt a softening process, which costs little or nothing; and that if a water company were allowed to supply water they should only supply it in the softest condition in which it could practically be produced.

Of course that was a very natural demand from the point of view of the consumer, but it remained to be seen how, if they drew water from deep wells for the supply of London, a softening process could be carried out on the gigantic scale which would then be necessary. With regard to that point, they looked forward to have some valuable information given them by Mr. Homersham and also by Mr. Baldwin Latham.

Papers were then read by S. C. Homersham, Baldwin Latham, H. C. Sorby, W. Anderson, and Prof. Odling.

Mr. W. S. MITCHELL, wished to make a remark or two with reference to Mr. Sorby's paper. The difficulty had always been to get small spores in such a form that they could be seen, but a plan had now been adopted to cultivate these spores, and in the Exhibition there were two methods shown of doing this. One at No. 193 in the Central Avenue, exhibited by Messrs. Nicholson and Mr. Carpenter, and the other in the Physiological Laboratory, where Dr. Koch's method was exhibited, which consisted of cultivation in a gelatine mixture, a kind of solid soup, and that was under the charge of Mr. Watson Cheyne. A plate of glass was taken on which some of this mixture was spread; on this a single drop of water was placed, which was then covered with glass, so that no matter from the air could reach the surface, and then the spores were allowed to grow. Some could now be seen which had been growing for fifteen or sixteen days. This method had been carried out, he understood, in Berlin for two years, but this was the first time it had been shown in this country.

Mr. JABEZ HOGG wished to say, in reference to certain remarks which had fallen from the Chairman, that he had no intention of defending the conditions of London cisterns in general, and that his remarks of yesterday applied strictly to well-covered house cisterns; he had always acknowledged that pollution must take place in uncovered tanks. He might add that in the evidence he gave at the Kingston inquiry, he stated that the small fish and eels, and other unwholesome things found in some cisterns, could not have spontaneously bred there. With regard to the paper just read, he should have been glad indeed if he could say he agreed with Dr. Odling's conclusions. The meeting, however, would have been in a much better position to discuss his conclusions if they had been put in print, and he was sorry that this had not been done, as they were in fact the most important part of the paper. He was so far in accord with him that purity, as expressed by chemists, had a very different meaning to that attached to it by the public, and he hoped Dr. Odling would, in future, say that they must not take the purity of the water, as he set it forth in his reports, to mean absolute purity and freedom from unwholesome conditions, that is from organic germs, freedom from what medical men knew to be deleterious to human life. Dr. Odling had said that the pure water of the Kent Company contained more organic matter than the water of the Thames; this appeared to be a fiction—a chemical fiction; and Professor Frankland, who originated the previous sewage contamination theory, now put it aside, and told them it had no value whatever; in fact it had so little value, that it merely expressed something that chemists understood, and the public did not. The public were not in a fair condition to say what the chemist meant, but they know what they wanted, they wanted water perfectly free from all organic impurities, and if they got that, they cared little whether it was one grain or a dozen grains of mineral matter to a gallon. The one grain, however, which some chemists despised was more than sufficient if it contained a specific germ, as that of typhoid fever or cholera, to poison a whole town of 40,000 inhabitants. What more did chemists require in the way of impurity? Chemists could tell us of the impurity of water; but they could not assure us of purity and safety. Chemistry could not detect the millionth, or trillionth, part of a grain of deadly organic matter in a gallon of water. That being so, it showed that chemists could only very imperfectly perform the duties undertaken by them; they could not protect the public health, as they had sometimes been led to assert. Dr. Odling had referred to the Registrar-General's reports of June; but he had in his hand later reports, those of July also issued from Somerset-house, and with regard to three or four towns supplied with deep well water, he noticed that Brighton had a death-rate of 13·9 to the 1,000; Hull 19 to the 1,000; Portsmouth 14·1 to the 1,000; whilst London had 24 to the 1,000. That showed that there was a considerable difference in the death-rate of towns supplied with pure and wholesome water, such as he held deep well water to be. In London with the rise in temperature, during the month of July, there was a corresponding rise in the deaths from diarrhœa and dysentery; there were 39 in the first week, then 104 in the next, and 336 in the succeeding week. In the next month they rose again to 533, exceeding the corrected average by 242—435 were of infants under one year of age, and 78 of children between 1 to 5. There was usually a considerable difference in the death-rate whenever the temperature of water ranged above 60 degrees, then it was that the danger of an impure drinking water was greater. He had placed on the table two specimens of deep well water from Canterbury, one taken before being submitted to a softening process, the other after it had been softened by Clark's process. The deposit thrown down he had examined under the microscope, and could find no trace of organic matter, not even a diatomaceous body, which he expected to find under a high power.

Mr. EDWIN CHADWICK, C.B., said the chemical tests for water omitted altogether what was called the biological, or stomach test, of which he might give a remarkable instance—that was that there was a change in the supply of water to the Millbank Prison from the Thames, which had formerly been used, to that of the well at Trafalgar-square, and there was a return by the medical officer of the prison, in which he showed the difference produced in the population by this change. The evidence of the benefit resulting from the change was perfectly overwhelming. In Glasgow, Aberdeen, and Manchester, all the water was found to produce dyspepsia, which chemists did not detect or take account of, but it was perfectly decisive as to the quality of water, especially during particular portions of the year. He thought it would be well if the investigation as to the sanitary results were pursued by asking the officers of prisons to note the difference produced in the health of the prisoners by a change of water; those who have been for a time in a hard-water district, and those who were in a soft-water district, and he had no doubt that results would be obtained similar to those recorded in the instance he had referred to at Millbank, and which were utterly unnoticed by any chemist at present. Again, the Chairman would know very well how the quality of water depended on its aëration. At Pangbourne you might take up water, and find it quite brilliant, showing evidence of good quality, but when that same water was taken to London, and put into a cistern where it came in contact with the air of the cistern, you were really drinking down air with all the impurities which were likely to arise. In going into overcrowded rooms, or low neighbourhoods, medical officers would tell you that in washing, after an operation, their fingers quite smelt of the water they obtained there. He recollected on one occasion, when making an inspection in Rotherhithe, the medical officer cautioned him against taking any water there, for it would be dangerous, because the water beds were situated close by the cesspools and absorbed the cesspool air. Some years ago, he asked Dr. Hofmann if he could analyse a London fog, which carried disease with it; but he could only separate the dust and dirt, and he failed to analyse them. Again, with respect to the paper which spoke of the protection of rivers by the action of plants, he would point out the immense difference between fresh sewage and that which was putrid. When the houses of a town were drained, or water-closetted, so that the sewage discharged fresh, it was noticed that fish returned to the river which they had forsaken. That had been noticed at Carlisle—the fish reappeared, and were finer in quality altogether.

Mr. BISCHOF said it had been a point of the greatest interest to him to learn that spongy iron, after a very few minutes' contact, had such a powerful effect in destroying animal and vegetable life. Mr. Anderson had said that his anticipations at Antwerp were not quite fulfilled, and that was quite true; but he never anticipated the difficulty which had been experienced there. To deal with a small tidal river contaminated with all kinds of polluting matter, and to convert such water into a potable water, every one would admit was a matter of the greatest difficulty. However, the plan introduced by him had been styled a "complete success" by the chairman of the Antwerp Waterworks Company, at the last general meeting. Dr. Odling had been speaking under great difficulties as regards time, no doubt; but to him, as a chemist, it would have been of much interest if he could have given some hint as to how he arrived at the statement that organic matter in water might be said roughly to contain 40 per cent. of organic carbon. As a chemist, he could scarcely conceive that there should not be an enormous difference in different organic matter, because some water was contaminated largely—in fact, almost exclusively—by animal, and other water by vegetable matter, and they all knew that animal and vegetable matter differed very greatly in the proportion of carbon they contained. He wished to refer to only one more point. He had in his hand the return of the Registrar-General for July 20th, 1878, which stated:—"The weekly deaths from diarrhœa and simple cholera, which had been 23, rose to 78, 156, 256, and 349 in the corresponding weeks. The deaths from diarrhœa are differently distributed in the fields of the water companies. Thus, the deaths in the last four weeks were 786 in the districts supplied with the Thames and Lea waters, whereas the deaths in the districts supplied with water drawn from the chalk by the Kent Company were 19; but of the same population, the deaths in the former were to the deaths in the latter as 3 to 1." As there might be a visitation of cholera this autumn, and as they all agreed that diarrhœa and simple cholera, although totally distinct from Asiatic cholera, would still predispose to it, this was a point of very great interest, and he should be glad if Dr. Odling, or any one else, would express an opinion whether these figures which he had just read did not throw an important light on the relative wholesomeness of the different supplies of water to the metropolis.

Dr. BARTLETT said, one observation made by Dr. Odling very naturally led up to the few words he had to say. He stated that certain water, when thoroughly filtered, would then be good enough, and pure enough, for all potable purposes; another leading observation was made in Mr. Anderson's paper, namely, that by mixing iron in a very finely powdered state with water, a far greater efficacy was obtained than can be in the ordinary way, by passing it through coarse filter beds or compressed blocks of porous iron or other filtering substances. He so far cordially agreed with that statement that it formed the very pith of what he wished to say. At the present time the question of filtration, whether in the water companies' sand-beds, or in the domestic filters which persons now used for the purpose of correcting any omissions on the part of the companies, was highly prominent. One section of the public appeared to rely entirely on this process, and another semi-scientific section were apt to place no reliance whatever on it. It had been stated, over and over again, that filtration could not remove matters in solution, but only those in suspension; but to that statement he took objection, because during the last ten or fifteen years, in the process of testing a great number of filters—in fact, almost every kind which was presented to the public—he had found, that to a lesser or greater degree, nitrogenous matters in solution were removed. The manufacture of filters, and the scientific application of filtering media, had improved, but although he said this with great confidence that there were filters which would remove nine-tenths of the nitrogenous matters in solution, still, he was equally certain that nine-tenths of the filters before the public were perfectly worthless, because with the tenth part of nitrogenous matter which was not removed there was that amount of unfiltered water passing through into the storage receptacle. Now, if the tenth which passed through contained any of the germs of disease, or communicable matter of disease, whether germs or not, that would be equally as fatal to the drinkers as if it were entirely unfiltered water. He had been led to this train of reasoning more particularly because during the last six or eight months he had been testing filters which removed nine-tenths of the decomposable organic matter; and the other tenth would have been removed had the filters been mechanically perfect. He had been making experiments on a very fine precipitate, sulphate of barium, and found that that freely passed through many of the filters, and therefore it became obvious that matters which were very much smaller than that would equally pass through. He then went on with salts of uranium, a still finer precipitate, and found they almost invariably went through. Then it occurred to him it would be well to try if he could not stop this. Both these salts were white, and, therefore, were perfectly visible to the naked eye, or, in the finer particles, under the microscope. He tried to stop it by using finely powdered carbon, animal, vegetable, and mineral. The result was that he found that with carbon of all three kinds, when reduced to much finer particles, they also came through the greater part of the filters he tested with it. This was most important, because anyone could go home and make similar experiments for himself. In working this out, he found after having used a considerable amount of very fine carbon, he had stopped very nearly the whole of that one-tenth of decomposible matter, and in fact he had decomposed the greater part of that tenth. Knowing the oxydising influence of spongy platinum, he went one step further, and used platinum black. Of course he would not recommend this as being suitable for ordinary filtering purposes, because of its expense, and there might be other objections also; but it did absolutely oxydise and remove every trace of decomposing nitrogenous matter. That being the case, it was certain that perfect filtration could be obtained. Following this up, he had tried carbon in the finest divided state, so fine that he found by the microscope the particles were finer than the markings on a diatom, for under a 50th power he could not measure them, although he could measure the markings of diatoms. Carbon, therefore, could be obtained, if necessary, in so fine a form of sub-division that an immense amount of oxydising power was thereby obtained. It might be said, how were you going to filter water through that extremely finely divided carbon. He thought possibly that cotton wool, which obstructed all germinal matter passing through, as was shewn in the well-known experiments of Professor Tyndall and M. Pasteur, was a means to the end, but soon afterwards he found that cotton wool decomposed in water, and therefore that upset the experiment. He therefore tried two other media, one a peculiar kind of slag wool, and the other asbestos fibre, both of those retained the finest particles of charcoal, and formed a perfect filtering medium as far as developing the oxydising property of finely divided carbon was concerned. Having obtained this result, he must add that he was not aware of any filter now before the public which had no decomposing matter in its construction. The introduction of the cork caused decomposing matter to be mixed with the water, and under the microscope large quantities of moving organisms were to be found in the decomposing matter of the cork itself. The same thing, in a lesser degree, occurred with india-rubber, and, therefore, he laid it down as a fundamental axiom in filter-making that no decomposing matter of any kind should enter into its construction. Further than that, the filtering media should neither pass the finest possible charcoal, nor should they be choked up by it. These two points formed the most important tests he had to bring forward. If they fell back on the old plan of testing filters which he had been in the habit of using for twenty years, they would be misled as to the mechanical deficiences of which he had spoken of, for it was no use whether one adopted Dr. Frankland's process for the analysis of water, or the estimation of ammonia, to suppose that because you were able to oxydise three-quarters, or even nine-tenths of the decomposible nitrogenous matter, that the filter itself was therefore of any value. If this were recognised, and people would make the experiment for themselves, he believed better filters would be produced, as purchasers would be able to test the filters by these means. There would be at last a possibility of arresting much of that which was injurious to health; and it was not impossible that they might prevent even the smallest germs, which must be of some size, passing through the very fine medium he had suggested.

Mr. THOMAS SPENCER said they had heard a great deal of the necessity of softening water, and a great many processes for effecting that purpose had been mentioned, but they had heard nothing as to the physiological difference to the animal system of very hard water and very soft water. For forty years he had been going through most of the towns in England, and he could never get that question answered—what was the physiological effect on the system of hard water, as hard as that supplied by the Thames, as compared with soft. He might say that he knew most of the water supplies of the world, and he did not know of a better supply anywhere than that which came from the Thames when properly filtered; he did not mean by any chemical means, but when well filtered mechanically. He had constructed waterworks at Calcutta, and knew many of those on the Continent, and if the Thames water were well filtered, it would be one of the best water supplies to any large town in the kingdom. When he put that question he never got a reply, but was told he did not require any explanation—that salts of lime and magnesia were not desirable. Two years ago, he suggested to the authorities of a town with which he was connected, that to settle this question it would be well to get accounts from the authorities of the different towns, and ascertain where the death-rate was highest – whether in towns having a soft water supply, or hard water. That report had now been returned, and no doubt would be in print before long, when it would be found that the death-rate was larger where soft water was used, and this to a much greater extent than he had anticipated. He must say also that he began as a soft water fanatic, but there was no doubt that one reason why soft water was so much recommended was that in many of the towns in the north, calico-printing, and similar works were very numerous, and as soft water was much better for such operations, people naturally supposed that similar water was better for domestic purposes.

Mr. MAIGNEN said he had hoped some paper would have been read on the subject of filtration as a whole. They heard a good deal of how water was contaminated in a very astonishing way, but how to get over the difficulty they had heard very little. He could not attempt to do justice to the matter in the very few minutes he had at his disposal; but what he had to draw attention to was this, that on Thursday last he was in the laboratory of M. Pasteur in Paris, who asked him "how will your filter last?" Now this was a subject worthy a whole day's discussion. The first necessity of filtration was that, when impurities had been collected in the filtering material, it could be easily removed, and thrown away and replaced. Dr. Bartlett had knocked the nail on the head by drawing attention to a very important fact. If a microbe had a body, it was just possible to conceive an impediment, or a series of impedimenta, fine enough to prevent it passing through. Dr. Bartlett told them that he had used charcoal the particles of which were smaller than the smallest known diatom, and if these particles did not come through a particular form of filter, it was conclusive that the diatom itself could not pass through. He echoed the statement made by one of the speakers, that if the London Thames water were properly filtered, it would be the best in the world, and he had reason to hope that this would soon be attained by means of the apparatus shown on the wall.

Dr. HAUGHTON said a great deal had been said in favour of the water they were obliged to drink in London, there being no option as to the source from which it was obtained; and he wished he could heartily endorse all that had been said in its favour, because it was unpleasant to have a bad opinion of that which one had to deal with continually. He listened to Dr. Odling's paper with great admiration until he came to the last sentence; but they were not told there whether his estimate of the London water as compared with the supplies of other towns was founded on its present condition, or on some former period, or on a fair average. He had in his hand an extract referring to the condition of things at the time of the epidemic of 1830; but it was written twenty years later, and those periods were not referred to with reference to the microscopical analyses and examination of the water. It stated that at this time there was hardly a water company in London the water of which did not reveal to the microscope solid particles of sewage floating about in the company of small weeds and sponges, and fine fat pulpy animalcules. At an interval of twenty years there was the same condition; and it was obvious that when such things had happened they might happen again, especially when eels and fish were found in reservoirs where they were not bred. It was not at all infrequent in disputed cases in the Law Courts for chemists to give evidence with regard to the supposed condition of streams; when one would state that the water was dirty, and another would say it was beautiful, and both had made analyses, and both were men of science. With regard to the basis on which this statement with regard to London water was founded, it appeared, so far as he could make out, that the ground upon which Dr. Odling claimed this wonderful excellence was the very ground which, in the earlier part of the paper, he said it was totally inapplicable to put before the general public. For if he only got the chemist's estimate of the amount of organic matter, and that was put forth to the general public as a test for the quality of the water in order to re-assure the said public that the water they were drinking was beautiful, they found Dr. Odling himself saying that it was not a reliable test. Yet at the end of the paper he said London water was very superior because of this very thing, for he brought no other evidence. That appeared to his mind very unsatisfactory, speaking not as a medical man, but as one of the long suffering public who had to drink water which had been testified to be contaminated, not far from the intake of the companies, with organic matter of the foulest description. It was true those cases were not very flagrant, except at particular periods, but they wanted a guarantee that they should not occur at all. What was the use of talking about filters, and telling the public the water was unfit to drink unless it were filtered. It was the grossest cruelty to the poor. They could not buy filters, and even if they were distributed gratuitously, there was not one family in ten who would take care of them, so as to see them renewed. You might filter out the cats and dogs, and the grosser particles of matter; but the better the filter the sooner it became filled with germs, and every kind of contamination. It was the very nature of a filter to become filled with foulness, to breed microbes, to become itself a source for contaminating the water, if it were not renewed within a reasonable time. The gentlemen who spoke so much in favour of filtration had an idea, which was good in itself, that the filtering medium should be so arranged as that it could be renewed; but to say that the general public were to depend on any kind of filter, patent or not, was stark nonsense. This evil was not imaginary, for it was given in evidence before the Metropolitan Medical Commission in 1830, that whenever water was contaminated so as to be nauseous, diarrhœa was invariably prevalent, and affected the health of every person drinking it. He did not want to increase the cholera scare, but he hoped to utilise it, by demanding of the authorities that no money should be spared to give a good supply of water, which should be available for every house in the city, without putting a single inhabitant to the expense of a filter.

Dr. ODLING, in reply, said he had been invited to read a paper on the chemistry of water, and had, therefore, confined himself mainly to chemistry; and for this under the circumstances he did not think he was to blame. At the same time he might say that for many years he was a medical officer of health, and had since attended to hygienic studies, and he came prepared to speak not only as a chemist, but also as a physician and hygeist. As regarded the general question, the influence of the presence of organic matter in water must depend, not on its quantity, but its nature. And any comparisons put forward with regard to quantity, irrespective of nature, fell to the ground altogether. Had there been sufficient time, it was his intention to discuss the question of quality as he had the question of quantity; and he had notes ready for the purpose, but time did not allow of their use. Any general statement, and any conclusion he had formed or expressed, with regard to quality, was formed on a consideration of evidence, and was gone into by him as minutely as he had gone into the question of the influence of quantity. The gist of the whole question in the present state of knowledge seemed to rest on an observation of effects. Of course if you took one week and compared it with another, or one town with another for a short period, you might arrive at almost any result you pleased; but if you took large populations, and examined the statistics for lengthened periods, it would be found that there was absolutely no difference whatever in the health of the population which could be ascribed to the drinking of river water, lake water, or spring water; from which it would seem all these different varieties were, in their different ways, well suited for the supply of large populations.

Papers were here read by Joseph Quick, jun., J. H. Greathead, Col. Sir Francis Bolton, and H. J. Marten.

Mr. T. SUFFIELD wished to enforce the recommendation often made by Sir Francis Bolton, as to the arrangement of overflow pipes of cisterns. The ends of such pipes should discharge into the open air, or into a rain-water pipe unconnected with the drains. He thought it would be well for water companies to make an arrangement with plumbers, and offer small rewards to their workmen, for the discovery and prevention of waste of water. The fittings of cisterns were frequently defective, the ball-cocks being badly made and badly fitted. He objected to the removal of standing waste pipes; he thought that the upper ends of such pipes should be closed, and then, by lifting them out, the means was provided for cleaning out the cistern. The drains should be more frequently flushed, with a view to the removal of the causes of the stoppages. He laid great stress on the importance of a constant supply.

Mr. E. K. BURSTAL desired to say a few words with regard to the use of the waste water meter. He would not cry down the use of that most useful apparatus which Mr. Deacon had invented, but he was quite certain that useful results could be obtained without that instrument. He had known himself, in two towns, that inspectors had to be sent round because that instrument merely showed that there was a waste, and they then had to send inspectors round to see where the waste was. He maintained that the use of that expensive contrivance might be dispensed with, and they might, by sending inspectors round with sounding rods and the necessary appliances, find out where the waste was, and check it, without using that apparatus. He might be thought old-fashioned in saying so, but he believed that to be the case. With regard to the cisterns which were generally in use for the supply of closets, he was much disappointed when he looked upon the exhibits of the London Water Companies in the Exhibition, and found the assortment of curiosities they had brought together. They had brought forward vacuum systems, and every sort of automatic system imaginable, but there was not one single instance of the double valve system, which had been introduced by Mr. Aris, some of which were now in use in Yarmouth, Lowestoft, Norwich, Derby, Leicester, and Oxford, and in all the towns noted for having a model consumption of water. In the towns of which he was managing engineer, they did not allow this automatic apparatus to be used, because they found they were waste-producers, not waste-preventers. In fact, to shew how imperfect they were, one of the syphon systems could be set to run continuously, and that was a system which one of the London Water Companies was recommending for use. He really thought that, instead of introducing these patents to the public—and the public were consequently getting rather puzzled to know what to use—they should adopt such a plain double valve system as was placed before them, so that they could not both open at the same time. The advantage of a cistern upon that principle was that they would have for, say, a fourth or a fifth flushing, eight or ten gallons in reserve, and assuming a constant supply, if the water happened to be turned off for half an-hour during the day, they would still have a reserve in the cistern, and that would render the use of large 100 gallons or so cisterns unnecessary. They would then only have to put their taps on their rising service, and they would not want any cisterns at the tops of the houses at all. That could be done at very little cost in provincial towns, and it could also be done in London. The remedy for the difficulty rested with the ratepayers, but the class of ratepayers who were the owners of small properties were the great obstructives. With regard to the water supply for fire extinction, the size of the service mains had not been taken into consideration for that purpose. It had been provided in all the local legislation that proper water mains should be laid down, and very few mains of less than 4 inches in diameter had been laid down since 1847; therefore, it was not right to say that provision had not been made for protection against fire; $1\frac{1}{2}$ inch mains were sufficient for domestic purposes, but they wanted 4 or 6-inch mains for an efficient fire supply. Mains of that size had been laid in the town with which he had been connected from 1849 down to 1855. With regard to the dual system, they knew it was impossible to construct a service upon a principle of that kind. If one tap was placed beside the other, no one could ever tell which tap to go to, and the expense was a very strong reason against its adoption; and if what they had heard with regard to the quality of the water from the alarmists was true, which he, however, did not think was the case, it would not be a proper thing to put in the power of servants to give them contaminated water from the tap on the right hand sink when they were supposed to give them pure water from the tap on the left.

Mr. CHADWICK would say a few words with regard to the paper on fire prevention. In Liverpool, where a great deal of incendiarism prevailed, the chief magistrate came to ask his advice as to what they should do in the way of prevention, and he suggested that they ought to put the water on the constant system, hydrant the streets, and place the keys of the hydrants in the hands of the police, so that on the occurrence of a fire, there might be no loss of time, no running to distant stations, as the men would be able to apply it at once. That system had been adopted also in Manchester, Glasgow, and in other places. A Committee of the House of Commons had also sat upon the subject, and it was shown that the effect of the adoption of that system was that they could bring the water to bear in about three minutes on the average; whereas, by sending for a distant fire brigade, however well organised, it was twenty or twenty-five minutes before they arrived at the fire. They afterwards improved their organisation, and brought the time down to fifteen minutes, but Mr. Braithwaite, the late Chief of the Fire Brigade, stated, that for the efficient protection of life and property, you must have the assistance within five minutes, and this system brought it within three minutes. What had been the authenticated experience of its employment? Why, it had reduced the insurance risks in Manchester, Liverpool, and Glasgow, where this system was carried into effect, by fully two-thirds, or rather more, and the loss of life had been reduced in the same proportion. The Board of Works had raised objections to putting the keys of the hydrants in the hands of the police. There were 4,000 men always on duty, patrolling the streets at night, but they objected to their having them, and said they must keep the control to themselves. It appeared that in the mere greed of power, which had not hitherto been withstood, they would keep everything in a condition of insecurity to the public, by keeping the keys out of the hands of the police, who could act immediately upon receiving information of a fire, and that in the face of the experience as to the saving of two-thirds of the losses by fire! There were double as many police-stations as there could be fire brigade stations, and he could not imagine how anybody could insist upon their separation for this purpose, at the expense of an enormously great destruction of life and property by fire. That system should also be applied in the theatres; the police had to be there for ensuring order, and they ought to have charge of all waterworks and appliances for the immediate extinction of fire. The most scandalous thing he knew was the ignorance of members of Parliament, who could go on acquiescing with the maintenance of the present system in the face of such facts. As to the dual principle of water supply, if they had any *recherché* system as to quality and quantity of water that was applicable, they might have a separate dual system, but they had heard that the result of softening the water, and bringing in soft water for consumption by a separate system, was that water would be brought in for washing and ablutionary purposes and for baths—for everything in fact which would be benefited by the introduction of soft water—yet in fact, though the benefit would be great, it was obvious enough that the streets could be washed with common water; and, on the whole, he had expressed the opinion that the separation was not worth while, and to that opinion he still adhered. In one district, where an inspector was sent to examine the effects of drinking the Thames water from a place highly polluted with sewage, the people laughed at the idea that they drank water; in fact they drank beer, and beer generally was drunk by the whole of the wage-earning classes. Such was their dread of drinking the water in one case, that when he went to look at a place in London where the finest water was delivered, viz., the Kent water, he was warned against drinking the water on account of the gases from cesspools making it a source of great danger. The reasoning was that the death-rate there, where they had the purest water of all, viz., the Kent spring supply, was higher than it was in other places, and the deduction from that was that the water was positively unwholesome. But it proved to be nothing of the kind, for the people did not drink the water. It was the rarest thing for them to do so; even when a mother went out with her children, she was very careful to provide beer for them, for fear of the danger from drinking the water.

Mr. JABEZ HOGG said it was very evident children did drink the water, and no doubt to that fact was due the increase in the death-rate among the infant population. With regard to the arrangement of the filter-beds shown in the building, no two of them were alike—no two water companies adopted the same size and proportion of filtering materials; some gave six or eight inches of sand for a surface layer, and others gave four or five. There was no uniformity in the arrangements for filtering water, and that showed that filtration was of far less importance than it was generally supposed to be. The water companies evidently felt that it was a matter of very slight importance whether they gave a filter bed of six or eight inches of sand or four or five feet. One of the readers of a paper had remarked upon the companies compelling people to remove their waste pipes; he should like to ask practical engineers a question upon that point. Water companies were not agreed as to the use of the waste pipes. Some years ago, he removed his own waste pipe, which went into the sewer pipe, and converted it into a surface overflow pipe. Two years ago, the New River Company sent him a compulsory order to remove this pipe, and put in another overflow pipe at the top of the cistern. He had to alter all his fittings at considerable expense, and at the end of two or three weeks he found the effect of the overflow pipe was to inundate his house, for on a fire breaking out in the neighbourhood, during the night, the cistern overflowed, and the water came down the staircases and spoiled his carpets. He expected to get nothing from the water company in the shape of compensation for the damage done by the overflow; nor for the great damage done to the basement by the damp. But for the company insisting upon the removal of old pipes, which had been working efficiently in his house for some years, the damage referred to would not have happened, and the only excuse for removal was that the company was going to give him a constant supply of water; two years had elapsed and the constant supply was still promised. A fifteen minutes' supply at 11 o'clock, and no other supply for the day, unless a fire happened in the neighbourhood, when the water was turned on again, and he was liable to an overflow, unless great care was exercised in the examination of ball-cocks. Then there were, again, dead ends of streets, and dead ends of the companies pipes, which greatly polluted our water cisterns, and as one gentlemen had stated, when these got emptied, they occasioned a semi-putrescent rush of waters into the sewers, or into house cisterns.

Mr. CHADWICK said there was one point he would mention with regard to waste prevention. In Manchester they had got it down to 17 gallons a head, and in other cases the same thing had been done. But these were cases were the water belonged to the Corporation, and it was the officer of the Corporation who went in to examine, and not of any trading company. That difference was the great reason for the failure of any attempt towards the reduction of waste in London. If things were done there as in Manchester, Liverpool, and other towns, he had no doubt that waste in the metropolis might be reduced even more than was anticipated. They anticipated a reduction of one-third in the waste, and if the matter were under a public authority, who ought to have the control of the whole apparatus, not merely of the mains at the doors, but the capil laried works within the houses, that reduction could be effected, but until they were placed on a public footing there would be no economy secured.

Mr. WALKER had intended to confine his remarks to the subject of waste, but he wished to answer one or two remarks of the previous speakers. A remark had been made about the warning pipes. They were led to infer, because there was no flow from the warning pipe, it indicated a want of supply. As a waterworks manager, he would say it indicated that the fittings were in good order. At the same time it was not necessary for works to belong to a company to have efficient supervision; and to show how these matters were looked after by a corporation, he would read part of Rule 16 of the Reading Corporation Waterworks regulations. "Every cistern shall be provided with an efficient ball-valve and warning pipe, and shall be fixed in such a position as to be easy of access for inspection." If warning pipes were fixed in such a position that when there was an overflow, or when they indicated that some of the fittings were out of order, and caused damage to the property of the consumer, he would say that the company's officers were to blame for allowing the warning pipes to be fixed in such a position that they would, by overflowing, destroy any property of the consumer. Then, again, with regard to filtered water, the supply with which he had to deal came from a river. He had tried several experiments with reference to filtration, and he had found that filtration took place almost at the surface of the sand. If they had a bed of sand two feet in thickness, they would find, after a few weeks' use, if they let the filter dry, they could lift the film off as if they were drawing a piece of damp paper off a table. He would not say that the thickness of sand should be reduced to a few inches or under two feet, but through even two feet of sand sometimes they would find living things in the mains. Perhaps a consumer would come and make a complaint about finding a fish or an eel in his supply, but it did not follow from finding them in the mains that the water was impure. He thought, however, when they found leeches in the water, they were justified in preventing children drinking it. Much had been said in the course of the morning with reference to cisterns, but as the morning had been wholly devoted to reading papers, and the discussion had been left to gentlemen who were well acquainted with the subject of water supply, he had refrained from saying anything. The remedy he thought was to have a constant supply laid on. If they were to take a bottle of river water that had passed through a filter, to all appearance it would be clear and bright; but put a stopper in that bottle, and seal it down, and in a month or so afterwards they would find there was a considerable deposit at the bottom of the bottle, and to all appearance they would say it was very bad or very impure water. Impure water for public use, he would say, was water that fish would not live in; and water that fish would live in was not impure. The conversation where he was sitting during the morning, turned on water supply to houses, and a lady said she had had the cistern in her house cleaned out, and the deposit found in it consisted principally of soot from the tiles, but that did not show that the water was impure. Then with regard to the remark as to water supply for fire extinguishing purposes, the diagram on the wall was an answer to that. A dual supply is not required. A town having a constant supply, and the fire brigade arrangements being under the control of the police, they could, in a few minutes after the alarm was given, fix a standpipe, and begin playing on the fire, and if the pressure was sufficient, they could do much in keeping down a fire before the engines arrived. With reference to waste prevention, he believed the best means of effecting that is to have a thorough code of regulations, and to have those regulations properly carried out. Much had been said with reference to Deacon's meters. There were no doubt a good many waterworks managers present, and other persons who must have received circulars, in which it was stated that managers were exceedingly pleased with the efficiency of Mr. Deacon's invention. One gentleman had stated that previously to the introduction of that apparatus there was a waste of 80,000 gallons a day going on in one district. He should think if there was a waste existing in any town of 80,000 gallons a day, it showed ignorance on the part of the engineer or the Board of Directors, and that there must have been great neglect. In reference to that subject, he would read a return with regard to the town he was connected with, viz., Reading, which stated that in 1874, the nett consumption was 47·71 per head per day; in 1876, with an increase of population and an increase of services, it was reduced to 30·24 gross, or a nett consumption of 16·99. But the circumstances which affected one town would not apply to another; some towns had a much larger trade supply than others, and they could not, therefore, draw a fair comparison on that account. In 1884, with a population supplied of 52,000, the gross consumption per head during the hot weather was 34·61, and the nett 18·26. This increase was due to the fact that a very great quantity of water was used in Reading for road-making and for new paving works which were now being carried on; and in addition they supplied 130,000 gallons per day to one railway company, also 23,000 gallons for sewer flushing, and in the town there were upwards of 8,430 water-closets. All this was done without waste-preventing meters, and if waste-preventing meters were used, they must increase the cost of management. With all those circulars which were sent, they had not stated anything as to any saving in working expenses, and he considered that to be a very important matter indeed.

Mr. E. K. BURSTAL said he had heard instances of six towns which, under companies' management—although two had recently been transferred to corporations—were the best managed towns in England —Nottingham, Derby, Norwich, Stourport, and Sheffield; and in fact he believed, in two cases, they had been transferred to the corporations because they were so well managed.

Mr. DICKSON said Mr. Burstal had made some observations with regard to the exhibit of the water companies, complimenting them on the admirable collection of curiosities they had shown, but complaining that they had not submitted to the public those apparatus which they considered best adapted to the purposes of the population. He would remind the Conference, however, that when the Commission sat in 1871, the whole weight of evidence tended to show that it was desirable that companies should have the power of inspecting, examining, and approving fittings to be erected in the houses; but, to the surprise of most people who followed the inquiry, the Commissioners, at the end of it, said they felt bound to recommend that no such power should be given, because they feared it would have a depressing effect on inventions and improvements of water apparatus. Consequently, while Manchester had the power of approving the apparatus to be used, the London compaties had no such power, and any kind of water fittings which complied with the standard of ordinary intelligence was deemed to be an efficient apparatus. The magistrates of the metropolis were the authorities to whom this question was relegated, and they were very reluctant to fine persons for having a defective water apparatus, if it could be shown that it would do what would in their opinion be ordinarily expected of some such apparatus. The consequence was that companies, knowing this weakness, were obliged to pass fittings which, if they had proper authority, they would possibly be able to exclude. The companies, therefore, were not in a position to bring before the public any exhibit which they could recommend for adoption, for if they did, there would be an outcry on the part of this or the other inventor that his invention was superior, and the companies would incur a great deal of odium in addition to what they at present experienced. With reference to the question of warning pipes, he would remind Dr. Hogg that the regulation in this respect said that the overflow in connection with drains should be removed within a certain time, or at the option of the consumer should be converted into a warning pipe, and that every warning pipe so connected with the cistern should be placed iu such a position as to be easy of access and inspection by the company's inspector; and he doubted not the reason of the remonstrance of the New River Company to Dr. Hogg on this point was that the pipe which he placed to his cistern, in substitution of the overflow pipe, was not so arranged that it could be seen by the inspector, ortherwise he should not imagine any water company would require a consumer to provide an overflow pipe. In fact, every water company would be glad to see any overflow pipe in the sense of one which took an overflow from a defective valve-cock, done away with. A warning pipe was a very useful thing, if properly placed and connected, as a sanitary convenience, as it introduced fresh air to the surface of the water. With reference to the paper on fire extinction, he thought there was rather too sweeping a condemnation of the London supply, which the writer said was deficient in pressure. It was stated that in London the whole water supply was pumped (see *ante* p. 954), which would very likely be misunderstood; the author was comparing the cities where the supply was by gravitation with other places where it was pumped. In London, as far as the fire supply was concerned, it might be stated to be by gravitation, because the water was pumped into reservoirs, which formed a head for the fire supply, just as much as in other towns where the supply was by gravitation without pumping. Then the writer stated that the average pressure was quite inadequate for fire extinction without the intervention of fire-engines, and again, further on, he said the supply was undeniably deficient. He might appeal to the memory of Mr. Chadwick, who was present at the inquiry referred to, whether the general effect on the mind of the committee was not that the average pressure was quite sufficient for ordinary requirements of the fire brigade. The pressure in any town would scarcely be such as would enable the public authorities to do without engines; in fact, it would be the most injudicious thing for any authority in London to have such a high pressure as to do without engines entirely. He would recommend the author of the paper to inquire of the fire brigade authorities for the results which accrued from the adoption of hydrants in the City of London. He could inform him that at the large fire opposite the General Post-office, there were a set of hydrants provided by firms on their own premises which were found to be of great use, and certain property would inevitably have been destroyed had it not been for those hydrants. Again, with regard to the Kent Company, it was shown before the committee that the pressure throughout the company's district was quite adequate for the purpose of the Fire Brigade if hydrants were provided, but the Metropolitan Board would not provide them until the company said that if they did not they would exercise the power of the Act enabling them to do it themselves, and thereupon they put up a few hydrants which were tried at large fires on the river side, where they were used without the intervention of steam engines, and the Metropolitan Board had since admitted that the pressure was adequate, and they had recently given an order for 200 hydrants to be erected in different parts of the whole district within the metropolitan area.

Mr. Deacon said he had only heard part of the discussion, and none of the papers, and would not have spoken had he not felt it desirable to throw in his experience against the objections which had been raised to cutting off sewer overflows from cisterns or replacing them by warning pipes. He had been instrumental in giving a constant service to a population of 700,000 or 800,000, in one place, and he believed at much less cost per head than had ever before been found sufficient. The quantity supplied was much less than under the previous intermittent service, and the methods he had adopted were now applied to many millions of persons, both here and in America. In Liverpool, the work had necessarily been done with comparatively little alteration of fittings. There were no such powers there as were possessed by some towns, notably Norwich and Manchester, where the corporations or companies had practically unlimited power to require the removal of fittings, and to order any others to be put in. The secret of ultimate success in Liverpool, and in many other places, without oppressive regulations, was the multiplication, by a method often described but not always understood, of the means of detecting actual cases of waste by a given staff of inspectors, and the inclusion of hidden as well as visible waste. Of all methods, that must always be the best which can produce the required result at the least cost, and with the least annoyance to all concerned. Those who still believed in the antiquated method of house-to-house inspection had not tried the more modern method, and were not, therefore, qualified to speak concerning it. The many who had tried it on a large scale were, he believed, unanimous concerning its much higher economy and efficiency. With respect to the difficulty of not getting convictions from magistrates, there was comparatively little necessity for going before the magistrates, when the facility for detecting waste was so greatly increased. Persistent cases of waste were soon brought to bay, when the delinquents found that the trouble and expense to them of attempting to evade the doing of what was reasonably required by the officials was not worth their while incurring. The warning pipe was one of the instruments by which they succeeded, and he was exceedingly surprised to hear it suggested that some form of warning pipe should not be used. There was no doubt whatever that, unless you had some overflow apparatus which either made cistern waste a nuisance to the individual or visible outside to the public, that waste would go on to a very much larger extent than would otherwise be the case. It was not necessary to turn to Liverpool, as they were now discussing matters concerning London. The same thing had been done here. In the Lambeth district the waste had been so far reduced that, where the same methods were applied, the consumption and waste, instead of being between 30 and 40 gallons per head, as formerly, was now down to something between 15 and 16 gallons on constant service. If people had all the water they would take under high pressure and constant service, they had all that it was possible to give them. There should be no desire on the part of the authorities to prevent the use of water, but only to prevent deliberate harmful waste. If this were done, sanitary advantages, as he had elsewhere shown, must inevitably follow, as they had followed in Liverpool and elsewhere.*

Mr. MAXWELL said this question of waste was a very elastic one. They talked about getting the supply to under 20 gallons per head, but in some of the American towns it was up to 60, 80, 100, and 120 gallons. If you had a family of four or five, each of whom had a separate bath in the morning, using 40 to 50 gallons each, that would soon mount up. He was engineer to a town where the waterworks belonged to the corporation, a dead level town. If he were the officer of a private company, it would be his duty, probably, to try and keep down all waste, to have no dribbling taps, and no water running otherwise than for some beneficial purpose; but the health of such a town as Hull depended on the water flowing into the drains, and as they could pay their way very well without being so sparing of water, and as they always had it to spare, he did not set himself so very dead against waste. They did set themselves against it in one way, which he would explain. Inspection was of two sorts; inspectors might go in and threaten and frighten people, but their inspectors did not; they kept all their consumers' valves, and washers, and ball-taps in order, and they found it paid them to do so.

Mr. TARBOTTON, said he wished to say a few words on the general question, and principally with regard to dual supply. In all these public supplies, whether water, gas, or the disposal of sewage, a dual system, as a general principle, was to be condemned. They all knew the practical difficulties which attached to these undertakings, and they also knew how very dangerous it was to allow a double system to be in operation. Of course there were exceptional conditions, and there were towns in Germany, and many other places, where it was perfectly easy to supply two classes of water; but in English towns he hardly knew an exception, except, perhaps, certain parts of the metropolis, where it would be possible and safe to carry out and introduce a double system. They knew what plumbers were in large mansions or institutions, and also what they were in small poor houses, and he was quite satisfied that two supplies ought never to be undertaken in London. The same thing applied to gas. You could supply gas at 12-candle power, or 18 and 20, but it meant duplication of services and mains throughout the whole system, and when you examined the amount of capital which had been expended on gas and water undertakings, it would be found, as a general rule, that the cost of the distributive service was 4-10ths of the whole, and that would have to be multiplied by two if a double system were carried out. With regard to the general question, he believed in the principle of constant high pressure service. They had had a high pressure service at Nottingham for nearly fifty years, without a single intermission, the pressure varying from 40 to 120 lbs. in all parts of the town, the system having been introduced by Mr. Hawksley. With regard to the prevention of waste, in a district which comprised a population of a quarter of a million, they had a very effective system of daily inspection carried out by specially trained men, and by that means they had reduced the domestic supply to a volume of something like 12 gallons per head; the total supply, including manufactories, being under 20. At one time it was something like 55. The same thing had prevailed in some other towns, where a similar reduction had been accomplished by the same means. The fire service was very effective, but they relied in a great measure on the pressure in the mains, which was sufficient to send the water over the highest warehouses and buildings; that, however, was supplemented by an efficient fire brigade.

Mr. SMARTT said he had a miniature farm or

* See final remarks in discussion upon the paper by G. F. Deacon, read to the Society of Arts on the 17th May, 1882.

garden, by experiments with which he found that sewage water passed through boulder clay lost very little of its nutritious qualities.

The CHAIRMAN said he must now bring the discussion to a close, though several other gentlemen had sent up their names, for only a few minutes remained for him to offer some remarks on the chief points which had been discussed that day. It would be presumptuous in him to attempt to go over anything like the large range of subjects which had been dealt with; but he could not refrain from saying a word or two on the question of the quality of water, which had been one of the most prominent subjects under discussion. They must all regret that the very admirable paper of Dr. Odling had not been presented *in extenso* in print, and that they had not been enabled to examine the facts upon which he was quite certain the arguments had been based, which had led Dr. Odling to the conclusions he gave at the close of his paper. With regard to some of those conclusions, they would be all of one accord, viz., that the purity of water should, in the first instance, be considered by the chemist in its entirety; that what chemists called impurities did not necessarily relate to unwholesomeness; that, taking the actual proportion of organic matter existing in water, it was so small as to be of no importance in considering the quality of water for potable purposes, and also that organic matter which at one time might have resulted from decay, might possibly have no real importance with reference to the quality of water; that it might exist to a considerably greater extent in what was considered as the most wholesome spring water, than in the water of a stream. Again, with regard to his fourth conclusion, all who had studied the subject of so-called self-purification of water had come to the conclusion that this self-purifying power of a stream was very great indeed, and that the oxygen dissolved in the water, and continually re-absorbed by it—an action favoured by the agitation of the water in its flow—had the power of removing, to a considerable extent by oxidation, the organic impurities with which the stream might have become polluted. But when they came to the last two conclusions at which Dr. Odling had arrived, he must say that, in the absence of the facts upon which they had been founded, they still remained debatable; these conclusions being—that there was an absence of evidence as to the injurious nature of organic matter which might sometimes be found even in carefully filtered waters, and that there was no evidence that disease-producing organisims were developed or propagated in waters so filtered, so as to be prejudicial to life. All who had given any attention to the subject of the influence of water in promoting disease, would be inclined to hesitate before accepting the latter proposition; and they must, therefore, look forward with great interest to the publication of the complete paper, which would, no doubt, give the facts and reasoning upon which this statement was based. It had been within his experience that water which had been considered as of the very highest quality, and which the advocates of deep wells would unhesitatingly pronounce to be a high quality, had, after its supply for house use, proved a source of disease. This led him to refer once more to the question of tanks. There had been a much greater unanimity of opinion than on any former occasion with regard to the mischievous results which might arise in consequence of the storage of water in houses. Mr. Hogg had explained that, in hesitating to adopt the statement that tanks or reservoirs were injurious, he only referred to open tanks, butts, or reservoirs; but that closed tanks he looked upon as harmless. Even so far he must confess he did not feel inclimed to agree with Mr. Hogg, from the very fact he had already alluded to, that a house supplied with one of the purest of London waters—a deep well water—was visited by disease such as Mr. Hogg pointed out as consequent on the pollution of water by matters connected with zymotic diseases, although the tank was apparently perfectly closed. There was not the least doubt that this was due to the causes insisted on by Mr. Chadwick, that wherever tanks existed there might, unless very great precautions were taken, be a possibility of pollution by gaseous emanations from sources of pollution. This being the case, there could not be a doubt that the constant supply, and the absence of cisterns, were fundamental points in the supply of wholesome water. How far measures could be taken to guard against waste, he must leave to those competent to deal with this part of the subject, by some of whom it had been shown, during the discussion, that, at any rate, considerable advances had been made in this direction. He should imagine that no householder would hesitate, if he desired to obtain a high-class water, to adopt such precautions as might be reasonably within his power to guard against waste, and that everyone would willingly bind himself to use the water carefully, provided he were perfectly sure of the quality. Even though certain arrangements which had been suggested might be inconvenient or unsightly, there was no doubt the advantage they would secure in promoting the supply of thoroughly pure water at a comparatively moderate cost, would counterbalance any of these disadvantages, in the opinion of all sensible people. They had discussed as far as possible the question of the advantages and disadvantages of a dual supply, partly in reference to the large consumption of water for ordinary purposes, and partly in reference to the application of water to fire extinction, but the question evidently still required much further consideration. There had been one or two advocates of a dual supply; but others had pointed out, and he thought correctly, that very great difficulties existed, which some were inclined to think insurmountable. The distinct supply, on a very large scale, of water of ordinary quality, such as they would not use for potable or other domestic purposes, would involve an enormous outlay of capital, and it would be very difficult to insure the use of such water in a manner which would be really safe to householders. It was gratifying to find that, since they last held a Conference, there had been a considerable assimilation of views amongst those who were formerly much opposed on the chemical aspects of the question. There was now a very considerable concordance of views amongst chemical authorities, and so he believed they would find that, amongst practical men, some of the difficulties which appeared insurmountable would gradually vanish, and that by comparing ideas and experience, they would speedily arrive at a very great advance in connection with the water supply of large towns. He regretted that the special attention which London had received in the discussion had led to very little being said about the water supply of villages or small towns. This was a subject which no doubt required so much earnest consideration that it would be desirable, before long, to have a Conference at which to discuss the subject on the still broader basis of a national water supply. In connection with this there were several important subjects which had not been exhaustively discussed, such as the question of the value of different systems of wells which were applicable on a small scale with comparative readiness, and the very important question of the extent to which purifying agents could be applied to water for small communities. They knew how valuable had been the results of Dr. Clark's process when applied so intelligently as it was, many years ago, by Mr. Homersham, and since by various others, such as Mr. Porter and Mr. Atkins. In some instances, water which it was almost impossible to use for domestic purposes, on account of its exceeding hardness, had become an excellent water by application of this method of treatment. He had personal experience of this, inasmuch as he took part in experiments which Dr. Clark made when he softened water at the works at Plumstead, about thirty years ago, and had since had the supervision of softening works erected for the supply of water from deep wells to the Herbert Hospital at Shooter's Hill. What had been so successfully accomplished at this place, and elsewhere more recently by improved processes, had demonstrated how readily water might be treated when the supply required was comparatively moderate. The same system had even been applied to towns and districts of some considerable size; but the question still remained to be determined whether it would be possible to apply this excellent process upon so large a scale as would be necessary in order to supply London, or the more important districts of it, with softened water. That the Kent Company had hesitated to apply this system to the deep-well water supplied to Woolwich and elsewhere, which was most beautiful and wholesome to drink, but ill adapted to other domestic purposes, seemed to indicate that practical difficulties still existed which had to be encountered, not merely by the application of capital, but by science combined with practical knowledge. With regard to other methods of purifying water, considerable improvements had been effected in recent years in the application of filtering media, such, for instance, as charcoal preparations, and iron in a more or less finely divided condition. If water were affected chemically by treatment with either precipitating or oxydising, or otherwise purifying agents, such treatment must be efficient in proportion to the amount of surface of water brought into contact with the agent applied. If iron exerted a purifying influence on water, it would obviously exert that to the greatest extent within a given time, if the surfaces of the iron and the water coming into contact were constantly renewed. That this was done to a considerable extent in a filter there could be no doubt, but when a column of water was passed through a column of filtering material, the latter must present channels in parts, admitting of the free passage of the water. By passing through these the water must to some extent escape being purified; but if you took the same purifying agent, and agitated it for a short time with water, you renewed the surface of contact between the water and it continually and rapidly, and so, as a matter of course, effected in a short time what you had to apply a considerable amount of time, and a comparatively very large amount of purifying material, to effect to anything like the same extent by the ordinary methods of purification by filtration. There could be no doubt that the action of charcoal as a purifying agent, quite apart from its action as a simple filtering agent, was much promoted, like that of iron, by constantly renewing the surfaces of contact between the charcoal and the water, and so he should imagine that filtering on the principle devised by Mr. Maignen, or other filters based on similar principles, would act more efficiently and rapidly than the mere passage of water through charcoal *en masse*. No doubt much had to be learnt with regard to the treatment of water by means of domestic filters, which would always be important in connection with the supply of small communities, and that of groups of people like soldiers on active service. A filter was popularly expected to accomplish two things: in the first place, it simply strained or clarified water, by separating suspended matter, and a properly-built filter might be relied upon to carry out this operation for a considerable period, until, in fact, the passage of the water was too much impeded by the clogging effect of the impurities deposited in the filter. Secondly, some filters would to a small extent purify water of dissolved matters, but it was important to bear in mind that that power could only be retained by a filter for a comparatively brief period. Many people bought a filter, and having set it up, they did not care much what the source of water was which they used, being satisfied that, by having bought one of the best forms of filter, and drinking nothing but the water filtered through it, they were secure against all evils ascribable to water. But that filter might, and was generally, filled month after month, and even year after year, and was supposed to continue perfect as long as the water ran through it, and was not even suspected of being inefficient until it became actually choked up. This was one of the most dangerous points connected with the application of filters to domestic purposes, and too much stress could not be laid upon it. He begged, in conclusion, to congratulate the Society upon the useful nature of the discussion, elicited by the valuable papers which had been brought before Conference.

Mr. Edwin Chadwick then proposed a vote of thanks to the Chairman, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

NOTES ON THE ITALIAN NATIONAL EXHIBITION AT TURIN.

The Exhibition now open at Turin is by no means the first that has been held in that city. As early as 1829, during the reign of Carlo Felice, it was proposed to hold a series of Triennial Exhibitions, the first of which was opened in the same year; but after the second, which was held in 1832, it was considered advisable to extend the interval to six years, so that the third was postponed until 1838, the fourth to 1844, the fifth to 1850. In 1856, no exhibition was held, as too short a time had elapsed since the International Exhibition of Paris of the previous year, in which the kingdom of Sardinia had taken part, and in consequence, another three years was allowed to pass before the sixth and last of this series of exhibitions was held.

The success of the Milan Exhibition of 1881 aroused a spirit of emulation on the part of the Turinese; and on the 6th of December a Commission was formed, and the basis of the undertaking was laid before the close of the year.

The Exhibition buildings have been erected in the Valentino gardens, one of the most delightful situations in Europe, and occupy that part comprised between the Corso del Valentino on the north, and the Corso Dante on the south, the Corso Massimo D'Azeglio forming the western boundary, whilst the River Po to the east, with the picturesque range of hills called the "Collina," on the opposite bank, clothed with vineyards, woods, and gardens, and studded with the villas of the rich Turinese, considerably heightened the beauty of the situation.

The edifices and enclosed grounds cover an area of 340,000 square metres (about 84 acres), of which the buildings occupy an area of 143,000 square metres, and nearly equal to that occupied by the Paris International Exhibition of 1867, and three times that of the Milan Exhibition of 1881.

The principal range of buildings is 650 metres in length, and are built in line with the Corso Massimo D'Azeglio. To the east of this main gallery are others at right angles, which are united at the opposite end by others parallel to the principal one. These buildings are in various styles, and were designed by Signor Camillo Riccio, the architect to the Executive Commission.

There are six entrances to the Exhibition grounds, the principal one from the Turin side being the Porta Reale, situated at the angle formed by the Corso Massimo D'Azeglio and the Corso del Valentino, and close to the palace of the same name. It is an imposing building $72\frac{1}{2}$ metres in length, consisting of a double colonnade between two square towers 35 metres in height. In one of these towers is the Astronomical and Meteorological Observatory, open to the public, and a collection of instruments, apparatus, drawings, and models relating to celestial and terrestrial physics.

A building to the right, which formerly formed the façade to the rifle range (*tiro a segno*), has been adapted for the post, telegraph, telephone, and newspaper offices, whilst the other tower is used as offices for the Executive Commission.

The second entrance, which gives access from the Corso Raffaele, called the Porta Moresca, is a striking building in the Moorish style, with three archways; it is richly decorated with gilding and bright colours. The other entrances are the Porta Dante, Porta Isabella, Porta Eredano, and a small landing stage from the Po, giving access to the mediæval castle; these entrances are in the châlet style and built of wood.

Facing the Porta Reale, and at a distance of 160 metres from it, is the entrance to the principal range of galleries, through a handsomely proportioned salon, octangular in shape, and covered with a cupola 34 metres in height. In this salon, and in a gallery to the left, are contained the exhibits of pottery and glass. Next follows the gallery of manufactures, 155 metres in length and 34 metres in width, at the end of which is the furniture department. A gallery 128 metres in length and 25 metres in width, contains the exhibits of musical instruments, and communicates to the left with the great concert-room, 40 metres in diameter, and covered with a dome-shaped roof. The principal entrance, however, to the concert-room is from the grounds, and is flanked by a colounade forming a semicircle.

Beyond the music gallery, is the great gallery of machinery in motion, 250 metres in length by 34·50 in width, extending nearly to the Porta Dante.

A spacious roadway runs parallel to the buildings, and tramways from all parts of Turin enter the grounds by the Porta Reale, and convey passengers to the Porta Dante. To the right of this roadway are a range of sheds and buildings, the principal being used for the exhibition of the memorials and relics of the conflict for Italian independence, railway plant, public welfare, carriages, and the boiler house. At right angles to the great gallery of machinery in motion are the galleries for machinery for general and industrial purposes; the exhibits of the Minister of War and for military equipment, the international gallery of electricity, the glass-blowing establishment of Candiani, of Venice, the boiler house for the engines that furnish motive power for the electric department, and a building containing the pumps of Messrs. Bosisio and Co., which supplies the ornamental fountain.

Parallel with the Corso Dante, and at right angles with the range of principal galleries, are the buildings containing the exhibits of agricultural machinery, educational, books, extractive and chemical industries, the collection shown by the Minister of Agriculture, agricultural produce, wine, oil, cheese, manufactures, the exhibits of the Minister of Public Works and Minister of Finance.

The Fine Arts occupies a building entirely to itself, and is situated diagonally in the angle formed by the range of principal galleries and those parallel with the Corso Dante. Its architectural features are purely in the Grecian style, with a semicircular portico for sculpture, which portico or colonnade encloses a garden.

This building covers an area of 20,655 square metres, of which 7,970 square metres are occupied by the picture galleries, architecture, and for part of the sculpture; 1,740 square metres by the colonnade, and 10,945 square metres being the area of the enclosed garden.

The mediæval castle and village, with the exhibits of ancient art, is placed most picturesquely amongst the trees on the banks of the river, and forms one of the principal attractions of the Exhibition. It is satisfactory to know that this work, the fruit of the study of eminent artists and archæologists, will form a permanent feature in the gardens of the Valentino after the Exhibition is closed, as it has been purchased from the Executive Committee by the municipality.

There is also a small encampment of the natives of the Bay of Assab, the little Italian colony on the Red Sea, a small exhibit of the principal products of the colony, and of the principal articles imported from Italy; trade samples of exports and imports are marked with the price, and serve as a guide to merchants and manufacturers.

Six natives have arrived in Turin, and are now encamped in the exhibition grounds.

On the banks of the Po are the sheds and buildings containing the exhibits of the Minister of Marine, naval construction and equipment, forestry, hunting and fishing, silkworm rearing, agriculture, divers, the pumping station of Messrs. Cerimedo and Co., and the interesting collection of the Alpine Club (one of the most complete in the Exhibition).

Besides the buildings just described, there are numerous pavilions, kiosques, &c., erected in the grounds, and serve for the different cafés, restaurants, and beer-halls, for the sale of wine, vermouth, tobacco, newspapers, &c.; some are in the Chinese, Moorish, Russian, and Swiss styles, and the restaurant of the Hôtel d'Europe in the Russian style, and covering an area of 600 square metres, particularly is worthy of mention.

The pavilions of the cities of Rome and Turin, with a full-sized copy of the temple of Vesta, must not be passed without remark.

A little steam tramway (two-foot guage) on the "Decauville" system, has been laid in the grounds, and the cars drawn by two miniature locomotives (weighing 3 tons each), the "Regina Margherita" and the "Torino," convey passengers from the Porta Reale to the Porta Isabella.

The periodical exhibitions of domestic animals, poultry, &c., are held in separate grounds on the south side of the Corso Dante, and cover an area of 42,000 square metres ($10\frac{1}{3}$ acres).

A service of steam launches has been established on the Po, between the bridge near the Piazza Vittorio Emanuel I. and the Exhibition.

The grounds are lighted three times a-week with the electric light, and the gallery of electricity is also thrown open to the public.

The following classification has been adopted at the Turin Exhibition:—

Division I. Fine Arts.—Section 1. History of art. Section 2. Modern art (painting, sculpture, and architecture). Section 3. Music.

Division II. Education.—Section 4. School construction, instruments and appliances. Section 5. Methods adopted for teaching literature and general knowledge. Section 6. Methods adapted for teaching the positive and experimental sciences. Section 7. Industrial and special instruction. Section 8. Books and libraries.

Division III. Scientific and Literary Publications.—Section 9. Documents and relics relating to the history of political events in Italy, from 1820 to 1870. Section 10. Scientific and literary publications.

*Division IV. Public Welfare.**—Section 11. Public welfare under a sanitary aspect. Section 12. Public welfare under an economic and moral aspect. Section 13. Public aid under a sanitary aspect. Section 14. Public aid under an economic and moral aspect.

Division V. Extractive and Chemical Industries.—Section 15. Quarries, mines, mineral, and metallurgical industries, mineral waters, &c. Section 16. Chemical arts, chemical products, dying, tanning, &c.

Division VI.—Section 17. General mechanics. Section 18. Industrial mechanics. Section 19. The mechanics of locomotion and navigation. Section 20. Military and naval weapons and equipment. Section 21. Agricultural machinery. Section 22. Scientific instruments, which includes electricity.

Division VII. Manufactures.—Section 23. Pro-

* "Previdenza ed assistenza publica," is here translated "Public Welfare" for want of a better title.

ducts of manufacture. Section 24. Gallery of labour (machinery in motion, and processes in operation).

Division VIII. Rural Economy, Horticulture, Forestry, &c.—Section 25. Agricultural industry, Section 26. Food. Section 27. Forestry. Section 28. Fishing and hunting, products of the animal kingdom, manures, &c. Section 29. Cattle, domestic animals, poultry, &c.

Each section is further sub-divided into categories.

The total number of exhibitors, according to the official catalogue, is 12,776, distributed as follows:—

Division	I.—Fine Arts	1,579
"	II.—Education	1,194
"	III.—Scientific and literary works	191
"	IV.—Public welfare	2,054
"	V.—Extractive and chemical industries	989
"	VI.—Mechanical industries	936
"	VII.—Manufacturing industries	2,663
"	VIII.—Rural economy, horticulture, forestry	2,591
Special Exhibits:—Astronomy, meteorology, exhibits of Ministers of Public Works, Ministers of Agriculture, Alpine Club, City of Rome, City of Turin		579
		12,776

The official general catalogue, a volume of about 1,000 pages, has just been published. There is also a catalogue of ancient art and guide to the mediæval castle, which contains a vast amount of information, both historical and archæological, relating to the 15th century.

TOBACCO CULTIVATION IN BRAZIL.

Some interesting particulars are given in the last report of the United States Consul General at Rio de Janeiro, as to the cultivation and manufacture of tobacco in Brazil. It appears that the cultivation began about the year 1600, in the province of Bahia, and from thence extended to all the other districts along the coast. Among the localities earliest known for their tobacco production was the lake district of Pernambuco, now the province of Alagoas, where an excellent quality was produced, which commanded very high prices. During the following century the cultivation increased so rapidly in Alagoas and Bahia, that at the commencement of the succeeding century, the average annual export had reached 2,857 tons from the latter, and 285 tons from the former province. The earliest export statistics available for the whole empire, are for the year 1839-40, in which the export amounted to 295,966 arrobas, the *arroba* being equivalent to about 32 lbs.; and the value exceeded £65,000. For the next thirteen years, the exports averaged 8,000,000 lbs. annually, with a value steadily increasing. During each of the years 1853-55, the amount exported was 22,000,000 lbs., of the total value each year of £200,000. In 1879-80, the export was 50,000,000 lbs., of the value £659,000; in 1880-81, 44,000,000 lbs., of the value of £650,000, and in 1881-82, 52,000,000 lbs. of the value of £680,000. Though the principal tobacco-producing province of the empire is Bahia, tobacco of good quality is grown in every part of Brazil, from the Amazon to the Rio Grande frontier. Some localities in the province of Amazonas have long been known for the excellent quality of their tobacco, while in the Rio market one of the brands most esteemed comes from the province of Goyaz. The local consumption of tobacco is very great, and principally in smoking. Bahia tobacco used to be largely exported in rolls, weighing eight arrobas, or 256 pounds each; of late years, however, large quantities of the leaves in bales are exported to Hamburg. Cigar factories are established in all large cities throughout the tobacco-growing regions, which give employment to a large number of men, women, and children. The methods employed in the cultivation and preparation of the plant are very much the same as they were nearly 200 years ago. The labour employed is that of slaves, to whom are assigned special descriptions of work. In former times curing tobacco in rolls required much constant labour, the ropes composing each roll being unwound, twisted, and re-wound during a period varying from ten to fifteen days. The Brazilian tobacco is generally characterised by its strength and dark colour, particularly in Bahia. In that province the practice is to manure heavily, which occasions a very rank growth and strong flavour. In Minas Geraes the tobacco is somewhat milder, and some advance has lately been made in a few localities towards improved processes of curing. This seed may be germinated in any season of the year, but the months of June, July, and August, are generally preferred for planting, because germination and transplanting are brought into or near the rainy season. Tobacco plants planted in this season are considered the best growers, and produce the largest leaves. Those, however, which are germinated in the dry season, and sustained by irrigation, grow with greater vigour, and possess a finer aroma. The land selected for the plants is cleared, and the surface worked with the hoe, after which it is marked off into parallel rows about three feet apart, according to locality and the size of the mature plants. In transplanting, the young plants are set from two to three feet apart, and are manured heavily in the pits opened for them. Great care is necessary for a time to protect the shoots from the sun, and to irrigate plentifully when the transplanting occurs in a dry season. The work of cultivation and keeping down the weeds is performed entirely with the hoe, and only two or three times during the season. In gathering in the crops, planters wait until the plants are fully matured, this being determined by doubling and breaking one of the top leaves. In Bahia and other Brazilian provinces the lower leaf is often picked by itself, and in a few days the next, and so on as long as the plant will develop the lower leaves into what is classed first quality. These leaves are hung up two and two, under cover and across poles, twenty-four hours after picking and sweating. When it is intended to twist the leaves into ropes, they are left hanging about two days, when they are taken down, carefully freed from the heavy parts of the midrib, doubled in halves, and laid away for the rope twister. This operation requires considerable dexterity, and is generally entrusted to the best slave on the plantation. The operation requires a rude windlass, which is slowly turned in winding the rope, which is twisted by hand. A boy is usually employed entirely to hand leaves to the twister. These ropes are unwound and re-wound once or twice a-day, for a period of ten or fifteen days, according to the weather, and are twisted a little harder each time. In curing, the tobacco grows darker and darker, until it becomes jet black. The juices exuding from the rolls are carefully caught and preserved until the last winding, when, mixed with lard, syrup, and various aromatic herbs, they are used to pass the rope through, previous to the final winding. The last step is to cut the cured ropes in certain lengths, and to re-wind them upon light wooden sticks, about two feet in length, the winding being very compact and regular. The rolls are then covered with leather or strong canvas, when they are ready for market. Formerly, these rolls were made to weigh 8 arrobas, or 256 lbs., though rolls of 3 arrobas were made for the home markets. At the present day the weights vary according to the locality. The large exportation of tobacco in leaf has considerably changed the character of tobacco growing in Bahia, the process of curing and packing the leaf being simpler than the old process of manufacturing *rolos*. Tobacco growing is heavily protected and taxed in Brazil, nearly all the provinces imposing separate protective taxes, in addition to those imposed by the Government. Besides these, the municipalities are permitted to levy taxes on the article. The present export tax on tobacco, in Brazil, amounts to as much as 18 per cent.

LONDON WATER SUPPLY.

The *Times* of Monday, August 25, contained a leading article on the results of the Water Supply Conference of the Society of Arts at the International Health Exhibition. The article concludes as follows:—

"Few people seem to be aware of the rapid growth of the difficulty. At the beginning of this century the Thames was as sweet in London as at Windsor or Reading. People could bathe in it, wash with it, and cook with it. For no other uses was it introduced into houses. There was no watering of the streets and roads, but in a hot summer evening the plugs were withdrawn, the water was allowed to run down the gutter, dammed at intervals, and dashed with shovels over the road. There were a vast number of surface springs and wells of very slight depth, the water of which was always clear, and generally quite wholesome, unless they happened to be too near a churchyard. Here and there were public pumps, many of them wheel pumps, which people used as they pleased, often for the muscular exercise. Even the poorer people had generally a good pump within easy distance, and the labour of water carrying was always mitigated by the pleasure of a chat with friends at the pump. It is only the recent growth of the present difficulty we are concerned with; for there is no denying that the sanitary condition of the metropolis was then very bad, and that it is much better now. Though so much smaller than now, and consequently so much nearer the green fields and the green lanes, the metropolis was not so healthy then as now by a good deal. Unquestionably we are taking good care of ourselves, and so far have reason to be satisfied. Yet our case as regards the supply and consumption of water bears a suspicious resemblance to that of the man who maintains a large family in comfort, elegance, and even splendour, denying them nothing, and not even permitting them to trouble themselves about the future, but who does not leave them a sixpence to enjoy and disport themselves in like fashion when he is gone. Whatever we do, it will not be for want of information. The present generation is not allowed to flatter itself that all is right. On the contrary, all is wrong, and the world will not have to wait even for expiration of this century to hear a chorus of indignation at the way in which England has squandered and misused the first of Nature's gifts."

THE IRIDIUM INDUSTRY.

Within the last few years, says *Engineering*, a new industry has arisen in the manufacture of articles from iridium, through the discovery of Mr. John Holland, of Cincinnati, that by the addition of phosphorus, the hitherto intractable metal could be easily melted. Previously to the present time iridium, unless alloyed with platinum, has had substantially but one use, viz., for pointing gold pens, and for this purpose it was used in the native state, suitable pieces of ore being selected and soldered in place. The metal itself was discovered in 1803 by Smithson Tennant, while investigating the metallic residues which remained when platinum ores were dissolved in *aqua regia*. In the early history of the electric light, in 1848, W. E. Staite patented the use of iridium filaments in incandescence lamps, and proposed to prepare the metal by fusing the oxide in a cupel of bone ash under the voltaic arc. The ingot thus obtained was to be annealed in an oxyhydrogen jet, and worked under hammers and between rolls at a white heat.

In certain cases thin strips of metal were to be cut from the ingot "in the same way as precious stones are cut by the lapidary." What measures of success he obtained, if any, is not known, but he appears to have devoted the greater part of his attention to arc lamps, and probably the scheme never got beyond the paper stage. The means he indicated, however, were the only ones which attained any success, and by their aid other experiments succeeded in obtaining small globules of the metal.

About four years ago Mr. John Holland, gold pen manufacturer, found it necessary to have pieces of iridium, larger than those generally found in nature, for the purpose of making points for a stylographic pen. After many experiments he found that by heating the ore in a Hessian crucible to a white heat and adding to it phosphorus, and continuing the heating for a few minutes, he could obtain a perfect fusion of the metal, which could be poured out and cast in almost any desired shape. The product was found to be about as hard as the natural grains of iridium, and, in fact, seemed to have all the properties of the metal itself. On chemical analysis it was found that the metal fused with phosphorus contained, according to two determinations, 7·52 and 7·74 per cent. of phosphorus. For many purposes it could be used in this state without further treatment, but when it had to withstand a white heat, as in some kinds of electrical apparatus, this capability of fusion destroyed its usefulness. Experiments for the purpose of removing the phosphorus were tken made by Mr. W. L. Dudley, of Cincinnati, who found that by heating the metal in a bed of lime the phosphorus could be completely eliminated. In the usual operation the metal is first heated in an ordinary furnace at a white heat, and finally after no more phosphorus makes its appearance, it is removed and placed in an electric furnace, with a lime crucible, and then heated until the last trace of phosphorus is removed; the manufactured metal will then resist as much heat without fusion as the native metal.

The principal sources of the supply of iridium are Russia and California. It is extracted from gold and platinum ores as a by-product, and is always found in small grains or fine powder, the largest pieces being about the size of a grain of rice. It is generally found alloyed with platinum or osmium. When pure it possesses a white lustre, resembling that of steel; its hardness is about equal to that of the ruby; when cold it is quite brittle, but at a white heat it is somewhat malleable. It is one of the heaviest metals, having a specific gravity of 22·38. When heated in the air to a red heat the metal is very slowly oxidised; but upon raising the temperature to about 1,000° Cent., it parts with its oxygen, and above that temperature it is not oxidised. It is insoluble in all single acids, and but very slightly soluble, when in a state of fine powder, in *aqua regia*.

According to the new system of manufacture, and in cases where the article is not subject to great heat, the metal is melted with phosphorus, and cast into the desired shape; it is then ground or worked into the exact required form.

Iridium is sawn by a copper disc 4 in. to 8 in. in diameter running at 2,500 revolutions per minute, and dipping into a bath of cotton-seed oil and corundum or diamond dust.

Many new uses are now opening for iridinm since it has been possible to melt and cast it. It is used for drawplates, to replace the ruby plate, in the manufacture of gold and silver wire; for knife edges, for scales and balances; for tipping hypodermic needles, and for many other purposes. It has been tried for the negative pole of an arc lamp, and was found to keep its shape, in spite of the heat, provided the positive carbon was not allowed to strike or fall too heavily upon it. One of the most important applications is for the contact points of telegraphic instruments; these outlive many platinum contacts, and do not oxidise or stick.

Efforts are now being made to effect the electric deposition of iridium, and considerable success has been obtained by Mr. Dudley, who, according to a paper which he recently read before the American Institute of Mining Engineers, hopes to make a commercial success of this art shortly. The solution is made by mixing iridium of iridosmine with common salt placed in a tube and heated to redness. Chlorine gas is then allowed to flow slowly through the tube for several hours, at the end of which time most of the iridium has combined with the salt and chlorine to form a double choloride of iridium and sodium, which rapidly dissolves in water, and forms a solution from which other salts can be prepared.

Obituary.

Henry George Bohn.—Mr. Bohn, the late veteran bookseller and publisher of York-street, Covent-garden, died at North-end House, Twickenham, on the morning of Friday, the 22nd inst., in the 89th year of his age. One of his earliest bibliographical works was the compilation of the catalogue of Dr. Parr's library, and from that time he was busily engaged in literary pursuits. His famous guinea catalogue was published in 1841, but although he continued to be a second-hand bookseller until the period of his retirement from business, he was, after the success of his extensive "libraries," chiefly a publisher and dealer in remainders. Since his retirement, in 1865, he has been employed in the collection of china and works of art, and during the last few years of his life he has been engaged in the compilation of a catalogue *raisonné* of his collections. Mr. Bohn was elected a member of the Society of Arts on November 21, 1849, and continued a member for many years, but soon after his retirement from business he resigned.

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Proceedings of the Society.

CANTOR LECTURES.

FERMENTATION AND DISTILLATION.

By Professor W. N. Hartley.

Lecture II.—Delivered Monday, May 19, 1884.

Diastatic Fermentation.

Diastase belongs to a class of substances known as soluble ferments. These bodies exert a very remarkable series of chemical reactions of a varied character upon certain substances with which they are brought into contact. The exact nature of their action is so unlike that of most chemical processes, that it is by no means easy to understand it. To say that the action is "catalytic," is tantamount to confessing an inability to explain it. Liebig has stated that all substances in a state of decomposition are capable of communicating a change in chemical composition to other bodies with which they are in contact. In his "Chemical Letters," p. 206, he says, in speaking of digestion:—"It was for a long time believed that the accelerated dissolving power which the mucous membrane of the stomach imparts to the hydrochloric acid, depended upon the presence of a particular substance called pepsine, a kind of digestive agent. The same opinion prevailed respecting a substance called diastase, contained in the extract of malt, by which starch is converted into sugar; and these substances have received certain designations." "But what have been called pepsine and diastase are nothing more than a portion of mucous membrane, or of gluten, having passed into a state of decomposition. The action of these bodies depends entirely upon their condition, just as is the case with yeast." "With a piece of the mucous membrane of the stomach, in a certain stage of decomposition, we may render certain animal substances soluble; whilst with the same membrane, in other stages of decomposition, we may convert starch into sugar, sugar into lactic acid, mannite, and mucus, or into alcohol and carbonic acid; and lactic acid into butyric acid, hydrogen, and carbonic acid." Since those words were written, we have learnt much information concerning the phenomena of true fermentation and putrefactive decomposition. We now know that, without the presence of minute organisms, such changes cannot take place, and that certain changes are brought about only by the presence of certain organisms.

I have used a phrase, true fermentation, which requires some explanation. True fermentation is such an action as the conversion of sugar into alcohol by means of yeast, which, being a living organism, is therefore insoluble, and the action of which ceases with its death. More than this, fermentation is active only so long as the yeast fungus flourishes; when it is languid, the production of sugar decreases; and when torpid, the chemical change is suspended. The action of a lifeless and soluble ferment like diastase upon a substance like starch is not a fermentation, but a process which may be distinguished by the name *hydrolysis*. The word was suggested by Dr. Armstrong (*Journal Chemical Society*, vol. xxxv., p. 647), as a fitting one with which to designate those reactions in which the elements of water enter into combination with a large molecule, and resolve it into two or more molecules of lesser weight. The name of the substances which act in this manner are the following:—

Soluble Ferments or Zymases.

Name.		Whence derived.
Diastase	....	Malt, veitches, &c.
Maltin	....	Malt.
Emulsin	....	Sweet and bitter almonds.
Ptyalin	....	Saliva.
Myrosin	....	Seeds of cruciferæ.
Pepsin	....	Gastric juice.
Pancreatin	....	Pancreas.
Invertase	....	Yeast.
Papäin	....	In the leaves of *Carica papaya*.

The action of the majority of these substances is confined to a transformation of saccharides, such as starch, and of glucosides, a class of crystallisable compounds largely contained in the vegetable kingdom.

A list of some of the simplest glucosides, the sources whence they are derived, together with the products of their diastatic fermentation, is here given:—

GLUCOSIDES.

Name.	Source.	Products.
Amygdalin ..	Bitter almonds ..	Glucose, oil of bitter almonds, prussic acid.
Salicin	Willow bark ..	Glucose, saligenin.
Helicin......	....	Glucose, oil of meadow-sweet.
Arbutin	Leaves of the bear-berry	Glucose, hydroquinone.
Potassium myronate..	Mustard seed ..	Glucose, oil of mustard, and potassium sulphate.
Tannin......	Gall nuts and oak bark	Glucose, gallic acid.
Rubian	Madder plant ..	Glucose, alizarine.
Inidican	Woad (*Isatis tinctoria*)	Indiglucin, indigo-blue.

In the transformation of starch, the products are not so strikingly different in character that they can be at once perceived by the senses, though it is true that the palate recognises a sweetness which the liquid did not possess at first; but in the case of amygdalin, and much more so in that of potassium myronate, the sense of smell at once informs us of the great change which has invisibly been wrought in the liquid.

EQUATIONS EXPLAINING THE DECOMPOSITION OF GLUCOSIDES.

(*a*) Amygdalin. + Water. = Glucose. + Benzoyl hydride. + Prussic acid.

$$C_{10}\ H_{27}\ NO_{11} + 2\ H_2\ O = 2\ C_6\ H_{12}\ O_6 + C_7\ H_6\ O + H\ C\ N.$$

(*b*) Salicine. + Water. = Glucose. + Saligenin.

$$C_{13}\ H_{18}\ O_7 + H_2\ O = C_6\ H_{12}\ O_6 + C_7\ H_8\ O_2.$$

(*c*) Arbutine. + Water. = Glucose. + Hydroquinone.

$$C_{12}\ H_{16}\ O_7 + H_2\ O = C_6\ H_{12}\ O_6 + C_6\ H_6\ O_2.$$

(*d*) Potassium myronate. + Water. = Glucose. + Allyl sulphocyanide. + Acid potassium sulphate.

$$C_{10}\ H_{16}\ HNS_2\ O_7 + H_2\ O = C_6\ H_{12}\ O_6 + C_3\ H_5\ CNS + R\ H\ S\ O_4.$$

(*e*) Tannin. + Water. = Glucose. + Gallic acid.

$$C_{27}\ H_{22}\ O_{17} + 4\ H_2\ O = C_6\ H_{12}\ O_6 + 3\ C_7\ H_6\ O_5.$$

DECOMPOSITION OF FAT BY PANCREATIC FERMENTATION.

Suet (Tri-stearine.) + Water. = Stearic acid. + Glycerine.

$$C_3\ H_5 \left\{ \begin{array}{l} OC_{18}\ H_{35}\ O \\ OC_{18}\ H_{35}\ O \\ OC_{18}\ H_{35}\ O \end{array} \right\} + 3\ H_2O = \left\{ \begin{array}{l} 3\ C_{18}H_{36}O_2 + \\ C_3\ H_5\ (OH)_3 \end{array} \right.$$

The above formulæ explain how the different glucosides are split up by the action of water into glucose and a variety of other products.

When bitter almonds are boiled with alcohol, not a trace of prussic acid or of oil of bitter almonds is found in the alcohol, but there has been dissolved a white crystalline solid substance, which is soluble in water, and to which it imparts a bitter taste. It is the glucoside amygdalin. When sweet almonds are crushed to a pulp, and ground up with four to six times their weight of water, a milky-looking fluid is prepared, which contains the substance emulsin. By the addition of alcohol, the emulsin is precipitated, and freed from oily matters. If to a solution of amygdalin in water a small quantity of emulsin be added, there is instantly recognised the smell of bitter almond oil and prussic acid.

When bitter almonds alone are crushed and mixed with water, the same change takes place, although, as previously mentioned, neither prussic acid nor bitter almond oil exist in the almonds, but only amygdalin, together with a little emulsin. Water is necessary to this reaction; and if an insufficiency is added, only a portion of the amygdalin is altered.

Everyone knows that mustard flour, when mixed with water, makes a mustard blister, which will cause excessive irritation if placed on the skin, and the very scent of it draws tears from the eyes. Many persons must have observed the fact that the ground mustard possesses these irritating properties only after it is moistened. It is easy to convince ourself of the fact by taking one of Rigollot's mustard leaves, which are carefully prepared dry and kept free from access of moisture; a few seconds in contact with warm water develops the pungent odour of mustard oil, of which there is not a trace in the dry mustard seed. By the action of the myrosin, which plays the same part as the diastase in starch, the potassium myronate enters into combination with water, which resolves it into allyl sulphocyanate or mustard oil, glucose, and acid potassium sulphate.

THE GENERAL CHARACTERS OF SOLUBLE FERMENTS.

1. They are all uncrystallisable albumenoid substances, coagulable by heat, and precipitable by alcohol. Though very soluble in water, they are incapable of diffusing through a vegetable or animal membrane, or of filtration under pressure through porous earthenware.

2. Their composition is very similar. The following figures show the composition of three important members of this class (Wurtz, *Dictionnaire de Chimie, Supplement*, p. 828):—

	Papaïn. (Wurtz.) Per cent.		Pancreatin. (Law.) Per cent.		Albumen-peptone. (Henninger.) Per cent.
Carbon....	52·48	..	52·75	..	52·28
Hydrogen..	7·24	..	7·51	..	7·03
Nitrogen ..	16·59	..	16·55	..	16·38

3. They manifest great chemical activity, or smallness of the relation of cause to effect. Thus one part of diastase can transform 2,000 times its weight of starch. One part of invertase can invert 5,000 times its weight of sugar.

4. Cessation of activity on coagulation. Diastase is incapable of saccharifying starch if heated to a temperature above 70° C., or 81°, when it becomes insoluble. Ptyalin loses its activity at 60° C.

5. Their chemical action is destroyed by contact with certain mineral substances. Thus borax destroys the activity of invertase, prevents the action of diastase on starch, of synaptase on amygdalin, and of myrosin on potassium myronate. (J. B. Dumas, *Comptes Rendus*, vol. 75, p. 925.)

6. They appear to combine with certain products of the changes they induce. Thus diastase retains dextrin in large proportions. Zymase, from the liver, retains more than 50 per cent. of glycogen. (Sugen and Kratschmer, *Jahresbericht der Thierchemie*, 1877, p. 360.) Invertase has been found to contain a large quantity of a gummy substance. (Barth. *Berichte, Deut. Chem. G.*, 1878, p. 474.) When treated with sulphuric acid, it yielded glucose. (Wurtz, *Dictionnaire, Supp.*, p. 828) Many of these bodies seem to combine energetically with mineral matters, as, for instance, with phosphate of lime, which is thus rendered soluble.

7. In the course of their action they undergo apparently no change in composition.

8. In all cases the changes they induce are accompanied by an absorption of heat, and the products have a smaller potential energy than the molecule of the original substance.

9. Organic substances, known as antiseptics or preventives of fermentation, are without action on zymases. For instance, phenol (carbolic acid), salicylic acid, chloroform, and prussic acid, have no action on diastase.

The reactions caused by one of these soluble ferments are not possessed by all the others, though many of the changes are common to several ferments. Thus, it has recently been discovered that the seeds of the vetch contain a diastatic ferment which acts very energetically on starch, producing sugar therefrom. The same substance has also an action like that of pepsin; it converts albumenoids into peptones. (Von Gorup Besanez, *Berichte Deut. Chem. G.*, vol. 7, p. 1478). Ptyalin, too, converts starch into sugar like diastase, and both ptyalin and diastase can liberate glucose from amygdalin and salicine. But no other substance, as far as I am aware, has been able to decompose the glucoside of black mustard except myrosin.

The Preparation of Diastase.—Diastase may be obtained from malt in an active state according to the process recently described by Mr. O'Sullivan at a meeting of the Chemical Society (*Chemical News*, November 14th, 1883). Malt is extracted with about twice its weight of cold water, and the liquid is separated by pressure in a filter press. The diastase is precipitated from the liquid extract by the addition of alcohol. Thus obtained, it is a white powder. Other methods have been proposed in which glycerine is used for the solution of the diastase, but the activity of the preparation is somewhat impaired by treatment with glycerine. The proportion of diastase in malt is about 1-500th, and this is more than enough to convert more than all the starch into maltose. If the starch extracted be 60 per cent. of the malt, and the diastase 0·2 per cent., this can convert 2,000 times its weight of starch, or more than six times that contained in the barley. Hence the reason why the proportion of malted to unmalted grain is one-fourth to one-seventh.

Somewhat clearer notions of the possible course of chemical change attending the saccharification of starch have been derived from the recent researches on papaïne of M. Wurtz. Albumenoid substances, when steeped in a solution of papaïne, retain a portion of the substance so obstinately that they may be washed with a large quantity of water without yielding any of the ferment. If, however, they are put into pure water at 40° C, the retained substances enter into solution as peptones, and, at the same time, papaïne is re-generated or liberated, which is then free to combine with another proportion of the albumenoids.

Pepsine behaves in quite a similar manner. (Wurtz, *Comptes Rendus*, vol. 93, p. 1104). It is rendered extremely probable that in the case of diastase a similar combination and decomposition results, since it has been proved that diastase removed from malt contains dextrin. The etherification of alcohol with a small quantity of acid, and the saccharification of starch likewise by a small proportion either of acid or of diastase, seem to be analogous chemical changes. Perhaps a more striking similarity exists in the formation of sulphuric acid in the lead chamber process, first devised by Chaptal, in which the oxides of nitrogen act as carriers of oxygen to sulphurous acid and water. In the presence of an inefficiency of water, nitro-sulphonic acid results, which, on contact with more water is decomposed into, sulphuric acid and nitric oxide. This decomposition seems to have some analogy with that which occurs when the combination of pepsine or of papaïne, with an albumenoid is put into pure water at 40°C. The chemistry of the process when sulphuric acid is employed for the purpose of converting starch into sugar is, so far as we aware, simply an addition of water to the molecule, which splits up the polysaccharide into molecules of maltose, or it may proceed further and by the same action convert the maltose into dextrose. In the same manner the action of acid on cane-sugar converts it into glucose commonly so-called, but which is in fact a mixture of two glucoses, one of which rotates a polarised ray of light to the right, the other rotates it to the left, hence the one is termed *dextrose*, the other *lævulose*. Now, as saccharose has a feeble right-handed rotation, which disappears during conversion into that which is left-handed, the change is called inversion. As there are two sugars present with opposite rotatory powers, it follows that the quantity of lævulose must be either larger in quantity than the dextrose, or else equal in quantity, but of greater rotatory power. This last is the true state of the case. The change of starch into maltose by means of diastase, the separation of glucose from glucosides, the inversion of cane-sugar, and the conversion of maltose into dextrose, are all brought about by the assimilation of water by the respective molecules of these substances, and the formations of molecules of a less complicated structure or constitution. As the word *hydrolysis* may fitly be employed to describe this action, the agents may be fitly termed *hydrolytics*, and by employing these terms, they are distinguished from ferments proper, while, at the same time, their action is not connected by phraseology with the phenomena of fermentation. What is the precise action of hydrolytics cannot at present be defined, but by collecting all the facts hitherto observed in the action of zymases, I have endeavoured to throw as much light on the matter as possible. In the case of sulphuric acid there is possibly a combination between the acid, and the carbo-hydrate which is decomposed by water, and re-formed from a fresh molecule of the carbo-hydrate.

Alcoholic Fermentation.

When a saccharine solution is exposed to the air at a temperature just comfortably warm, 68° to 70° Fahr., there ensues, after the lapse of some hours, a considerable disturbance in the liquid, which is made evident to the eye by a slow effervescence and an accumulation of froth upon the surface. If many gallons of liquid are under observation, and if yeast has been added, the disturbance becomes tumultuous from the disengagement of carbonic acid gas, and, at the same time, a strong vinous odour is perceptible in the gas. Yeast, which is so active in introducing this change, is a sort of viscous deposit which is found in vats or barrels, containing wine-must or beer-wort which has undergone fermentation. If the limpid juice of grapes be left to itself, it soon becomes turbid, and commences apparently to enter into a condition of spontaneous ebullition; at the same time, heat is generated so largely as to be sometimes perceptible to the touch. A saccharified solution of starch, whether obtained from potatoes or an infusion of barley or malt, goes through the same phase as a solution of sugar, or the expressed juice of the grape. At a certain period the effervescence slackens, and, finally, when it ceases altogether, it is found that the sugar is in great part, or even completely, replaced in the liquid by alcohol.

Vinous or alcoholic fermentation is the principal change observed during the process of wine-making, beer-brewing, and the production of alcoholic liquors and spirits generally.

In order to induce fermentative change in a saccharine fluid for the purpose of making beer or spirits, it is usual to add a small portion of yeast, leaven, or barm, by which the process is very much hastened, and carried out with regularity. The words used to denote the fermentative agent all signify a raising or bearing up of the substance fermented, that is to say, they refer to the "working" and frothing which is so remarkable. A knowledge of the fermentative process, and the technical application of this process, is historically traceable to the earliest times, and the course of inquiry into the nature and action of yeast has occupied scientific thought for something like two centuries.

Yeast both rises to the surface and subsides to the bottom of a fermenting liquid. The scum and dregs of this process were first examined by the microscope in the latter part of the 17th century, by Leuvenhock, who found that they consisted of minute particles of a definite shape, ranging in size from $\frac{1}{2000}$ to $\frac{1}{7000}$ of an inch in length. Cagniard de la Tour, and Schwann, in 1835, a century later, made the remarkable discovery that these particles were living, growing, and multiplying, their multiplication taking place at a prodigious rate, by a process of budding. An Italian chemist, Fabroni, discovered the nature of oval yeast particles to be that of cells, composed of a special variety of cellulose, and containing fluid matter, consisting of the elements carbon, hydrogen, oxygen, and nitrogen, in the form of an albuminous substance.

Van Helmont, a Dutch chemist, so far back as the commencement of the 16th century, recognised the gas evolved during fermentation as identical with such as is found in caves, wells, and cellars. Lavoisier examined the change produced in sugar by fermentation, and proved that its whole weight of the sugar is represented by the sum of the weights of the alcohol and of the carbonic acid produced. In accordance with this fact we say that the sugar is resolved into alcohol and carbonic acid. The part that the yeast plays in this change was undetermined until the year 1845, when Von Helmholtz discovered that it is the living yeast cell, or at any rate something inside the cell, which is the active ferment, for when a thin membrane, such as bladder, separates the yeast from the solution of sugar, no fermentation takes place in the vessel containing the sugar, but only in that containing the yeast, although there is a free communication for the liquids through the pores of the membrane. Dumas has proved this most completely by more recent researches; and he has shown, moreover, that fermentative changes cannot be communicated from one liquid to another by means of a neutral fluid. It is evident, then, that the live yeast cells are alone concerned in the change, and not the fluid particles which are in contact with them. It is a well-established fact, which no one now can call in question, that the chemical and physical phenomena already mentioned, namely, the resolution of sugar into carbonic acid and alcohol, and the upheaval or foaming of the mass, are intimately connected in some way or other with the life of a minute cellular fungus. When the life of the cells is destroyed by poison, the act of fermentation ceases. When the life of the cells is active by reason of a genial warmth, the presence of an abundance of mineral food, albuminous matter, and plenty of sugar, then fermentation is briskly carried on. By the addition of a very small quantity of yeast to mash or wort, a multitude of living cells are introduced into a liquid medium adapted in the highest degree to their nutrition, and they are thus capable of vegetating with most extraordinary rapidity. Pasteur has recorded an observation of the rapidity of growth of the wine ferment at even such a low temperature as 12° or 13° C. = 55° F.

"On October, 12th, 1861, at 10 o'clock in the morning, we crushed some grapes, without filtering the juice that ran from them; afterwards, at different times during the day, we examined the juice under the microscope, until at last, although not before 7 o'clock in the evening, we detected a couple of cells. From that time we kept these contiguous cells constantly in view. At 7.10 we saw them separate and remove to some little distance from each other. Between 7 and 7.30 we saw on each side of those cells, a very minute bud originate and grow little by little. These buds developed very near the point of contact, where the disjunction had just taken place. By 7.45 the buds had increased greatly in size. By 8 they attained the size of the mother cells; by 9 each cell of each couple had put forth a new bud. We did not follow the multiplication of the cells any further, having seen that in the course of two hours two cellules had furnished eight, including the two mother-cells." This increase is really nothing like so rapid as it would have been at a temperature of 77° to 86° F. (25° or 30° C).

The process of budding usually commences by a distortion of the cell at one side, which is followed by the cell-wall protruding; the protuberance increasing in size, becomes more or less rounded in shape; then a sort of strangulation process commences, which causes the cell-walls of the protuberance to meet, and at last the bud becomes detached. Sometimes a cell gives rise to several protuberances at once. An inaccurate discription of the mode of propagation of yeast has been given by certain writers, in consequence of which it is believed that the yeast cells burst, and that the contents, which are of a granular nature, attach themselves to mature cells and there grow. This, according to Pasteur, is never the case, though it is true that the yeast cells, under some abnormal circumstances of very rare occurrence, do occasionally burst. Their propagation, however, does not depend upon their bursting.

If we examine a speck of brewer's yeast under the microscope, with a magnifying power of from 400 to 600 diameters, we observe that certain of the oval cells are more or less elongated, while others are more nearly spherical in shape, and they are all isolated. In many of them there are apparently vacant spaces which are lighter or darker than the surrounding parts of the cell according as the object or the object-glass is slightly shifted. Granulations, too, are seen in the cells, and they present altogether a somewhat shrivelled appearance. Such cells are suffering from deficient nutrition an insufficiency of food; they are, in fact, half starved. If they be transferred to some fresh wort, and placed in shallow saucers so that they are freely exposed to the air, their appearance will be greatly improved. They will be seen to have filled out and become fatter, while the vacuoles or vacant spaces have disappeared, the granulations are scarcely visible, and the distended cell-walls are difficult to see, they are nearly all budding, and the buds are at different stages of development. The characters of the two conditions of yeast, as described by Pasteur, may be shortly summed up as follows:—

Old Cells. — Isolation and granulation; shrinking of the protoplasm to the cell-wall and creation of vacuoles; shrivelled appearance.

Revived Cells. — Cells distended; appear transparent to a greater degree; budding and growth of buds until detachment; interior gelatinous matter contains fine granulations not easily seen, but appearing at a certain distance brilliant.

Brewers are acquainted with two varieties of yeast and two kinds of fermentation, namely, that which occurs at a high temperature, and the yeast of which rises to the surface of the liquid is called a "high fermentation;" that which, on the contrary, is conducted at a low temperature, and the yeast of which is below the surface of the liquid, is called a "low fermentation." With all our brewers and distillers high fermentation is in universal favour, it is so much more rapid in its action, and generally saves both time and space. To adopt the process of low fermentation in a London brewery, would probably necessitate a large outlay for the extension of premises for the storing of beer while undergoing the prolonged process. This mode of fermentation is in operation at the Tottenham lager beer brewery, which has been specially built for the process. Both the high and low yeasts are the products of careful cultivation extending through past ages, the original and parent form of which was probably some variety of fungus growing upon either the hop or grape vine. Wheat is the cultivated product of some cereal, the original form of which has been lost, and in the case of these yeasts evolution has endowed them with new properties.*

The following is a description of the properties of these two varieties of the yeast fungus, which is termed *Saccharomyces cerevisiæ*:—

Low Yeast.—This may be appropriately termed German beer yeast, since it is almost entirely used in the brewing of lager beer.

The cellules are round or oval in their greatest diameter. It ferments wort at temperatures as low as (6° to 10° C.) 43° to 50° F.; under such cold wort other yeast is quite inactive. It never rises to the surface, even when the temperature increases to (20° C.) 68° F., and the fermentation becomes tumultuous. Its budding is less branched than is the case with high yeast.

High Yeast.—The cells are rather larger than those of the low ferment, and present a more globular appearance. Its budding is very rapid and more branched in form. It rises to the surface of liquids during fermentation, forming a head sometimes 6 ft. in height. It developes at (16° to 20° C.) 60° to 68° F.; at low temperatures it is quite inactive. When active fermentation takes place, in round or oval vats, the yeast rises upwards from the bottom at the circumference, and travels over towards the centre. The smell of acetic ether is generally perceptible in the gas which escapes.

* Even the yeast from different breweries ferments differently. Mr. Edward Purser informs me that yeast from Bass's brewery, at Burton-on-Trent, is extraordinarily active when transferred to Guinness's fermenting vats in Dublin, but in time its action becomes tranquil, being modified by the surrounding circumstances, and, probably by some difference in nutrition.

Rees has shown that high and low yeast may be obtained by cultivation under favourable conditions from opposite varieties, and he considers, therefore, that they belong to the same species, *Saccharomyces cerevisiæ*.

A second high yeast was discovered accidentally by M. Pasteur, which produces a beer with a special flavour resembling that of wine. The cellules are oval and indisposed to branching, in this resembling low yeast, but they rise to the surface like the preceding variety.

As fermentation is a process of great importance to the brewer and distiller, and one which is liable to miscarry unless great attention is paid to details in its management, I propose to state the conditions by which uniformity in the results are likely to be secured. These are—

1. A saccharine solution of a suitable strength containing a certain proportion of phosphoric acid free or combined, salts of potash and magnesia, and a sufficiency of nitrogenous substances as nutriment.

2. A pure yeast in a healthy state.

3. A suitable temperature.

4. Perfect cleanliness in the fermenting tuns.

5. Due proportion of yeast to sugar in the solution.

With regard to the proper strength of solution, it has been shown by Helmholtz that fermentation is only active and complete in solutions sufficiently diluted with water. If the proportion of water to sugar be less than four parts to one, the solution is too strong, and after a certain time the alcohol resulting from so large a proportion of sugar precipitates the albuminous matters in solution, and destroys the fermenting power of the yeast. An excess of sugar acts likewise in another way; it diminishes the amount of water in the interior of the yeast cell to a quantity below that which is necessary for its vital functions. If the sugar solution be too dilute, the irregularity in the fermentation and its slowness are apt to cause a secondary fermentation, which converts alcohol into acetic acid. This entails a double disadvantage; there is a loss of alcohol and an objectionable acidity which, beyond a certain point, has a retarding effect upon fermentation, notwithstanding the fact that yeast is always acid.

1. As yeast is a plant of low organisation, it is necessary to supply it with the mineral, and organic material such as will contribute to the formation of fresh tissues during reproduction and development. To ascertain what these are, we must turn to chemical analysis for our knowledge. According to Schlossberger (*Ann. der Chemie und Pharmacie*, vol. 51, p. 199) purified yeast contains:—

	High Yeast.	Low Yeast.
Carbon....	49·9 per cent.	48·0 per cent.
Hydrogen..	6·5 "	6·5 "
Nitrogen..	12·1 "	9·8 "
Oxygen ..	31·4 "	35·7 "
Ash......	2·5 "	3·5 "

Wagner's analysis:—

	High Yeast.	Low Yeast.
Carbon....	49·8 per cent.	44·4 per cent.
Hydrogen..	6·8 "	6·0 "
Nitrogen..	9·2 "	9·0 "

Schlossberger found the albumenoid cell-contents of the yeast to contain:—

Carbon.................	55·5 per cent.
Hydrogen	7 "
Nitrogen	13·9 "

Nægeli has examined the proximate constituents of yeast in a most careful manner (Mayers *Lehrbuch der Gährungs-Chemie*, p. 113). The sample was a low yeast, containing 8 per cent. of nitrogen, and it consisted of:—

Cellulose, gum, and cell membrane	37 per cent.
Albumenoids..............	45 "
Peptones	2 "
Fat	5 "
Extractives (leucine, cholesterine, dextrin, glycerine, succinic acid	4 "
Ash......................	7 "

It will be seen that nitrogen is a very important element, and nitrogenous matters must be a necessary form of nutriment for yeast.

This fact is now recognised, and it has been proposed by Birne, that in the fermentation of solutions containing a deficiency of such material, leguminous seeds, such as beans, should be steamed, and the mash so prepared be added to that about to undergo fermentation. The reason for this proposal lies in the fact that the leguminosæ are rich in a nitrogenous substance called asparagin, which has been found to be an excellent nutritive material for the yeast plant. Its composition is $C_4 H_8 N_2 O_3$, it is closely related to malic acid, as likewise is aspartic acid—

$$C_2 H_3 (OH)(CO OH)^2.$$

It is a well-known fact that yeast can derive its nitrogen and carbon from ammonia salts of organic acids, as for instance, ammonium tartrate. Pasteur's solution, which on exposure to air will undergo spontaneous fermentation by the nutrition of germs which fall into the liquid, is composed of sugar 10 grams.; tartrate of ammonia 1·0 gram.; yeast ashes of phosphate of ammonia 0·1 gram. (*Ann. de Chemie et Physique*, 3 vol. 58.)

The inorganic constituents of yeast, as shown by an analysis of the ash, were determined by me some fifteen years since to be very pure phosphate of potash, containing no trace of soda or other base, and soluble silica in small proportion. The analysis was made upon the ash yielded by 14 lbs. of compressed yeast from Messrs. Whitbread's brewery. The exact figures of my own analyses I cannot quote, but other chemists give figures in which 50 to 59 per cent. of phosphoric acid is combined with 29 to 39 per cent. of potash, 4 per cent. of magnesia, and 2 per cent. of lime. It is impossible to ferment sugar properly, unless these salts are present in the liquid in sufficient quantity. One might as well try to grow corn in the air, or feed a horse on water, as cultivate yeast without mineral nutriment, consisting of the phosphates of potash and magnesium.

2. The use of pure and healthy yeast is a condition of the very highest importance, but one which has been too much neglected, both by brewers and distillers.

There are several kinds of yeast which produce alcohol during the fermentation of wine or beer; they are named as follows:—

1.	Saccharomyces	Cerevisiæ	(Mayen)
2.	,,	Ellipsoideus	(Rees).
3.	,,	Conglomeratus	(Rees).
4.	,,	Exiginus	(Rees).
5.	,,	Pastorianus	(Rees).
6.	,,	Minor	(Engel).
7.	,,	Mycoderma	(Rees).

The species No. 6 is found in fermenting dough. No. 7 only acts as an alcoholic ferment under special conditions.

Where yeast becomes foul, it is because of the presence of more minute organisms, such as the *Bacterium termo*, which can oxidise alcohol into acetic acid; the *Bacillus amylobacter*, and the *Bacillus subtilis*, which yield lactic and butyric acids from even cellulose, starch and sugar. Certain forms of mould also produce foul yeast, as *Mucor mucedo*, *Mucor stolonifer*, and *Penicillium glaucum*. While the three last common forms of mouldiness can be readily seen, the presence of the former, which are named *bacteria*, or rod-like organisms, cannot be recognised without the aid of a powerful microscope capable of magnifying 500 diameters, at least. Yeast-cells may be diseased without being putrid, and they may be unhealthy without being diseased. The foul or diseased yeast is that which is mixed with minute organisms which it would be incorrect to describe as parasitic in character, but which thrive in fluids in which the *saccharomyces* developes. They are small rod-like or thread-like bodies, organisms very much smaller in size than the yeast-cells, and more difficult to observe, so that a magnifying power of not less than 400 diameters, with glasses capable of the best definition, are necessary. It is better to employ objectives with a magnifying power of 750 diameters. Were these disease organisms absent, acetous fermentation could not take place.

There are two customs practised with regard to the fermentation process; the first is the change of yeast of one brewery for that of another, the second, the mixing of several kinds of yeast, that is to say, the produce from different breweries, which is adopted by distillers. When the brewer finds his beer is being spoilt, and the fermentation process is getting troublesome, he sends to another brewery for some fresh yeast. Such a state of things as necessitates this arrangement is always found to coincide with a swarm of the thread-like organisms among the yeast-cells and in the beer. Sometimes they are found in the finings, and are therefore introduced after the chief fermentation process is over. The foreign organisms, smaller than yeast-cells, have much less vitality, and can therefore be made to perish by a treatment which is not injurious to the larger fungus. Pasteur has devised three methods of purifying yeast; they are the following:—

1. Growing yeast in water containing 10 per cent. of sugar. The operation to be conducted in shallow basins.

2. Growing yeast in wort containing an addition of 1½ per cent. of tartaric acid and 2 to 3 per cent. of alcohol.

3. Purifying successive growths of yeast by addition to the wort of a 10 per cent. solution of carbolic acid, in the proportion of one part of the solution to every hundred of wort. (Pasteur, *Studies on Fermentation*, p. 232.)

These methods are said to be impracticable on a large scale, but the following process of purification is deserving of attention.

Washing the yeast with an aqueous solution of salicylic acid, containing not more than one part of the substance in 10,000 of water, and not less than one in 20,000. (J. Bersch, *Gährungs Chemie für Praktiker.)*

The growth of the smaller organisms is checked, if not altogether stopped, by the action of disinfectants, but the yeast continues to develop with great rapidity, and soon greatly outnumbers the others. The purification of yeast by cultivation in pure sugar, and not in an infusion of malt or grain or a potato mash, is dependent upon a fact observed by Mayer, namely, the absolute necessity for inorganic nutriment, consisting of phosphoric acid and potash, while the yeast is in the saccharine solution, and the exhaustion of the plant if this be omitted.

The yeast may become unhealthy even when not diseased, by being grown for too long a time in a liquid deficient in mineral food; fermentation is thus languid, and those objectionable organisms, the filamentous ferments, may gain the race in the production of alcohol or acid. There is no doubt that in all fermentations artificially carried on, there are two processes at work, that which is alcoholic and that which is acid; and the result is favourable or unfavourable as the one or the other is the more rapid.

In a mash made from grain the necessary mineral food is always present, but it is doubtful whether there is always sufficient in a mash made of potatoes; indeed, in this latter case, it depends very much upon how the mash is made.

The reason why a distiller uses a mixture of yeast of different growths is, because he gains greater uniformity in the results from a given weight of the material; for where one growth may be deficient in mineral nutriment, the cells old and languid, another may be contaminated with disease ferments, while other two kinds may be perfectly healthy and vigorous. The law of the survival of the fittest then comes into play, and the most healthy cells increase with such rapidity, that the others are soon found to be in a very small minority.

3. The third condition is a suitable temperature to which yeast may be exposed without injury. Yeast may be subjected to a temperature of 32° F., provided the rise of temperature subsequent to this is gradual. If carefully dried, it will withstand heating to 212° F. Damp yeast loses its activity at or about 128° F. The most advantageous temperature for fermentation lies between 77° and 86° F. These conditions are easily stated, but not so easily maintained, because a large amount of heat is evolved during fermentation which escapes if the quantity of liquid is not very large, but the tuns hold many thousand gallons of mash and the increase in temperature is greater than the cooling power of the surrounding air. This fact may be observed in the record of some experiments carried out by Donovan; the quantity of fluid under examination is not stated, nor is the temperature of the atmosphere recorded, but we have the course of the fermentation indicated by the original gravity of the wort, and its decrease by the resolution of the sugar into alcohol and carbonic acid :—

Time.	Temperature.	Specific gravity of wort.
1st morning	70° F.	1·050
,, evening	70° F.	1·050
2nd morning	72° F.	1·046
,, evening	76° F.	1·032
3rd morning	80° F.	1·022
,, evening	84° F.	1 012
4th morning	88° F.	1·007
,, evening	88° F.	1·005
5th morning	88° F.	1·003
,, evening	88° F.	1·001

The course of a fermentation depends much upon the weather lasting from three to nine days, but the rise of temperature as here indicated is as much as 18° F. It is an advantage for fermenting tuns to be made of iron, with an outer jacket of wood; in this way the outside air is less liable to affect the temperature of the liquid, and, should the mash become too warm, cold water may be made to circulate inside the jacket, or steam, as circumstances require. Another plan for regulating the temperature of fermentation is to have the tuns enclosed in a wooden chamber, and above the surface of the liquid for coils of pipes to be placed, through which may circulate a refrigerating mixture for reduction of temperature, or steam for an increase. It is not, however, so necessary, as a rule, to hasten fermentation by warmth, because the initial temperature of the wort can be easily adjusted.

4. Cleanliness of the fermenting vessels is obviously of importance, because otherwise other ferments than the alcoholic may easily cling to the sides, and so induce an acid fermentation; this is particularly the case with the *Bacterium termo*. On this account

it is of importance to have the fermenting vessels constructed of some material which is easily cleansed. The best form of fermenting tun, when not made of metal, is that which is made of oak, rendered perfectly impervious to liquids by the staves being soaked in melted paraffin or in a shellac varnish. (J. Bersch. *Gährungs Chemie für Praktiker.*)

Melsens (*Comptes Rendus*, vol. 70, p. 629) has made some observations on beer yeast, and arrived at the following conclusions, which are indicative of the extraordinary vitality of this organism :—

1. Fermentation can proceed among melting ice, that is to say, at a temperature too low for the germination of grain.

2. Yeast immersed in water enclosed in strong vessels, is capable of resisting compression caused by the effort to expand when the water is frozen, even when the expansive force is equal to a pressure of 8,000 atmospheres.

3. The energy of the ferment is diminished, but life is not destroyed by a degree of cold more intense than any artificially produced (1870), or about—100° C.

4. Alcoholic fermentation is suspended when the temperature is kept for some time at 45° C. (120° F.)

5. Alcoholic fermentation is arrested when it proceeds in closed vessels, and when the pressure of the evolved carbonic acid exceeds 25 atmospheres the yeast is killed.

Some remarkable experiments were made by the late M. Dumas on fermentation. *(a)* He has shown that it takes exactly twice as long to ferment cane-sugar as grape-sugar, in point of fact, the process of inverting the cane-sugar requires as much time as the conversion of the glucose into alcohol. *(b)* When the proportion of yeast to glucose was 20 to 1, the fermentation was just as rapid as when five times as great, or 100 to 1; in other words, under identical circumstances, yeast being in excess, the duration of fermentation is proportional to the quantity of sugar. The regularity of the reaction upon the sugar is caused by the great multitude of cells taking part in the fermentation. With a magnifying power of 550 diameters, there were counted 60 to 77 distinct cells in each apparent square millimètre, which means 19,800 cells per actual square millimètre, or 2,772,000 per cubic millimètre, so that, in introducing 10 cubic centimètres of yeast paste into 150 cubic centimètres of water, there were really employed twenty seven thousand seven hundred and seventy-two millions of cells. (*Annales de Chemie et de Physique*, 5, vol. 3, p. 57.)

Some idea of the magnitude of this number may be conveyed in the statement that every second of a man's life, if he lived for about 900 years, would not out-number these yeast-cells.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

Report on Electric Lighting. By Prof. George Forbes.

The following is the first of a series of reports on the Exhibition which it is proposed to publish in the *Journal* :—

The electric light at the Health Exhibition this year resembles very much that of last year at the Fisheries Exhibition in the same place. But to the critical eye there is a vast improvement; last year a gigantic system was installed in haste, and there was not the means to estimate properly the extent to which the lighting would be carried. The experience then gained has gone far to smooth away the preliminary difficulties. The engine-shed has been enlarged, and the plant laid down according to a more intelligible scheme, and all the arrangements have a more systematic basis. The result is correspondingly satisfactory, and serves as the best connecting link between the isolated installations, which have hitherto been most common, and the centralised stations for large supply, which it is expected will soon be generally demanded. The most evident improvement is in the general arrangement of the engine-shed; but experience has also done much in guiding many companies to sounder views as to the dimensions of cables and other all-important details.

To begin with the engine-shed, steam-power is supplied chiefly by Davey-Paxman engines, three of these engines being employed to drive two long countershafts in one line; these are 60ft. and 45ft. in length respectively. From these a vast number of dynamos of various kinds are driven. There are also three special engines by the same makers working the dynamos of the Hammond Company, the Gülcher Company, and the Jablochkoff Company respectively. A Hodgson rotary engine and a "Tower" spherical engine are also at work each upon a "Victoria" dynamo of the Brush Company.

A gas-engine is also shown close by, driving another "Victoria" dynamo, to illustrate Mr. Dowson's system of generating gas for the purposes of motive power.

One of Lautensach and Bittner's gigantic thermopiles has also been placed in the engine-shed, but it does not seem to have been put in operation up to the present date.

Nearly the whole length of the building is occupied on one side by two large Davey-Paxman pairs of horizontal engines, and the six boilers required for this duty. These boilers also supply steam to the two rotary engines mentioned above.

These six boilers are all connected together. One main water-pipe runs along the whole length of the six, and the pumps are so connected, that if one fails, the others act and supply through the main. The pumps are by Mumford, of Colchester. There is a throttle-valve attached for the feed of each boiler. Each boiler has an independent safety-valve and stop-valve. The exhaust steam is carried away by the funnels of these boilers. The steam pipes to the two engines are connected with all the boilers.

Each of the two large engines indicate about 350 horse-power. The one which drives the 60-ft. countershaft has a 19-in. cylinder and 32-in. stroke. It is mounted on girders instead of being upon a solid bed-plate. This is for convenience of export. The cylinders are connected to the girders by strong brackets, which give great rigidity. The main valve is in a separate case to the cut-off valve, and this involves the use of less pressure to move the main valve. The cut-off can be varied from 0 up to $\frac{3}{4}$. There is a cylinder on each side of the driving wheel, and one governor acts upon both. The governor is supplied with a spring, to vary the action of gravity, so that the speed may be increased. It is not driven by belts, but by toothed-wheel gearing. The efficiency of one of these governors was shown on a recent occasion here, when the 21-in. link leather belt broke when in full action, and the speed changed by barely a revolution a minute. Schönheyder's lubricator is used in this engine. There are two driving pulleys 12 ft. diameter and 16 in. wide. The engine runs at 72 revolutions, and the pressure of steam has been 85 lbs. These driving wheels have each a 15-in. belt of linked leather driving a pair of 39-in. pulleys on the long countershaft, the distance between centres being 31 ft.

The second large double-cylinder engine drives a countershaft of 45 ft. length. This engine resembles the first, but it has an $18\frac{1}{2}$-in. cylinder, with a 32-in. stroke. It has only one driving-pulley, 12 ft. diameter and 24 in. wide. The 19-in. linked leather belt which broke on this work has been replaced by another, 24-in. wide.

The third engine, of Messrs. Davey and Paxman, is a fixed horizontal compound engine, in use by the Hammond Company to drive the Ferranti 1,000-lighter alternate current machine, a 40-lighter Brush machine, and a Ferranti 200-incandescent lighter. It has a single gridiron valve and a cut-off valve. The exhaust valve is in the same case as the slide valve of the low-pressure cylinder; the latter cuts off at $\frac{1}{2}$-stroke. The high-pressure cylinder has a diameter of piston of 15 in. and a stroke of 2 ft., and the low-pressure 22-in. with a 2-ft. stroke. This engine has indicated up to 220 horse-power, with a pressure of 120 lbs. It drives two pulleys, one 10 ft. diameter and 16 in. wide for the large Ferranti machine; the other a smaller one for the other two dynamos. This engine is fed by two boilers called a 50 and a 16 horse-power boiler respectively. These have each a donkey pump and injector.

The fourth engine is a compound one used for seven Fülcher dynamos. It resembles the last, but the diameters of the high and low pressure cylinders are $12\frac{1}{4}$ and $20\frac{1}{2}$ in., and the stroke 2 ft. It runs at 100 revolutions. With its attached boiler it can indicate 130 horse-power. The driving wheel is 8 ft. 6 in. by 16 in.

Another semifixed compound engine on the top of its boiler works the Jablochkoff dynamos. It has no special features of interest.

The first large engine described is assisted in driving the principal countershaft by a 25 horse-power engine, working, it is said, up to 100 horse-power. Altogether over 1,100 horse-power is developed in the engine-shed.

The main countershaft, 60 feet long, drives two secondary countershafts, one of them driving six Gramme machines of the British Electric Light Company, viz., two A's, one D, and three E's; the other driving ten double Edison machines. It also drives the following dynamos direct:—One Bürgin, four Pilsen Joel, one Siemens alternate current with exciter (small), and two Paterson and Cooper's "Phœnix" machines, all these on one side of the countershaft, and on the other side one huge Siemens direct machine for 420 ampères and 80 volts, a Clerk machine with Siemens exciter (for the "Sun" lamps), two large low resistance Siemens alternate current machines with exciter, and another Siemens direct current dynamo. An Elphinstone and Vincent 400 lighter machine is also in place and at work.

The second countershaft, 45 feet long, drives three Hochhausen dynamos, one Brush (23 arcs), one Oppermann with exciter, and one Gerard.

A great deal of interest attaches to the large machine exhibited by the Hammond Company. This is a 1,000 incandescent lamp alternate current machine by Ferranti. It resembles his well-known type of machine in many respects, but is conspicuous for the perfecting of details of construction, and for some novelties which are introduced. It is fed by a large quantity of Siemens direct current dynamos, attached to the same shaft as the alternate current machine. The shaft has a large bearing on each side of the Ferranti armature, of the fly-wheel, and of the Siemens armature, and has, in addition, a thrust bearing. These bearings are lubricated under pressure, the oil being collected in a reservoir, filtered, and pumped up to a supply reservoir. In the other types of Ferranti machine it has been found that, to prevent abrasion, the collecting rings must be oiled, and the resistance thus introduced is in many cases equal to the total resistance of the armature. In the present type of machine the terminal wires are attached to rings on the shaft which rotate within hollow rings, the intermediate space being filled with mercury to complete the electrical contact. This arrangement seems to work admirably. This device was patented by me in 1883. It has been said that the direct and alternate machines are on the same shaft. This is not strictly so, for the shaft of the Siemens machine is driven from that of the Ferranti machine through a leather ring clamped to each of the shafts. The Siemens machine gives 30 ampères and 120 volts, and works through the two sets of 24 Ferranti field magnets, each set of 24 being connected in parallel. The Ferranti machine gives 400 volts at 600 revolutions. It supplies Woodhouse and Rawson lamps in the Aquarium refreshment bar and the dining-room in the conservatory.

Another large machine deserving special attention is the Siemens machine, exhibited by the water companies. It is called a B 2 dynamo. It is designed to give 420 ampères current, with 80 volts electromotive force, and is used for the fountain illuminations. On the armatures there are ribs of copper from end to end, held bound by strong metal bands enclosing them. These bands have their greatest width radial, to prevent local currents being developed, and are in pairs; and two pairs go to each terminal commutator. There are about twenty arms to the commutator. There are two pairs of brushes, each pair being side by side. The width of each brush is 4 inches. The position of the brushes is adjusted by a worm-wheel. The machine is compound wound, the series winding goes through the four arms of the field magnets in parallel, and is of wire about $\frac{1}{4}$ inch diameter; the shunt winding goes round all four arms in succession, and is of No. 12 wire. The mechanical and constructive details of this machine are worthy of close inspection.

A machine shown by the Brush Company shows the enormous improvement which can be introduced by recognising, and so dispensing with, the local currents in the mass of iron constituting the armature. In this machine the armature is built upon a coil of hoop-iron, with H pieces let in during the winding to support the coils. A very great gain is said to have been obtained by this alteration.

The Hopkinson-Edison type of machine, manufactured by the Edison Company at New York, is exhibited by the Edison-Swan Company.

Of other machines mention may be made of the cheap classes of direct current and alternate current machines shown by Oppermann. The Gerard Company also show some small and cheap machines; among these is a very small compact laboratory machine, suitable to work with a treadle, which works four incandescent lamps.

The Victoria dynamos are on the model of the Schuckert machines, which, as turned out at Nürnberg, have acquired so high a reputation. In the Victoria, however, there are four poles, and the resulting pairs of coils on the armature are in parallel, so that there are only two brushes.

The Gramme, Hochhausen, Gülcher, Jablochkoff, Bürgin, Phœnix, and other machines, require no special notice here.

In the Consolidated Company's exhibit their secondary batteries are charged by a compact Parker-Elwell machine, with an 8-in. armature, giving 25 to 30 ampères and 130 volts; when run for a short time it can give 60 ampères without injury.

Having thus passed in review the dynamos at the Exhibition, it becomes a matter of interest to learn the size of cables used by different firms, and the current carried by them. In the following table the name of the company or firm, or other distinguishing mark, is given in the first column. The number of cables in parallel, or sections, is given in the second. The size of wire is in the third, thus 7/16 means 7 wires of No. 16 in a cable. The current in ampères fills the fourth, and the fifth gives the ampères in volts:—

System.	No of Sections.	B.W.G No.	Amps.	Volts.
Siemens { main	I	19/16	160	76
Siemens { return	4	7/16	40	304
,, Swan	3	19/16	142	200
Bowman	I	14/16	9	350
Lea	I	14/16	22	260
Gramme-Brockie	I	14/16	12	400
Brush (part)	I	14/16	} 11	1,200
,, (part)	I	7/16		
Brush-Hammond (part)	..	14/16	} 11	2,000
,, ,, (part)	..	7/16		
Pilsen-Joel	3	7/18	9	600
Gülcher	2	9/12	200	65
Hochhausen	I	7/18	12	1,645
Clerk's Sun Lamp (part)	I	7/20	} 9	500
,, ,, (part)	I	7/16		
Hochhausen (mast)	I	14/16	20	250
Edison Swan	I	3/4	630	110
Opperman	I	19/14	53	200
Victoria (driven by Tower engine)	I	19/16	70	160
Sweden-Gatehouse	3	19/16	220	88
Ferranti	I	19/12	180	250
,,	I	14/16	20	250

The total illumination is over 5,000 incandescent lamps, besides some 300 arc lamps. It is worthy of remark that Sir F. Bolton's fountain display uses up from 120 to 180 horse-power in the illuminations. As this Exhibition is to a great extent illustrative of what can be done on a large scale, the nature of the lighting is worthy of record. The following facts have accordingly been compiled for the purpose.

Arc Lighting.

The small corridor and the south promenade and vegetarian room are lighted by 11 Ball lamps with 1 Ball dynamo; the electric machinery room by 6 Werner and 6 Cardew lamps, fed by 1 Brush machine; the west corridor and the south annexe by 8 Clark Bowman lamps with 1 Phœnix dynamo; Old London by 5 Lea lamps with 1 Gramme dynamo; the south central avenue and part of the east and west central gallery are lighted by 60 Jablochkoff candles with 3 machines, and there is a fourth spare one; in the west central gallery, 7 Brockie lamps and 1 Gramme dynamo; west and east annexes, 23 Brush lamps and 1 dynamo; east corridor, west and east quadrants, east arcade, and Du-Val dining-room, 40 lamps and 1 Brush dynamo by the Hammond Company; west gallery, 39 Pilsen lamps, 3 Schuckert dynamos; central gallery, 29 lamps, and 1 machine by Hochhausen; central fountain by 1 lamp and machine by Crompton, 10 lamps and 1 machine by Clerk, the latter being also distributed in the cascades and water pavilion garden. The Clerk machine is designed for 3 circuits of 10 lamps each. The Queen's-gate entrance has a Fox lamp and Oppermann machine; the masthead has 6 lamps on 1 machine by Hochhausen, and the conservatory has 4 lamps on 1 machine by Siemens.

Incandescent Lighting.

Ten Edison machines light the following spaces:—Entrance vestibule, 23 Swan lamps and 107 Edison lamps; the arts gallery, 172 Swan and 122 Edison; Bertram and Roberts' dining-rooms, 64 Swan and 264 Edison; cheap dining-room, 31 Swan and 115 Edison; literary superintendent's room, 20 Edison. The south gallery, 2 Siemens alternate machines with 2 exciters—1,063 Swan lamps; dairies, 2 Gülcher machines, 370 Crookes lamps; Old London, 1 Gramme and exciter, and 30 lamps by Mackie; east central gallery, 340 Gatehouse lamps and 1 Elphinstone Vincent dynamo; water company pavilion, 1 Oppermann alternate current machine with exciter, and 234 Woodhouse and Rawson lamps; Prince of Wales pavilion, 1 Siemens with exciter, 180 Swan lamps, and 1 Siemens with exciter to 40 Woodhouse and Rawson 25 volt and 10 candle power, besides 10 of 50 volts and 20 candle power; the aquarium, west arcade, and west dining-rooms and tea-rooms, 1 Ferranti alternate current dynamo with Siemens exciter, and 909 Woodhouse and Rawson lamps; refreshment bar, 1 Phœnix dynamo and 40 half Bernstein lamps of 25 candle power; cocoa tavern, 1 Victoria dynamo, and 100 Victoria lamps of 100 volts and 20 candles; Chinese restaurant, 204 Crookes 50 volt lamps, which with 300 more are fed by 6 Gülcher machines; Indian Court, 38 Bernstein lamps on a Hochhausen machine. Nineteen of these are series on two parallels. Doulton's pavilion has 24 Gerard lamps of 50 candles on 2 Gerard machines.

The only secondary batteries in regular action are those of the Consolidated Company in the machinery in motion gallery. The plates are made of corrugated strips of lead coiled into a disc and pressed into a square form.

Twice the lighting has failed up to this date (August 14). Once a driving belt gave way, and once a boiler-feeding valve stuck, and the boilers being all connected together the steam escaped. It may be said that the boilers being connected in parallel, and one of them short circuiting the mains, the whole of them were burnt up or run dry).

Mr. W. D. Gooch has superintended all the arrangements. Everything seems to be as well arranged as is possible with so great a mixture of systems in use. This is the most extensive application of electric lighting hitherto seen in this country.

BRITISH ASSOCIATION.

Sir Frederick Bramwell's Address to the Mechanical Science Section.

After alluding to the formation of Section H, Sir Frederick Bramwell said—At our jubilee meeting at York, I called the attention of the Section to the fact that in 1831, when the Association first met in that city, they arrived there laboriously by the stage-coach, and that practically the Manchester and Liverpool, the Stockton and Darlington, and some few others, were the only railways then in existence. I also called their attention to the fact that in 1831 there were but very few steamers. I find the total registered in the United Kingdom in that year was only 447. If under this condition of things, the proposition had been made in 1832 at Oxford, as it was made in 1882 at Southampton, that the next meeting but one of the Association should take place in Montreal, the extreme probability is that the proposer would have been safely lodged in a lunatic asylum, for suggesting that that which might have involved a six-weeks' voyage out, and a four-weeks' voyage back, could ever be seriously entertained.

. . . . . .

There are those I know who object that Section G deals too little with pure science, too much with its applications. It may be, as the members of Section G might retort, that it is possible to attend so much to pure science as to get into the unchecked region of scientific speculation. . . . I think all men, even although they be followers of science in its purest and most abstract form, will concur in the propriety of Section G dealing with engineering subjects generally as well as with abstract mechanical science. Once admitting this, I may ask—certain what the answer must be—whether there is any body of men who more appreciate and make greater use of the applications of pure science than do the members of this Section. Surely every one must agree that we engineers are those who make the greatest practical use, not only of the science of mechanics, but of the researches and discoveries of the members of the other Sections of this Association.

Section A (Mathematical and Physical Science).—The connection between this Section and Section G is most intimate. With any ordinary man I should have referred, in proof of this intimate connection, to the fact that the President of A this year is a member of the Council of the Institution of Civil Engineers; but when I remind you that it is Sir William Thomson who fills this double office, you will see that no deduction such as I have hinted at can be drawn from his dual functions, because the remarkable extent and versatility of his attainments qualify him for so many offices, that the mere fact of his holding some one double position is no certain evidence of the intimate connection between the two. But setting aside this fact of the occupancy of the chair of A by a civil engineer, let us remember that the accomplished engineer of the present day must be one well grounded in thermal science, in electrical science, and, for some branches of his profession, in the sciences relating to the production of light, in optical science and in acoustics; while in other branches, meteorological science, photometrical science, and tidal laws are all important. Without a knowledge of thermal laws, the engineer engaged in the construction of heat motors, whether they be the steam-engine, the gas-engine, or the hot air-engine, or engines depending upon the expansion and contraction under changes of temperature of fluids or of solids, will find himself groping in the dark; he will not even understand the value of his own experiments, and, therefore will be unable to deduce laws from them; and if he make any progress at all, it will not guide him with certainty to further development, and it may be that he will waste time and money in the endeavour to obtain results which a knowledge of thermal science would have shown him were impossible. Furnished, however, with this knowledge, the engineer starting with the mechanical equivalent of heat, knowing the utmost that is to be attained, and starting with the knowledge of the calorific effect of different fuels, is enabled to compare the results that he obtains with the maximum, and to ascertain how far the one falls short of the other; he sees, even at the present day, that the difference is deplorably large, but he further sees, in the case of the steam-engine, that which the pure scientist would not so readily appreciate, and that is, how a great part of this loss is due to the inability of materials to resist temperature and pressure beyond certain comparatively low limits; and he thus perceives that unless some hitherto wholly unsuspected, and apparently impossible, improvement in these respects should be made, practically speaking, the maximum of useful effect must be far below that which pure science would say was possible. Nevertheless, he knows that within the practical limits great improvements can be made; he can draw up a debtor and creditor account, as Dr. Russell and myself have done, and as has been done by Mr. William Anderson, the engineer, in the admirable lecture he gave at the Institution of Civil Engineers in December last on the "Generation of Steam and the Thermodynamic principles involved." Furnished with such an account, the engineer is able to say, in the language of commerce, I am debtor to the fuel for so many heat units, how, on the credit side of my account, do I discharge that debt? Usefully I have done so much work, converted that much heat into energy. Uselessly I have raised the air needed for combustion from the temperature of the atmosphere to that of the gases escaping by the chimney; and he sets himself to consider whether some portion of the heat cannot be abstracted from these gases and be transmitted to the incoming air. As was first pointed out by Mr. Anderson, he will have to say a portion of the heat has been converted into energy in displacing the atmosphere, and that, so far as the gaseous products of the coal are concerned, must, I fear, be put up with. He will say, I have allowed more air than was needed for combustion to pass through the fuel, and I did it to prevent another source of loss—the waste which occurs when the combustion is imperfect; and he will begin to direct his attention to the use of gaseous or of liquid fuel, or of solid fuel reduced to fine dust, as by Crampton's process, as in these conditions the supply may be made continuous and uniform, and the introduction of air may be easily regulated with the greatest nicety. He will say, I am obliged to put among my credits—loss of heat by convection and radiation, loss by carrying particles of water over with the steam, loss by condensation with the cylinder, loss by strangulation in valves and passages, loss by excessive friction or by leakage; and he will as steadily apply himself to the extinction or the diminution of all such causes of loss, as a prudent Chancellor of the Exchequer would watch and cut down every unproductive and unnecessary expenditure. It is due to the guidance of such considerations as these that the scientific engineer has been enabled to bring down the consumption of fuel in the steam-engine, even in marine engines such as those which propelled the ship that brought us here, to less than one-half of that which it was but a few years back. It is true that the daily consumption may not have been reduced, that it may have been even greater; but if so, it arises from this, that the travelling public will have high speed, and at present the engineer, in his capacity of naval architect, has not seen how—notwithstanding the great improvements that have been made in the forms of vessels—to obtain high speed without a large expenditure of power. I anticipate, from the application of thermal science to practical engineering, that great results are before us in those heat motors, such as the gas-engine, where the heat is developed in the engine itself. Passing away from heat motors, and considering heat as applied to metallurgy, from the time of the hot blast to the regenerative furnace, it is due to the application of science by the engineer that the economy of the hot blast was originated, and that it has been developed by the labours of Lowthian Bell, Cowper, and Cochrane. Equally due to this application are the results obtained in the regenerative furnace, in the dust furnace of Crampton, and in the employment of liquid fuel, and also in operations connected with the rarer metals, the oxygen furnace and the atmospheric gas furnace, and, in its incipient stage, the electrical furnace. To a right knowledge of the laws of heat, and to their application by the engineer, must be attributed the success that has attended the air-refrigerating machines, by the aid of which fresh meat is at the end of a long voyage delivered in a perfect condition; and to this application we owe the economic distillation of sea water by repeated ebullitions and condensations at successively decreasing temperatures, thus converting the brine that caused the Ancient Mariner to exclaim, "Water, water everywhere, nor any drop to drink," into the purest of potable waters, and thereby rendering the sailor independent of fresh-water stowage.

Sir Frederick Bramwell then proceeded to refer to the application, by the engineer, of electrical science, and to several other of the subjects dealt with in Section A. He then treated of the relations of mechanical science to the other sections, and concluded with these words:—

I trust I have now established the proposition with which I set out, viz., that not only is Section G the section of mechanical science, but it is emphatically the section of all others that applies in engineering to the uses of man the several sciences appertaining to the other sections; an application most important in the progress of the world, and an application not to be lightly regarded, even by the strictest votaries of pure science, for it would be vain to hope that pure science would continue to be pursued if from time to time its discoveries were not brought into practical use.

Under ordinary circumstances I should have closed my address at this point, but there is a subject which at this, the first meeting of Section G after the meeting at Southport, must be touched upon. It is one of so sad a character that I have avoided all allusion to it until the very last moment, but now I am compelled to grapple with it.

In the course of this address I have had occasion to mention several names of eminent men, many of them happily still with us, some of them passed away; but I doubt not you have been struck by the absence of one name, which of all others demands mention when considering physical science, and still more does it come vividly before us when considering the application of science to industrial purposes. I am sure I need not tell you this name, which I can hardly trust myself to speak, is that of our dear friend William Siemens, whose contributions to science, and whose ability in the application of science, have for years enriched the transactions of this Section, and of Sections A and B, for in him were combined the mechanic, the physicist, and the chemist.

But a brief year has elapsed since he quitted the presidential chair of the Association, and, with us at Southport, was taking his accustomed part in the work of this and of other sections, apparently in good health, and with a reasonable prospect of being further useful to science for many valuable years to come. But it was not to be; he is lost to us, and in losing him we are deprived of a man whose electrical work has been second to none, whose thermic work has been second to none, and whose enlarged views justified him in embarking in scientific speculations of the grandest and most profound character. Whether or not his theory of the conservation of the energy of the sun shall prove to be correct, it cannot be denied that it was a bold and original conception, and one thoroughly well reasoned out from first to last.

I feel that were I to attempt anything like the barest summary of his discoveries and inventions, I should set myself a task which could not have been fulfilled had I devoted the whole of the time I had at my command to the purpose. I had, indeed, thought of making his work the subject of my address, but I felt that his loss was so recent that I could not trust myself to attempt it. There is no need for me to dwell further upon this most painful topic. He was known to you all, he was honoured and loved by you all, and by every member of this Association he had so faithfully served, and over which he had so ably presided; and he enjoyed the respect and esteem of the best intelligence of England, the land of his adoption; of the Continent, his birthplace; and of Canada, and of the United States, whose populations are always ready to appreciate scientific talent and the resulting industrial progress. It is not too much to say that few more gifted men have ever lived, and that with all his ability and talent he combined a simplicity, a modesty, and an affectionate disposition that endeared him to all.

I am sorry to conclude my address to you in this mournful strain. I have endeavoured to confine my allusions to our dear friend within the narrowest limits, but if I have overstepped these I trust you will forgive me, remembering that "out of the fulness of the heart the mouth speaketh."

WOOD INDUSTRIES OF RUSSIA.

Few countries, says the *Times*, can show a better utilisation of forest products than Russia, and particularly in the furnishing of industrial employment to the peasantry. Carriage and cart building forms an important item in woodwork, giving occupation to at least 530 villages, particularly in the governments of Nijni Novgorod, Viatka, Kazan, Moscow, Riasan, Vladimir, Jaroslav, Tula, and Kalug. The annual production in the government of Moscow is 116,000 roubles, the wheels alone in that of Ekaterinburg amounting to the value of 145,000 roubles per annum. It is a singular fact, however, that a vehicle is rarely, if ever, finished on the spot where it was begun, one village providing the spokes, another the boxes, while a third will make the body. The manufacture of wooden spoons is on a large scale, about 126,000,000 being turned out every year. The same subdivision of labour is seen in this case, one workman cutting the wood into lengths, another shaping the spoon in the rough, a third hollowing it out, and a fourth varnishing it. The spoons are usually made of birch and poplar, or boxwood for the most expensive, the average price per 1,000 being from six to eight roubles. Some 3,200 cubic fathoms of wood are annually cut up into spoons, one cubic fathom making about 4,000. They are exported in great numbers *viâ* Irbit to Khiva, and *viâ* Astrakhan to Persia. The government of Kazan is noted for producing the majority of the "donga" or yokes, which are made of elm and willow. Of these, a family that includes three workmen will produce from 700 to 1,000 in the course of the winter. The frames, however, which are made of birch and maple, come from Kaluga, and are sent to market at Kursk. The alder tree yields the dye with which the harness is stained. Combs for weavers are a specialty of a place called Jegorieffalow, in the government of Riazan, and are produced at the rate of 500,000 a year, the reeds being bought in the south, and the metal work at Moscow. The spinning-wheels, however, all come from the government of Jaroslav. A place called Swenigrod, in Moscow government, supplies veneered and inlaid furniture and parquets; while Viatka, Kostroma, Vladimir, and Novgorod make the lacquered furniture peculiar to the empire. Tula provides concertinas to the amount of 250,000 per annum; and in Viatka government are also made organs and violins. In the same locality are grown great numbers of lime trees, the bark of which is turned into bast for matting and sacks, as also for making bast shoes, to the extent of 100 millions per annum. The best matting, known as "schangskaia," is imported to England, and to supply these industries, over half a million lime trees are annually cut down in Viatka. Paper-making is beginning to employ a considerable amount of wood, while of grosser industries, the annual production of tar is 2,000,000 poods (one pood equals 36 lbs.); of birch oil, 4,000,000 poods; pitch, 150,000; turpentine oil, 60,000; and charcoal, 8,000,000.

Obituary.

Sir Robert Richard Torrens, K.C.M.G.—Sir Robert Torrens died on Sunday, 31st ult., at Falmouth, after a short illness. He was the eldest son of the late Colonel Robert Torrens (some time M.P. for Boston, by his marriage with Charity, daughter of Mr. Richard Chute, of Roxburgh, county Kerry), and was born at Cork in 1814. He was educated at Trinity College, Dublin, and in 1841 was appointed Collector of Customs in South Australia. In 1852 he became Treasurer, and subsequently Chief Secretary of that colony. He was nominated a Knight Commander of the Order of St. Michael and St. George in 1872. He was also a magistrate for Devon, and M.P. for Cambridge, from 1868 till 1874. He became a member of the Society of Arts in 1872, and was occasionally a speaker at its meetings.

General Notes.

Gold-miners in New South Wales.—The number of miners engaged in gold-mining during the year, according to the returns furnished by the Mining Registrars, is 6,750. Of these, 5,742 are Europeans and 1,008 are Chinese. Taking the output of gold divided by the number of miners as indicating the average earnings of the miners, we find that each miner earned 18·34 ozs. of gold, valued at £67 18s. 6·53d., for the year.

Petroleum in Venezuela.—According to the *Corps Gras Industriels*, the portion of Venezuela comprised between the Rio Zulia, the Rio Cattamubo, and the Cordilleras has numerous asphalte mines and sources of petroleum. Special reference is made to a locality about four miles from the confluence of the Rivers Tara and Sardinartre, where jets of petroleum mixed with boiling water are thrown up. It is said that the rate of discharge is four gallons per minute. Venezuela petroleum has a density of 0·83. It is of interest to know that beyond the confluence of the rivers spoken of, the stream is navigable at all seasons for vessels of 40 to 50 tons burthen.

Vienna and Teplitz Exhibitions.—An Exhibition has been held at Vienna, organised for the express purpose of displaying the progress made in the application of machinery to manufautures on a small scale, in contrast with the extensive mechanical arrangements which are usually associated with modern industrial progress. The Hoffmeister motors for use in connection with electric power are spoken of in the *Metallarbeiter* as calling for special notice. The maximum force of the motors exhibited appear to be three horse-power. Up to about 20 years ago this branch of industry was comparatively neglected, and the very comprehensive display now organised deserves special notice. The Teplitz Exhibition, though local in its character, embraces subjects of general interest, and amongst them are various objects which illustrate the progress made by Austria in more than one branch of the metal industry.

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Proceedings of the Society.

CANTOR LECTURES.

FERMENTATION AND DISTILLATION.

By Professor W. N. Hartley.

Lecture III.—Delivered Monday, May 26th.

Distillation and the Products Therefrom.

One of the most delicate tests for alcohol consists in adding to liquid to be examined a little iodine solution and a small quantity of solution of potash; on gently warming, a yellow turbidity is seen, and frequently a crystallised substance separates out on standing. This is iodoform, which is insoluble in water, and is capable of being easily and well crystallised; the crystals are readily recognised by the microscope, and such is the delicacy of the reaction, that one part of alcohol in 300,000 of water may be detected with ease. By fractional distillation, the alcohol is concentrated in water, and by performing the concentration in an improved manner, less than $\frac{1}{1000000}$ of alcohol added to water has been proved to be present. This reaction M. Müntz has applied to the examination of river, rain, and sea water, and to the examination of the soil. (*Comptes Rendus*, vol. xcii., p. 499). All kinds of water, except that from springs, contain a substance capable of giving the iodoform reaction. This body is more volatile than water. It is absent from water specially purified, and it does not occur in very pure spring water. Alcohol, in fact, pre-exists in rain and snow water, both in town and country. The quantity in the River Seine is about $\frac{1}{1000000}$th, and the same amount is found in rain. This amounts to one gramme per cubic metre. Snow and sea water contain quantities not very different. This diffusion of alcohol in water is explained without difficulty. The surface of the globe and ocean depths contain organic matter in abundance, which is incessantly undergoing decomposition. Organisms of minute size, which execute this work of disintegrating organic matter, are nearly all capable of producing alcohol in greater or less quantity. M. Berthelot has observed (*Ann. Chimie et de Physique*, series 3, vol. l., p. 322) the production of alcohol from many different substances under the influence of various fermentative agents. There must be, it will be admitted, a continuous production of alcohol during the decay of vegetable matter freely exposed to the air and the organisms contained therein, especially when the vegetable matter contains starch, glucose, or glucosides. Even cellulose is known to undergo fermentation. If this be the case, alcohol should be found in the soil in notable quantities. Experiment has confirmed this view, by proving that poor soils contain sufficient alcohol to give a distinct reaction when only 100 or 200 grammes are used for the test; but rich soils, or soils rich in organic matter, contain large quantities of alcohol, so that it is indeed possible to extract this substance, and verify its essential properties. It is only necessary to consider that, though the alcohol is formed in the soil, it will obey the law of vapour tension, become vaporised and diffused in the atmosphere, from which it is washed out by the fall of rain.

The Dublin water supply is brought in closed pipes from the Wicklow Mountains to within five miles of the city, whence it is delivered from a reservoir in pipes at high pressure. Such water gives evidence of the presence of alcohol.

The third distinct order of our subject deals with the separation of the alcohol from water, after its preparation by the process of fermentation. The boiling point of water at the ordinary standard pressures of the atmosphere, equal to 30 inches of mercury, is 100° C. or 212° F., that of alcohol 78·5° C. or 173·1° F. At the sea level the pressure of the atmosphere may frequently vary between 28·5 inches and 30·5 inches; the boiling points of water corresponding to these temperatures are 210° F. and 213° F. Indeed, changes in the weather may cause the boiling point of water to vary as much as 5° F. in our climate. These alterations in pressure would cause corresponding changes in the boiling point of alcohol. If we gradually raise the temperature of alcoholic fluids to a point when vapours are freely formed, it is observed that though there is a continuous absorption of heat, yet the liquid does not increase in temperature. The heat which is absorbed during the first period is doing work of a different character from that employed subsequently. There are two phases in the process, and two different kinds of worked performed by the heat employed in boiling even a kettle of water.

The first phase is indicated by a rise of temperature from 60° F. to 212°; the second phase by a change of state, from that of a liquid at 212° to a vapour at the same temperature. The quantities of heat required by different liquids in these changes varies greatly, but the variation is greatest when they pass through the second phase. Thus one pound of steam at 212°, if converted into water at 212°, will give up heat sufficient to raise 996 pounds of water from 60° to 61° F. The heat rendered up by one pound of alcohol vapour at 173° during condensation to liquid at 173° will heat 374·9 pounds of water from 60° to 61°. These figures are sufficient to show that a small quantity of steam will boil a large quantity of alcohol. Stills of improved construction depend upon this principle.

The simplest form of distilling apparatus consists of a close vessel connected with a tube immersed in water; the tube is open, and as the vapours expand and pass into the tube, they are cooled down sufficiently to assume the liquid state, their heat being rendered up to the water. It is necessary, then, to have a large body of water to begin with, or else for the water to be continually changed. An ordinary still and worm consists of a boiling vessel with a large head for the accumulation of the bulky vapour, connected with a coiled tube immersed in a tub holding a large body of water, which is continually being changed. The coils of the tube are largest at the upper part of the worm tub, where the vapours are the most bulky. The change of water is effected in this way. A stream of cold water is conducted down to the bottom of the tube, which being there distributed, displaces the water at the top, this latter having condensed, alcohol vapour has become warm. As the liquid below gradually makes its way upwards, it comes in contact with successive coils of tube, each one being hotter than the other, until the top coil is reached, which is at a temperature differing but little from that at which the liquid is being distilled. The more perfect forms of stills are so designed as to take advantage of the latent heat of the vapours to raise the temperature of the liquid to be distilled. How this is carried into practice, I will presently explain.

When a mixture of alcohol and water is distilled, the liquid will not boil constantly at 173° until all the alcohol has passed over, but will rise in temperature gradually throughout the distillation until 212° has been reached. The distillate, if separated into fractions boiling between fixed points, consists of a series of mixtures of alcohol and water in definite proportions. The mixtures richest in alcohol come over first, that is to say, at the lowest temperature.

The latent heat of the vapour of a liquid with a high boiling point, can be made to boil a liquid with a lower boiling point; for instance, steam at 212° can boil alcohol at 173°, and alcohol at 173° in turn can boil ether at 94·8°. With a simple still, strong alcohol can be obtained from wash by repeated distillation only. Woulffe realised the fact that this wasteful and tedious process could be dispensed with, by connecting together a number of rectifying chambers in such a manner that the vapour driven off from the chamber nearest the fire should be condensed in the second, and by the heat given out by its condensation, cause the more volatile portions of the liquid of the second to distil into the third chamber, and those of the third into the fourth, and so on, until a sufficient degree of concentration is attained. Adam put this principle of rectification into practice, and it is well illustrated by a description of the working of Laugier's still. In this arrangement another process, that of dephlegmation, is put in operation, which is exactly the reverse of rectification.

It consists in partially cooling the vapours, whereby they are separated into an alcoholic and an aqueous portion; the former passes on to another cooler, only the latter being condensed. Laugier's apparatus consists of separate parts connected by the necessary pipes; these are 1st, a worm tub; 2nd, a dephlegmator; 3rd, a rectifier; 4th, a still. The rectifier is warmed by the waste heat in the flue, the still only is heated by a direct fire. The wash passes first into the worm tub, where it absorbs all the heat given off in the condensation of the alcoholic vapours, thence it passes into the dephlegmator, where it becomes heated to near its boiling point by the condensation of water vapour only; it next passes into the rectifier, where it is boiled by the aid of steam from the still; the alcohol in the steam becoming concentrated in the liquid, is boiled off; finally, the liquid in the rectifier is run into the still, from which vessel it is periodically discharged. The general arrangement, as shown in the diagram, is effective in separating the two liquids, and the former goes upwards and the latter downwards. It is not adapted to distilling mash of different kinds, nor for yielding alcohol of the highest strength at one operation. The first apparatus to fulfil these conditions was devised by Mr. Coffey, a Dublin man. Although a variety of apparatus for distilling have been constructed by Savalle, Siemens Brothers, and others, yet some form or modification of Coffey's still is most commonly used in this country. It is constructed largely of wood and sheet copper; the wood being a bad conductor, prevents loss of heat, but it is liable in turn to give rise to leakage, and requires frequent renewal. The wash is raised by a pump to the top of a column, the upper half of which is a condenser, and the lower a dephlegmator; by means of a zigzag copper tube, the wash passes downwards, and upwards again, to the top of a second column, into which it is discharged, where it undergoes a process of distillation, by means of steam rectification, on a series of perforated shelves connected with each other by over-flow pipes. Such stills may be built of any size, and I have seen them of such dimensions that the pumps of each still were capable of passing 8,000 gallons of wash per hour.

It is a well-known fact that spirit from different sources differs in character. Ethyl alcohol, apparently of the greatest purity, may contain small quantities of other alcohols which give a flavour and odour; thus alcohol from the marc of grapes contains propyl alcohol as well as other alcohols, rum from molasses contains butyl alcohol, while spirit from potatoes contains amyl alcohol. In addition to these bodies a number of ethers may be present; thus acetic ether, which is a product of fermentation, is, under certain circumstances attending fermentation, occasionally present in considerable quantities. There is a very simple and easy method of detecting all such impurities, well known to practical men, which consists in pouring a little spirit upon the hands, allowing it to evaporate, and smelling the residue; or moistening blotting-paper, and examining it in the same way. The senses of smell and taste are exceedingly acute in most persons, and the facility with which minute traces of impurities may be detected is remarkable. I have examined large quantities of strong alcohol, and by a method more delicate than any other, and I believe it to be one of the purest commercial products. The worst specimens examined were those which were intended for drink. The method of examination depends upon the fact that those rays in the spectra of metals which lie beyond the most extreme of the visible region, and therefore are called the ultra-violet rays, are extremely sensitive to the absorptive power of certain organic substances. I have recently examined some kinds of spirit by this process, which consists in causing the rays emitted by an electric spark passed between two points of metal to traverse a vessel with sides of rock crystal containing the liquid, and afterwards to pass through a slit and a prism and lens of quartz, and receiving the rays on a photographic plate.

Compounds of carbon and hydrogen, or of those with oxygen, may be divided into two classes—those which exert an absorptive action at one end of the spectrum only, and those which exert a selective absorption, in which rays are selected from the centre of the spectrum. Bodies of the latter kind give rise to what are called "absorption bands."

Bodies of the constitution or chemical structure of the alcohols and sugars increase in absorptive power with the number of carbon atoms in the molecule, or, in other words, in the case of alcohols with rise in boiling point, while bodies of the nature of benzene, and others of the aromatic series, have a greatly increased absorptive power dependent upon the imtimate linking of the carbon atoms, as it has been expressed, or as I would prefer to say, by the greater condensation of the carbon in the compound. Accordingly, the spectra do not show variations with the number of carbon atoms, or increase in the boiling point, and, furthermore, the absorption is not general but selective.

Some colourless bodies which display such selective absorption are the examples of benzene derivatives given on the next page.

In the preparation of alcoholic beverages, we may add essential oils or aromatic substances to pure spirit, and distil, and this is the manner in which gin is prepared; but in making whiskey, especially by the old process, certain details must be attended to, beginning with the preparation and drying of the malt, and in turn the fermentation and distillation. Of course there may be, and doubtless are, persons who consider anything which can be sold for whiskey as whiskey, but truly there are only two liquids to which this name strictly belongs. Beverages sold by the name, however, may be made in the following six different ways :—

1st. Prepared by flavouring a potato spirit not defuselised.

2nd. Prepared by flavouring a silent spirit.

3rd. Prepared by flavouring a purified corn spirit.

4th. Prepared by distilling malted grain other than barley; such a liquid is potheen, which is prepared from wheat.

5th. Prepared by the distillation of a mash of barley, or of barley and oats mixed with malt dried over a fire of coke or anthracite.

6th. Prepared by distilling a wash prepared entirely from barley malt dried over a fire of peat.

Silent spirit is alcohol of such purity that it does not betray its origin, whatever that may be.

Irish whiskey is generally of the character of No. 5, while Scotch whiskey belongs to No. 6. Such varieties of spirit are distilled in pot stills, and are fit to drink only after keeping for two years and a half. Other liquids sold under the name of Scotch and Irish whiskies may be anything, from diluted and flavoured potato spirit containing fusel oil to a good corn spirit made from a mixture of barley and maize with malt, which is blended with a malt whiskey of strong flavour. I once had a specimen placed before me, which it is my conviction was nothing more than potato spirit flavoured with wood creosote.

The difference between malt dried with peat and with anthracite is, that while the former yields up in the smoke the volatile aromatic substances which occur in the vegetation growing on or in the peat, as well as such as are produced by incomplete combustion, otherwise dry distillation, the malt dried with anthracite is free from such substances. This may be considered by some as a disadvantage, since the only aromatic bodies present are those contained in the malt, which are really very small in amount, but such whisky has a mild flavour which is much appreciated. When plants containing aromatic bodies are present in the turf, those which are very stable substances are volatilised by the heat, and condensed upon the malted grain; during the process of fermentation, they become dissolved in the alcohol, and are distilled off therewith, and the liquid afterwards keeps them in solution. Sometimes they become converted into ethers, and their etherification is in progress for some considerable period of time during the maturity of whiskey.

I have examined several samples of Highland malt whiskey, with the object of detecting the presence of aromatic substances. The following example illustrates the mode of examination. About 300 cubic centimetres were fractionally distilled. The boiling points

Examples of Benzene Derivatives, otherwise called Aromatic Substances.

Name.	Composition.	Source.
Benzene	C_6H_6	Coal-tar, benzoic acid.
Cymene	$C_6H_4 \begin{cases} CH_3 \\ C_3H_7 \end{cases}$	Oils of Roman cumin, lemon, thyme, and nutmeg.
Benzoic Aldehyde	C_6H_5 COH	Oil of bitter almonds.
Cinnamic Aldehyde	$C_6H_5 \begin{cases} C_2H_2 \\ COH \end{cases}$	Oils of cinnamon and cassia.
Salicylic Aldehyde	$C_6H_4 \begin{cases} OH \\ COH \end{cases}$	Oil of meadow sweet.
Vanillin	$C_6H_3 \begin{cases} OCH_3 \\ OH \\ COH \end{cases}$	Vanilla pod and sugar-cane.
Anethol	$C_6H_4 \begin{cases} OCH_3 \\ C_3H_5 \end{cases}$	Oils of aniseed and fennel.
Thymol	$C_6H_3 \begin{cases} CH_3 \\ C_3H_7 \\ OH \end{cases}$	Oil of thyme.
Eugenol	$C_6H_3 \begin{cases} OCH_3 \\ C_3H_5 \\ OH \end{cases}$	Oils of bay, cloves, and pimento.

of the several fractions are here given; they each measured about 38 cubic centimetres, and were eight in number:—

	Boiling Point.	
1st fraction	78°	The boiling point was constant. These fractions consisted almost of pure ethyl alcohol, a little ethyl-acetate was noticed in the first two. No. 3 possessed a slight odour of butyl alcohol; but No. 4 had no distinctive odour or flavour
2nd ,,	78°	
3rd ,,	78°	
4th ,,	78°	
5th ,,	78° to 80°	Amylic compounds were recognised in both of these fractions. In No. 6 some aromatic body was present.
6th ,,	80° to 95°	
7th ,,	95° to 99°	These were practically the same, and contained large amounts of water. An aromatic substance was present in No. 7.
8th ,,	99°	

The 6th fraction had an odour suggesting the presence of some aromatic substance, its boiling point is 80° to 95°. When submitted to the action of the ultra-violet rays, a series of photographs were taken after the rays had passed through various thicknesses of liquid, ranging from 5 millimètres to 1 millimètre. Distinct evidence of the presence of an aromatic body was obtained, the spectrum yielded being one characteristic of such substances.

The spectra were four inches in length, and the rays extended from the blue to the extreme of the ultra-violet region. The linear measurements of the prism spectra were reduced to measurements of the wave-lengths of the transmitted and absorbed rays.

Fraction No, 7, boiling point 95° to 97°, was submitted to a similar examination.

I hope at some future period to be able to give some further information concerning the aromatic substances to be found in whiskey.

I cannot conclude this course of lectures without thanking my hearers for the very close attention with which you have listened

FRACTION NO. 6, BOILING POINT 80° TO 95° C.

Thickness of layer of liquid.	Description of spectrum.	Measurements in hundredths of an inch.	Wave-lengths in tenth-metres.
5 mm.	Spectrum continuous to........	87	3530
4 mm.	,, ,, ...	87	3580
3 mm.	,, ,, ...	95	3456
2 mm.	,, ,, ...	96·7	3447
1 mm.	Continuous, strong, to	99	2420
	Absorption band from	99 to 164	2420 to 2949
	Rays transmitted:—		
	Strong spectrum	164 to 182·5	2949 to 2849
	Continuous, faint, to........	192	2801
	Spectrum ends at	192	2801

FRACTION NO. 7, BOILING POINT 95° TO 97° C.

Thickness of layer of liquid.	Description of spectrum.	Measurements in hundredths of an inch.	Wave-lengths in tenth-metres.
5 mm.	Spectrum continuous to........	115	3283
4 mm.	,, ,, ...	117	3268
3 mm.	,, ,, ...	119	3260
2 mm.	Spectrum continuous to........	119	3260
	Absorption band from	119 to 157	326·0 to 2995·5
	Rays transmitted	157 to 211·5	2995·5 to 2709·5
	Spectrum ends at	211·5	2709·5

me. In describing the scientific principles involved in carrying out the operations of the brewery and distillery, I have given you the latest information, obtained from various sources; I have drawn inferences therefrom, and thrown out suggestions which I hope may prove useful. Those whose business renders it necessary that they should have a practical knowledge of the processes described will, I trust, pardon all shortcomings, since the subject is one which is hardly capable of satisfactory treatment in a course of lectures so few in number. It is not without reason that scientific men are sometimes considered to be too dogmatic; but as I hold in the highest respect all practical knowledge, knowing how long it has successfully dealt with operations carried out on a large scale, how laboriously it has been acquired, being the accumulated outcome of years of continuous work, I trust that I have not created the impression of imparting knowledge in a dogmatic spirit. I am of opinion that practical knowledge should be guided by theory, but that while both go hand in hand, the latter should be subservient to the former. It should be borne in mind that a scientific reason can be given for every detail in every operation. Those who carry out large operations, and are not acquainted with the scientific laws which govern these details, have but an imperfect knowledge of their business, and are powerless to control the results in certain emergencies. Having had some experience in superintending extensive operations, I am in a position to appreciate how frequently the conditions of an experiment involving chemical change are modified when dealing with large masses of material, and how operations easy of performance in a small way, become expensive and cumbrous, if not altogether impracticable, on a large scale.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON HOUSE DRAINS AND DRAINAGE APPLIANCES. BY W. K. BURTON.

The portion of the Exhibition which has been allotted to the demonstration of the various kinds of drains and drainage appliances, and of the manner of fixing and using these, is one which is out of the beaten track of the casual visitor. Moreover, the general aspect of the appliances is, perhaps, not particularly inviting, and for these reasons one sees but few people walking through the South Annexe, except such as take more or less technical interest in the exhibits.

There is, however, much which should be instructive even to the casual visitor, as the various appliances tend to show in what direction the improvements in the means of draining houses are tending. A few words on the subject may not be out of place before we enter particularly into description of some of the exhibits.

When improvement in house drainage work first came to be seriously considered some thirty or forty years ago, the tendency which showed itself was one towards a reduction in the size of drains. This was quite contrary to former practice, when nothing was so commendable in a house drain as that it should be so large that a man could walk upright in it. For such elongated cesspools as these drains were, there were substituted pipe drains of sizes from twelve inches diameter downwards. An attempt was generally also made to secure a sharper fall than had been given to the old brick culverts. Still there was much left to be desired. Pipes were better than brick drains, but not very much better in many cases, where the laying of them, not only as regarded workmanship but direction and fall, was left to the sweet will of the particular workman employed. Probably in not one case in a hundred was the direction of the drains considered as part of the design of the house, but after the foundations were in, the pipes were laid in whatever was considered the best position by the particular workman who laid them. This latter generally chose to lay them *under* the house, and had a knack of making them wind and curve about in a truly marvellous manner. No record was kept of where they had been laid, and if, after some years, there was a suspicion of "something wrong with the drains," there was no means of telling where to get at them, nor even if the knowledge could be obtained, any means of doing so without considerable damage to the house.

The tendency of modern house sanitation is the very reverse of this. It may be summed up in a very few words. The object attempted to be attained, in these days, is the laying of all pipes in straight lines between manholes, so that every foot of pipe which has been laid may be examined by simply lifting one or more iron covers.

We see, in the section of the Exhibition referred to, two excellent examples of the means which are used to secure this state of affairs. Two exhibitors have built manholes of the kind mentioned. Those manholes—of which it will be understood there is one at each end of every straight length of pipe drain—have the drains running along their floors in the form of channels constructed of half pipes. By holding a small mirror at a certain angle in the channel, it is easy to see right through the pipe as one sees through a gun barrel, and to judge of its condition. It will be seen that wherever the drain takes a bend, or wherever there is one pipe junctioning into another, there must be such a manhole. This would appear to involve a great number of these, and it may surprise some to know that most houses of the nature of those in the best streets in London, may be drained as described with three or even only two manholes.

The manhole next the sewer has always a trap in it to keep the sewer-gas back, and is generally termed a disconnecting chamber.

Messrs. Houghton and Co., of 21, Sloane-terrace, show a disconnecting chamber with Field's trap, Angell's cover (which is hinged, and shuts down air-tight with a key), and a channel pipe of the nature made by Baily and Co., the Pottery, Fulham, who have themselves an exhibit of channel pipes of all shapes.

Mr. H. King, of Clarence-place, High-street, Kensington, shows a disconnecting chamber which differs from the last mentioned only in the fact that the trap used is Buchan's, and the cover Botting's. This cover has neither hinges nor key, but makes a joint by means of a rubber ring fitted into a groove in the cover, which is made somewhat heavy. The ring is pressed by the weight of the cover on to a sharp ridge running round the inside of the frame.

Mr. W. P. Buchan deserves somewhat more than a passing notice, as, if I am not mistaken, he was the first to suggest the method of through ventilation to be afterwards described, which is now universally adopted, and who invented the trap which bears his name and which is designed to secure this through ventilation. Mr. Buchan has received the sincere flattery of many who have imitated his trap with great exactness.

Passing on to the question of drains themselves, the most interesting thing to be noticed is the various ways of making the joints which must of necessity be used to connect one pipe with another.

It is almost unnecessary to say here that the material most used in the manufacture of pipe drains at the present day is stoneware or fire clay. The pipes are, as a rule, two feet long, and in ordinary work the joints are made with either clay, mortar, or Portland cement. Of the first two materials I may at once say that they are not suitable. A perfectly sound joint can be made with Portland cement, but there is the drawback that considerable skill is required to make it, and that when made it will not yield in the very least, so that the smallest settlement in the ground results in the breaking of one or more pipes.

Various methods of jointing have been invented to overcome these difficulties, the one which has had the greatest popularity, and so far as I can judge, has deserved the most, being that known as Stanford's patent. Samples of pipes with Stanford's patent joint are exhibited by Mr. Henry Ough, 16, Austin-friars, E.C.

The pipes used are the ordinary socket pipes, but in the socket there is a ring of a black pitchy composition, whilst on the other end of the pipes there is a ring on the outside. Both these rings are turned accurately to fit each other, each forming a portion of a sphere, the result being in fact a ball and socket joint of a kind. To fit the pipes, it is only necessary to moisten the collars with oil, tallow, or a mixture of resin and tallow, and to gently work one into another. The nature of the joint allows of a little play, without any breakage; but perhaps the greatest advantage of the arrangement is that when it is used there is no possibility of there occurring the defect which so often is discovered when pipes are jointed with cement, and which consists in a piece of this material sticking up into the inside of the pipe, and forming the means of causing a stoppage.

Although, as I have said, stoneware pipes are still the most generally used for house drains, there is at present a growing tendency to substitute cast-iron for stoneware in those cases where it is unavoidable to bring the drains under the house. The iron pipes are in longer lengths than the stoneware the joints can be made more securely water and gas-tight by caulking them with lead, and there is less chance of breakage through any settlement of ground.

The North British Plumbing Company, 4, Upper Baker-street, N.W., exhibit a set of specially heavy cast-iron pipes, prepared for draining purposes. These include all necessary connections, traps, &c., and all are coated with a composition which prevents the possibility of their rusting.

Before leaving the subject of drains, I must mention two exhibits showing methods of testing, to discover whether a really sound piece of work has been made or not.

Messrs. Watts & Co., of Broad Weir Works, Bristol, exhibit the "Asphyxiator," a revolving fan arrangement which may be used to pump volumes of smoke into drains; any leakage will, of course, be detected by the smoke issuing from it.

Mr. Charles Hawksley, of 30, Great George-street, S.W., shows an arrangement which, if far more complicated than that for the smoke test, is also far more searching. By means of a small hand air-pump, air is forced into the drain, which has to be previously stopped at all untrapped openings. A glass U tube, filled with water, and fixed at each end of the drain, serves to show whether any pressure in the drain is secured by the pumping, and if it is, whether it falls or not by leakage when pumping has ceased.

Having said so much on the drains themselves, I must at least make passing remark on the methods used in these days to ventilate such drains. The acme of ventilation would be gained could we have a brisk current of fresh air through every foot of drain-pipe which was laid. We may be unable to secure quite this, as short branches must often be left unventilated; but in a good modern system of drainage, there will be movement of air through all but very small portions of the drains.

This is usually managed in the following manner:—The disconnecting chamber, already described, is left open to the air either by fixing a grating over it, or by carrying from some more convenient point in the open air, to the disconnecting chamber a large pipe. From the upper end of the drain, or of each of several branches of it, there is carried a pipe to a point clear of the house. This pipe is usually four inches diameter, and often forms the soil-pipe. The wind blowing across this pipe tends to cause air to flow up it, and, consequently, air is drawn in at the ventilator of the disconnecting chamber, which ventilator is, therefore, usually termed the air inlet. The most perfect ventilation is gained by leaving the air inlet quite open by having a grating as mentioned; as, however, there can be no certainty that there will not be occasional reversals of the current, the air issuing in such cases from the inlet, this arrangement is objectionable where the opening must of necessity be placed in a very confined situation near windows, as for example, in one of the narrow front areas so common in London houses.

In such cases, it is the practice of at least some sanitary engineers to affix to the air inlet what is termed a mica flap or valve, which is simply a light sheet of mica, so hinged that it will open to incoming air, but will close against issuing air.

Both the disconnecting chambers exhibited are fitted with mica flaps made by Mr. Francis Botting, of 6, Baker-street, and as this particular make differs from others, and has, in my opinion, some advantage over them, I shall give a brief description of it.

In most mica flaps, the position of the mica is such that when there is *no* air current, the flap is completely closed. The consequence is that some force is necessary to open it and to keep it open, and thus the air current is greatly impeded. In Mr. Botting's valve the mica is so hung that it is normally *open*, some slight force being required to *close* it. As a consequence, no opposition is offered to the incoming air.

The modern method of disconnection of baths, sinks, basins, &c., from house drains, is now so well known, that it requires mention only here. The custom is to cause all such appliances to discharge through syphon traps over gullies in the open air. The only point requiring explanation is the necessity for a trap or a pipe which is to discharge into the open air, as, at first sight, it would appear that complete disconnection is secured without it. Certainly a complete immunity from sewer or drain gas is secured, but something more than this is necessary. It has to be borne in mind that the discharge pipe, even from a bath or washhand basin, and far more from a sink, becomes more or less foul. Any air blowing through it into the house will, therefore, have a disagreeable smell, and the use of the syphon trap is to prevent the possibility of such air blowing in.

There are numerous exhibits of gullies suitable for receiving the discharge of waste pipes. I may mention as particularly deserving notice one by Messrs. R. Houghton and Co., which is fitted with a movable top piece, with branches for receiving the discharge pipes, and another by Messrs. Broad and Co., which is very well shaped, and has an arrangement for gaining access to the drains.

Mr. King's exhibit, already mentioned, shows very clearly not only the disconnecting chamber, but the whole arrangement of ventilation, disconnection of discharge pipes, &c., already mentioned.

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*REPORT OF SCREW GAUGE COMMITTEE OF THE BRITISH ASSOCIATION.**

1. Since the presentation of its first report on a gauge for small screws at the meeting of the Association held in 1882 at Southampton, this Committee has further examined into the recommendations there made, with the result that they have now to propose some important modifications, the general effect of which will, it is felt, be to materially facilitate the introduction of the system.

2. The want of unanimity on the part of the Committee, referred to in Paragraph 7 of that Report, arose mainly on the question as to whether the inch or millimetre should be taken as a unit of measurement. It is evident that if either is rigidly adhered to, and in any way employed in the nomenclature of the screws, as, for example, in specifying the diameter, pitch, or threads per inch or per mm., the same dimensions could not be expressed in whole numbers in the other unit, and thus a material obstacle would be at once introduced to its adoption.

3. It should be pointed out, however, that it has hitherto been the common practice to designate such small screws as the Committee alone is considering, not by any specific dimension, but by a number, which, as a rule, is arbitrarily chosen, and does not of itself form a guide to the size of the screw. Considering then, that the unit of measurement is only indirectly connected with the subject of a screw gauge, the Committee has felt that the two units might be reconciled so far as relates to such a subject, and that thus one important difficulty would be removed.

4. The manner in which the series of screws adopted lately by Swiss manufacturers is correlated has been sufficiently explained in the previous report, and very full explanations are given in the two

* Second Report of the Committee, consisting of Sir Joseph Whitworth, Sir William Thomson, Sir Frederick Bramwell, Mr. A. Stroh, Mr. Beck, Mr. W. H. Preece, Mr. E. Crompton, Mr. E. Rigg (Secretary), Mr. A. Le Neve Foster, Mr. Latimer Clark, Mr. H. Trueman Wood, and Mr. Buckney, appointed for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes. (For First Report, see *Journal*, vol. 32, p. 115.)

original pamphlets to which reference is there made.* The diameter (D) is related to the pitch (P) by the formula $D = 6 P^{\frac{6}{5}}$, (1) all measurements being in millimetres, and P having successively the values 1 (or $0{\cdot}9^0$) mm.; $0{\cdot}9^1$ mm.; $0{\cdot}9^2$ mm.; $0{\cdot}9^3$ mm. . . . $0{\cdot}9^n$ mm.

Thus n, the index, becomes a convenient designating number for the screw, and the formula (1) may be expressed $D = 6 (0{\cdot}9^n)^{\frac{6}{5}}$, where $P = 0{\cdot}9^n$.

5. The pitch of any screw can be at once ascertained from its designating number by raising 0·9 to the power indicated by that number; and from this pitch the diameter is directly deducible by the formula (1), so that the number (n) given in the first column of the table, by which a screw is known, is intimately related to its dimensions.

PROPOSED SMALL SCREW GAUGE.

Number.	Nominal Dimensions in Thousandths of an inch.			Absolute Dimensions in Millimetres.	
	Diameter.	Pitch.	Threads per inch.	Diameter.	Pitch.
I.	II.	III.	IV.	V.	VI.
25	10	2·8	353	0·25	0·072
24	11	3·1	317	0·29	0·080
23	13	3·5	285	0·33	0·089
22	15	3·9	259	0·37	0·098
21	17	4·3	231	0·42	0·11
20	19	4·7	212	0·48	0·12
19	21	5·5	181	0·54	0·14
18	24	5·9	169	0·62	0·15
17	27	6·7	149	0·70	0·17
16	31	7·5	134	0·79	0·19
15	35	8·3	121	0·90	0·21
14	39	9·1	110	1·0	0·23
13	44	9·8	101	1·2	0·25
12	51	11·0	90·7	1·3	0·28
11	59	12·2	81·9	1·5	0·31
10	67	13·8	72·6	1·7	0·35
9	75	15·4	65·1	1·9	0·39
8	86	16·9	59·1	2·2	0·43
7	98	18·9	52·9	2·5	0·48
6	110	20·9	47·9	2·8	0·53
5	126	23·2	43·0	3·2	0·59
4	142	26·0	38·5	3·6	0·66
3	161	28·7	34·8	4·1	0·73
2	185	31·9	31·4	4·7	0·81
1	209	35·4	28·2	5·3	0·90
0	236	39·4	25·4	6·0	1·00

6. It is evident that, by takingthe exact successive powers of 0·9 for the pitch, complex numbers would soon be arrived at. Such dimensions would, however, involve a degree of accuracy which is hardly attainable in practice, and it may be shown that, with two significant figures employed throughout to express the pitch, the degree of accuracy likely to be attained in screws of the kind under consideration is reached. Relying on this fact, the series of pitches given in Column VI.* is arrived at for screws ranging from ·236-in. to the smallest in use, 0·01-in. in diameter, in place of the mathematically exact series obtained by raising 0·9 to successively higher powers.† And this is the series which the Committee recommends for adoption.

7. Viewing the numbers thus obtained in the first place merely as a graduated series of pitches, and ignoring the unit of measurement, it may be admitted that the series of powers of 0·9 from which they are deduced is perhaps as good a one as can be suggested for the purpose, and it is found to very closely correspond with experience. Thus Column VI., which gives the nearest approximation to this series that is practically required, is well adapted for such a system of screws. It is to be observed that in selecting a series of pitches there are three simple alternatives to choose from: (1) to have a constant arithmetical difference between successive pitches, in which case either the pitches of small screws would differ by too great an amount, or those of the larger screws by too small an amount; or (2) to divide the entire range into sets, in each of which the differences are constant. The third alternative is to take successive powers of some other simple fraction, for example 0·8, but such a series would not so well correspond with the screws most generally employed.

8. Accepting this series, it may, however, be urged that it should be based on some aliquot part of an inch rather than on the millimetre. But any advantages to be gained by such a modification are inappreciable. For an examination of the numbers at once shows that they are, for the most part, awkward fractions of a millimetre, and the metric system of measurement thus enjoys no advantage in this respect over that based on the inch. From the point of view of interchangeability, however, of screws to be manufactured in this country and on the Continent, it is essential that the same basis of measurement of the pitch be everywhere adopted; because, having agreed upon only two significant figures on one basis, terminable decimals are obtained, but such terminable decimals could not be accurately expressed by two significant figures on the other basis of measurement.

9. Again, it is to be remembered that the use of metric measurement to designate the pitch need not inconvenience English manufacturers who are desirous of cutting the screws in their lathes. For, as has recently been pointed out by Mr. Bosanquet,‡

* *Systématique des vis Horlogères*, by Prof. M. Thury, Geneva, 1878. *Notice sur le Système des vis de la Filière Suisse*, Geneva, 1880, by the same author.

* It may be incidentally pointed out here that this series comprises two screws, with pitches of 1 mm. and 0·25 mm., which would be serviceable for micrometers.

† Sir Joseph Whitworth's gauge, in general use, ends at ¼-in., where this commences.

‡ *Phil. Mag.* (Fifth Series), vol. xv., pp. 217, 438.

it is easy to cut a thread whose pitch differs from one millimetre by an amount which may for all ordinary purposes be neglected ($\frac{1}{55300}$th), with a guide-screw based on the inch by the addition of a wheel of 127 teeth, and thus the series here recommended could, on the rare occasions that it became necessary, be originated on any screw-cutting lathe provided with the requisite wheels. But the Committee do not consider it needful to specially contemplate facility in the originating of the threads, as the screws under consideration are made in a plate or by the aid of dies; and manufacturers on a large scale would be provided with a special lathe for the purpose.

10. Whether the inch or millimetre is adopted as a unit of measurement, the series of pitches for these small screws becomes an ideal rarely attained in practice, for with screws tapped in a plate, or even with dies, the exact pitch aimed at will often not be attained; neither is it safe to assume that two screws, tapped in corresponding holes in different plates, will have precisely the same number of threads per inch. This is especially the case with the smaller screws, as may be proved by accurately measuring the pitches of several tapped in holes that are nominally alike.

11. The fact here stated affords a reason against extending the practice of designating screws by their number of threads per inch, already sometimes resorted to in the case of large screws, to the screws now under discussion. It is found that screws, nominally alike, frequently differ in this respect by as much as five or even ten threads in the inch, nor need this occasion surprise when it is remembered that the screw-plates employed must expand to varying extents in the hardening, that the hole is often not more than three or four threads deep, and that the pressure applied by hand must vary considerably. Such a nomenclature would thus involve the use of inconveniently high numbers to express a minute degree of accuracy but seldom attained, while they convey but little real information, since mere examination would not enable any one to distinguish between, say, a screw of 169 and 181 threads per inch.

12. The series of diameters must next be considered. Before the formula $D = 6\,P^{\frac{6}{5}}$ was adopted, it was ascertained by the minute examination of about 140 small screws that the series very closely corresponds with those recognised as good in the trade, and the screws made in the new plates, known as *Filières Suisses*, which the Committee have had an opportunity of examining, appear to them to be well proportioned in this respect. The series of diameters, like the pitches, are expressed by two significant figures in each case, as the values for D deduced from the formula (1) are necessarily indeterminate in most cases. These diameter are given in millimetres in Column V., and their nearest equivalent in thousandths of an inch in Column II. As the Committee considers that these screws are well-proportioned as regards pitch and diameter, and approves the formula (1) being taken as a basis, it is led to recommend this series of diameters being adopted in conjunction with the pitches already discussed. It has been suggested to the Committee that the introduction of such a system into general use in this country might be facilitated by punching against each hole in the screw-plate, side by side with the designating number, as given in Column I., the approximate diameter of the screw made in it, as expressed in thousandths of an inch (Column II.), as these numbers would convey a meaning to English workmen more definite that the numbers in Column I. or V. The Committee sees no serious objection to such a course; but it should be remembered that screws have hitherto always been recognised by a number seldom higher than twenty-five, and it may be questioned whether any substantial advantage is gained by substituting such high figures as are involved in the expression of the diameters.

13. It will be seen that the series here recommended gives twenty-six screws for the range from $\frac{1}{4}$-inch to the smallest in use. Comparing this number with those of two of the best systems commonly met with —namely, the Latard (Perrelet et Martin) and Bourgeaux plates, we find that—

For a range of 21 sizes of watch screws on the Latard plate, this gives 15
For a range of 23 sizes of watch screws on the Bourgeaux plate, this gives 17
For a range of 36 sizes of clock screws on the Latard plate, this gives 23

The entire series is thus less than that of well-established plates, and cannot, therefore, be considered greater than the requirements of practice demand; while the fact that the watchmakers (who probably require the most extensive assortment of screws) in Switzerland have accepted it, confirms the Committee in its opinion that the series is not deficient in this respect.

14. It remains to consider the form of thread. There are so many practical points to be taken into consideration in discussing such a question that it becomes specially useless to rely much on theory for guidance, and the divergence observable among the forms adopted by different manufacturers is thus very great.

The most important points to be borne in mind in its selection are—

(1) The threads must be easily cut with the class of screw-cutting tackle ordinarily met with in workshops.

(2) The strength of the threads on the male and female screws must be so correlated that the liability of either to strip is a minimum.

(3) The resistance of the core to torsional stress when force is applied in rotating the screw must be a maximum.

(4) The friction should be as small as possible, in order to reduce wear.

15. In regard to the first of the above conditions, it is to be observed that very many of the screws considered by the Committee are usually made by

means of a plate in which are round tapped holes. Such a hole forms a thread by causing the metal to "flow" from a space towards a thread, and its action is obviously of quite a different character from the cutting action of dies or of a chasing tool. In the case of plates with notched holes the cutting and squeezing actions are combined.

16. As bearing on the second condition, it is evident that, as the strength of the threads depends so essentially on the materials of which the screw and nut are made, and these are very varied, no precise and invariable rule is attainable. If strength were the only point to be considered, a purely triangular form without any rounding would be the best, contact being assumed to take place over the entire surface. But in practice it is impossible to secure such perfect contact, and it becomes needful to round off the crests from all the threads; and this rounding is the more necessary as the screws are smaller, and irregularities in the manufacture becomes relatively more marked. This modification is also necessary in view of condition (1) already considered.

17. The third point—namely, the resistance of the core to torsional stress—is determined primarily by the depth of thread. If the sectional area of the ring cut away is less than that of the core, the probability of the latter breaking across may be regarded as approximately equal to that of the threads stripping; but it is impossible to maintain a constant ratio, as such a condition would require the thread to be so fine, in the case of small screws, that there would be no sufficient hold in the nut. Thus in the very smallest screws (those below ·030 in. in diameter) the ratio $\frac{\text{area of core}}{\text{sectional area of thread}}$ is less than 1, and it gradually increases till a proportion of between 2 and 3 is attained.

18. Condition (4) is evidently best satisfied by a square thread. Such a form is, however, impracticable in the case of the small screws under consideration, but it is obviously approximated to according as the angle of a triangular thread is made less and the rounding greater.

19. The angles that have been adopted in practice show, as might be expected, considerable variation. On the one hand an angle of 60° is rarely exceeded, the thread being thus derived from the equilateral triangle, and, on the other hand, 45° may be taken as the lower limit.

20. The depth of a thread is evidently a function both of its angle and of the amount of rounding at the top and bottom. It may conveniently be expressed as a fraction of the pitch (taken as unity). In the case of the small screws in general use the mean value of the depth thus expressed is found to be 0·563, the maximum being 0·771, and the minimum 0·311. It is evident that any increase in the depth beyond what is essential will materially and needlessly increase the difficulty of manufacture when a screw-plate is used; at the same time the depth must not be too much reduced, on account of the greater tendency of the thread to strip. It is further important that the additional torsion involved in cutting a deep thread, which materially increases the risk of tearing the metal across, should not be lost sight of.

21. The Committee, after comparing together a large number of different forms of thread, some of which are in actual use, while others have only been suggested, were much tempted to recommend the Whitworth thread for adoption by the British Association, because it is so well known in this country, and experience has proved indisputably that it is excellent when employed for engineers' bolts, &c. But, as appears from sections 16 and 18, in the case of small screws the tendency should rather be to increase the rounding on account of the difficulties of manufacture, and the depth of the Whitworth thread is 0·64 of the pitch, which is considerably in excess of 0·563, the average adopted in practice. The Whitworth thread is, moreover, characterised by a greater angle than is usual in small screws.

22. The advisability of modifying the form of thread of small screws, as compared with those of greater diameter, is fully recognised by the Swiss Committee, their thread for the former having an angle of 47½°, while that for the latter is 53°, nearly the same as that of the Whitworth thread. In the case of small screws made in the *Filière Suisse* the crest of each thread is rounded off with a radius equal to $\frac{1}{6}$th the pitch, and the hollow with $\frac{1}{5}$th the pitch. The actual depth is 0·60 the pitch, somewhat less than in the Whitworth thread.

23. While approving the general form of thread here described, this Committee could not but feel that the difference in the roundings ($\frac{1}{6}$th at top and $\frac{1}{5}$th at the bottom) was unnecessary. Looking, moreover, to the fact that very many of the screws of the sizes now under consideration are for electrical and telegraphic instruments, and, therefore, may be of brass, and that, with such dimensions, it is impossible for the eye to ascertain whether a given screw satisfies the required conditions in regard to such small differences between the crest and hollow of the thread, the Committee feels that an equal rounding ($\frac{2}{11}$ths of the pitch) at the top and bottom would be preferable. This would maintain the angle of thread and the depth the same—namely, 47½° and $\frac{3}{5}$ths of the pitch respectively.

24. Having now discussed the three main points that require to be considered in any system of screws—namely, the pitches, diameters, and form of thread, it seems desirable to enumerate briefly the recommendations at which the Committee has arrived. These are:—

(1) That the series of diameters for screws from $\frac{1}{100}$th inch to $\frac{1}{4}$th inch be that given in millimetres in Column V., the nearest thousandths of an inch being given in Column II.; these diameters being the series calculated by making P, in the formula $D = 6P^{\frac{6}{5}}$, have in succession the following values:—

1 (or $0{\cdot}9^9$) mm.; $0{\cdot}9^1$ mm.; $0{\cdot}9^2$ mm.; $0{\cdot}9^3$ mm.; . . . . . $0{\cdot}9^n$ mm.

Only two significant figures are taken to represent the diameters.

(2) That the pitches of these screws be the above gradually decreasing series, each pitch being $\frac{9}{10}$ths of its predecessor, but that only two significant figures be used in their expression. The series thus obtained is given in Column VI.

(3) That in view of the desirability of securing a system of small screws, international in its character, English manufacturers of screws, screw-plates, &c., adopt the exact pitches given in millimetres in Column VI., which, as we explained in par. 9, can, if required, be originated on an English lathe. Further, in view of the fact that small screws and screw-plates, while nominally alike, will not unfrequently differ considerably as regards their number of threads per inch, the practice of designating such screws by their number of threads per inch should not be adopted. For reference, however, the approximate number of threads per inch, as calculated from the pitch given in Column VI., are given in Column IV.

(4) That the designating numbers given in Column I., being the indices of the powers to which 0·9 is raised to obtain the pitch, be punched against each hole in the screw-plate, and that, if thought desirable, its diameter in thousandths of an inch (Column II.) might be punched side by side with this number.

25. In his *Systématique des vis Horlogères*, Prof. Thury has done for the small screws used by watch, clock, and scientific instrument makers what was done forty years ago by Sir J. Whitworth for the larger screws used by engineers; and, like the admirable system introduced by the latter, the scheme here advocated is based on the data obtained by measuring the several dimensions of many screws accepted by practical men as being well-proportioned.

26. The Committee has had an opportunity of examining both screws and screw-plates (for the smaller screws) made on this system, which it is convinced will satisfy all the demands of practice. The Committee can, therefore, confidently recommend its adoption by the British Association, subject to the slight modification discussed in par. 23; and it feels that an important incidental advantage would be the support it would at once receive on the Continent, and the consequent increased rapidity with which it might be expected to come into general use; for it cannot be doubted that its recognition by so important a body as the British Association would have considerable influence in establishing the system abroad.

[The recommendation for the appointment of this Committee having failed to reach the Committee of Recommendations at Southport in time to allow of its sanction by the General Committee, the Council at their meeting on November 6th, 1883, requested the Committee to continue their labours, and undertook to recommend to the General Committee at Montreal that this report be printed among the Reports.]

THE SUPERGA RAILWAY.

The new railway to the Superga from Turin, opened to the public a few months since, cannot fail to be regarded by all engineers with great interest. To the general public it has already proved a great attraction, and few visitors to the Exhibition leave Turin without having made a pilgrimage to the Superga by the "Ferrovia Funicolare."

The Church of the Superga was built in fulfilment of a vow made to the Virgin by the Duke Vittorio Amedeo II. of Savoy at the siege of Turin in 1706, and having gained the victory over the French its construction was decreed, and it was built from designs of the celebrated architect, Juvara. The crypts contain the tombs of the princes of the House of Savoy. The church is built on a hill about five miles to the east of Turin, at a height of 678 metres above the level of the sea.

The railway to the Superga cannot be regarded as a mere cable line, where the rope has to be of sufficient strength to haul the dead weight of the cars and their freights up hill, as is the case with the Vesuvius funicular railway, the Highgate steep gradient tramway (recently opened), or with the various wire rope railways that are being worked in America and elsewhere. This line, on the other hand, is the first practical application of a system invented by an Italian engineer, Signor Tommaso Agudio, by which the power of a fixed engine is transmitted to the mechanism of a driving car or "locomotore" by means of an endless steel rope running at a high speed, and in the present case five times as fast as the train. In this way a far lighter rope can be used than would be the case were the trains merely hauled up. The first experiments of this system were made by Signor Agudio as far back as 1863 and 1864, on the incline of Dusino on the line between Turin and Alexandria, and afterwards on the French side of the Mont Cenis near Lanslebourg in 1874 and 1875, and notwithstanding the favourable results obtained, no further application of the system was made until the present time. On the experimental line just mentioned, an incline of 38 to 100 (1 in 2·53) and 1,300 metres in length (over three-quarters of a mile) was successfully worked.

Finally, in March, 1883, a concession was granted by the Italian Government to the Municipality of Turin for the construction and working of a cable line, on the Agudio system, from the hamlet of Sassi at the foot of the hill to the Superga, together with a subvention of 900,000 Italian lire (£36,000), which concession was transferred to a limited liability company formed in Turin, who, in addition to the Government subvention of 900,000 lire, will receive from the city of Turin a further subsidy of 300,000 lire (£12,000), and, amongst other conditions, the Municipality, after a certain number of years, are to have a share in the receipts from the working of the line.

The principal feature in this system of railway is a steel wire rope, which is made endless by careful splicing, this rope being driven at a high speed by a stationary engine.

The endless rope in the present case passes from the Sassi terminus, situated at the foot of the hill, and about three miles by steam tramway from the Piazza Castello (which is the centre of the tramway system of Turin), and up the hill to the Superga station, where it passes over a large terminal pulley 4 metres in diameter (13 ft. 4 in.). At the lower or Sassi end the rope passes round the driving pulley fixed on the main shaft of the engine, suitable apparatus for its proper tension being provided, which will be described afterwards.

The lower portion of the loop of endless rope, which is driven in an upward direction by the engine, is supported in its passage up hill by a sufficient number of grooved pulleys fixed at about the level of the rails to keep it from touching the ground, and at a distance of 52 centimetres (21 ft.) outside the left-hand rail of the track; on curves guiding pulleys are used, and are placed horizontally, and instead of a groove, have a flange on their lower side; the bearings being constructed in such a way as to protect the axles from dust and rain.

The upper portion of the loop, or down line, is carried at a height of about 4 metres above the level of the rails by 35 grooved pulleys, of which 15, 2·30 millimetres in diameter (7 ft. 8 in.) are placed with vertical or slightly inclined axis, in order to guide the rope round curves, whilst the remaining 20, which are 1 metre (3 ft. 3 in.) in diameter, serve to support the rope on the straight parts of the line. As only the lower part of the loop of endless rope is used for driving the trams, the return, or upper part, no longer requires to be carried parallel to the line of rails, and the 35 supporting pulleys, which are securely carried on brick pillars, are placed where it has been found most convenient, sometimes on the right and sometimes on the left-hand side of the track.

The slack in the rope is taken up by a gravitation car to which the terminal pulley at the lower end of the line is fixed, the car being held back against the pull of the rope by a counter weight. The weight now used is 1,300 kilogrammes (26 cwt.) The length of ways upon which the car travels is about 15 metres, and whilst the rope is running it is in constant oscillation, moving irregularly through a space of about $1\frac{1}{2}$ metres (4 ft. 10 in.) The down hill or upper portion of the loop passes over this pulley, which is 4 metres in diameter (13 ft. 4 in.), and from thence, at the level of the ground, round another pulley of similar diameter fixed at about 20 yards further up the line than the driving pulley (which is placed in the middle), back over this, making two turns over these two pulleys before proceeding on its journey uphill, the object of the additional pulley being to prevent the slipping of the rope on the driving pulley, as would be the case were it in contact with only a small portion of the circumference, instead of being so with the whole. The second pulley is fixed upon a slide carriage, which, by means of screws, can be adjusted so as to take up any permanent lengthening of the rope. The driving pulley is also 4 metres (13 ft. 4 in.) in diameter, and has several grooves in case an extra turn of the rope should be found necessary.

The cable is 22 millimetres ($\frac{15}{16}$ in.) in diameter, composed of six strands each of eight wires of crucible steel, 2 millimetres ($\frac{1}{16}$ in.) diameter, wound round a hemp core. The breaking strain is given at 135 kilogrammes per square metre, or about $85\frac{3}{4}$ tons per square mile, but the actual strain upon the rope does not exceed 25 kilogrammes per square millimetre, or $15\frac{3}{4}$ tons per square mile. The weight of the rope is $1\frac{1}{3}$ kilogrammes per metre run (about 1 lb. per foot).

The stationary engine was constructed by Messrs Sulzer, of Winterthur, and is of 300 nominal horse-power. It consists of two horizontal cylinders, the valve gear being on a plan introduced by the firm, the engines can be worked with or without the condensor. Steam is supplied from four boilers of the Cornish type,

The terminus at Sassi being 223 metres above the level of the sea, whilst that of the Superga is 642 metres, the difference of level between the two extremities of the line is 419 metres, and its length being 3,150 metres (or about 2,000 metres less than the old carriage road), the mean gradient is 13·30 per 100 (1 in 7·51). The minimum gradient is 7 per 100 (1 in 14·30), whilst the maximum gradient is 20 in 100, or 1 in 5. The minimum radius of the curves is 300 metres.

The line is of the ordinary 4 ft. $8\frac{1}{3}$ in. guage, in order that the cars may be used on the steam tramway to Turin.

The rails are of the Vignoles type, weighing 18 kilogrammes per metre (36 lbs. per yard) and are fixed upon longitudnal sleepers, which are connected by cross sleepers of iron, to which is firmly bolted another longitudinal sleeper which carries a double rack with teeth placed vertically, into which the pinions of the driving car work.

In order to secure the permanent way from slipping, two piles, $1\frac{1}{2}$ metres in length, are driven on the lower side of each cross sleeper.

The width of the line at formation level is 4·20 metres (14 ft.), whilst that of the tunnels is 4·50 metres (15 ft.). The first tunnel is 67 metres in length, and situated at 783 metres from the lower terminus; whilst the second is 61 metres long, and at 1,799 metres from the same place.

The central rack is formed of a bar of steel 11 centimetres ($4\frac{3}{8}$ in.) in depth by 12 millimetres ($\frac{1}{2}$ in.) thick, bent in such a way as to form a double row of teeth, in which the pinions carried on the lower ends of the vertical shafts of the "locomotore" or driving - car, can work. This driving - car or "Locomotore Agudio," which is the most important feature in this system, consists of a metallic frame-work supported by four wheels which run on the rails, and which are completely independent of the mechanism of the "locomotore" which they carry.

The frame carries two horizontal axles; at the left hand end of each (looking up the line) are fixed a grooved pulley 2·30 metres in diameter (7 ft. 8 in.) The driving cable passing under the front pulley and over it to the hind one, and back underneath again, sets them in motion, transmitting its speed to them, which is converted into power by the mechanism. This hind axle carries near each end a bevel wheel, which can be thrown in and out of gear by a friction clutch. These wheels gear into other bevel wheels fixed at the uppermost end of two vertical shafts, one on each side of the central rack, and carry at their lower ends the pinions which gear into it.

It will be readily seen that whilst the rope is running, the driving pulleys on the horizontal shaft will transmit their motion by means of the bevel gearing to the pinions working in the rack, and that the speed of the car, as compared with that of the rope, will depend upon the ratio between the diameter of the driving pulley on the "locomotore," which is the receiver of motion, and the pinion, and which in the present case is as 5 to 1. The bevel wheels have 28 teeth, and the pinions 23.

The front axle, on the other hand, carries the two bevel wheels near the centre, so that when in gear with the horizontal ones on the vertical axles, a reversed motion is given to the car, whilst the cable is constantly running in the same direction. Thus the train can be stopped by throwing both sets of bevel wheels out of gear, driven uphill by throwing the hind bevel wheels into gear, reversed by throwing these out of gear and putting into gear the front pair. This is only used for backing the train at the stations and for starting it, as the downhill journey is accomplished by gravitation, when both sets of bevel gearing are disconnected, and the speed of the train is controlled by the brakes.

The right ends of the horizontal axles also carry pulleys over which a brake strap passes, the tightening up of which serves to check the speed going down hill, and for pulling up the train when going slowly. The most powerful brakes, however, are those which act upon the hind vertical axles, and consist of wooden blocks which, by means of suitable screw gearing, can be brought to bear upon a cylindrical projection cast upon the lower side of the horizontal bevel wheels. The blocks wear rapidly, but can be easily replaced. As a further precaution, a means of gripping the central longitudinal sleeper is provided, consisting of a pair of jaws which can be tightened up by a screw, and this takes a tight hold of the sleeper and effectually stops the train.

In going up hill, four pawls—a pair on each side of the central rack—are brought into play, and in the case of the breaking of the rope, would act as a ratchet and stop its running down hill.

The train at present is composed of two carriages, capable of containing 60 persons each; and the "locomotore," both for ascent and descent, is always on the down hill side of the train.

The carriages are not only provided with powerful brakes, which not only act upon the wheels, but also with a means of gripping the central sleeper, as is the case with the "locomotore."

Communication between the conductors of the train is constantly kept up with the driver of the stationary engine by a simple system of telegraphy, so that it is possible for those in charge of the train to give instructions to increase or slacken speed, or to stop the rope at any moment. Between Turin and Sassi the carriages of the Superga Railway are drawn by the locomotives of the Turin and Gassino Steam Tramway, which is laid on the provincial road, the railway being connected with it by means of a siding, and in this way passengers from Turin have not to change carriages.

The arrangement of the points and crossings is highly ingenious, a portion of the central sleeper with rack being lowered into a trench by means of cams, in order to allow the wheels of the carriage to pass from one line to the other.

The coutractors for the construction of the line were Messrs. Delvecchino and Perini, and great credit is given to Mr. E. Perini, the representative of the firm, for the manner in which he has worked out all the details, and overcome a host of difficulties which could not fail to have arisen in an undertaking of this nature.

The greater part of the material for the construction and working of this line was made in Italy, the Railway Plant Works of Savigliana supplying the central rack, metallic sleepers, girders for bridges, &c., the carriages and trucks. The two "locomotori" were made at the workshops of the Alta Italia Railway, with the exception of certain portions of special mechanism which were executed by the Royal Arsenal of Turin, and by Messrs. Enrico, engineers. The pullies, bearings, &c., were supplied by the foundry of Messrs. Colla.

The number of persons employed for working this line are 44, composed as follows:—1 engineer and traffic manager, 2 station masters, 2 ticket clerks, 2 guards, 2 brakesmen, 3 drivers, and 2 assistant drivers for "locomotori," 2 engineers, and 2 stokers for stationary engine, 1 oiler and linesman, 2 pointsmen, 1 head platelayer with 4 assistants, 1 ganger, and 10 labourers for maintenance of line.

No experiments have yet been made as to the cost of working, consumption of fuel, &c.

It is evident, however, that the Agudio system is especially adapted for very mountainous countries, where the gradients for a locomotive line would be too heavy, and where abundant water power might be availed of for motive power.

An official report states that during the month of May 13,880,000 kilo. (about 12,553 tons) of coal were imported from Germany into Italy by the St. Gothard line. This is the largest monthly export of coal from Germany to Italy that has yet occurred.

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Proceedings of the Society.

CANTOR LECTURES.

THE BUILDING OF TOWN HOUSES. THEIR ARRANGEMENT, ASPECT, DESIGN, AND GENERAL PLANNING.

By Robert W. Edis, F.S.A.

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Lecture I.—Delivered Monday, Feb. 18, 1884.

In accepting the invitation of the Council of this Society to give three of the Cantor Lectures of this season, and in choosing as my subject "The Building of Town Houses," it seemed to me that I might, from the experience gained during the past five and twenty years in my professional career as an architect, give some information and suggestions on the various points which should be specially observed and insisted upon in any building wherein sound construction, healthy arrangement, common-sense treatment of the rooms, and practical knowledge in their general fitting up, are all-important, where health, cleanliness, and comfort, and economy of service and labour are considered necessary. I use this phrase advisedly, for day by day, and year by year, I see in London, and other large towns, hosts of houses erected of the flimsiest construction, built with the most trashy materials, and finished without the slightest regard to the laws of health, comfort, or ordinary artistic character, externally or internally.

The speculative builders—and under this term I mean not only the host of small men who help to raise, fungus-like, the streets of flimsily-built cottages and fourth and fifth rate houses which disgrace our suburbs, and form the houses of the bulk of our working classes, but also those larger capitalists who have carried out, in the last twenty years, the innumerable streets, squares, and terraces in our more fashionable quarters, and whose erections, certainly from an art point of view, are, to a large extent, equally to be condemned—have too long had their way without control of any kind, save that which is provided for under the Metropolitan Building and other local Acts, and which simply permit of the district surveyors insisting upon certain thicknesses of walls, but gives them no power to reject inferior materials, or to prevent the too often scamping and utterly unsound work, the utter disregard of all known sanitary laws, or the commonest precautions to insure health and comfort.

It is surely time that every house erected in the great centres of habitation should have some systematic supervision, so that ordinary precautions shall be insisted upon to secure proper sanitation, to prevent the use of grossly inferior materials, and to prevent these plague-spots being formed in our midst; for it must be borne in mind that every house built under the system I have condemned, not only tends to the individual discomfort of the special occupier, but adds materially to the unhealthiness of a neighbourhood.

Within the last few months, the Metropolitan Board of Works have recognised the necessity of seeing that all buildings of which the drawings are submitted for their approval are so supervised, and have a special officer whose duty it is to see that the specifications are properly carried out, and that sound and proper materials are used; but their supervision can only be extremely limited, as it only applies to buildings carried out on their own property.

In all towns there are, I am aware, certain local Acts which, to a limited extent, insist upon a minimum amount of cubical contents, and a minimum height in the various rooms, and require certain minimum superficial contents in the back areas—which often form the only ventilation and lighting spaces for all back rooms—and that some sort of sanitary arrangement shall be carried out, so far as drains, &c., are concerned, but these requirements are too often over-ridden by the cunning and rascality of the speculative builder. As I have written elsewhere, "the Metropolitan Building Act is practically useless for any real sanitary purpose; it leaves all questions of drainage, proper arrangement of sinks, cisterns, and supply and service pipes, ventilation and heating, lighting, and general protection from building on improper and damp foundations unrestricted." It takes no note of inside construction, as regards soundness and character of timber and joiners' work, or of the proper making up of plaster, or of the strength of lead pipes, the thickness of lead work on the roofs, and in no way troubles itself so long as the mere ordinary requirements as to thickness of walls, depth of fire-place openings and recesses, &c., are carried out.

In the building of new and the rebuilding of old houses, it is essential that proper regard shall be had to the rapid growth of the sanitary science, and not only to comply with, but "anticipate as far as possible, its many requirements, and especially those of them which will, I believe, in a few years be considered by the population at large as absolutely necessary for habitable dwellings, not only as regards the actual sanitary fittings and appliances of the houses themselves, but also as regards their actual construction from the foundation upwards, and also more especially as regards the light and air spaces with which they are surrounded." *

If Government cannot take up the matter, and provide for such competent inspectors as may be necessary, who shall certify that every new house erected is built of sound materials, is properly drained and ventilated, and in fact is a healthy habitation, surely it would answer the purpose of a private company to take up the question on a large scale, and for some moderate fee, if required, make a proper inspection of any building, and certify as to its general soundness, the general character of materials used, and its fitness for human occupation.

I believe that most common-sense people would be glad to pay a small fee for some such searching inspection and certificate, and I am quite certain that if the public were to decline taking any house that was not certified as properly built with sound and proper materials, and in which the ordinary known laws of sanitation were not well and sufficiently carried out, we should see a great deal less of the scamping class of buildings, which are now daily rising around us.

It has been my lot to inspect numerous houses of the so-called better class of speculative builders' houses. I have in many cases found the walls very badly built with inferior materials, porous bricks and wretched mortar externally covered over with Portland cement to hide their deficiencies, with masses of cement mouldings overlaying their general faces, stuck on to flimsy brick or stone cores; cast cement ballustrading, party walls honeycombed with flues roughly pargetted, as the internal lining of plaster is called, and in many cases the plugging for joiners' work of all kind driven in to within a few inches of the smoke flues, so as to render them absolutely dangerous from fire; the stone floors in basement showing unmistakeably the dampness of the subsoil, laid on a few inches of bad concrete, the fittings of most inferior character; the inside walls and ceilings covered with plaster of such thickness as to invite shrinkage and cracking; the timbering insufficient in strength, so as to cause the floors to shake with the mere walking across them; to say nothing of the trashiness of the so-called internal decoration, in the shape of plaster cornices and centre flowers, all put up to attract the ignorant into a belief that the rooms are well and expensively finished; the drains unventilated, and laid on made up ground, so that the joints soon become leaky and unsound; the cisterns placed in the darkest and most inaccessible places, so that it is almost impossible to get at them to clean them out; the various lead pipes buried in the plaster work of the walls, and carried here, there, and everywhere, without protection from frost or means of access for examination and repair; the floors showing wide gaping spaces between each board, owing to unseasoned wood being used, through which dust and filth collects between the ceiling and floor, impossible to clean out, and, I need scarcely say, engendering stuffiness and unhealthiness everywhere.

The unfortunate tenant sees the house carefully painted and papered, and, from want of knowledge, imagines that the house is everything he can wish, and only finds out, after he has signed an agreement or lease, the wretched whited sepulchre that he has taken, which if it be not indeed a means of bringing illness or death to any of his belongings, is a certain cause for continual expenditure in repairs and making good the defective work, which, in taking it, it never occurred to him he would have to pay, thus adding materially to his annual rent, as well as to the general discomfort of every one in the house.

Practically, there is no real supervision of a vast proportion of the houses we live in;

* Report by Rowland Plumbe, F.R.I.B.A., to the Artisans' Labourers' and General Dwellings Company.

perhaps one per cent. of the houses erected are designed and superintended by a competent architect, the other ninety-nine being left to the tender mercies of the speculative builder, who is controlled only in a very limited degree, in the great centres of population, by certain Acts which provide for main drainage, water, and gas supply. Moreover, even if a competent architect be employed, the Jack-in-office ignorance of some of the officials of local vestries, or estate agents, bind him with red tape, or fence him about with difficulties and requirements which act prejudiciously, not only to the individual lessee, but to the whole of the surrounding district. I have the misfortune at this moment to be dealing with one of these Jacks-in-office, who insists on a building being faced with materials which time and experience have shown to be utterly unsuited to the London atmosphere. I can only hope that within a few years a law will be passed, enforcing the ground landlord to enfranchise, on terms equitable alike to himself and the building owner, so as to prevent as far as possible any really unfair interference which is based on supreme ignorance or power of brief authority. In the case I name there is no remedy; the agreement provides for drawings to be approved by the landlord or his agent; the agent, a man of no architectural or building knowledge, declines to recognise the fact that he is receiving for his employer, as ground rent, nearly four times the amount of the rental hitherto paid as gross rental, and that the unfortunate building owner is spending many thousands of pounds which, unless the law is altered, will revert to his master or his heirs in some sixty or seventy years, and insists on a certain character of facing being carried out, utterly at variance with all the experience of past years, and opposed to all advance either of art or construction.

All such legal restraints on the part of property owners, or on the part of local vestries, which are based merely on caprice or ignorance, must, in the nature of things, be swept away; the common sense of the people, their necessities and requirements—based on higher knowledge and greater desire to have the individual homes put in order and arranged, so that each house may in itself form an integral portion of a well-arranged and sanitarily constructed whole, by which the community will be equally benefited—will, by-and-by, insist on a new order of things, so that the monopoly of sites in crowded towns shall not be vested in the hands of a few individuals, without the lessees having the right of the equitable redemption of the ground rentals, whereby at least the buildings on which they have spent enormous sums of money shall remain theirs for ever, by payment of such sums which may fairly be demanded for their enfranchisement.

The present system of leasehold tenure in England generally is as iniquitous as it is unjust, leading in many instances to inferior work, overcrowding, and general badness of building, and, by the narrowmindedness and ignorance of grasping agents, to the setting aside of all modern improvements in building and construction.

If our towns are to be reconstructed and added to on healthy and proper principles, each house must be properly constructed, and certain fixed rules insisted upon, as regards proper general health arrangement and sanitation; for "the same rule," to quote Dr. Richardson, "applies to accumulation of health as to the accumulation of wealth." "Take care of the pennies," says the financier, "the pounds will take care of themselves." "Take care of the houses," says the sanitarian, "the towns will take care of themselves." It follows, therefore, that so far as common-sense laws can be applied to the rebuilding of the houses of closely packed communities, they should be on some general and uniform system, so far as laws of health are concerned, which all must follow. But this only applies to sanitation; so far as general arrangement is concerned, the wants of the individual must necessarily be consulted; and so far as the artistic improvement of our towns is concerned, I am strongly of opinion that the greater the variety of designs, the greater will be the artistic character and general picturesqueness of our streets.

We do not want whole rows of houses which, in bad sham plaster decoration, shall imitate the feeble monotony of the Rue de Rivoli in Paris, or which shall, by the censorship of some body of specialists or local official, crowd our cities and towns with pseudo Italian palaces, or Gothic town-halls, as ill-suited to our climate as they are opposed to all true principles of common sense, construction, and design.

To sacrifice internal comfort, light, and ventilation to some special order of fenestration, Greek, Roman, or Italian, or to the cramped and narrow lines of a mediæval fortress, or building of bygone ages, seems to me to convey nothing but poverty of thought, or narrow-minded conventionalism, equally opposed to all true principles of architecture as it is to the wants and requirements of the people of the 19th century.

Comfort and convenience of arrangement, ample light and ventilation everywhere; protection from damp and miasma, impure and unhealthy smells; warmth, freedom from draught; pure air, pure water, general cleanliness, and attention to all laws of sanitation, are first of all to be considered in every house. The architect or artist can so fashion the external clothing of a good framework as to make it agreeable in its outline and general constructive decoration; but the elevation should be subservient to the plan and constructional requirements necessary to provide all these desiderata, and should not be made the paramount feature in the design of a new house, or in the rebuilding of an old one.

I have lately been reading a powerfully written article by Dr. Richardson, in which he sets forth, in vigorous but not exaggerated language, the various communicable diseases which are "promoted or introduced by the errors of construction in the dwellings of our communities;" and I have been much struck by the number of preventable ills which he associates with bad ventilation, damp, bad drainage, impure water supplies, want of light and through draught, uncleanliness and foulness, or stuffiness of modern dwellings; and as, in the course of my remarks, I shall have occasion to specially allude to the means by which all these evils may be at least ameliorated, if not got rid of altogether, I hope you will permit me briefly to refer to and quote some of his remarks, for I cannot too strongly impress upon you, that the sole object of these lectures is rather to treat the houses we live in from a general health point of view and common-sense treatment of plan, design, and fittings, rather than from any mere personal opinion so far as regards particular type of architecture to be adopted in internal planning or external design.

If my teaching is to be of any service to the public at large, it must be based on broad general facts rather than on individual theories as to artistic design, or any special views as to any particular mode of treatment in any of the matters I may bring before your notice. If the various views that I shall lay before you in exposing the innumerable evils of which I shall have to complain in general house construction meet with your approval, I have no fear of the results artistically, for I shall condemn, in the strongest manner, all the innumerable shams which help to make our houses unhealthy and unartistic, and to recommend the simplest and, as far as possible, the most common-sense mode of external decoration, which will at least do away with the dull monotony of sham plaster fronts and ill-constructed openings, which may be called by the ignorant palatial or quaint, terms synonymous and equally foolish when applied to ordinary street architecture.

To begin with, typhus, typhoid, relapsing and scarlet fevers are mainly due to foul air, impure smell, or water, or closely packed and unventilated rooms, while the poisons thrown off by these diseases are retained in the walls and flooring, if badly constructed; while impure air arising from dust and dirt accumulations, and bad sanitation, tend to other illnesses in a minor degree, such as dyspepsia, nervousness, and depression, "during the presence of which conditions (to quote Dr. Richardson) a person is neither well nor ill." Another of our worst English diseases, "pulmonary consumption, or consumption of the lungs, has been largely promoted by the presence of unchanged and impure air in the dwelling house," while "neuralgic and miasmatic diseases" are brought about by the same causes, assisted by atmospheric moisture or damp, so often to be found in houses built either upon clay or in moist situations, where the ordinary precautions of covering the whole surface area with concrete or some other damp preventive has not been carried out.

Dampness, which is so often to be found in the basements of town houses in conjunction with impurity of air brought about by bad ventilation or imperfect sanitary arrangements, or general closeness and stuffiness of rooms in which dirt and dust are perforce allowed to accumulate, is more or less directly the cause of all the malarious diseases—ague, neuralgia, and rheumatism—and here the speculative builder comes in, with venom certain and incurable, with soft spongy bricks which absorb a large amount of water, with mortar composed of road drift or scrapings, foul and unhealthy; with damp and unseasoned timber, ingredients in the plague spots which warmth of fires bring out in vapour, and wherein moisture seems ever present, dimming the mirrors or condensing on painted walls, or absorbed in paper or distemper; which, on every damp day, becomes a visible barometer, marking plainly the change of temperature.

In badly constructed and ill arranged houses, how often do we hear the inhabitants complain of what is technically called "draught," which means sudden and irregular change of temperature; unpleasant as it is in itself, it is most insidious and dangerous in its results, bringing about colds, chills, and general "disturbance in the circulation of the organs of the body."

It is unnecessary to dwell further upon the numerous ills which we have it in our power to lessen, or altogether get rid of, by attention to the general construction of the houses we live in. I can only insist generally with Dr. Richardson, that "the intention and object of domestic sanitation is so to construct houses for human beings, or if the houses be constructed, so to improve them, that the various diseases and ailments incident to bad construction may be removed to the fullest possible extent. The diseases need not be looked upon as necessities of existence, but may be recognised as results of ignorance, or as accidents which, though they may not spring from sheer and wanton ignorance are removeable by accurate foreseeing and all providing knowledge."

In towns, where, for the most part, all houses are built in groups, either in streets, terraces, or squares, and rarely detached, owing to the value of building area and frontage, the general aspect is naturally fixed by the location of the building, and the laying out of the street or terrace of which the particular house already forms or is to form a part; and, therefore, it is of the utmost importance as far as possible to secure as much light and sun as can be obtained by the slightly varied aspect which is given by semi-octagonal or circular-projecting windows with side lights, more especially where the plotting of the site lies more or less due north and south.

All these bay-windows and projections find little favour with the local authorities, who, as far as possible, do all they can to prevent their being carried out, whether it be from the fanciful objection that they tend to stop proper circulation of air in the street, or from the still more ridiculous objection of their interfering with the ordinary frontage line. Nothing can be more miserable and unartistic, nothing more insulting to good taste, than the dreary monotony and vulgarity of most London streets, old and new, whether they be of the commonplace character of Gower, Wimpole, and Harley-streets, with stockbrick facing—with here and there what are called red dressings to the windows—or the meretricious and tasteless vulgarity of the never-ending rows of cemented fronts in the new districts of Bayswater, Tyburnia, and South Kensington, in which the design of each front is made up of plaster cornices, bad in design and construction, plaster architraves, and unmeaning pediments filled in with cast plaster ornament of the meanest and most tasteless description. The eye is wearied with the everlasting sameness, and is almost thankful when one of the occupiers suddenly causes his house to be painted externally bright red or yellow, for the relief from the sickly glare and sham of the cement or stone-painted frontages. How much more artistic and picturesque could our streets be made if broken up with bays and gables, cutting up the sky-line, like the streets in many of the old towns in Germany and Belgium; and how much more cheerful and healthy would be the rooms wherein these bays are thrown out, and through which sun, air, and light can be obtained in more ample quantity, than by means of the two or three parallelogram-shaped openings which generally form the windows in most London fronts. Anyway, there is an old adage, which is more or less true, that "where the sun does not enter, sickness in some sort or way is sure to obtain." We do not get too much sun in smoke-covered towns; and surely every possible allowance, consistent of course with what is due to the comfort and enjoyment of our neighbours, should be made for flat-sided projections, by which more sun and light can be given to our homes.

Fancy being on the south side of a street, where the windows face due north, and into which, for nearly the whole of the year, the sun can never shine, save very occasionally in thin slantwise streaks. Were it not for the generally disagreeable views that are obtainable from the backs of town houses, I should be often inclined to advise that all the best rooms in such a case should be placed at the back, with projecting bays, which the authorities who rule over street frontages cannot interfere with, and so to obtain, as far as is practicable, considering the close packing of the building area of all towns, some glimpse and use of the sun during all hours of the day.

Why, too, cannot the backs of our houses be made more decent, if only by means of glazed bricks varied occasionally with bands of colour When we see the backs of some of the grand stucco-covered palaces of our western suburbs, we are apt to think of the old rhyme which, written on some piece of modern church or chapel architecture, says that—

> "They built the front, upon my word,
> As fine as any abbey;
> And thinking they might cheat the Lord,
> They made the back part shabby."

Of course I know glazed bricks are more expensive than the common stocks, but the extra expense would be amply repaid by the extra light and better air, for the glaze naturally makes the brick not absorbent, and every shower of rain would wash the walls, so faced, clean.

The laying out of streets and squares in towns has very little changed in the last few hundred years, owing more or less to the value of the frontage, and the necessity of providing for some general street line beyond which the main front walls should not project; but there is no sound reason why flat bays, so arranged that they do not look into each other, should not be permitted in every house; the general picturesqueness of the streets would be materially improved, without, in my opinion, interfering in any way with the proper circulation of air, which must, in the nature of things, be duly considered in the laying out of new streets, and which must be maintained in all old thoroughfares.

Why should we not have every new house in such places as Berkeley or Grosvenor-squares built with projecting oriels and bays, and high pitched gables; the gables would add materially to the light and comfort—not to say anything of the artistic character—of the rooms, while the latter would surely be preferable to the generally miserable so-called dormers, which are, as a rule, set back behind the balconies or parapets, in the attics of most town houses; these, I am told often, are quite good enough for servants, a selfish, cruel, if not a suicidal opinion; for if we are to have servants in health, and fitted to carry out their daily occupations, with comfort to themselves, and justice to their employers, their rooms should be just as light, airy, and cheerful as any others in the house. Let the sun call them in the morning if you can, and give a greeting in a light cheery manner to the commencement of their daily labour. In addition to the manifest improvement to the elevation and rooms of the house, all these irregularities tend to promote movement in the air, to give light and shade, and thus to help towards health in the building, and pleasure in our walks abroad.

Rules that have long since been found to be useless, and practically detrimental, not to say preventive of any improvement in the building of town houses, so far as their frontages are concerned, seem to be tied up with musty red tape in the musty heads of vestry officialism. The old machine goes on with its everlasting and monotonous click, worn out, effete, useless, and absurd—there it is, and will, I suppose, remain so, until some general common-sense order of the day turns it figuratively into the dust yard of oblivion, and a new *régime* and a new order of things arises, from which we may hope for practical common sense in all matters pertaining to the building of new, or to the rebuilding of old houses, instead of the stupid bumbledom of most modern Board and Vestry officials; and we may be thankful that at least one large owner of land in this City—I mean the Duke of Westminster—sets a good example on his own property, by encouraging in every way in his power, a departure from the old fogeydom of street design, for "fresh fields and pastures new," in which projections and gables are asked for rather than decried, and modern improvements in building construction and materials are not only permitted but encouraged.

All town houses must necessarily be influenced by local conditions, and in speaking in any way of aspect, these conditions must materially influence all questions of general aspect; but I cannot too strongly urge the desirability of bettering, as far as practicable, special local conditions, by a far more common-sense view of projections and arrangements for providing sunlight and air, than generally obtains with many of those who, unfortunately, are the critics, as well as the judges, of what they presume is necessary for modern requirements.

In speaking upon the next part of my subject, that of design, I desire to recognise and appreciate, in the largest possible sense, the varieties of taste which must necessarily prevail in an age where, as a rule, precedent and fashion are all predominant. I have no wish to force any particular period of architecture upon you, or to ask you to agree in any of my remarks; it must necessarily be more or less eclectic if, as wise men, you desire to embody as far as is consistent with your building all that is good in past, and to incorporate therein the improvements in materials and general building appliances of the present; but I do insist that the external design, properly considered, that is, the general elevation of the street front, should and must be subservient to the internal requirements;

and that the light, air, ventilation, and common-sense requirements of the house must in no way be sacrificed to the external design, for no beauty of mere architectural effect will compensate for discomfort and bad internal arrangement.

I live in a square, in which a certain portion of the houses have been carried out in semi-classic sort of treatment, in which the comfort of the bedrooms has been, to a large extent, sacrificed to meet the requirements of the external design, in which the windows are inconveniently placed and altogether insufficient, owing to their having to be adapted to the classic elevation. All this sacrifice of internal comfort and convenience to external effect is inconsistent with common-sense and ordinary requirements of health, and any architect who sacrifices comfort, utility, and internal arrangement to mere external effect is unworthy of being trusted for a moment. A good plan will make a good elevation; but an elevation in which specific rules which might be fitting for a Greek temple or a mediæval fortress are insisted on, is in no way suitable to an ordinary house, in which the first essentials are lofty and well-arranged windows, and proper light and air space.

Gothic tracery and pointed openings are not suited to ordinary sash windows, and it surely is inconsistent with modern street design to attempt anything in which one or other of the so-called five orders of classic architecture has to be worked into a house in which the frontage is perhaps 18 or 20 ft. at most. When it was attempted in the beginning of this century in the terraces of Regent's-park, generally two or more houses were embraced in the design, a manifest inconvenience and absurdity when one owner wants to paint his front red and the other yellow.

I have already condemned, as strongly as words can do, the vulgarity and unartistic pretentiousness of the host of modern buildings erected in our fashionable suburbs in imitation of Italian palaces or Roman temples, with sham plaster columns running up the whole height, gigantic pediments, and unmeaning and unnecessary cornices, such as can be seen in the terraces of Regent's-park, the confines of Belgravia and Tyburnia, and other quarters, where the fashionable speculative builder of the day has imitated—in plaster—temples and palaces utterly at variance with the requirements of ordinary houses. The fashion of the day is running into modern Dutch, or so-called Queen Anne, and inasmuch as this style admits of ample fenestration, and does not limit the size of light openings, and relies for its piquancy and character on honest red brick instead of sham plaster and vulgar imitation, we may be thankful for small mercies, and be content with a revival of a 16th and 17th century Renaissance school of architecture, which gives us at least colour and picturesqueness in our London streets.

I go so far as to say that the man who builds a red brick house in a town, where want of colour tends to make everything glaring or, where smoke-covered, gloomy, is a benefactor to his species; and I go still further in saying that to a great extent the materials used should, in a manner, be those which are peculiar to the country and locality. Granite is natural to Aberdeen, and used rightly, is a godsend to the place; stone of various kinds is indigenous to certain localities, and naturally suggests itself to the particular neighbourhoods. I should hardly suggest the desirability of putting up a red brick house in an Aberdeen street, although I think Aberdonians might well obtain more warmth and colour in a naturally cold quarter, by judicious use of red and rose-coloured granite mixed with their sparkling grey, which is charming when the sun causes it to light up and glisten, but cold in the extreme when made dead and dark by mist and rain.

We have plenty of good brick clay; we can obtain readily first-class red bricks and terra cotta, and both these materials are more lasting and more suitable to London smoke and the deleterious action of London atmosphere than almost any stone which exists. We have only to take a walk through London, and see the manner in which even the best qualities of stone have become disintegrated by the action of smoke and other impurities which abound in a London atmosphere, and to understand the difference between it and burnt clay, either in brick or terra cotta, to realise that any materials such as terra cotta, glazed faience or brick, are impervious by the nature of their composition to the action of smoke and other impurities, are more suitable than stone for ordinary buildings in our cities and towns.

Glazed and coloured brick, and faience, and terra cotta, admit of almost any variety of design; they give picturesqueness, warmth and colour where they are wanted.

I should like to see London streets made picturesque and beautiful in colour with terra cotta and glazed faience, which every shower shower of rain would cleanse and improve, and should like to see every stucco-fronted building decaying and unlet. As a rule, this sort of work is not only imitation of stone, bad in taste, bad in construction, and unfit to last any time, but glosses over inferior building, and covers a multitude of sins which it would be well for the occupiers, from a mere common sense and sanitary point of view, to lay bare.

We do not want pseudo-Italian palaces, or bad copies of French street architecture, with forced arrangement of fenestration and cutting up of wall space, utterly at variance with home requirements; nor do we want so-called mediæval structures, in which light, ventilation, and air are sacrificed to narrow Gothic or pointed-headed windows and doorways.

So far as I can judge, it seems to me that the so-called Elizabethan or later Renaissance of this country is infinitely more charming and more suitable to every-day wants and requirements than any other style, Greek, Roman, or Gothic; anyway, we want to express in our external work a sense of comfort and utility, and to provide ample light and air space for the rooms, of which the front wall is only the external casing; and any style which combines these desiderata will commend itself to common-sense people, in place of those external architectural styles which have nothing in common with English taste, or English home life.

Classic design, based on rules which were charming in the temples of Athens or Herculaneum, or the monumental buildings of Italy, are not fitted to street architecture; everything is sacrificed to the symmetry and proportion of the elevation, and the arrangement of the interior is left, more or less, to go as it will.

It is not in any way a part of the purpose of these lectures to enter into the various features of architectural design in other countries, or I might enlarge upon the beauty and vigour of the Venetian Gothic, or on the richness of Italian Renaissance, the charm of much of the work of Palladio in Vicenza, or the magnificence of the Florentine and Genoese Palaces; but all the work in these special schools was done at first hand by great masters in their art, and were more or less suitable to the luxury and splendour of the age; but any mere copyism of any of these styles in the cities and towns of this country seems to me utterly opposed to the condition and requirements of English life.

Good architectural effect may be perfectly well obtainable with a good common-sense plan, and there is no possible excuse for a design, whether classic, Gothic, or Queen Anne, which does not first of all recognise the internal necessities and conveniences, and which is not subordinate to a great extent to everyday internal requirements of a well-arranged and comfortable house. While I advocate first of all that the elevation or design should be made subservient to the plan, I do not see the necessity of following the types of various schools of French, Italian, or 13th, 14th, or 15th century Gothic buildings; and when I see the pretentiousness of imitation of either of these schools, I am bound to confess that it suggests nothing but an ignorant conceit, which would not for a moment have been carried out by the great architects whose works we admire, had they had all the modern improvements which increased knowledge and higher skill in invention have brought about.

In our monumental buildings, and even in our ordinary street fronts, architecture should be much more intimately allied with the sister arts of sculpture and painting. Even a porch in which the ornament is modelled with care by an artist, or the corbel of a projecting bay, will redeem an otherwise bad design from commonplaceness; a proper regard for proportion and arrangement of outline in the most simple building shows the work of a true artist, much more than the overlaying of his work with useless ornament or carving, or the overcrowding of parts with feeble enrichment stuck on balustrading and pediments. In house design, it seems to me, that first of all the design should convey some expression of the comfort and general planning of the building, and that its fenestration should show, above all, proper regard to the lighting and ventilation of the rooms, and generally bear the characteristics of the material with which it is carried out, and with English rather than foreign features.

I know of only two or three instances in which Portland cement has been rightly treated in street fronts, in which the architect, the late Mr. Owen Jones, relied upon general effect by incised lines or ornament, carefully avoiding projecting strings and cornices, which might seem suggestive of stone or sham construction. In street frontages, it is desirable, as far as possible, to do away with the sameness and monotony of long lines of façades, in which there are no breaks in the sky line or picturesque cutting up of the roofs, except those not very pretty features in the shape of chimney cowls, which offer themselves in every form of ugliness that zinc workers can conceive, over the whole of the London area.

If importance is wanted in an elevation, let it be got by good sculpture in such portions of the building as are nearest the eye line; a porch properly treated with good modelled decoration, either in figure or relief ornament, can be made as imposing as you like, while balcony fronts can be of good wrought iron, like some of those in the old picturesque towns of Spain and Germany, instead of lumpy and heavy with ballustrading, which not only shuts out light from the rooms, but suggests an element of danger by their utterly false and generally insufficient construction; but I confess to a feeling of astonishment when I see friezes and cornices of buildings in narrow streets, some forty or fifty feet from the street level, covered with elaborate carving and enrichment which it is impossible even to look at without craning the neck, and which can only be appreciated by the servants who inhabit the attics over the way. There is no possible reason why street frontages should not be made picturesque and beautiful instead of tame and ugly, and the commonest of fronts can often be redeemed by some good bit of detail and decoration in the shape of red brick, terra cotta, or glazed faience. If the public will only remember that plaster or cement is generally used to gloss over bad and inferior brickwork, and decline to take houses in which all this bad and false surface covering is used, even speculative builders would be forced to conform to the requirements which higher artistic education and knowledge are gradually insisting upon. Picturesque fronts, with projecting oriels or bays and gabled roofs, need cost no more than some of these wretched travesties of Italian or French architecture, with so-called Mansard roofs and cramped dormer lights, and would give grace and charm, and colour, where now commonplaceness, vulgarity, and bad taste reign supreme.

Too often the first principles of proportion are lost sight of, owing to the want of proper culture of the eye, and details which might be well suited to a Genoese or Roman palace are stuck on to a narrow street frontage. As was well said by the late Sir Gilbert Scott, in a paper read by him some twenty years ago before the Architectural Association—

"It is ridiculous to suppose that such an art as architecture is to be learned without the most careful study of its existing proportions, or that originality is likely to be developed upon a basis of ignorance; and it is equally unlikely that excellence will be attained solely through the medium of knowledge, without the most zealous and careful training of the eye to the most delicate and scrupulous perception of the right and the wrong in form and proportion. The want of this is the most crying sin in modern architecture, especially, I fear, in this country. . . . As the greatest of moralists has said, 'Keep thy heart with all diligence, for out of it are the issues of life,' so we may say to the architect, 'Keep thine eye with all diligence, for out of it are the issues of art.'"

There is no need why London street architecture should not embody every modern improvement, and be carried out in a commonsense and picturesque style, suitable for everyday wants, and in conformity with all the various scientific principles of sanitation which the nineteenth century has produced, "instead of rescusitating old forms and old features, which our forefathers would have gladly changed" had they had the knowledge or benefit of modern improvements. I have no desire to see any one uniform style of building, but whatever style is taken up by the individual owner—presuming always that he is not to be stopped by the caprice or ignorance of some local board official or agent to his ground landlord—it is first of all essential that it should be made to adapt itself to the internal requirements, and that there be ample light, and common-sense treatment of the window spaces, so that they be arranged in the rooms in proper places, and not thrust into corners, or raised so high from the floors as to be prison-like, to suit the external design; and whether Greek, Italian, Queen Anne, or any date or period of so-called Gothic art, it must be governed by present wants, and every sanitary and modern invention which may make the individual house more comfortable, more healthy, and more convenient for the purposes for which it is required, and thus to assist to the general good by providing buildings which are not only soundly constructed, and in conformity with all the known laws of hygiene and sanitation, but picturesque and pleasant in their elevations, adding thus to the pleasures of those, the greater part of whose lives are necessarily spent in the towns in which they have to carry on their daily avocations.

Renaissance, whether German, Italian, or French, freely or simply treated, and all the later phases of the Jacobean and English Elizabethan periods, are capable of being successfully adapted to present home life and modern requirements.

So far as my experience goes, the public generally are unaware of the real advantages and merits of terra cotta for facing street fronts. Some few may recall the excellence and beauty of the terra cotta work in the lovely cloisters at the Certosa, near Pavia, and in innumerable or ecclesiastical and domestic buildings in other parts of Northern Italy and Germany, although I believe casts of parts of some of the more important buildings have been taken for the Museum at South Kensington, and for the Crystal Palace at Sydenham; but few are really cognisant of its great superiority as a building material in crowded towns over ordinary brick or stone. In the first place, when properly burnt, it is absolutely impervious to smoke, and is unaffected by acid fumes of any description; it is about half the weight of the lightest building stones, and its resistance, when burnt in solid blocks in compression, is nearly one-third greater than that of Portland stone; it is not absorbent—a great desideratum when damp has to be considered—it is easily moulded into any shape, for strings, cornices, or window-sills and architraves, can be easily modelled for figure or other enrichment, and last, but not least, in these days of high taxes and increasing School Board rates, is cheaper in London than almost any description of really good building stone. It can be got in good warm yellow or red colour, and, when glazed, can be produced in almost any tones of soft browns, greens, reds or yellows—and its strength, durability, and imperviousness to all the destructive influences of town atmospheres, to my mind, recommends it as the building material most adapted for facing street frontages.

Within the last two or three years, Mr. Holroyd, of Leeds, has materially improved the glazing of terra cotta and fire clay, and, under the name of "Burmantofts Faience," is producing most excellent material for external and internal work, for which almost any colour of glazed ware can be readily obtained at a price very little in excess of good Bath stone—and when it be remembered that this material mellows with age, is washed clean by every shower of rain, and practically shuts out all damp from the walls in which it is used for facing purposes, it will, I feel sure, commend itself to those who desire to have beauty of colour combined with sound and truthful material, and an important element of healthy construction in our London houses. It should be used in small blocks, so as to avoid the unevenness which is caused by the unequal shrinkage of the material in burning, and which in string courses, cornices, or even ordinary facing, would occur if large blocks were used.

Let me say a few words about iron railings. To what disastrous order of things we owe the prison-like bars and straight lines of the ordinary front railings in our streets, I am at a loss to understand; but surely nothing can be more hideous or more unartistic. We must have these iron enclosures to our areas, first of all, to avoid the shutting out of light and air to our basements, and next for the sake of security; but surely they need not be made in never ending rows of perfectly straight bars, with spear like heads, suggesting nothing but dread of impalement should one be so unfortunate as to fall from one of the usually badly constructed balconies which, in festival times, are generally shored up to ensure the safety of those who, once or twice in a lifetime, crowd them for the purpose of looking at a Lord Mayor's show, or other similar interesting fête. Wrought ironwork, if worth anything at all except for prison bars or girders, is meant to be wrought and twisted into endless form and shape. Why cannot we redeem the general want of taste in London streets by something like good design in balcony fronts or area railings. They may be made just as secure, and just as useful, if made ornamental in form, like the beautiful ironwork of the old towns in Spain, Italy, and Germany, which can be seen in the humblest street front as well as in the princely palaces; or like the English work of the last century, some few specimens of which remain in some of the older squares and streets of London, instead of being mean, ugly, and commonplace.

I have recently had some wrought ironwork done for me by a young artist smith in London, which can hold its own, in skill of handicraft and application of artistic treatment in the right spirit to the material, with much of the olden work, and at a cost very little in excess of the usual trashy railing which is reproduced in endless monotony, to the disfigurement of all our streets and squares.

It is in these small matters that the taste of a people is shown, and it is by these minor features of design in the necessities of street architecture that picturesqueness and grace are to be obtained.

I do not suggest expensive and flowing ornament; with delicately wrought foliage or flowers but if only we could see a few good wrought-iron panels of simple character interspersed here and there amid the upright bars, we should admit, I think, that it is by these small matters that the ultimate improvement in London façades may be obtained. The same remarks might apply with equal justice to street lamps. What can be more hideous than the vulgar cast-iron posts that are stuck up at intervals throughout our streets; but until the gas which is said to illuminate them be something better than the noxious compound which it is at present, we can hardly expect better or more artistic setting of the feeble glimmering of gas-light which it encloses.

It would seem as if the sense of sight, and the love of the beautiful, when applied to ordinary everyday matters, are not appreciable elements in the ordinary English character, or it would be impossible to believe that, year by year, we should be content to accept and pay for things which are not only vulgar and commonplace, but unartistic and detrimental to any real improvement in our street architecture. If art were costly, I could understand that a so-called nation of shopkeepers would object to any change; but when, annually, enormous grants out of public funds to which we all individually contribute are applied to the improvement of artistic training by means of so-called schools of art, and the fact that good design is practically no more costly than bad design, I marvel much that, long suffering as we are, we put up with ills which are curable, and with vulgarities which are disgraceful to any educated nation.

I must ask you, as time warns me that I must conclude, to allow me to deviate from my syllabus so far as to include the remarks I may have to address to you on general planning in my next lecture, as this practically is intimately associated with the items of sanitation, light, heating, and ventilation which are specially set forth in the syllabus.

Let me close this lecture by a quotation from one delivered over a quarter of a century ago, by a writer who was then one of the greatest of living word painters:—

"If you build well and artistically you will talk to all who pass by, and all those little sympathies, those freaks of fancy, those jests in stone, those workings out of problems in caprice, will occupy mind after mind of utterly countless multitudes, long after you are gone. You have not, like authors, to plead for a hearing, or to fear oblivion. Do but build large enough, and boldly enough, and all the world will hear you; they cannot choose but look."

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON SANITARY APPLIANCES. BY W. K. BURTON.

Sanitary appliances, as distinguished from actual drains and drain attachments, are, for the most part, to be found in the East Annexe, and are grouped under the heading "Class XXIII." The position given to these is better than that given to the drains, and the exhibits, although for the most part they consist of water-closets, fixed basins, urinals, and so forth, are more attractive, as gilding and brilliant colouring have been by no means spared on them.

I shall first notice an appliance which might possibly have found its best place among the drainage arrangements, but which has been exhibited in Class XXIII. I refer to Rogers Field's flushing tank, exhibited by Messrs. Bowes, Scott, and Read, of Broadway-chambers, Westminster, S.W.

Mr. Field has possibly done more to bring house drainage to its present state of perfection than has any other man, and this invention of his is one particularly worthy of notice. Its object is to secure the periodical passage of a large volume of water through the drains of a house, so as to ensure their being thoroughly flushed. The manner in which this is brought about is simplicity in itself. The tank has attached to it a large syphon which, from a peculiarity in its construction, will start with a very small dribble of water. All that is necessary is to fix the flushing tank over the extreme upper end of the drain, and to supply it with a dribble of water which may be so regulated as to fill it once a-day, twice a-day, or once in two or three days, or just as often as may be desired. When the tank has thus been slowly filled up the syphon starts, and the whole contents are quickly emptied, sending a great flush of water down the drain. The tank may be supplied in various ways besides that mentioned; for example, by the discharge of a bath or other appliances.

Coming to the subject of water-closets, I may say that the number of those shown is legion, and that the chief impression produced by looking at the whole of those exhibited is one of wonder at the closeness with which one maker has, for the most part, imitated another.

The object which is attempted to be gained with all closets of modern design, is the complete clearing away of all soil immediately the water flush is applied, the best closet being that which retains the least trace of such deposit in any of its parts.

The old pan closet, now condemned by all sanitary authorities, was an excellent example of how to construct an apparatus *not* to do what had been mentioned.

Closets of modern construction may be divided into two great classes, the valve closet and the wash-out closet, although there are several which fall half-way between the two.

In the valve closet, the basin is closed at its lower end by a valve which opens when the handle is raised, the water-flush being admitted at the same moment. The soil is carried from the basin through a trap into the soil pipe, after which the valve is closed. The water, however, continues to run for some time after the handle has been allowed to fall, so that the basin fills partly full of water and remains partly filled until the closet is again used.

The wash-out closet consists merely of a basin and trap, the outgo from the basin to the trap being sometimes at the back of the former, sometimes at the side; in one case at least in the front and in several cases at the bottom.

The two matters chiefly to be attended to in designing a wash-out closet are (1st) that the soil shall drop into water, not on to the sides of the basin, and (2nd) that the whole apparatus can be thoroughly flushed by the two gallons of water which the water companies allow to be used.

So many valve closets, excellent in every particular, are exhibited, that it would be invidious to select any one as an example.

Concerning the wash-out closets, we might perhaps mention that of Bostel as exhibiting great excellence of design and of general finish. It is exhibited by the Hygienic and Sanitary Engineering Company, Limited, 23 and 24, Charing-cross, London.

As an example of a closet lying half-way between a valve and wash-out apparatus, we may take Pearson's "twin basin." This closet consists of a large basin divided into two compartments. These are kept filled with water by a self-acting arrangement. The soil falls into one of them, but at the bottom of the other there is a large plug closing the outgo; on raising this plug the whole of the contents of both basins are discharged into the soil pipe.

Various plumbing and other appliances are exhibited by Messrs. Dent and Hellyer, of 21, Newcastle-street, Strand. This firm deserves great praise, as having brought out many of the best sanitary fittings that are to be had. We may specially mention among those exhibited the **V** or anti-**D** trap. This trap is intended particularly for fixing under closets, and has the same self-cleansing properties as the syphon trap, whilst it is not so likely to be untrapped by a great rush of water as that appliance is. A novelty is shown by the firm in the shape o a movable grease-trap for fixing under sinks upstairs. Where, as is frequently the case in restaurants, &c., the kitchen is at the top of the house, great inconvenience is often experienced through the choking with grease of the necessarily long pipes which pass from the sinks to the nearest gully in the open air. To collect this grease before it reaches the discharge pipe, Mr. Hellyer has invented the movable grease trap, which is placed immediately under the sink, but can be readily uncoupled from the pipe and carried to the nearest convenient place for the depositing of the grease.

Du Bois' traps and bends, exhibited by Messrs. George Farmiloe and Son, 34, St. John-street, E.C., deserve notice. These consist of syphon traps and bends of various sizes, to all appearance similar to other traps and bends, but unlike them in being neither cast nor made up from two pieces soldered together, but being in fact "drawn," presumably by hydraulic power. They are of the most ductile lead, and can be worked by the plumber more easily than other traps can.

Dry earth closets are now generally admitted to be the best appliances to use when closets may be out of doors, as in the case of cottages, country houses, &c. There are several exhibits of such, the most noticeable being that of the "Moule's Patent Earth Closet Co., Limited," of 5A, Garrick-street, London, W.C.

There is not space here to describe the various baths, fixed hand basins, urinals, and so forth, which are to be seen on all sides. Suffice it to say that the visitor will see many of these objects, all more or less conveniently and handsomely fitted, some of them being, in fact, works of art in themselves.

The Sanitary and Insanitary Houses.

In the grounds of the Exhibition there have been erected two houses, each with drainage systems, the one intended to illustrate the defective condition of affairs only too commonly met with, the other intended to illustrate a system as perfect as modern sanitary science can make it. The buildings are at present in a somewhat unfinished state, but they are quite far enough advanced to illustrate what is intended.*

Taking first the "insanitary" house, we find on the first floor a closet of the very worst form, namely, the pan closet. In this there is under the basin (in ordinary circumstances the only part of the apparatus visible) a huge cast-iron container, which becomes a receptacle for filth which accumulates there and evolves noxious gases, which escape every time the handle is raised and the water seal between the "container" and the basin is thus removed; or, for the matter of that, escape more or less at all times, because the container is by no means perfectly air-tight. This closet is situated in the very middle of the house, so that no means of ventilating it can be got. Under it there is the objectionable **D**-trap, which, as well as the container, acts as a receptacle for soil—as a miniature cesspool in fact.

Beside the closet there is a sink, and this, instead of discharging into the open air, is connected directly with the **D**-trap already mentioned, the discharge pipe giving ready egress to the gasses generated in this same.

The soil pipe taking the discharge from the closet is made up of portions of lead and of light iron pipes,

* They have been completed since this was written.

the junction between the two being made by smearing a little red lead putty round the part. There is no ventilation whatever. The drain leading from the soil pipe is laid in the sinuous manner already mentioned in the article on house drains and drainage appliances, and is left exposed at several places, to show that the joints are innocent of any material to prevent the free egress of sewer gas. The closet on the ground floor is little better than that upstairs. It is of the kind known as the "long hopper," and is supplied with a miserable dribble of water from a "stool-cock."

On the ground floor there is, besides the closet, a scullery sink placed in the most unsuitable position that could readily have been found. This discharges by a straight iron pipe into a built pit below, usually dignified by the name of a grease trap. The only protection against the gases generated from this pit, and rising from the drain and sewer, is a "bell-trap." The portion of this apparatus which forms the slight seal which at any time exists, is removeable, and as a matter of fact is usually removed, to facilitate the flow of water down the discharge pipe, by the servant who may use the sink. In the floor under the sink there is over the cesspit a similar trap for sweeping the dirt off the floor into.

The waste pipes of the cisterns are connected directly with the drains.

It might be supposed that the state of affairs represented in this model house is a sort of caricature of what is to be seen anywhere. I can assure the reader that this is far from being the case. That in fact the state of affairs represented is one such as is to be found in probably nearly fifty per cent. of houses in London. The committee who arranged the house might have shown a much worse state of affairs than they have, without in the least overstepping the bounds of truth.

In contrast to the house jnst described stands the other one. In this latter the closets are placed against the outside wall so that they can be properly ventilated. The one upstairs is a valve closet, that on the ground floor a wash-out. Both forms have already been described.

The soil pipe is a sound lead pipe fixed outside the house, and carried full size to a point clear of the roof.

The sinks, and so forth, discharge through syphon-traps over a gully in the open air. The cisterns overflow into the open air by pipes simply projecting through the outer walls of the house.

The various branch drains run as curved channel pipes along the bottom of a manhole and branch into each other. From the manhole a perfeectly straight iron pipe runs from the back to the front of the house, where there is a disconnecting chamber, such as we have already described when treating of drains and drainage appliances. This is provided with channel pipe, disconnecting trap, air inlet, and cast-iron cover.

On the whole, the *simplicity* of the good arrangement, as compared with the bad, is very noticeable.

EDINBURGH FORESTRY EXHIBITION.

No. II.

The Executive Committee of the Exhibition prepared a classification, but practical difficulties were found in the way of carrying it out in its entirety, and the geographical principle was adopted, by which the exhibits of each couutry were brought together. The heads of the Classification were as follows:—Class I, practical forestry, including implements and tools, models and plans, machinery, fencing materials, &c. Class II., forest produce, raw and manufactured, including woods of all kinds, cooperage, turnery, basket and wicker work, tanning and dyeing substances, gums, oils, drugs, &c. Class III., scientific forestry, including botanical specimens, parasites, forest fauna injurious to woods, preservative processes, fossil plants, &c. Class IV., ornamental forestry, including growing specimens of rare and ornamental trees and shrubs, rustic work, dried specimens. Class V., illustrations of forestry, including paintings, photographs and drawings. Class VI., forest literature and history. Class VII., essays and reports. Class VIII., loan collections. Class IX., economic condition of foresters and woodmen; with a Tenth Class of miscellaneous, to include articles bearing on the objects of the Exhibition, but not coming within any of the previous classes.

Although this classification was not carried out, it represents fairly well the objects exhibited by the different countries. The contents of the Exhibition might also be broadly divided into (1) *Forest*, including the trees, trunks, branches and leaves, seed and cones, monstrosities, &c., the tools used by foresters, transplanting machines, protective materials, and forest animals; (2) *Wood*, in the rough and made up, including curiosities, furniture, and useful articles, as well as materials obtained direct from wood, such as paper from pulp. In the first of these divisions may be mentioned the four bamboos from Burmah, grouped at the corners of the central transept to reach to the roof of the dome. These are 150 feet in length. The Californian Redwood Company exhibited a section of *Sequoia sempervirens*, 13 feet in diameter. The tree from which it was cut was 295 feet high, and from counting the rings, it is computed that it was 2,000 years old; 6,250 cubic feet, or 75,000 feet board measure, were cut out of this tree. There is also a complete chamber formed of the bark of a tree exhibited by the Company. The bark, which is of varying thickness, is raised 12 feet high, and the interior, the floor of which is formed by a section 13 feet in diameter, will accommodate forty persons. Tools were also well represented. Transplanting machines, capable of removing trees 30 feet high, and from two to ten tons in weight, were exhibited. The Queen lent heads of red deer from Windsor and Balmoral; the Prince of Wales and the Duke of Edinburgh a large number of forest animals and sporting trophies.

In the second division there is a considerable display of furniture, casks, tubs, &c. Among the curiosities are an arm chair made from a pile taken from one of the piers of the old bridge, Rochester, in 1822. The old bridge was in progress in 1360, and finished in 1392, so that the pile from which the chair was made had been nearly 500 years under water.

Returning to the geographical arrrangement, it will be well to begin with the British department.

The first collection to be seen by the visitor is that contributed by the War-office. Here are shown specimens of the various woods used in the Royal Arsenal, such as oak, teak, ash, mahogany, &c. There is also a case of the timber employed in making charcoal for gunpowder, and the charcoal made from it. Stocks for rifles in the rough blocks, and chiefly cut out of close-grained walnut, are displayed; and the Royal Small Arms Factory contributes lances in various stages of manufacture.

Captain Mackenzie, conservator for Epping Forest, shows a collection of numerous specimens of freaks of nature, in extraordinary self-grafting of branches, interlacing of roots, and peculiar contortions of trunks, also plans for lodges which have been erected in the forest for the accommodation of workmen. The far famed Burnham Beeches are represented in large photographs and specimens of their wood. The Commissioners of Woods and Forests exhibit a specially interesting collection of objects and information connected with Dean Forest and Highmeadow Woods, Gloucestershire; New Forest and Crown Woods, in Hampshire; and Windsor Parks and Woods. The extent of the forests under the management of the Commissioners are as follows:—Dean Forest and Highmeadow Woods, 19,500 acres; Windsor Forest, 10,000 acres; New Forest, 18,750 acres; Bere Woods, 1,434 acres; Alice Holt Wood, 1,887 acres; Woolmer Forest, 1,870 acres; Parkhurst, Isle of Wight, 1,152 acres; making a total of 54,593 acres. Oak is still regarded as the main crop, but the mixed plantations consist chiefly of ash, birch, beech, Spanish chestnut, elm, lime, horn-bean, larch, cluster pine, spruce, the Corsican pine, and the Himalayan deodar. From the Dean Forest are specimens showing comparison of growth between transplanted and non-transplanted oak trees, and a record of comparative growth kept since 1809. The injury to timber from the careless tearing of the branches, or from leaving dead branches attached to the trunk is exhibited in different tabled specimens, also sections show the inroads of blight and canker, of grubs, and of ants. From the New Forest are sections of oak and other timber of ages from 10 up to 200 years, showing the varying growth of timber under varying circumstances, and in different kinds of soil, also sections showing the progress of disease in timber, and the result of checking it by excising the diseased portion at an early age of the tree. From Windsor Forest was sent the root of an elm tree taken out of a drain by means of a tool for removing obstructions in drains, also a number of logs of wood showing the effects of cutting off branches close to, and at a distance away from, the main stem. Forest tools were sent from all of the forests.

The Scottish Arboricultural Society occupies, with its important exhibit, the northern division of the western transept, and a large portion of space in the nave. The exhibits here are arranged according to the classification alluded to at the commencement of this article. Under Practical Forestry are shown meteorological instruments, dendirometers, axes, and other tools, models of bridges, embankments, &c., specimens of fencing, gates, &c., and a large number of specimens of forest produce. Here is a silver fir railway sleeper which had been in use for seven years, and is still sound; the Baltic timber sleepers laid at the same time were worn out a year before. A large number of seeds and cones are exhibited. Under the head of Scientific Forestry are dried specimens of the forest flora, fossil plants, and photographs of rare and remarkable trees. The Duke of Buccleuch sent photographs of representative trees growing on the Eskdale Estate. Among these is "The Duke," 60 feet high, containing 232 cubic feet, and "four oaks" from one root, 56 feet high, and containing 317 cubic feet. A sycamore at Hagg-on Esk, a favourite tree of the late Duke's, is 90 feet high, containing 803 feet. There are also two spruce firs of 140 years of age, each 124 feet high. The Society also shows sections of timber exhibiting the various diseases to which different trees are liable, sections showing the effects of injudicious pruning, the injuries caused by squirrels, curious growths, some of which bear fanciful resemblances to human figures. The description of there exhibits occupies thirteen pages of the catalogue.

BAVARIAN BEER.

Consul Horstmann, of Nuremburg, says that breweries were in existence in Bavaria previous to the founding of the City of Munich, by Henry the Lion in 1158, but up to the 15th century, the principal drinks of the inhabitants were mead, a fermented mixture of water, honey, and various fragrant herbs, and Bavarian wines. One of the first breweries established in Bavaria was at Weihenstephan in the year 1146, by the Bishop of Freising. In 1370, there were but three breweries in Munich, which number in the course of two centuries had increased to fifty-three. In the 16th century wheat beer was introduced into Munich from Bohemia, and threatened in the beginning to supersede the brown beer; but the opinion soon began to be held that white beer was not wholesome, and, moreover, it was contended that the consumption of wheat for that purpose would soon drain the country of that cereal, and there would be none left for other purposes. Different measures were taken to restrict the brewing of white beer, all of which proved failures, and eventually the Duke of Bavaria took to himself the sole right of brewing it, and thus was established the royal white brewery which exists to the present day. In 1881, there were 5,482 breweries in Bavaria, or rather more than one to every thousand inhabitants. In Munich the smaller breweries have been gradually swallowed up by the larger establishments, and there are now twenty-nine breweries in the city, the largest of them using about 364,000 bushels of malt, and producing about 7,000,000 gallons of beer annually. Most of the beer produced in Bavaria is consumed in the country itself, only about seven per cent. being exported, the principal cities taking part in this export being Munich, Kulmbach, Nuremburg, and Erlangen. In the making of this beer two methods are in general use, the one by a process of infusion, the other by a process of decoction. The object of the mashing is not only to extract the sugar and the dextrin which is contained in the malt, but also to produce sugar and dextrin from the existing starch, with the help of the so-called diastase of the malt, and a temperature of 167° Fahrenheit. The process of infusion and of decoction differ from each other in the manner in which the temperature of the mash is raised to the proper degree for producing sugar. In the first-named process the mash is brought up to the proper temperature without any part of it reaching the boiling point. In the process of decoction, which is the one universally practised in Bavaria, the mash is brought up to the required temperature by putting a part of it in the kettle and heating it to the boiling point, and then conducting it back to the rest of the mash, so that the whole reaches a temperature of 125° Fahrenheit. A part is then put a second time in the kettle and boiled, and again returned to the rest of the mash, so that it reaches a temperature of 167° Fahrenheit. The proper temperature is generally reached by twice boiling a part of the mash, although in some few breweries it may be done in three successive boilings. This process takes more time, and requires greater attention, than the heating of the whole to a certain temperature, but better results are obtained by it. It produces a beer richer in dextrin, while by the method of infusion a beer is produced containing less dextrin but more alcohol. The Bavarian winter beer contains about 4 per cent., and the summer beer 4·5 per cent. of alcohol, while porter contains from 6 to 7 per cent., and ale 6 to 9 per cent. of acholol. The malt used for Bavarian beer is obtained partly from Bavaria itself and partly from Hungary, and the hops are mostly of Bavarian growth, these being universally acknowledged as the best Consul Horstmann says that Bavaria takes the lead of all nations in the consumption of beer, the average annual consumption being 260 quarts per head of population, compared with 125 in England, 165 in Belgium, and 45 in the United States, and he estimates that at Munich the annual consumption reaches the enormous figure of 470 quarts to each person, or about one quart and a third daily.

FIG ÇULTIVATION IN SICILY.

There are several varieties of the fig tree in Sicily, some yielding a large, others a small fruit, and this fruit varies in its degree of sweetness, also in colour from white to black. The fruit of some varieties ripens sooner than that of others. The trees grow equally well in poor and rich soil, and bear abundantly when planted on the mountain side and in the valleys. Consul Woodcock, of Catania, says that the favourite varieties of Sicilian figs are the *Sangiovannaro*, the *Sottuno*, the *Melinciano*, and the *Ottalo*. The *Ottalo* has smooth leaves, the peduncle of the flower and fruit is longer and the fruit is sweeter than that of the other varieties. The *Ottalo* fig is considered to be the best for drying. The fig is propagated from the suckers that spring up from the roots, cuttings from the tree being also used, and these are set in the months of February and March. In orchards the distance maintained between the trees is about twenty-six feet. The fig is long-lived, as it is constantly being renewed by shoots that spring up from the roots taking the place of the main trunk when it becomes old and decayed. The soil is worked in the spring, and also in the November following. The best varieties in Sicily are grafted, and also budded upon the stock of the wild fig, this operation being performed also upon healthy trees of the best varieties, and the time chosen for it in March, or when the trees are in blossom in June. Great care is exercised in the cultivation of the tree to remove all dead and diseased branches, and to avoid too much cutting and pruning. The fruit is dried in the following manner. It is gathered when partially ripe, that is when the fruit is more green than ripe, and immediately plunged into boiling water, and allowed to remain only a very few minutes. It is then placed in a spot sheltered from the sun, and the next morning, at sunrise, spread upon a platform in order that it may be flooded with sunlight, care being taken not to place it upon the ground on account of its dampness. While drying, shallow willow-work baskets are used for holding the fruit, and these are never placed upon the ground, but kept in an erect position. At sundown the fruit is covered to protect it from the night dews or unexpected showers of rain, and this operation is continued for several days until the fruit becomes thoroughly dry. When dry it is placed in layers in small boxes or baskets, these layers being arranged very neatly and artistically, the fruit being pressed down firmly by hand until the box or basket is full, when they are securely covered and kept in a dry place ready for shipment.

CORRECTION.—SUPERGA RAILWAY.—Page 1021, column 8, line 19, for "21 ft." read 21 *inches*; line 28, for "millimetres," read *metres*. Column 2, line 9, for "square metres," read *square millimetres;* line 10, for "square miles," read *square inches;* line 12, for "square miles," read *square inches.*

TOBACCO MONOPOLY IN SPAIN.

Tobacco is a monopoly of the Government in Spain, and its cultivation in the Peninsula is prohibited. Consul Reed, of Madrid, states that nearly, if not quite, all of the tobacco consumed in the Peninsula is imported from Cuba, Porto Rico, and the United States. It is brought in the leaf and manufactured at the Government factories, in which a vast number of persons are employed, chiefly women and girls. The largest factory is at Seville, and gives employment to about 2,000 people. According to the statistical returns of the Director-General of Monopolies, the amount of tobacco manufactured during the year 1883, amounted to about 18,182 tons, of which 3,008 were made into cigars, and 2,231 into cigarettes. The remainder was used for smoking and cigarette tobacco. Tobacco is divided into classes, and is furnished to the Government by contract for a certain time, generally one to three years, and large fortunes are frequently made by the contractors. In awarding these contracts the following is the system employed. Due notice is always given in the *Gaçeta de Madrid*, that a public auction will be held on a certain day to supply the Government with a certain amount of Cuban, Porto Rican, or American tobacco. On the day named tenders are deposited with the Commission consisting of the Director-General of Monopolies, who is president, two other persons, and one or two secretaries. For the tenders to be in due form the persons presenting them must be Spanish subjects paying Government and municipal taxes; whenever a foreigner, as is often the case, desires to tender, he must do so through a Spanish subject. The tender must be accompanied by a document, duly signed by the proper authorities, stating that the applicant has paid his taxes, together with a receipt from the *caja general de depositos* that he has deposited the necessary sum, ranging in amount from £7,000 to £30,000 (according to the quantity to be furnished), as a guarantee to the Government for the fulfilment of the contract. If the applicant obtains the contract, the amount remains on deposit, but if unsuccessful, it is returned next day, less 2 per cent., which is retained by the *caja general de depositos*, or in other words, the Government. The tenders are handed to the Commission a few minutes before the hour named for the auction, and there are usually from five to seven tenders for each contract. At the hour named the *subasta* (auction) commences, and the tenders, in the order in which they have been deposited, are handed one by one by the President of the Commission to the Government Notary, who opens and reads them aloud to the public. After all have been read, the President awards the contract to the lowest bidder, provided the tender is found to be in due form. Very explicit directions are always given in the *Gaçeta de Madrid* announcing the *subasta*, as to the manner in which tenders should be made out, and if a tender should vary in the slightest degree from these directions, there is always someone to protest, and it is rejected. The Government have established in all the cities and towns a species of wooden booths, called *estancos*, for the sale of tobacco, cigars, and cigarettes, and it is only at these places that they can be bought.

General Notes.

Iron and Steel Institute. — The autumn meeting of this institute will take place in the City of Chester, on September 23rd, and three following days. The following papers and subjects for discussion are announced:—"On the Geology of Cheshire," by Aubrey Strahan; "On Improvements in the Siemens Regenerative Gas Furnace," by Frederick Siemens; "On Recent Improvements in the Method of the Manufacture of Open-Hearth Steel," by James Riley; "On a New Form of Regenerative Furnace," by F. W. Dick; "On the Manufacture of Crucible Steel," by Henry Seebohm; "On the Recovery of By-products from Coal, more especially in connection with the Cooking and Iron Industries," by Watson Smith; "On the Most Recent Results obtained in Germany in Utilising the By-products from Otto and other Coke Ovens," by Dr. C. Otto; "On the North-Eastern Steel Company's Works at Middlesbrough, and their Products," by Arthur Cooper; "On the Spectroscopic Examination of the Vapours Evolved on Heating Iron, &c., at Atmospheric Pressure," by John Parry. Eaton Hall and Hawarden Castle will be visited, as well as a considerable number of works.

Nuremberg Metal Exhibition of 1885.—This international display of precious metals and alloys, organised by the Bavarian Industrial Museum, promises to be of remarkable interest. The Government has decided upon giving medals of gold and silver. Free entry will be granted to all works which are again exported, and a lottery will take place in which the prizes will consist of objects which have been exhibited. A guarantee fund of £5,000 has already been arranged, and the various German Consulates in other countries will assist in the work. It is stated in the *Metallarbeiter* that Indian metal work, as well as Persian and Kabyle specimens, will be exhibited. In America, Spain, and Portugal the idea has been warmly taken up, and the participation of Japan is considered certain. France, Italy, Belgium, and Austria have been applying for space in an encouraging manner. As to Germany itself, it would seem that the old metal-working towns, Hanau, Pforzheim, Stuttgart, Gmünd, &c., will be represented in a special manner. The historical department will be of great interest. The light will partially be obtained from above, the objects shown being thus exhibited under specially favourable circumstances.

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Proceedings of the Society.

CANTOR LECTURES.

THE BUILDING OF TOWN HOUSES. THEIR ARRANGEMENT, ASPECT, DESIGN, AND GENERAL PLANNING.

By Robert W. Edis, F.S.A.

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Lecture II.—Delivered Monday, Feb. 25, 1884.

Planning, Sanitation, Lighting, Heating, and Ventilation.

On the general planning of a house depends, to a great degree, the comfort and health of the occupiers thereof, beyond which the cost of keeping it in order may be considerably increased or decreased by the attention, or want of attention, to the numerous small details which make all the difference between a good and a bad plan.

If a great amount of passage space with stone flooring, to be daily subject to broom and holystone, abounds, you want a certain number of hours' work daily out of one servant to keep it clean; if the general fittings are so arranged that there are inviting places for dust and dirt to accumulate under, and for all manner of filth to lodge above, another servant's time is tolerably taken up for some hours in keeping them clean and sweet; if chimneys smoke and will not draw, there is not only waste of time in lighting the fires, and relighting them, perhaps, several times in a day, but a good deal of temper lost, with possible friction, between the master or mistress, and the maid; if ranges will not burn, or burn too much, and will not heat the water, and will persist in adding to the miseries of the house by emitting, and, owing to the want of proper arrangement of swing doors, and sufficient fresh air and ventilation, perfuming the whole house, at inconvenient hours, with stray whiffs of cooking; or, as is often the case, with whole gales of disagreeable smells of cooking meat or vegetables, the owner or occupier, who may come back, weary and worn, from a day of worry and hard work in his particular occupation, is inclined to flee the house, to go to his club, in fact, anywhere rather than submit to the filthy and sickening forerunner of his dinner which meets him on his crossing the threshhold of his house.

How many of us know the nausea and annoyance which these ante-prandial stenches bring upon us, which, unsubstantial as they are in reality, oft-times destroy all appetite for the real food of which these preliminary whiffs and gales are the unpleasant forerunners in so many of our town houses. Or, what is more annoying and unpleasant than to find that, directly the street door is opened, it is like putting the match to a series of small blasting holes in a mine, and, one after another, we hear door after door bang, bang, all over the house, and the rattle of small arms, in the shape of blinds, picture frames, and other articles hung on the walls, going off along the whole passage and staircase line, damaging the walls, and irritating our nerves, until the cause of offence is taken away by shutting the street door; or, perhaps, after nightfall, when we open the front door, we are met in the face with a great rush of foul and heated air arising from the gaslight in the hall, where no ventilation exists to modify or do away with this common evil.

The staircases are often causes of trouble and evil, especially to weak-chested and short-winded people; they are often so badly designed, and pushed into the narrowest possible spaces, that the riser of each step is perhaps seven inches high or more, and the flights are so steep and long, without rest or break, that in our journey upwards to the second floor, where our bed or dressing-room is provided, we are apt to feel very much like a man out of condition who has suddenly been called upon to clamber up a steep hill, without the benefit of the pure air which the out-of-door exercise generally brings; or perhaps some dull, foggy morning in winter, when the frost has been a little more severe than usual, and has therefore kept down the smoke and fog, we are met, in our half-awakening to the darkness and cold of the early morning, by the not very pleasant information that one of the water pipes has burst, and is flooding the house; and we, if our knowledge carries us so far, have to turn out of a warm and comfortable bed, and hastily robed in a dressing-gown, to find our way through a narrow trap-door, in which we may possibly stick for a few minutes, to grope our miserable way through the dusty and sooty roof to some inaccessible corner therein to the cistern, to turn up the ball-cock or shut off the water—if such a provision has been provided—by means of the stop-cock, and half-drenched, thoroughly cold and miserable, and probably as black as a sweep, to finish up with stepping between the ceiling joists, and breaking through the thin lath and plaster, to find ourselves suspended between "the devil and the deep blue sea"—in other words, the inside of our roof and the servants' attic, and all for want of a proper arrangement of the water cisterns, proper casing-in of pipes, and a proper gangway and access to both.

In all probability, during our compulsory travel through hitherto perhaps unknown regions, we shall have seriously damaged our nether limbs by tumbling over the naked bell wires, which the modern builder delights to carry inside the roof, generally without cover or support, and shall then find that some of our bells will not ring, or what is perhaps worse, and is not an exaggerated fact, that when we pull one of the levers or bell cords, we set going a whole band of jingling bells, which suggest to those below an idea that the house is on fire, or that everybody in the house has gone mad.

Occasionally perhaps, in the middle of the day, the cisterns run out, and there is no water anywhere, and the cook is scared to death for fear of being blown up by a bursting boiler, and every sink, closet, and lavatory is rendered not only useless but absolutely foul and unhealthy. Someone has to go for the turncock, who, of course, has just started on his rounds, and when he comes, someone has to give him a shilling for the pleasant information that it "can't be expected that a hundred gallon cistern is sufficient for the use of the house;" or "that the fittings are all wrong, or worn out, or not the right kind," and then—"the deluge"—for the plumber comes in, and a really pleasant chatty gentleman he generally is, but we find his society palls upon us after a time, and his bill for the various little jobs makes him absolutely loathsome. Or in summer time, our own or our neighbours' dustbin emits most unfragrant smells, which, coming up from the front area, necessitate all the front windows of the house being closed, and we are thus almost asphyxiated inside with unventilated rooms, or nauseated with the foul stench which finds its way all over the house, and when the dustman who hails "ahoy," from a distant part of a neighbouring street, like the approach to a strange ship at sea, is brought to an anchor opposite your house, you are forced to give him a fee or a drink before he will empty your dustbin, as he says it has got some refuse or other in it which the dust contractor is not bound to remove, and he will not do it without the usual blackmail. Or, perhaps, the housekeeper informs you, in the blandest way, that the scullery drain is stopped up, and "she is quite sure that the maid has done nothing at all to cause it;" and when you have it opened up—as the builder has not thought it necessary to put in any grease trap—you find the pipe furred and foul with rancid filth enough to brew a whole hospital-full of ailments.

Or, again, you are hospitably inclined, perhaps, and invite your friends to dinner, or the modern crush called an "at home," and your rooms soon become so hot and suffocating for want of proper ventilation that they are almost unbearable, and you and your guests get nausea and headache, or if the windows be open, worse still, cold and neuralgia.

I might go on for hours enlarging upon the ills which, I am quite sure, many of you who live in the ordinary unsanitary and unhealthy houses erected in the last fifty years, suffer from ills that are curable or to be considerably alleviated, by a little knowledge, and by the application of some little of that forethought and common sense which most of you use in your various daily avocations.

My object this evening is to attempt, first of all, to give you some few suggestions as to the proper planning of your houses, and to include therein some general simple rules for at least avoiding many of the manifold ills and disagreeables to which I have briefly alluded.

In my former lecture I urged the desirability, not to say the necessity, of some enforced system of supervision over the building of all new houses, whatever their class or size, as in so many cases many people are, more or less, obliged to live in certain districts, and, practically, have to take what they can get in the way of houses, and to take them, more or less, on trust, they themselves not being competent to know whether the house is really fitted for healthy habitation; and are naturally not inclined, even if the landlord will permit it, to have it pulled about and thoroughly examined, and then if they do not like what they find, to make it good after, for all this entails expense which they ought not to incur. They may, perhaps, think that the rooms are sufficient in number, and the arrangements convenient; they are told that the drainage is perfect, the water supply ample, that hot and cold water is laid on to the top of the house, and that there is gas in every room; but how is it possible for the mere outsider and non-professional man to know whether the cisterns are properly placed, the drains laid properly and ventilated, and the various pipes about the house so placed as to be readily laid bare for inspection; or whether the roof is sound, the timbering sufficient, and the walls built with materials that will not let through damp and rain; or whether the chimneys smoke, or the range is sufficient and suitable, and not too expensive in cost of fuel; and the hundred and one matters that make all the difference in the way of comfort and health between a well and badly built tenement.

It is not fair to ask the incoming tenant to pay for professional advice, unless it be that he knows what he is about to take, and is prepared to add to his yearly rental for the term for which he takes the house, by sinking a certain sum of money in making good the manifold defects, and, in fact, doing the landlord's work for, perhaps, his own present comfort, but for the ultimate advantage of the landlord, who, if the house be taken on lease, not only accepts, without thanks or return of any kind, all the improvements which have been made, but still further mulcts the unfortunate lessee by a heavy claim for dilapidations, and for generally doing up the house with paint and paper for the benefit of the next tenant, who, perhaps, continues the same expenditure, and thus, eventually, the bad and rotten structure has become, by the outlay of different tenants, a tolerably decent habitation.

All this sort of robbery—for it is nothing else—demands Government interference; the tenant should have the right to recover for all work done which can be shown to have been absolutely necessary for the healthy enjoyment of the house which he is compelled to take on trust; and if some law enforcing this could be passed, we should have less bad building and fewer unsanitary houses; when I say unsanitary, I mean not only from bad drainage, but from improper and unsound fitttngs, bad ventilation—usually none at all—and the generally scamping nature of the work.

I am glad to find that Sanitary Aid Committees are being formed in various parts of London, in connection with the Mansion House Council, for the purpose of bringing to the notice of the officers of health, in the various metropolitan vestries, all houses which contain in themselves nuisances, which are not only dangerous to the individual occupiers, but to the community at large, and of endeavouring to insist upon the proper carrying out of the Nuisance Removal Acts, Metropolis Loca Management, and the Artisans' and Labourers' Dwellings Acts, for the improvements of houses which are in a faulty condition.

They are publishing information as to what these Acts can enforce, and bringing them before the occupiers with a view of aiding them in forcing their landlords to comply with the various requirements of these Acts, so that they, the tenants, may, if they wish, insist upon certain sanitary rules being complied with; but all the Acts are fenced about with difficulties which, in ordinary cases, are very difficult to overcome, and when, as is often the case, the vestryman is a large owner of small property, it is somewhat difficult to make him act as an impartial judge on matters which must manifestly affect his own pocket.

A Bill has lately, I believe, been introduced by Mr. Monckton, M.P., into the House of Commons, and which I hope will become law, to provide for a much better and more systematic supervision of all new buildings, whereby a tolerably sound construction may be ensured; for instance, that the foundations be dry, and a proper damp course inserted, that the drains shall be laid of adequate size, and to a proper fall, properly ventilated and cut off from the main sewer, and that there shall be no direct communication between the house and the drains; that all closets and slop sinks, &c., shall be in proper situations, and properly ventilated, and not opening direct into the house from the top of the principal staircase, as is often the case in many houses built fifty years ago; and, in fact, to carry out some general scheme of sanitary arrangement such as I have shadowed forth in my former lecture. But I fear much that the question of the appointment of the inspectors under the Act (if it becomes law)—which is to be vested in the various local vestries or boards, subject to confirmation by the Local Government Board—will be a rock on which there will be much foundering of good intentions.

Inspectors qualified for all this sort of work must be men of position and standing, with ample general knowledge of all the details which make up the sanitary wellbeing and construction of the house, able to hold their own against all official Bumbledom and bullying; men *sans peur* and *sans réprôche*, anxious to carry out their duties conscientiously, and not to fence them about by narrow-mindedness or faintheartedness; able to look at their work from a broad, not a narrow and dogmatic point of view, by which their authority may be either rendered widely useful and beneficial, or otherwise merely irritating and senseless by petty spite and jealousies; and competent to seek out real abuses and to condemn them, and to insist upon their removal, whether the property belongs to their masters or to mere outsiders.

Such men can only be obtained at good salaries, and must not be men who are paid a few pounds a week, as is the case with the usual so-called sanitary inspectors. As having had the honour of being once, for a brief period, a member of a vestry which has earned for itself a somewhat unenviable notoriety in the metropolis, I unhesitatingly assert that I believe, with proper businesslike control and management, ample funds might be saved from the present rates sufficient to pay a staff of such competent inspectors as I have named; but unless this be done, it can hardly be expected that the community at large—which is already somewhat too heavily taxed, and on which such preposterously heavy and grossly unfair rates as the present School Board rates are continually increasing—will consent to any additional burden being thrown upon them; and if the expense is to be thrown, as is proposed, upon the owners of property, it can hardly be expected that they (the owners) will be prepared to accept a Bill—which will manifestly reduce their annual receipts from the property considerably—with any amount of satisfaction or assistance.

Good planning means not merely the arrangement of a certain number of rooms on a certain number of floors, but careful and close attention to the general domestic requirements and arrangements of the ordinary householder, and to all smaller details which make up the comfort and convenience of the house. It means that every foot of space shall properly be laid out, that there shall be no dark corners, and no inaccessible places in which cisterns or lumber are stored, that every room, closet, and staircase, shall have ample light and ventilation, and that staircases shall be conveniently arranged, easy of going, with broad landings, and of sufficient width to allow of passing easily.

Each room has to be considered, and its relative proportion and position in the plan. The dining-room, or general eating-room of a house, should be so arranged that, although above the kitchen level, it is not at any unreasonable distance, whereby an extra amount of carriage of dishes and service is required, and, as a necessary sequence, smell of food all over the house, and likelihood of the hot meats becoming warm or cold, of risk of accident and breakage in carriage, and discomfort in the meeting of servants passing and repassing.

If it be possible in an ordinary town house of the first or second class, the dining-room should be placed at the back, as it is rarely used except at meal times, and good outlook is not necessary; besides which, in summer-time, when it is sometimes pleasant to have windows open, if the room face a much used thoroughfare, there is all the unpleasantness of noise of traffic, and constant inrush of dust; whereas, if placed at the back, provided always the light area into which the room looks be of sufficient size, and lined with glazed bricks, with some slight variation in coloured lines or panels, with window boxes, filled with sweet smelling flowers or shrubs, there is freedom from noise and dust, and the comfort and quiet of the room is considerably enhanced.

Next the dining-room, should, if possible, in every house, be arranged a small service-room, with a light service lift from the basement, by which a considerable saving of labour will be gained, better service, and if, in this room, a small hot plate be fitted up, heated by gas, the plates can be brought in hot instead of half cold, as is so frequently the case. This lift should be taken down in the basement to a small china closet or pantry, close to the kitchen, but quite separate, so that it may not be made a funnel or shaft up which the smell of the kitchen can ascend. If, however, the kitchen be really properly ventilated, with plenty of fresh air inlets and extract shaft over the fire-place—that is, immediately over the cooking portion of the kitchen—there should be no risk of smell, even if a serving hatch is made direct into the kitchen; but it is better, if possible, to separate the two by a small lobby. If this special service room cannot be provided, a small lift may easily be arranged in the buffet, or at one end of the dining-room, and this need be only of the lightest description, so as to be easily workable by a maid servant. To the lift, a speaking tube or electric bell, or both, should be attached, and these will not only be found convenient at meal times, but in sudden emergencies, when unbidden and unexpected guests arrive and stay to dinner or luncheon, will give an easy means of communication between the mistress and the cook. It is well to get a service room on the ground floor, next to the dining-room if possible, as this can be fitted up with sink and cupboards, all useful for washing up and storing away glass and china, and thus avoiding the risk of carrying up and down stairs. Naturally, the servant, man or woman, is anxious to save him or herself as many journeys from the basement as possible, and thus frequently he or she is inclined to overcrowd the trays, to the imminent risk of everything upon them.

As a rule, a dining-room must have a central light over the table, but this should not be of such a size as to impede the view from either end, or to cause an amount of heat on the heads of those who are sitting round it. A small light, with a shade made to throw its rays direct upon the table, with—if gas be used—side brackets next the sideboard, and on either side of the mantelpiece, so as to distribute the light all over the room, and light up the pictures or whatever else is upon the walls, is infinitely better than a great blaze over the table, neither pleasant or comfortable to those who have to face its glare, and oft-times unpleasant heat. Nothing is so unpleasant in a dining-room as the heat, which too often in our London rooms, when we have a dinner party, makes the room stuffy, close, and most unbearable, taking away from the enjoyment of the dinner itself, and helping to faintness and headaches, and to spoil the best appointed and best cooked dinner in the world.

To avoid all this, it is essential that pure fresh air shall be introduced and distributed over the room, to take the place of that which necessarily becomes foul and tainted by fumes of cooked meats, gas, and the straining of the cubical contents of air supply by a larger amount than usual of people using the room.

If there be no means of providing fresh air, and no means of extracting foul air, it follows that in a very short time the good air originally contained in the room will become tainted, and after a time heated and foul, as the only ordinary means of obviating these evils are by opening the doors or windows for fresh air inlet, and of trusting to the fireplace opening for extracting a certain amount of foul air which, remember, is always drawn down in waves over your heads, and is more or less breathed, in its passage to the fire pump, by every one in the room.

Stand on a chair in an ordinary London room, about an hour after the room has been lit up, and the dinner commenced, and you will then obtain for youselves some practical knowledge of the suffocating and foul nature of the upper stratum of air in the room, and will not wonder that faintness, nausea, and headache, are often necessary portions of a dinner party in an improperly ventilated room.

All this can be cured by providing in, say, each corner of the room a tube, adjusted in proportion to the size and height of the room, for the access of fresh air through gratings from the outside wall; and the current and amount of air injected, so to speak, into the room, can be easily adjusted by an ordinary butterfly valve, and all dust and soot, and other impurities kept back by a piece of fine silk or wet sponge. These tubes are often put in much too small, and the size of the outside grating is not considered; in all cases the size of the tube should be proportioned to the cubical contents of the rooms, and the external grating should be, practically, twice the area of that of the tube, as the ironwork of the grating, as a rule, diminishes its usefulness in ventilating area by about half.

If it be not possible to arrange for an extract shaft in the ceiling, a large-sized ventilator may be put in the flue over the fireplace, provided always it be fitted with talc flaps to prevent all back draught; but even the introduction of fresh air alone by some such means as those I have named will make a difference in a few minutes of many degrees in the temperature of the room.

In ordinary houses nothing has struck me as so wanting in thought as the general arrangement of the staircase. As a rule you enter from the front door into a narrow passageway, with perhaps an internal screen, with folding-doors which are rarely shut, and immediately opposite is the main staircase of the house, so that anyone, on entering, not only commands the absolute thoroughfare of the house, but sees everybody who goes up or comes down, by which the privacy of the house is materially interfered with, and the whole house is made subject to sudden draughts of cold air, which are driven up the well hole, as it is called, by the opening of the street door.

There is no reason why the ordinary narrow entrance should not be increased two or three feet, so as to make a moderate sized hall, in which you may have a fireplace, which will help to supply warm fresh air all over the house, and by a little care in planning, the first flight of stairs at least may be screened from view.

There are now very many good ventilating grates which can be so arranged as to provide, with communication from the outside, warmed fresh air, and if one of these, of sufficient size, be placed in the hall, it will not only help to ventiltae it, and to lessen the evils of heated and foul air generated by the gaslight, but can be made the means of introducing warmed fresh air all over the house.

The staircase itself, whether it be of wood or stone, should never rise more than 6½ inches to each step, and, if possible, a landing or resting place should be arranged every twelve or fifteen steps. In ordinary London houses the half-landing is sufficient, but all winders are fatal to a good staircase.

In the hall it is essential to have proper ventilation; if you shut the screen or inner hall doors, as a rule, the air becomes ventilated and heated by the gas lights, and the staircase and passages are fed with foul instead of fresh air. It is essential, therefore, that a proper supply of fresh air should be brought in independent of the door, and this can be done by means of a proper ventilating grate, or if there is no fireplace, by a simple ventilating letter box, or by some such arrangement as that which I have suggested for the dining-room; in fact, in every room throughout the house fresh air should be brought in, either warmed over hot water coils, or direct through tubes communicating with the outside, or through some of the best of the now numerous ventilating grates, which are made so as to feed the house and to mix with and counteract the evils caused by overcrowding, or by the products of combustion of gas or oil lamps.

The library may be arranged as a comfortable and quiet apartment at the back, while the front space may be devoted to the morning or general reception-room, in which all the cheerfulness which the outlook into a London street can be obtained; but do not sacrifice the entrance and hall entirely to these rooms. Give an extra foot or two to the passage-way of the house, and you will not only make it more imposing and important, but will add materially to its comfort and convenience when you receive guests, and to its healthiness, by providing a larger shaft for air circulation.

The basements of London houses are generally so badly arranged and ventilated that they add materially to the stuffiness of the houses; for, as a matter of course, all foul air is apt to fly upwards, and if the basement be foul, heated, and unhealthy, it forms the practical reservoir from which the whole house derives a large amount of its general temperature and tone, and too much care cannot, therefore, be taken in its proper sanitary arrangement. Above all, in new houses it is important that the whole surface of the ground shall be covered with concrete, and that proper damp courses shall be inserted in the walls to keep down all damp, with air bricks for ventilation under all wood floors. The basements should be, in every sense, kept dry and sweet, and all passage floors made absolutely damp proof, and the latter can best be done by putting down Portland cement concrete six or eight inches thick, finished off to a fair surface so as to form an even floor, and not, as is so often done, finished with a thin layer or covering of finer cement over the concrete bed, which by-and-bye is sure to peel off and leave a rugged and uneven floor.

The scullery should, as a rule, form part of the kitchen, where the kitchen is not used for servants' meals and sitting-room, and not be shut off, or, if so, by a low glass screen. It is merely a washing-up place, and should be under the immediate supervision of the cook, and not, as is so often the case, a small, dark, unpleasant, and ill-ventilated hole, in which unpleasant smells are supposed to be allowed. It should be as fresh and as sweet as any other portion of the basement, and although used for the washing-up and general dirty work of a kitchen, it should not be allowed to remain dirty, or to be a place in which dirty pots, unwashed and greasy plates, and vegetable refuse are left for hours to breed foulness and unhealthiness everywhere.

Line the whole of the scullery walls, and, as far as possible, those of the kitchen also, with glazed tiles, so that there be no absorption and retention of the smells which must necessarily accrue with the ordinary work of this portion of the house; bring in fresh air, provide means for extraction of foul, but do not make a pestilential corner in which all the impurities of the house are to be confined, the smell of which may find its way over the whole house.

I cannot too strongly advocate the finishing of all the walls in a London basement, so far as the working portion of it, together with the passages, are concerned, with glazed tiles; they are cleanly, absolutely nonabsorbent, reflect and give light, are easily washed, and tend to make the house sweet and healthy. The pantries and larders should be so arranged that they have continued ingress of fresh air, and should in all cases be lined with glazed tiles or bricks, so that the evils arising from the contents should not be allowed to be absorbed in the distempered walls, and to render them stuffy and unhealthy.

They can easily be made fresh by bringing in outside air, by means of external gratings and tubes, and everything should be done to provide a constant draught and sweeping out of the foul air which is naturally engendered by hanging game and uncooked meat. The shelves should be of slate, or, better still, of polished marble, so as to be absolutely non-absorbent and easily cleaned.

As in all town houses where space is limited, a large portion of the back offices derive their light and air from the small enclosed areas at the back, it is of the utmost importance that these areas should be lined with glazed bricks, to keep them as light and as sweet as possible, and as the air at the bottom is likely to become stagnant and vitiated, a direct current should be ensured up all these small light areas, by means of a large induct shaft built under the basement floor from the front area, so as to provide for constant circulation and change of air; this can be done at a very trifling cost, as the shaft may be formed of, say, glazed drain pipes 18 inches diameter, covered at each end with large open gratings made to lift up, so that the shaft may occasionally be cleared out.

In every basement a comfortable room for servants should be provided; some small sitting-room, fitted up with book shelves and cupboards, and if possible facing the street, so that the workers of the house may have some sort of spare room in which they may be at rest from their ordinary duties; for if you want good servants you must treat them as ordinary beings like yourselves; and it is hardly fair to leave them for all hours in the heated and not always pleasant atmosphere of the working rooms.

I cannot too strongly insist upon the necessity of making those about us as comfortable as possible; for I am quite sure that if we provide comfort and health for them, they will be much more capable of doing their daily work fairly, and acting well by us. Remember always that a large proportion of their lives is spent absolutely underground, and that it is essential that they should have at least one room which shall be cheerful, well ventilated, and as pleasant as we can make it. Put yourselves in their places, and do as you would be done by, and, so far as my experience teaches me, I am morally certain that the master or mistress who treats his servants as he would treat his equals, by providing well-lighted apartments for them to live and sleep in, will be more certain of keeping good servants, and of obtaining good work from them; if they are to be mewed up in ill-ventilated, uncomfortable, and unhealthy chambers for the greater part of their daily lives, you can hardly expect their work to be properly done; the atmosphere in which they live will enervate them, and bring on lassitude, and ennui, which will absolutely make them comparatively useless.

The kitchen department should, as far as is consistent with proper and quick service, be shut off from the staircase of the basement, as this naturally acts as a funnel up which all smells ascend, so that when the door at the top, which opens into the hall, is open, they escape and permeate the whole house; a swing door can generally be arranged at the bottom of these stairs, closed with one of those patent American valve springs which close the door at once without allowing it to bang.

In every house, if possible, a small coal and luggage lift should be provided; in a new house, where a back staircase is provided, it may run up in the well hole; and in any old house it may often be arranged outside the back wall, with openings on to the various staircase landings.

If attention be paid to these smaller details in house planning, I believe that in many cases the cost of a servant may be saved, for every one knows the daily labour in winter time of carrying up heavy scuttles of coals and wood, and the great addition to the work of the house by having constant journeys from the basement to the second and third floors.

The wine cellars may well be arranged in the centre of the house, as these should be kept always to a certain equable temperature, if good wine is not to be spoilt; but under all circumstances a certain amount of ventilation should be provided.

Too much care cannot possibly be taken in providing all the necessary conveniences in the way of store closets, conveniently arranged near to the kitchen, so as to reduce to a minimum the service and labour expenditure in the house; and in every case proper ventilation is easily obtainable by a little forethought on the part of the architect or builder, so that each closet and cupboard may be kept sweet and airy; there should be no dark corners in which dust and filth may be allowed to accumulate, but ample light and ventilation everywhere. It is so easy to provide for a large fresh air drain or channel from back to front, such as I have named, of every new house, out of which separate ducts may be taken to every cupboard or closet; and this main air shaft or duct should be continued into the back area, or lighting space for the back rooms, so that a constant draught shall be caused, and the air not allowed for a moment to stagnate.

The back areas are often of necessity made small; and if unprovided by some arrangement such as I have described, by which a constant current and change of air is enforced, the lower portion becomes absolutely foul and unwholesome, and any air drawn from it for ventilation is practically worse than useles.

In Professor Kerr's book on the planning of country houses, he lays great stress on comfort as an essential element in every well-planned house. Now this means good constructive care in the arrangement of the different portions of the house; all proper and requisite conveniences, light, warmth, and good ventilation everywhere; freedom from damp and smells, no smoky chimneys, and no badly-constructed floors, through which noise from above or below may be readily heard. If these essentials are not properly looked after, the finest design, the most useful decoration, the most graceful art, all go for nothing, for common-sense people are so apt to appreciate the mere material comfort and convenience of the house much more than the art work in the external elevation, or in the internal decoration of their rooms.

The basement of a house should be made perfectly impervious to damp, for if the lower storey be damp and unhealthy, it follows that the whole house is made more or less uninhabitable. If the lower floor be made perfectly damp-proof, and the walls be lined with glazed tiles or some other impervious material, the floors made dry, and thorough draught be provided from back to front, the healthiness of the whole house will be considerably increased.

I do not propose to enter upon the question of drains or sewage ventilation, as this subject has been treated by many more able lecturers than myself in these rooms, who have made it their special study, and I would only propose very briefly to refer to it. I can only insist upon every closet being thoroughly ventilated, upon all sink wastes being cut off from the main sewer, and upon all drains which must perforce be carried through the house being laid and bedded in concrete, with manholes at each end, to sweep them clean from end to end if necessary, for proper traps cutting off all drains directly from the main sewer. That all sink wastes empty clear over proper traps, and to avoid everywhere any connection with the main drains, whereby sewer gas can in any way be brought into the house.

All closets and bath-rooms should, if possible, be lined with tiles or some equally non-absorbent material, for unless this is done, they soon become stuffy and unpleasant.

To show the present unsanitary condition of many London houses, I may be allowed for a moment to draw attention to the report of the London Sanitary Association, as reported in the *Architect* of this week. The society has examined in the past twelve months over 400 houses. In nine of these the drains were found entirely stopped up, without any connection with the sewers; in 79, or 20 per cent., the soil pipes were found to be leaky, allowing sewer gas, and in some instances liquid sewage, to escape into the houses; in 93, or 23 per cent., the overflow pipes from the cisterns led direct into the drains and soil pipes, allowing sewer gas to percolate everywhere into the house; and if we may judge of the general run of houses by these few examples, we must have but small belief in the care or common sense of the ordinary householder.

This shows, practically, how little regard we have for the healthy and sanitary condition of our homes, and a want of common sense which is not only wicked to ourselves and our own immediate belongings, but to the community. As I said of the small matters which in my opinion marked the taste of the people, so I say that this want of common sense and individual care in little things which pertain to the general well-being of the house, marks the want of sense of the people in matters which make up the sanitary or unsanitary state of their dwellings.

The drawing-rooms of the house should naturally be made as cheerful as possible, and doors arranged so as to allow for the proper circulation of your guests when the rooms are crowded.

The arrangement of windows and fire-places should be carefully studied, so as to allow of sufficient wall space for furniture, and in these rooms bay and recessed windows and cozy nooks will help to make them more liveable and comfortable, whether for the ordinary occupants, or on such occasions when you receive your friends.

In my next lecture I shall have something more to say about the fitting up of these rooms, as so much depends upon the manner in which this is done; whether they be made cheery and pleasant, or cold and formal.

As a rule, I think two fire-places are a mistake, unless the rooms be absolutely divided by doors or portières, as when only one fire is alight, there is a tendency for it to act as a pump, and to draw down smoke through the other.

If the room be very long, a small coil of pipes, taken off the hot-water service, may generally be arranged under the back window, over which fresh air may enter for ventilation.

I need not again refer to this part of my subject, as what I have said in a former part of this lecture on ventilation will apply to every room in the house, for whether it be a living or bedroom, to my mind it is essential that fresh air shall be brought into it quite independent of opening doors or windows.

It is no part of the intention of these lectures to advertise the wares of any particular inventor, but I have been much struck by the manifest advantages of the "Griffin grate," which seems to me to solve, to a great extent, the difficulties of heating, ventilating, and smoke consumption at the same time; but of course this only applies to the months in which fires are necessary, and must not do away with other modes of bringing in fresh air when fires are not wanted. The grate I have named seems to provide for a continuous circulation and renewal of warmed fresh air, not, as is so often the case, polluted by contact with hot iron; and it is said to be economical in consumption of fuel, and to consume its own smoke, as far as practicable, without mechanical means. To my mind it has one disadvantage; its general ugliness of design, but this is a fault which its inventor can do away with by getting any good designer to work out a decent-looking front suitable to the mechanical arrangements of the grate; otherwise its advantages are manifest, for it not only provides for ingress of fresh air, but withdraws a large amount of foul air from the room, for the purpose of keeping the fire in a high state of combustion.

I cannot, of course, pretend in a short lecture of this kind to give any elaborate idea of the planning of every room. Street houses are more or less, by the limited nature of the ground on which they stand, bound to be very similar in plan; but they can all be materially improved by a careful study of the wants and requirements of the ordinary householder, and by a proper regard and attention to all the smaller conveniences which practically render the house comfortable or the reverse.

In every house, on every floor, means should be provided of through ventilation from back to front, so as to enable them practically to be swept clean at some time in the day, by a current of air from back to front.

As a general rule, London bedrooms are often very badly arranged; either the wall space is planned that the bed must be placed immediately opposite the light, or in a thorough draught between the door and fire-place. I am inclined to think that the modern system of arrangement in French bedrooms might with advantage be more frequently carried out in town houses, and that the rooms might be made suitable for the double purpose of private sitting as well as bedrooms. In a house in which there are several grown-up sons and daughters, it will be evident that some such arrangement will commend itself, so that each may have a private working-room for writing or studying, apart from the general living-rooms of the house. The bedroom may often, therefore, be divided up so as to form at one end—that farthest from the window—recesses for bed and washing-closet, which can be screened off in the daytime by a curtain, and the rest of the room fitted up as a sitting-room wherein the occupant may receive his or her own more intimate friends if need be.

The dressing-rooms are often made much too small. They should be of sufficient size to hold a bed if requisite, so that it may be used on occasions when, let us say, the master of the house comes home late, and does not want to disturb the wife of his bosom in the small hours of the morning; or when sickness is in the house, the room can be used for a nurse; or if the master of the house be a professional man, afflicted occasionally with sleeplessness, he would often like to take up his work instead of tossing about for hours, or lying restless and tortured with all the troubles which seemingly come in upon him on such occasions, like bad dreams in the quiet hours of the night, and become more vivid and intense as the wakefulness increases; whereas if he could take up some of that professional or other work on which his thoughts are conjuring up all kinds of troubles and difficulties, the reality would soon drive away the nightmare, and after a time sound and refreshing sleep might be induced, instead of the oft-times unrefreshing and unsatisfactory rest which comes after hours of utter wakefulness, and utter weariness of the brain and nerve.

I am quite sure that we might, with advantage, study the arrangements of our neighbours across the Channel, and provide bed recesses and washing closets self-contained within the rooms, but so arranged as to be capable of being shut off in the daytime, and leaving the room cheery and pleasant for working purposes; for in these days, when the lady part of the community as well as the men take up a certain amount of the work of the world, irrespective of the daily duties in the house, the comfortable privacy of a separate room would often be acceptable and pleasant.

The nurseries of a house should be cheerful, well lighted, and well ventilated, and made opening into each other, so that at night time the door may be left open, and the air space made as large as possible. A small pantry or scullery should be fitted up on the same floor, with sink and ample closets or cupboards for crockery and toys, and, if possible, a water-closet and bath-room close adjoining.

Of the servants' rooms, which are as a rule arranged on the top floor, I have already spoken; I can only add that they should be made as healthy and convenient as any other rooms in the house, well lighted, and being in part in the roof, care should be taken in all new houses to protect them from undue heat and cold by means of boarding and slates, by over laying the former with battens, on which the slates are hung, so that, as far as practicable, the rooms may not be rendered hot and close in summer, or icy cold in winter.

All these precautions can easily be taken in the building of a new house without any great additional cost, and will amply repay the extra outlay by the increased comfort and healthiness of the house.

Somewhere on the top floor a box-room should be provided, lighted from the roof, and this should be boarded all round, so as to prevent the damage which is often caused in plastered rooms by the boxes being placed roughly against the walls.

A cistern room with top light is also essential in every well-found house, boarded in to keep it as clean and free from dust and filth, which would be sure to foul the water; top-lighted, so as to enable the cisterns to be examined and frequently cleaned out, and out of this room access might be made to the outside of the roofs, as, with the occasional snow-storms which we have in London, it is necessary that a proper means of getting out to the roofs so as to cleanse them from snow, which, if left to melt, in all probability would cause the rain-water heads to be choked with half-thawed snow, and the gutters to be filled to such an extent as to cause the top water to overflow, and spoil the ceilings of the house.

I should like to see tiles used more frequently in London houses, where they are designed with high-pitched roofs and gables, so as to give colour to the usual sombreness and dulness of London streets. They are not only more cheerful in colour, but render the house much warmer than slates. As far as practicable, all water pipes, hot and cold, should be run up together, properly labelled and easily to be got at, in a chase or recess which should be cased over and screwed up, so as easily to be got at. The hot-water pipes, if properly felted in, would contain a sufficient amount of heat, long after the kitchen fire is out, to keep the space, even if next to an outside wall, well above freezing point.

The bell wires should all be laid in zinc tubing, the gas pipes always iron, and not what is called composition, and in no case should any pipe of any kind be rendered inaccessible by being buried in some remote corner, or in the plaster work of the rooms. The ordinary plumber and gasfitter takes no heed of how his pipes go, and what happens to them after he has fixed them in their places; his anxiety seems to be to carry them by the shortest possible way to the points at which they are to be used, and unless carefully looked after, you may be tolerably certain that they will be so hidden away that, in case of accident, you will have to pull up half the floors of your house, or knock about a good many of your walls, to discover any leakage, especially if it be in a gas pipe.

Fire risk rarely enters the head of any builder, and he is content to leave the upper floors to be cut off by the burning of the wooden attic stairs, and allow the occupants to be slowly grilled or suffocated, that is, so far as any means of escape shall have been provided by him. In all high street houses ready access should be made at various points in the attic storey to the roof, and iron ladders fixed against the party walls, so as to enable the occupants to get readily away. This has its objections, of course, as enabling thieves to pass from an empty house to any of those in the same block; but good trapdoors, well bolted and lined with iron, would practically keep them out, or at least they would make noise enough in their attempt to open them to make themselves heard when the house was occupied by the family, and in their absence, I take it that the valuables of the house would be put away in safety; and these light-fingered gentry are not, as a rule, disposed to run any large amount of risk in making raid for the purpose of carting away wardrobes, bedsteads, and other bulky furniture.

Speaking tubes should be put up in every house, or at all events one communicating on every floor, for it is quite easy to establish a simple code of signals by which one whistle calls the downstairs servants, and two for those on the nursery floors. In this manner the constant running up and downstairs to answer bells, and then to bring what is wanted perhaps up many flights of stairs, is avoided.

There are innumerable other little things which tend to increase the comfort and convenience of the house, but which it is impossible to even refer to in the time at my disposal. Suffice it, that in building a house, not only is it necessary to study the planning and design externally and internally, but a good architect or builder will take care to fit it up with all the improvements which modern skill and ingenuity have given to his hand; and if this be done, not only will the comfort, convenience, cleanliness, and healthiness of the house be materially enhanced, but the value will be so considerably raised as to render it a matter of interest to the owner to see all these smaller details properly attended to.

But, after all, every man's house is his castle, and all these views of mine as to art, science, and sanitation may be worthless; the glitter and shine of the world to so many has more charms than the reality. In the pomp and show of their surroundings many men pride themselves; their dinners are splendid and luxurious, their reception-rooms laden with the rich things of the earth, and the show and the glitter express the affectation and the imitation of others dwelling in the midst or on the confines of higher ranges of society, and in all else there is little care or thought.

As Emerson says truly, in one of his essays, "Take off all the roofs from street to street, and we shall seldom find the temple of any higher God than prudence. The progress of domestic living has been in cleanliness, in ventilation, in health, in decorum, in countless means and acts of comfort, in the concentration of all the utilities of every clime in each house. . . . The houses of the rich are confectioners' shops, where we get sweetmeats and wine; the houses of the poor are imitations of these to the extent of their ability." Avoid all such imitations; let our houses be fitted for everyday wants, for everyday requirements; let them above all be clean, be comfortable, be healthy; let there be no unfound skeletons, no tangles that are not unravelled; open up the doors, let light and air in upon the skeletons, search them out; make the houses you live in pure from end to end, and depend upon it you will have less disease of mind or body, less worry, less enervation, unless you agree with the Scriptural statement that "Ahithophel set his house in order and hanged himself." One would have expected him to have hanged himself because his house was not set in order.

Remember always that the healthiness, the comfort, and the pleasant and artistic arrangement of your houses, means the healthiness, the teaching, and the bodily and mental health of your children; the seeds of illness may be sown broadcast in your children, and the life may fail when you should be garnering the fruit.

I pray you do not treat my views as Utopian and absurd, and be not content with Hamlet's advice, so far as the ordering of your houses is concerned, to—

> "Rather bear the ills we have
> Than fly to others that we know not of."

Let me close this portion of my lectures by a quotation from Dr. Richardson's eloquent opening address at the Brighton Health Congress, in 1881, on the seed-time of health.

"By a few rules, in short, which all prudent and wise people may carry out in their own houses, the accidental perils of the seed-time may be kept from the homestead as easily as from the prison house. Let every man and wife be their own sanitarians, and make their house a centre of sanitation. Let the sun keep out the damp; separate the house from the earth beneath; connect the house with the air above; once, nay twice, a year hold the Jewish passover, and allow no leaven of disease to remain in any corner or crevice; let the house cleanse itself of all impurities as they are produced; and all the good that science can render you is at your absolute command."

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON HOUSE DRAINS AND DRAINAGE APPLIANCES. BY W. K. BURTON.

(*Continued from page* 1016.)

The Birmingham Sanitary Association, 28, Upper-priory, Birmingham, show—amongst many other appliances—"Potts' Patent Edinburgh Air-Chambered Sewer Trap." This is an arrangement to take the place of the manhole bottom with channel pipe and trap, which was described at the beginning of this article. The chief peculiarity of the appliance consists in a transverse partition dividing the chamber into two equal portions. The object of this partition is to prevent any sewer air which may pass the disconnecting trap from being drawn through the house drains by the air current which, as has been explained, passes along them. The sewer-gas escapes into the open air at one side of the division, whilst fresh air for the ventilation of the drains is drawn in at the other.

Messrs. Banner Brothers and Co., of 11, Billiter-square, London, E.C., have a large and interesting exhibit. In the "Banner system" it is usual to ventilate the drain by an inlet and outlet, as already described. The soil pipe is, however, trapped at the foot by one of Banner's patent ventilating traps, which, besides keeping back any drain gas, has provision for an inlet of fresh air, a constant current being (it is claimed) ensured by the use of a patent ventilating cowl applied to the top of the soil pipe ventilator. No traps are fixed under the closets.

Amongst the numerous appliances exhibited by Messrs. Banner Brothers, perhaps the most ingenious is their patent water-closet. I have heard this apparatus described as "a beautified pan closet," and in general appearance it has something of the aspect of this most objectionable of closets, but in reality it has none of the drawbacks possessed by the old "container" apparatus. Every part is open for inspection, and all parts are self-cleansing.

The London Sanitary Protection Association, of 1, Adam-street, Adelphi, have exhibits of "Defective Plumbing removed from London Houses," by direction of their engineers.

There are to be seen pipes of various sizes, which have served for closets, urinals, &c., and which are some of them completely stopped, others so nearly so that there is a water way of perhaps only a quarter the diameter of the pipe. There is one sample of a ventilating pipe completely choked with a bird's nest, and there are several old D-traps, more or less eaten away by sewer-gas, in one case half the trap being entirely gone. Perhaps the most interesting sample of these horrors is one which shows that in spite of all that is being said and done by sanitary reformers there are still some plumbers who cannot or will not get themselves out of the old grooves of work. This is a closet D-trap, with four or five pipes from sink, cistern, drip-tray, &c., branching into the sides of it, one entering considerably above the water line. This arrangement had been fixed in a house only a few months before the time at which the Health Exhibition opened.

THE NATIONAL "FOOD COLLECTION." BY W. STEPHEN MITCHELL.

In the southern gallery of the Exhibition, a prominent and central position is assigned to a part of the "Food Collection" of the Science and Art Department, the nucleus of which, when first formed in 1857, was located in the South Kensington Museum, and in its more developed form was removed, in 1874, to the Bethnal-green Museum.

The object of the collection, as stated in the first edition of the handbook, is "to represent the chemical composition of the various substances used as food, and, secondly, to illustrate the natural sources from which the various kinds of food have been obtained."

Since the removal to Bethnal-green, it is only the first part of the scheme, the "representation of the chemical composition of foods," which has been maintained, though, situated as the collection now is in the Exhibition, it has surroundings of a character somewhat similar to those which originally formed the second portion.

The plan adopted for representing the chemical composition of foods was what is called "displayed analysis," a suggestion made by Mr. Thomas Twining, of Twickenham, in 1856.

The term "displayed analysis" was used to indicate that actual weighed quantities of food components are displayed, instead of their quantities being stated in figures.

In analysing foods, there are two kinds of analysis that may be made, either that which is called "proximate," which ascertains the quantity of albumen, starch, fat, cellulose, and other compounds in a food; or that which is called "ultimate," in which their "proximate principles" or compounds are further analysed to ascertain the quantities of the chemical elements, carbon, hydrogen, nitrogen, and so on, which they contain.

Why both are required will be referred to further on, together with the explanation why the ultimate analyses are given "reckoned as starch." It is the proximate principles only that are shown, in the "displayed analysis" of foods. The ultimate analyses are given in figures. The distinctive feature of the scheme is this series of displayed analyses, since analyses in figures are given in many books. Keeping in consideration the popular requirements for the success of this "visual teaching," and that the chemist obtains his results in grains (437·5 of which go to the avoirdupois ounce) or in grams, while the public is in the habit of looking at food weights in lbs. and ozs., it was arranged that the proportions given should be as if a whole pound of each food had been analysed. The larger quantities were arrived at from the smaller by the simple process of multiplication. As foods themselves, and in many cases their "proximate principles," cannot be kept from disintegration in a museum, models are substituted, and materials having the appearance of the "proximate" principles are used. Looking at rice for example, there is to be seen a lb. of rice, and there by the side 2 oz. 147 grs. of water, 1 oz. 87 grs. of fibrin, 12 oz. 70 grs. of starch, 35 grs. of fat, 63 grs. of cellulose, and 35 grs. of mineral matter. The figures relating to the ultimate analysis are given thus, "for one part of flesh formers in rice, there are ten parts of heat givers, reckoned as starch."

In this way it was hoped that the public would be familiarised with the idea of looking at their foods as being what they essentially are, apart from their flavours and odours being a source of pleasure, just so many different forms of conveying to the blood for distribution those elements, in proper proportions, which according to changing requirements each person needs. As many provincial art collections have sprung from the influence of South Kensington, so it was hoped that provincial museums would have copies of the type "Food Collection." A "travelling collection," with this end in view, was formed, but very few applications have been made for it. Such were the intentions with which the collection was originated, and such was the plan adopted for the proposed popular teaching. Throughout the many modifications it has undergone, and the important changes in the designations "heat givers," "force producers," and "flesh formers," the main features have not been departed from. The collection has not, however, developed equally throughout, and while analyses of vegetables and fruits of many kinds are given, there are only two of fish, mackerel and cod, none of birds, and but few of animal foods.

Looking at the scheme as a whole, it seems evident that it was supposed that those who would consult the collection possess some knowledge of a portion of organic chemistry, not such a wide organic chemistry as we have now, but such a knowledge as, when the plan was proposed, there was good reason to believe was gradually spreading in a popular form. At the time of the formation of the collection, which is more than a quarter of a century ago, the interest taken by the reading public in such a subject was greater than at present. Prout's contribution to the celebrated "Bridgewater Treatises" had not passed into the stage of being merely of historic interest, and Liebig's "Familiar Letters on Chemistry" were much in fashion. His writings captivated. Eloquent in richness of historic knowledge, comprehensive in grasp of the many bearings the new chemistry might have, clear in stating facts without using unexplained technicalities, simple in the sequence of ideas which it was no fatigue to follow, and grand in the vast problem of life dealt with, he irresistibly carried minds of many kinds along with him. There was, too, the additional attraction of novelty. The subject was novel, there were novelties in the successive editions to which he constantly added, and it was in itself a novelty to have the writings of a German chemist simultaneously brought out in English, which at his own wish was done by his pupils Gregory, Lyon Playfair, and Blyth.

The "Food Collection" was practically a series of illustrations of those parts of the "Familiar Letters" and "Animal Chemistry," which referred to the food of man. Far different in scope from such books as Sir Thos. Elyot's "Castel of Health," Henry Butte's "Dyet's Dry," Tobias Venner's "Via Recta ad Vitam Longam," or Dr. Arbuthnot's Essay, his works, which dealt with the chemistry of foods, were kept strictly to chemistry. Digestion and the moral effects of different foods on different constitutions were but incidentally alluded to. The mechanical and physical outcomes of the chemical separations and unions of the component elements of food were the theme. His keynote was, "all vital activity arises from the mutual action of the oxygen of the atmoshpere and the elements of the food." The older writers could not have dreamed of approaching the subject of the actions of foods by such a road as this; or if any of them, from seeing Mayow's forgotten account of his experiments, had their day dreams, they remained mere dreams. Looking at the course of events as they actually followed one another, we know that it was not till 1752 that Black arrived at the explanation of what carbonic acid is, not till 1772 did Rutherford separate nitrogen; it was 1774 before oxygen was known as a separate air, and it was not till after Cavendish in 1784 had shown that water is a chemical combination of hydrogen and oxygen, that the generalisations of oxidations was made by Lavoisier; not till the interaction of these elements and compounds was known could Thénard have opened up the chemistry of organised beings. Liebig, from attending his lectures in Paris in 1823, saw as from a newly-discovered coast hill a whole country of illimitable extent inviting exploration. All was fresh for those who should push forward first. He was both original in his own work, and in the generalisations he based on that work, combined with the work of others; and even his popular expositions have the indefinable charm of individuality. Now he is but little read, probably because it is known that some of his inferences have had to be modified, and on many points he is "out of date."

The practical result is that the "Food Collection," which was a carefully worked out illustration of some of his work, remains to many little more than an elaborate set of calculations, seeming to offer no more interest in daily life than a chemical history of the stones of which a town is built, or of the granites or porphyries which adorn it.

In considering the collection, and what practical use it may be, this cannot be lost sight of without the risk of mistaking its real purport, that it is confined to showing, with the greatest accuracy attainable, what is the chemical composition of foods. If to any student it appears an unintelligible collection, that is because he is not possessed of that part of chemical knowledge requisite for understanding it. If to any it appears practically useless, that is because there is not possessed that knowledge requisite for using it. It was, at the time of forming the collection, supposed that such knowledge was possessed or would be easily obtained from reading Liebig, and the plan has not been altered. Therefore, it is that in the handbook which reproduces the tables of analysis for people to have for reference at home, while definitions are given of the sense in which the terms "force producers," "heat givers," and "flesh formers," are used in connection with the collection; still some knowledge of the basis of organic chemistry, obtained from some other source, is pre-supposed, and, as the *Times* of January 19th, 1877, pointed out, "students rather than the general public" were in view.

The kind of knowledge pre-supposed can be briefly indicated, and it will be seen that though, in most text-books, organic chemistry comes after inorganic chemistry, it in no way follows that inorganic must be "read up" before proceeding to organic, so far as to be able to understand the meaning of the collection.

This was early found as one food after another was analysed. They all contain compounds of carbon, hydrogen, and oxygen; some also contain compounds of these and nitrogen. Liebig divided food compounds into two great groups, those which contain nitrogen, and those without nitrogen. This distinction into nitrogenous and non-nitrogenous compounds is retained, as it is based on fact, though their relative functions are understood differently from what they were in the earlier period of Liebig's writing. Nitrogenous compounds also contain sulphur, though the special function of this, if it have any at all, is not known. There are other elements also present with these in small quantities. About the functions of most of these we are still ignorant.

As we at present understand the chemistry of food, the interest centres on the amounts of nitrogenous and non-nitrogenous compounds as it did present at the time of the appearance of Liebig's "Animal Chemistry," 1841. He then wrote "The supply of heat lost by cooling is effected by the mutual action of the elements of the food and the inspired oxygen which combine together. . . . . . It matters nothing what intermediate forms the food may assume, what changes it may undergo in the body; the last change is uniformly in conversion of its carbon into carbonic acid and of its hydrogen into water." He had drawn the inference that the production of heat in the body was effected by the process of oxidation independent of any force production manifested by the action of muscles. This he assigned to another cause. The destruction of muscle tissue. "It is obvious that the work performed consists in the waste or consumption of bodily parts." It is difficult to picture to the mind the kind of changes Liebig supposed took place when he speaks of work performed consisting "in the waste of the substances of muscle or nerve." This, however, is of only historic interest, for in 1866 Professor Frankland, in a lecture at the Royal Institution, "On the Origin of Muscular Power," showed, as the result of calculations based on observations alluded to further on, that the oxidation of carbon into carbonic acid, and hydrogen into water, not only supplies heat to the body, but also the source of muscular power, and since then the disentegration theory of muscle tissue has been modified. This is the most important of Liebig's generalisations that further research showed to be incorrcct. [The nomenclature used in the collection was modified about 1868 or 1869 in accordance with the newly adopted view.] The importance of the oxidation of carbon and hydrogen was not only as great as Liebig took it to be, but greater; not merely keeping up warmth, but also supplying muscular power. The title flesh formers is still retained as a fitting name for the nitrogenous compounds, since muscle is not formed without them, though they are also heat givers and force producers, as the carbon and hydrogen in them appears to be available, as if they were carbon compounds, especially when carbon compounds are not present in sufficient quantity. Experience proves that in severe hard work they are of great importance.

Liebig, besides pointing out oxidation of foods as "the first condition of animal life," applied himself to ascertain the relations between the quantities of oxygen inspired, the quantities of carbon and hydrogen taken in as food, and the consequent quantities of water and of carbonic acid formed. He here laid the foundation of the study of the quantities of the elements used as food, as distinct from the former rough calculations in dietaries of the weights of meat, bread, vegetables, &c., consumed. In the hands of subsequent observers following his lines, the subject has attained considerable exactness.

His own inquiries into the quantities of different kinds of food, consumed by different classes of people, were numerous. For accuracy, he relied much on the known quantities served out to troops as rations. He then reduced the values of different compounds to some convenient standard of comparison. For example, "The fat of butter and that of flesh contain carbon and hydrogen very nearly in the same relative proportion as starch and the various sugars. These differ from fat chiefly in containing more oxygen. It is easy in our calculations, by adding oxygen, to convert a given amount of fat into starch. In this way we find 10 parts of fat are equivalent to 24 of starch. In like manner, by deducting a certain amount of water, we can reduce milk-sugar to its equivalent of starch, and by thus reducing all the non-nitrogenous elements of food to their equivalent value as expressed by starch, we can compare them."

In ways such as this, he could readily compare the total amount of carbon and hydrogen taken in in a day, in a form available for use. The form has to be considered, since carbon, hydrogen, and the other elements of food are not available in the form of elements, but only as compounds. This method of comparison is still used.

Some foods contain so large a per-centage of water that they are of small value as food. This is especially the case with fruits. For example, apples contain 83 per cent., gooseberries 86, peaches 85, onions 91; of other vegetables celery contains 93 per cent., cucumbers 96, and rhubarb 95. So a pound of any of these would contain very little carbon, hydrogen, or nitrogen. Taking Liebig's method of comparing food values, is is seen that sixteen pounds of cabbage would furnish only as much "nourishment" as a quarter of a pound of meat. Not only was the amount of water found to be very different in different foods, but the amount of carbon, hydrogen, and nitrogen varied. Liebig pointed out, having reference probably to the old theory of transmutation, that if the requisite amounts of carbon, hydrogen, and nitrogen are not present in the foods taken, these amounts cannot be in the body to do the work they have to do.

Hence the practical need of determining these two things with accuracy.

1. The amounts that are needed.

2. The foods—and the quantities of the foods from which the amounts can be obtained.

The two lines of inquiry are quite distinct. For example, if the knowledge of the composition of turnips were of no use in regard to the food of man, it still would be of use for cattle feeding. The knowledge of the composition of any particular food may lead to its more general adoption or disuse. In England potatoes are far more largely used than oatmeal. Yet potatoes have but 17 per cent. of carbon compounds, while oatmeal has 73. Since Liebig led the way, so much has been done, that it is the results of many hundreds of analyses of different samples of different foods which are given in "Tables of Analyses." Owing to variations in conditions of growth, they vary somewhat, and figures selected represent the mean of the many analyses made.

In the national food collection the proportions of the carbon compounds present are stated not only in their actual quantities, but also reckoned out to their equivalent values expressed as starch, on Liebig's plan.

As to the second consideration, the quantities needed, Liebig pointed out how these varied according to temperature, but remarkable advance has been made on his conclusions with regard to the variation in amounts needed in relation to work done.

Investigations have been carried on by two distinct methods.

1. The one that which Liebig first adopted has been to note the different quantities of food eaten by people taken in groups according to their occupation, and the amount of work they do. The most exact of these inquiries have been on large numbers of men dieted uniformly under control, soldiers, inmates of workhouses and prisons, while the most varied, but necessarily not so exact, have been such as Dr. Edward Smith's enquiries made for the Privy Council during 1863 and 1864, on the diets of "distressed operatives," and "the food of the poor labouring classes of England." The quantities of food taken are then calculated out into the amounts of carbon, hydrogen, and nitrogen they contain, and with analyses of foods, ready at hand, this is merely a matter of arithmetic.

Such results can be of value when the averages are based on a wide number of observations. Some margin must be allowed for the variation of the compositions of the foods they eat according to localities and season.

One advantage of this method is that the returns can be obtained without any apparatus, and without the collector having any training in experimenral research. This may be called the "method of intakes."

2. The other method is just the reverse, taking the body's expenditure instead of its income as the basis. This method requires apparatus for collecting the carbonic acid gas, the water, and the urea given off. Some experiments Dr. Edward Smith made on himself were on the relative amount of carbonic acid given off during various degrees of exertion Pettenkoffer carried out experiments on a watchmaker, who worked for three days in a case, the amount of food and oxygen admitted to him, and the amount of carbonic acid gas and water, &c., given off, being accurately weighed. The work he did during the three days was varied, so as to ascertain the relation between work, and the amount of oxidation that took place. The celebrated ascent of the Faulhorn by Professors Fick and Wislecenus, and other observations by others, have been made with the same end in view. The conclusions arrived at, not all at once, but by correcting and checking one observation with another, have been:—

(1.) That the amount of carbonic acid given off (that is, the carbon oxidised), and of the water formed (the amount of the hydrogen oxidised), varies with the amount of work done.

(2.) That, reckoning the amount of hydrogen into its equivalent of carbon (taken at three times), the average quantity of carbon oxidised in the twenty-four hours is 4,900 grains.

(3.) That the quantity of nitrogen used during the same period is 300 grains.

(4.) That by the first of the two methods it is found the amount of nitrogen has to be increased considerably when hard work is done. The chemico-physiological explanation of this is still a matter of uncertainty.

These facts being known, the practical problem in a dieting which shall supply amounts of carbon, hydrogen, and nitrogen in proportion to work done, but not in such unnecessary quantities as to lead to the overstorage of fat or to energy which will manifest itself in insubordination or wanton mischief, is to select foods in such proportions that neither the nitrogen nor the carbon shall be in excess or deficient. The tables of some public dietaries are drawn up with this end in view, and examples of some (showing only weighed quantities of carbon and nitrogen) are exhibited in a case at the end of the series.

The aim of the collection is to enable people at home to regulate their diet as the public dietaries are regulated. They must first know their wants, and the analyses already prepared, show how the wants can be most efficiently supplied.

The last edition of the hand-book expresses that, after going over the subject the reader will be in a position so to adjust the proportion of the several articles of food to one another, so as to construct useful dietaries in which there will be no marked excess of carbon over nitrogen, or of nitrogen over carbon, that is, no marked excess beyond the quantities respectively required for each element. The nearest approach to working this out are the tables of Dr. E. Smith, given in his report alluded to above.

It is for the information of hard-working artisans and labourers that the work-power of various foods is expressed in foot-pounds. Assuming a pound of any food to be duly digested, assimilated and oxidised in the body, there is a maximum of muscular power which it can produce. It does not necessarily follow that it will produce that amount, since digestive power of assimilation or some personal defect may interefere with its doing so. But it is of use to know that not more than a certain amount can be obtained, and it is, therefore, useless to expect to obtain for example as much power from a pound of potatoes as from a pound of peas, or from an ounce of tea as from an ounce of cocoa. The standard of measurement—the foot-pound, that is one pound raised one foot—is a convenient one, and it is not unfamiliar to engineer mechanics. The calculations are based on the thermo-dynamic experiments of Prof. Frankland, made in 1866.

The acquisition of a knowledge of the chemical composition of foods is not a mere fad, as, if rightly applied, it may have very useful results. For example, when in 1872, five hundred miles of rails on the Great Western Railway were shifted in a fortnight, 3,000 men were employed, working double time. The men, as usual, carried their own supplies of bacon, bread, cheese, cocoa, &c., but in addition to this the company made arrangements for a supply of oatmeal and sugar. Oatmeal has 16 per cent. of nitrogen compounds, and 73 of carbon compounds. Temporary fire-places were built along the line, a cook was provided for each gang of twenty-men, and a pound and a-half of oatmeal, with half a pound of sugar, was served out, well cooked, to each man, during each twenty-four hours. The men not only liked this form of taking extra nitrogen and carbon, but during the whole of the work no case of illness occurred in spite of the severity of the labour.

It is well-known that when the British navvy is matched against those of other nations on a hard-working job, he generally does more real hard work than they can get through. A contractor, for some railway work in Sicily, found progress retarded by the relatively small amount of work the Sicilians did. It struck him they did not eat meat enough, as in their thriftiness they would not spend the money for it. He adopted the plan of partly paying them in what was really needed for the work, more nitrogen and carbon in a compact form, and as meat was obtainable, he paid partly in meat, instead of money that might have been spent in other ways. The result was a marked increase in the amount of work they did, which came very nearly up to the average of the British.

EXPORT ASSOCIATIONS ON THE CONTINENT.

While the marked development of British export trade within a certain period has been mainly due to the activity of private enterprise, the efforts now being made by various continental nations to extend their trans-oceanic commerce, are in a certain degree promoted by associations, in which the needful financial and industrial resources are combined. Thus, according to the *Journal de Roubaix*, an export company has been formed at Brussels, with a capital of £100,000, for the purpose of encouraging trade in Belgian products by undertaking financial responsibilities, and by exploring distant markets in the interests of Belgian industry. Similar organisations are said to be in contemplation as regards French export trade, but the suggestion is made by the journal in question that manufacturers should unite in forming small groups, the members of which make different classes of goods, and that such combinations should undertake the execution of the projects referred to.

Past experience has not been uniformly favourable to schemes of this description, which seem (according to the *Economiste Français*) to have been tried in Germany under apparently favourable circumstances.

An association was formed at Stuttgart in 1853, with a capital of about £20,000, of which a quarter was furnished by the State. It paid during the first three years of its existence dividends at the rate of 4 per cent., and was liquidated about 1868, there being not much more than half of the original capital available for distribution amongst the shareholders. A fresh effort was made in 1881, and an export sample collection has been organised, to which 500 members have contributed. An extensive export association was formed at Berlin in 1878, which has 3,000 members, and has recently opened an export bank, with a capital of £12,500. A financial organisation, on a much more extensive scale is also spoken of, the capital of which would be £2,500,000, and which is to some extent originated by Prince Bismarck. An Austrian society, founded in 1871, has arrived at satisfactory results, principally in Persia, India, and South Africa. In connection with this association and others of a similar kind, an information office has been opened at Vienna, for giving exporters all needful information as to the wants of foreign countries, rates of freight, and other matters of utility.

THE PRECIOUS METALS IN MEXICO.

In 1808, the population of Mexico consisted of six millions; it rose in 1856 to 7,829,000, and is now estimated to exceed twelve millions. The greater part of the inhabitants belong to the indigenous race of Mexican Indians, who retain their original dialects, although Spanish is the official language of the country.

The state of Chihuahua is considered the richest in the Mexican Republic. It is divided into twenty cantons, in which there are 127 mining districts; and in these districts 575 mines have been worked since the Spanish conquest.

Indeed, the greater portion of the gold and silver mines that are now in action were also worked at the time of the Spanish conquest. While the country was under Spanish rule, that is to say from 1537 to 1821, the mines produced gold to the amount of £13,753,682, and silver to the amount of £417,253,940. Since that period, and up to 1880, the mines produced gold to the amount of £180,131,662. The total value of the gold and silver produced between 1537 and 1880 is £621,022,042, the average annual production being to the value of £1,812,000. Compared with this, California, Nevada, Colorado, Utah, Dakota, Montana, Idaho, Oregon, Washington, New Mexico, and Arizona, have produced the precious metals from 1848 to 1882, of a total average value of £13,560,000; and a large portion of this was obtained from territory which formerly belonged to Mexico.

It has been found necessary to abandon mines, even when yielding more than nine troy pounds of silver to the ton of ore, on account of the difficulty of transport and want of labour; but with systematic mining and economical methods of reducing the metal, added to the necessary capital and improved means of communication, Mexico would regain the foremost position among countries producing the precious metals which she held up to 1848. The completion of the central railway, which traverses the state of Chihuahua, will contribute towards bringing about this result. It has often been said that there is no coal in Mexico, and that this want will prove an obstacle to the development of the natural resources. This, however, is not the case, as the Government has published an official list of localities where coal deposits exist. Petroleum is also found in large quantities.

PRIZES OF THE SOCIETE D'ENCOURAGEMENT.

The Société d'Encouragement pour l'Industrie Nationale, founded in 1801, and declared of public utility by a decree of 21st April, 1824, has determined the subjects for the competition of 1886. The large medal, bearing the image of Jean Goujon, will be devoted to Architecture and the Fine Arts. The following have been the recipients of this prize:—1870 (Commerce), M. F. de Lesseps; 1870 (Chemistry), M. H. Sainte Claire Deville; 1872 (Agriculture), M. Boussingault; 1873 (Physics), Sir Charles Wheatstone; 1875 (Commerce), Mr. Jacques Siegfried; 1876 (Mechanics), M. H. Giffard; 1877 (Chemistry), Mr. Walter Weldon; 1880 (Fine Arts), M. Charles Garnier.

The Grand Prix of the Marquis of Argenteuil (12,000 fr. = £480) for the inventor or discoverer of the improvement most useful to French industry, especially for those objects in which France has not obtained superiority over foreign countries, either as regards the quality, or the cost of production, of the articles manufactured. This prize has been successively awarded, in 1846, to M. Vicat; in 1852, to M. Thoreul; in 1858, to M. Heilmann; in 1864, to M. Soral; in 1870, to M. Champonnois; and in 1880, to M. Poitcoin.

Mechanical Art.—1,000 fr. (£40) for the utilisation of the power absorbed by brakes.

Chemistry.—3,000 fr. (£120) for the manufacture of black diamond; and 4,000 fr. (£160) for the artificial production of fatty substances and wax.

Agriculture.—1,000 fr. (£40) for the bringing into cultivation of waste land by fruit trees.

Further information may be obtained at, and descriptions should be addressed to, the offices, 6, Place Saint-Germain des Prés, Paris.

The first lecture of a new course of lectures on Fuel will be given at the Evening Class Department of King's College, London, on October 6, from 7 to 8 p.m., by Mr. W. G. McMillan, Demonstrator in Metallurgy. This course is intended to include the subjects required for the City and Guilds of London examination in Fuel.

General Notes.

Australian Coal Production.—In 1829 the quantity of coal raised in New South Wales was 780 tons, valued at £394; in 1857 the quantity was 210,434 tons, valued at £148,158; in 1858 the coal exports of New South Wales amounted to 216,397 tons, valued at £162,162; in 1883 the quantity was 2,521,247 tons, valued at £1,201,941. The total quantity exported during the twenty-six years, 1858-83, was 27,095,302 tons, valued at £13,536,823.

Proposed Technical School at Elbeuf.—The *Jacquard* calls attention to the efforts now being made by the Industrial Association at Elbeuf to establish a technical school which would be on a level with the institutions of a like description at Bradford and Leeds. The scheme has been drawn up in a very detailed form, and embraces a three years' course of study. There will be eight professors, with a competent body of technical assistants. The general expenses would amount to £2,000 a-year, and the necessary machinery and appliances would cost £8,000, the erection of a suitable building being estimated at about £3,000 more.

THE LIBRARY.

The following works have been added to the Library since the last announcement:—

Amos, Sheldon, M.A.—A Systematic View of the Science of Jurisprudence. (London: Longman, Green, and Co., 1872.) Purchased.

Brereton, William H.—The Truth about Opium. (London: W. H. Allen and Co., 1882.) Presented by the Author.

Britten, F. J.—The Watch and Clockmakers, Hand-book, Dictionary and Guide. (London: W. Kent and Co., 1884.) Presented by the Author.

Browne, Lennox.—Science and Singing. (London: Chappell and Co., 1884.) Presented by the Author.

Burt, Major T. Seymour, F.R.S.—The Æneid, Georgics, and Eclogues of Virgil. Three vols. (London: Effingham Wilson, 1883.) Presented by the Translator.

Eastlake, Charles L.—Notes on the Principal Pictures in the Old Pinakothek at Munich. (London: Longmans and Co., 1884.) Presented by the Publishers.

Ewing, R. M.—The School and College Handbook of Agriculture. (London: W. Swan Sonnenschein, and Co., 1884.) Presented by the Publishers.

Godard, John George. — George Birkbeck, the Pioneer of Popular Education. A Memoir and a Review. (London: Bemrose and Sons, 1884.) Purchased.

Greenwood, William Henry.—Steel and Iron. (London: Cassell and Co., Limited, 1884.) Presented by the Publishers.

Holland, Thomas Erskine, D.C.L.—The Elements of Jurisprudence. (Oxford: Clarendon Press, 1882.) Presented by the Author.

Holtzapffel, John Jacob.—Turnery and Mechanical Manipulation. Vol. V. (London: Holtzapffel and Co., 1884.) Presented by the Author.

Jagnaux, Raoul. — Traité pratique d'analyses chimiques et d'essais industriels. (Paris: Octave Doin, 1884.)

Local Government Board.—Twelfth Annual Report, 1882-3. (London: Eyre and Spottiswoode, 1883.) Presented by the Medical Officer.

McLaren, Walter S. B., M.A.—Spinning Woollen and Worsted. (London: Cassell and Co., Limited, 1884.) Presented by the Publishers.

Ormerod, Eleanor A.—Guide to the Methods of Insect Life. (London: Simpkin, Marshall and Co., 1884.) Presented by the Author.

Perry, John, M.E.—Practical Mechanics. (London: Cassell and Co., Limited, 1883.) Presented by the Publishers.

Pollock, Frederick, M.A., LL.D. — Essays in Jurisprudence and Ethics. (London: Macmillan and Co., 1882.) Purchased.

Scribner, G. Hilton.—Where did Life Begin? (New York: Charles Scribner's Sons, 1883.) Presented by the Author.

Smith, Robert H. — Cutting Tools Worked by Hand and Machine. (London: Cassell, Petter, Galpin and Co., 1882.) Presented by the Publishers.

Solly, Rev. Henry.—Re-housing of the Industrial Classes. (London: W. Swan Sonnenschein and Co., 1884.) Presented by the Publishers.

Springinühl, Dr. Ferd.—Italiens Weine und die concentration des Mostes im vacuum. (Frankfurt-a-M.: James Weller, 1884.) Presented by the Author.

Thompson, Silvanus P., D.Sc.—Dynamo-Electric Machinery. (London: E. & F. N. Spon, 1884.) Presented by the Author.

Wallace, Roger W.—The Patents, Designs, and Trade-marks Act, 1883, with Introductory Chapter, Explanatory Notes, Notes on Decided Cases, &c. (London: William Maxwell and Son, 1884.) Presented by the Author.

Watt, Alexander.—The Art of Soap Making. (London: Crosby Lockwood and Co., 1884.) Presented by the Publishers.

Wharton, C. J.—Electricity as a Motive Power, by Count Th. du Moncel and Frank Geraldy, translated and edited with additions by C. J. W. (London: E. and F. N. Spon, 1883.) Presented by the Editor.

Winchell, Alexander, LL.D. — World-Life or Comparative Geology. (Chicago: S. C. Griggs and Co., 1884.) Presented by Messrs. Trübner and Co.

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All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE BUILDING OF TOWN HOUSES. THEIR ARRANGEMENT, ASPECT, DESIGN, AND GENERAL PLANNING.

By Robert W. Edis, F.S.A.

[The right of reproducing these lectures is reserved.]

Lecture III.—Delivered March 3rd, 1884.

Fittings, Planned Furniture, Constructive Decoration.

In my former lectures I have endeavoured to point out, in the brief space of time at my disposal, some few of the evils which so many of us have to endure in modern-built houses, and to suggest means for their removal or amelioration.

I have sought to show that good design in external elevation, and picturesqueness of treatment, are not incompatible with good internal arrangement, or with the comfort, sanitation, and common-sense treatment of the house. I have done my best to expose the barbarisms and vulgarities of so-called speculative building ; to point out the inconsistencies and lowering influences of having our streets and squares carried out in one dreary "dead level of unimaginative uniformity;" and in this my third, and last address, I hope to offer to those who are furnishing old, and to those who are building new houses, some suggestions which may commend themselves as worthy of carrying out, and as tending to the better ordering, greater comfort, and more artistic homeliness of the rooms we live in.

In the early portion of this century, to quote Mr. Redgrave, R.A., in his pleasant little book, "The Manual of Design" :—

"While our architects were content to put columns that supported nothing, roofs that covered nothing, and parapets and balustrades that protected nothing ; to contrive sham attics to hide the construction of ugly roofs, to make us peep through the scroll-work of a frieze, or the channels of a triglyph, instead of a window, or to make the pedestal of a statue into a chimney pot, how was it likely to fare with furniture which became a sort of toy architecture? Was it to be wondered at that all constructive shams were increased tenfold when used as ornament? Was it surprising that Grecian stone altars formed our sideboards, Roman temples our cabinets, sarcophagi our cellarets and wine coolers, or that our harpsichords stood on lyres instead of legs; that constructive truth, in short, was wholly and entirely disregarded, in order that some favourite type might be reproduced? Was it to be wondered at, moreover, that men broke loose from these dead shams, and getting sick of these classicalities, entirely deserted constructive truth and symmetrical arrangement ; went mad first after Rococoism, and then, in our own days, after picturesque naturalism, and that the very revolution of taste produced the wildest contradictory faults."

While I want to see our homes artistic, that is to say with decoration and furniture good in design and taste, and harmonious in colour, and not overlaid with trashy decoration, or fitted with useless lumber, I hold that true art in the house means the practical rendering, in good taste and pleasant guise, of all the absolute necessities and requirements of modern life, and all domestic art is bad which ignores the purposes to which the furniture, decoration, or general belongings of a house are to be put. Comfort, utility, and good sense should go hand-in-hand with the internal finishing of every house.

Men take pride in the building of their houses, and spare no pains or expense in seeking to make them comfortable and convenient internally, and artistic and beautiful in their external design ; but they seem so often to forget that the true and healthy decoration and artistic furnishing of the building should be considered and thought out as part and portion of the whole fabric, that they cannot properly be separated, and although, to a certain extent, eclecticism may, and must, prevail in the smaller items of moveable furniture, and in the numerous necessary articles which make up the comfort of the various rooms, the general scheme of decoration and fitting up their houses should form a "part of an harmonious whole, in companionship with other art." That, in fact, as Mr. Ruskin wrote in one of his eloquent lectures, in one of his early books, "The Two Paths:"—

"The only essential distinction between decorative and other art is the being fitted for a fixed place, and in that place related, either in subordination or in command to the effect of other pieces of art; and all the greatest art which the world has produced is thus fitted for a place and subordinated for a purpose."

We build our houses ample and luxurious, and having built the outside shell, are apt in our pride to say:—

"I built my soul a lovely palace house,
Wherein at ease for aye to dwell,
I said, O! soul make merry and carouse,
Dear soul, for all is well."

And often in the furnishing and fitting up of our individual palace, we cram it with heavy, useless, and unartistic things, which suggest another verse in the same poem:—

"But in dark corners of her palace stood
Uncertain shapes; and unawares,
On white-eyed phantoms, weeping tears of blood,
And horrible nightmares!"

The "horrible nightmares" being emphasized in the motley crowd of ofttimes hideous lumber brought in to fill our rooms, without thought of how they will harmonise with the palace we have reared, or accord with the comfort and necessities of our home life.

In recent times, in the ordinary furniture of our houses, we have brought in, it is true, a new order of things, and to a certain extent gone back to the designs of Chippendale and others, and have made the designer and manufacturer work up to the improved taste of the people; but it seems to me we are yet labouring somewhat in the dark, and do not exercise that forethought and common sense in the fitting up of our houses, which combined would, I believe, add so materially not only to our comfort, but to the general sanitation of the houses we live in.

We are still content to look upon the furnishing of our rooms as more or less the purchasing of various ready made goods, which can be stored and used for a while, and removed as occasion may require; and in doing this are apt to get furniture and fittings which, like ready-made clothing, are often misfits, and in part only answer the purpose for which they are bought; and are not inclined to consider with any amount of care the requirements of the various rooms, and to construct our fittings to suit those requirements, and to make them not only useful and ornamental, but part and portion of the rooms we live in, in harmony and keeping with the general design, and carrying out those views which are considered necessary for proper sanitation in all well ordered buildings. In fact, we complete our buildings without thought as to their internal fitting up, and when the rooms are painted, papered, and whitewashed, we treat the filling of them with furniture as something quite apart; and as a consequence, the care and thought bestowed in their design and decoration is often materially marred by the character of the furniture with which we fill them. More than this, by this want of thought, there is often much increased expense in the building which, by a proper and due regard for its final fitting up and completeness for occupation, might have been avoided; for instance, window recesses, which can be well fitted with box or ottoman seats, answering the double purpose of comfortable resting places, and store places for papers, clothes, and other household goods, are finished with panelled and moulded wooden backs and skirtings altogether unnecessary.

Recesses in rooms, which naturally suggest themselves as proper places for fitted cupboards, are completed with mouldings and skirtings which have to be removed, or increase the expense of the fitting by the labour and time involved in "scribing," as it is called, the fitting to the mouldings, which are not only not wanted, but are absolutely in the way. Window shutters and fittings are often so arranged that when the necessary blinds or curtain poles are fitted to them, the shutters will not open; and when cupboards are provided by the builders, they are practically useless, or so arranged, that their tops form dust traps and spaces for lodgment of dirt and filth, which lies for months before it is cleaned away, and of necessity helps to make the rooms stuffy and unhealthy.

If there is any truth that all fittings and materials which "catch dust, keep dusty, hide dust," and on being "swept or shaken, yield clouds of dust," are bad, then I will ask any of my readers to take an early opportunity of inspecting the tops of their bookcases, or wardrobes, cupboards, or other heavy furniture with which their rooms are filled, and I fancy they will be somewhat startled by what they will see, and believe that a great deal of these moveable fittings, while filling up the wall space, and difficult to move even at the periodical autumn and spring cleanings, should be got rid of, if possible, as not only unhealthy, but absolutely uncleanly; for it must be remembered that a certain amount of this dust and dirt gets disturbed by every draught and inrush of air from open windows, and mixes itself with the air we breathe, and falls upon and pollutes everything in the room, carpets, curtains, clothes, and coverings of all kinds.

Most people require now-a-days that there shall be some other means of ventilating their rooms beyond merely opening doors and windows, and all this work should be constructed and arranged as part of the furniture and fittings of the house; that is to say, in all newly-built houses, any arrangement for bringing in fresh air behind grates or through tubes should not require the cutting away and making good, and therefore double expense, usual wherever any system of ventilation is attempted to be carried out; the tubes, instead of being after-thoughts, should be properly arranged and thought out, and form part of the decorative construction of the rooms, or they will prove anything but artistic additions, and will tend to damage the general pleasant and harmonious effect of the rooms.

Everyone now-a-days hangs pictures on the walls, or divides the wall spaces by mouldings which form picture or chair rails. As a rule the builder has taken no thought of these requirements; the walls have to be cut about and plugged to ensure the proper fixing of the mouldings or rods.

Most people have a certain number of books, which they want to arrange in some convenient place in the library of the house; either moveable bookcases have to be provided for these, or if recesses be fitted up, there is a good deal of extra expense and damage caused by cutting away the walls, cornice, and skirting; and finishings, which have all cost money, have to be cut away or covered up; so that practically double expense is incurred.

I hold that the architect should consider all these matters in the general planning of his rooms, that in fact, as far as possible, the question of planning furniture and fitting up recesses, window and other openings, should form part of his original design; and that in many rooms of the houses, constructed and useful furniture may be designed to suit the different requirements of the various rooms, which, if thought out in the planning of the house, would not only save money being spent in finishings, which would then be unnecessary, but would provide a large amount of the heavy furniture of the house, such as wardrobes, bookcases, buffets, boxseats, and other usefu fittings, at considerably less cost than the bought goods, and in accord and harmony with the design of the house.

Most people are alive to the necessity of proper drain sanitation, and in taking a house, every common-sense person bargains that the drains and sanitary arrangements shall all be perfect; but the builder rarely thinks how easily he might ensure constant flushing and cleaning out of the house drains, by collecting the waste water from rain-water pipes, baths, and cisterns, or even housemaids' sinks where generally fairly clean water is carried away. All this is allowed to waste and filter slowly, perhaps, over open traps, into the various drain outlets. At the cost of a few pounds one or more of the many flushing tanks now invented might be placed in the front or back area or both, into which the waste water from baths, housemaids sinks, cisterns, and rain-water pipes might easily be collected; and, these tanks being automatic, would, as they were filled, continually let loose a great body of water, back and front, so as to sweep clean, two or three times in the day at least, the whole of the main house drain, and thus the water now wasted would be made useful for sound sanitary purposes. I do not say these flushing tanks are necessary where the general drainage is really sound, but I do say that they would be found constructive fittings which would materially tend, without difficulty or expense, to the daily scouring out of the drains, and to the better sanitation of the house.

Whenever a bath is provided, it is generally left open, and forms a receptacle for dirt and dust, which is not always cleaned out when the bath is filled. I suggest that the bath be slightly lowered into the floor, and fitted with a hinged top, about seat high from the floor, so as to keep the bath clear of dirt, and when not in use, make it answer as a table or seat. A bath-room is often fitted up with cupboards for linen, and if the hot-water cistern be placed in the room on the floor level, or sufficiently high for use, the linen cupboard, with lattice shelves, might easily be fitted over it, with closed doors of course, by which the linen would always be kept properly aired; and if the room be lined with tiles, as I suggested in my former lecture, there would be no fear of damp or moisture from steam condensing on the walls.

The bath should be formed in a recess, with tile lining all round and overhead, and the recess might then be fitted with cupboards over, and drawers and useful shelves at one end, so as to provide storage room for a large amount of spare clothing and linen, for which it is often so difficult to find room.

In the bedrooms, which I hold should, more or less, in all town houses, be arranged so as to form sitting as well as sleeping rooms, why cannot we have, say, one side of the room fitted up with wardrobe drawers, bookshelves, boot, and medicine cupboards, all designed as part of the internal finishing of the room, carried up to the ceiling line, with top cupboards for store places for clothing which is not immediately required. If some such fitting as this were arranged on the fireplace side of the room, where generally the chimney breast projects, leaving deep recesses on either side, the mantelpiece might form a central feature, simply designed with ornamental tiles next the iron grates, and enclosed in plain wood mouldings with wide shelf for ornaments; a good looking-glass let into a panel over, so as to lighten up the room, and be used for dressing purposes, with shelves on either side for books or dressing paraphernalia; the fire opening enclosed with a glazed faïence or marble fender, and the woodwork finished in general keeping with the other work in the room; the skirting of the room made to run round the fitting as a base, and the ceiling cornice carried round and enframing the whole. Such a fitting as this might have the ends formed into hanging closets for dresses, with long looking-glass panels let in; and in other parts arranged with drawers, boot cupboards, enclosed trays and shelves for linen, and in fact be made to take the place of the usual so-called suite of furniture consisting of wardrobe, chest of drawers, and dressing table; and the whole might be carried out in plain deal stained and varnished, or painted and varnished, to match the other woodwork; the top portion, above the glass over the mantle, being coved out so as to meet the face of the projecting side cupboards, and covered with gold stamped leather paper, or decorated with stencil work, so that the whole should be harmonious and pretty in design, as well as essentially useful in every part. Such fittings, or fitments, as they have been called, could be designed to suit the requirements of the various rooms, large or small, as the case may be, and would not only increase the pleasantness and comfort of the room, but would do away with a number of the usual moveable pieces of furniture under and over which dirt and dust collect, and which cannot be moved by the maid for the purpose of cleaning behind and below.

Expense would be saved, to begin with, in the room; the skirting board and cornice on this side of the room would be omitted from the first cost, and in the usually somewhat cramped areas of the rooms of London houses, the wall and floor space taken up by the usual pieces of furniture would all be lessened, and the room made practically more comfortable and convenient, so that by arranging the bed recess at one end, the whole of the general area would be left clear to be fitted up as a living room with a central carpet, and outside space next the walls and fitting, either painted, stained, or finished with parquet.

I am quiet sure all such arrangements as these would materially add to the comfort and convenience of every room, and by avoiding all dust traps, narrow spaces between walls and furniture—which always exist when the furniture is moveable and placed next the skirting—wherein fluff and dirt can collect—the room would be made healthier in every way.

I am aware that I may be met with the objection that all this kind of constructed furniture cannot be carried out when a tenant only occupies a house for a limited term of years, that is to say, on a yearly agreement, or on the ordinary leased tenure of seven, fourteen, or twenty-one years, inasmuch as the fittings, arranged as I have suggested, if absolutely fixed to the walls, become more or less the property of the landlord at the end of the term; but even supposing they are not made to unscrew and take to pieces, and that—as in all probability if this was done so as to leave them as tenants' and not landlord's fixtures—when taken down they would not fit in any other house. I believe that, as a general rule, an incoming tenant would be glad to take them over at a fair valuation, after allowing for depreciation for wear and tear; and when you remember that the depreciation of furniture, except in special cases of art work, may be taken at something between five and ten per cent. per annum, it follows that at the end of a term of twenty-one years' lease, the special fittings will have paid for themselves to a great extent; and you would have to incur no more cost in providing some such similar arrangement in another house as you would have to do in buying new furniture in place of much of the old, which, as a rule, would not be found any more suitable either to the new house, or the enlarged views and increased requirements which you would probably have at the end of such a term.

I may be wrong, but I believe a house fitted up as I suggest would, to most common people, command a higher rental, and that thus a fair and ample per-centage on the preliminary outlay might be secured; but even if this were not so, surely the increased comfort and health of the occupants of the various rooms must be taken into consideration, and what you might lose directly you would gain indirectly.

The question of constructional and decorative improvements, as between landlords and tenants, will, in all probability, undergo a material change in the next ten years, and be made the subject, as they undoubtedly should be, of legislative consideration; for the present iniquitous system by which the landlord reaps practically all the advantages of alterations and improvements, which are absolutely necessary to make the usual badly built houses fit for decent comfortable and healthy occupation, cannot, in the nature of things, be much longer maintained; and as year by year legislation is seeking to improve the position of the tenant in all questions of holding of land and farm buildings, I cannot but believe the present unfair arrangement of leaseholds and ground-rents in house property, will, 'ere long, be fairly met, by which I am morally certain a much better character of building will be ensured in our cities and towns.

In most houses it is common to have the store places for clothes and other household goods practically self-contained in every room, and therefore we put therein furniture sufficient for our requirements; but we all know how soon our drawers and wardrobes get overcrowded, and the nuisance and annoyance it often is to have to take out coat after coat, or dress after dress, until we reach the particular one we want, which may be stowed away at the bottom of the drawers or chest; and it, surely, must appeal to ordinary common-sense to utilise in every way, with constructive fittings as far as possible, all spaces which, as a rule, are practically useless. Why not, therefore, in the window recesses of every bedroom, provide fixed Ottoman boxes, which can be used as seats as well as store places, and if covered with stuffed tops, may thus not only be made useful but ornamental; while in the sitting-rooms they might be used for store places for papers and magazines until bound up, and thus avoid the littering of our rooms, or the storing away of all such things in inaccessible places where they are never dusted, and only help to breed dirt and disease.

While we may delight in collecting artistic and valuable pieces of furniture as we may collect pictures, engravings, or china, we do not want to make our rooms into curiosity shops or museums, and must have a certain amount of absolutely useful furniture in every room.

If we watch the progress of the art of furniture in all ages, we find that while it gradually became more luxurious and elaborate in its finishing, the artists who designed them always bore in mind, to a great extent, the necessity for the various pieces being made useful, and it was not until the Rococo period of the last century, that mere show, caprice, and elaboration formed the chief elements in furniture design. The old coffers, cabinets, doubled-bodied presses or *armoires*, credences, and buffets of the sixteenth century, while elaborate and luxurious, were generally adapted for the requirements of the people; and to-day, when the requirements and the general comfort of our surroundings, as well as the healthiness and well-being of the people, are daily becoming more thought of, we may fairly insist that the fitting up and arrangement of the interiors of our houses should be just as much considered as the external elevation, or the mere decoration of our walls.

If instead of the usual heavy and ugly valences, which so many people still insist upon placing over their windows, as a top finish to the curtains, we were to provide framed recesses, constructed with the architraves or mouldings which run round the window openings, with slightly arched heads, leaving room for a slight iron rod to be fixed behind and out of sight, with space for the proper and easy running of the curtain, we should, to my mind, have not only a much more artistic but certainly a much more healthy and less expensive arrangement; and these arched heads would form part of the constructive finishing at no more cost than the framed and panelled window linings and architraves, and if carried up to the ceiling with the cornice returned round, would leave no spaces for the accumulation of dirt and dust, such as are now provided by the projecting boxed linings and heavy valences, fringes, and poles which the modern upholsterer provides. Let me not be misunderstood in this remark; I do not mean that the modern upholsterer provides these, to my mind, expensive and utterly unhealthy arrangements for the sake of increasing his bill; he does it often to suit the taste—or rather want of taste—of his employer, and in ignorance of the better effect and artistic character of the simpler and more constructive fittings such as I have suggested, and practically from the fact, which I have always so strenuously sought to condemn, that the furniture is treated entirely as a separate art in the household, and is not in any way considered, as it should be, as forming part of the general design of the internal constructive fittings of every house.

It is impossible to lay down any particular rules for the design of these constructive fittings, nor would I if I could; they must be made to suit the various rooms and requirements of the individual owner; but I do say that the use of properly designed and arranged constructive furniture should enter much more largely than it does at present into every home, and that if considered in the planning, and carried out in the finishing of the house, more comfort and better arrangement of the rooms might be combined with considerable saving of cost and infinitely better artistic character of the general fittings of the building.

In the dressing-rooms, where as a rule in town houses the space is very limited, every one knows how difficult it is to provide room for all the articles of furniture required. All such constructional fittings such as I have named would add materially to the healthiness and convenience of the room, and comfort of the occupants.

As I said here, in one of the series of lectures which I gave four years ago, the bedrooms and dressing-rooms should be clear of everything, as far as practicable, that can collect or hold dust in any form; should be bright and cheerful, pleasantly furnished, not with the everlasting heavy mahogany wardrobes and dingy-looking chests of drawers, but with light and cheerful furniture of good and simple design, in which everything should be carefully arranged and studied for use not show. We do not want heavy and unnecessary hangings and furniture, which hold dust, keep dust, and are necessarily unhealthy, for if we are to secure healthy and refreshing rest and sleep, it is of the highest importance that nothing shall take away from or taint the pure air which is necessary during the hours of sleep, so that our waking may not find us feverish and nauseated by the continual inhaling of the impure air, which all such dirt and dust traps tend to create.

Let the whole floors be painted or stained, or, better still, finished with parquet flooring, which is almost non-absorbing, and which can be cleaned by a damp cloth every day, and rugs or simple homespun carpets laid down beside the bed and elsewhere where required, so as to be easily taken up and shaken every day without trouble; and if you do away with all resting-places for dirt and dust on the tops of wardrobes and hanging-closets, and behind and under chests of drawers and other heavy furniture, there will naturally be much less labour required in cleaning and purifying the rooms.

The nurseries of the house, the rooms in which our little ones spend so much of the early portion of their lives, should naturally be made healthy and beautiful, fitted with cupboards and cheerful light furniture, with no holes and corners in which broken toys and damaged picture-books may be stored away; the wall spaces utilised with planned furniture, divided as far as possible for each child, with the floor space left as open as possible for exercise and play. Nothing should interfere in these rooms with ample light and sunshine, for, as plants turn towards the sun and light, so children grow up more healthy where care is taken to avoid darkness and dinginess; and on the careful and proper fitting of their rooms depend their bodily as well as mental health. Want of light and sunshine means everywhere "stunted bodies, imperfectly formed blood, feeble limbs, dull senses and torpid minds." As Miss Nightingale says in her "Notes on Nursing," "Where there is sun there is thought, all physiology goes to confirm this; where there is a shady side of deep valleys, there is cretinism. Where are cellars and the unsunned sides of narrow streets, there is degeneracy and weakness of the human race, mind and body equally degenerating. Put the pale withering plant and the human being into the sun, and, if not too far gone, each will recover health and spirit."

In all the upper rooms of a house, which may be used as nurseries, I would, where practicable, construct semi-octagonal projecting bays, so as to provide for the greatest possible light and sunshine; and if this cannot be arranged, the windows should be as widely splayed inside as possible, and no light or sunshine shut out by heavy curtains or venetian blinds; and here too, as in the best rooms of the house, should be thick plate instead of the miserably thin glass which is considered sufficient in the upper portions of so many houses. The thick glass gives truer light, is less penetrated by sound, and helps to retain the warmth of the room after the fires have gone out, and the house is left to cool in the long night hours. For ventilation, some such pleasant arrangement as that originally designed by Mrs. Priestley, and which may be made part of the constructive fitting of the windows, may be carried out. This consists of a double glass lining, or practically a small glass case fitted into a window, a little way from the external light surface, with folding glass doors to open in front, but with the top left open, so that the lower sash may be raised, and, without draught, admit fresh air into the inner case, which escapes at the top, and finds its way upwards into the room, and helps to keep the room pure and sweet. The case may be filled with flowers, and the top covered in with thin gauze or silk, so as to prevent blacks and other impurities being drawn into the room, and the air passing over the plants or ferns is filtered and purified, the plants absorbing to a large extent all the "ammoniacal and carboniferous impurities," with which the air of large towns is materially laden, while the charm and colour of the delicate fern foliage and growing flowers adds to the pleasant aspect of the room.

All these you may say are small matters, but they make up half the evils and half the troubles of life, and are certainly well worth considering in rooms in which our children live and sleep.

Apropos of nurseries, as I wrote in an article in "Our Homes," "it is possible that there may be some sort of sentiment existing which makes mothers desire to keep for all time the long disused toys belonging to their children in early life. I have seen boxes and cupboards half filled with broken toys and other useless lumber, which only serve as resting places for all kinds of impurities, seldom disturbed and rarely cleaned out; while, in our hospitals and amongst our poorer neighbours, there are hundreds of children who would be delighted with these no longer required toys and belongings of our own childhood. Clear out all such lumber, and give all that is fit for anything—old picture-books, old toys, old clothing, to those who will heartily appreciate them; and while conferring a pleasure on these little ones of our poorer neighbours, who cannot possibly obtain in any other way such things as toys and picture-books, you will be clearing away things which are now only lying useless in some out of the way corner or cupboard, and adding to the comfort and cleanliness of your own house. How many thousands of poor children are there who would be benefited and amused, and whose lives might be made more cheerful and more happy, by the contents of many a box or cupboard of toys and books which are no longer required. Every housewife knows how old books, old papers, old clothes, old linen, accumulate in the course of a few months. Instead of these being periodically cleaned out and given away, they are often carefully stowed away, in the most out of the way places, practically as useless, and help to make the rooms and house generally stuffy and unhealthy, when they might be the means of giving health and pleasure to others who have no means of purchasing them for themselves."

We are so apt to think that the commonest of furniture, so long as it is fairly strong, is good enough for our nurseries; surely this is a cruel and unwise thought, for our little ones should, above all, be brought up amongst beautiful things and graceful influences; let the fittings and surroundings, and the decoration of their rooms all help to inform and impress upon their minds something of grace and beauty, of form and colour, and assist in the early teaching of their sense of sight; surround them with pretty objects, teach them method and tidiness by having everything about them showing tidiness and method; teach them to love nature, to appreciate good form and colour; let them see how nature "restricts her true ornaments, the flowers, to the most salient and culminating points of plants, and sprinkles them sparingly, contrasted with the foliage; that art itself is nature," and that, as Shakespeare tell us—

> "Nature is made better by no mean,
> But nature makes that mean; so o'er that art,
> Which you say adds to nature, is an art
> That nature makes."

There is one other piece of fitted furniture which I think might be much more largely brought into use into London houses, where, as far as practicable, it is desirable to save labour and service, and that is the so-called lavatory. I cannot see why every bed and dressing-room should not be fitted with a tip-up basin arranged in one angle of the room, next the window, and with hot and cold water laid on, and covered with a hinged top, so as to fold down and cover basin, soap trays, and other washing requirements, the front fitted as a cupboard, and all made to match the other woodwork in the rooms; the waste-pipe might be taken into one of the flushing tanks I have named, or otherwise effectually cut off from the sewer, so that there need be no fear of foul air finding its way into the rooms, and thus the comfort and convenience of the room would be still provided for, and the expense and bother of moveable basins and ewers done away with.

In the reception rooms of a house much expense might be saved by making the mantel-pieces much more important features than they are at present; if instead of the usual cheap and trashy marble mantle, with its heavy and vulgar trusses supporting nothing, we were to have simply designed wood mantels filled in with marble slips or painted tiles next the fire grates, with recessed looking-glass over, and cupboards and shelves at the sides made for holding ornaments, or guns, or books, cigars, or whatever else might be required in the particular room for which it was designed, how much more artistic would be the effect of the room, while at the same time a useful piece of furniture would be provided.

I do not mean that we should perforce buy one of the present ready-made fashionable so-called over-mantels, with their spindly turned ballusters and velvet-covered recesses, which are generally too large or too small for the ornaments we have, and which require fresh purchases to be made of ornaments we do not want, in order that they may be filled. But I would have the mantel-piece an important object in the room. We gather round the fire in winter, and have it always before our eyes, why, therefore, should it be formed with the usual tasteless marble framework which we are so accustomed to see in many modern town houses. In the smaller bed and dressing-rooms it may be made useful as a dressing table, and so save the expense of moveable table and looking-glass.

In the dining-room of the house, if possible, a recess should be arranged and fitted up with a handsome buffet, in place of the modern expensive and, oftentimes, very useless sideboard. It can be made to hold china and glass, with glass cupboards above, and to include a light lift from the basement, with store places for wine and decanters; can be fitted with drawers and shelves for prints or photographs, and, at a comparatively moderate cost, be made an useful as well as ornamental feature in the room, answering several purposes; or the back of the recess might be panelled with centre glass reflecting the end windows and the table, and adding thus to the picturesqueness of the room.

This glass panel could be made, if necessary, to slide, and form a serving hatch from the usual small back room in most second and third rate houses; but all this sort of work, I am aware, means time, thought, and design.

Now, as a rule, the owner is not prepared to give the necessary time or thought to any such arrangement, even if he have the knowledge to enable him to make the design; besides which he does not know, unless he be an architect or an artist, how the finished work will look; whereas he can see for himself in any good upholsterer's shop a variety of made-up sideboards; and thus he prefers to buy the ready-made goods, and to get the best fit he possibly can for his money.

This practically applies to all questions of fitted furniture, but so far as the fitments I have described for bed and dressing-rooms, he may, if he will, see various designs of these, applied to different shaped rooms, in the show-rooms of Messrs. Jackson and Graham, in Oxford-street, who have shown a willingness to depart from the ancient upholsterer traditions, and in the belief that my views are fairly sound, and at all events worth a trial, in questions of fitted and planned furniture, to carry out various designs I have made, expressing, so far as it was possible in the made-up spaces in a large show-room, the views I have advocated.

I should weary you were I to enlarge more upon this portion of my subject. What I have said as regards the constructive fitting up of our bedrooms and sitting-rooms, applies with equal force to every room in the house, that is to say, in the offices, in the hall, in the lobbies, in the landings. But it is useless advocating any such doctrines, if you are content to buy ready-made furniture without regard to its suitability or general fitness for your rooms.

As a matter of course, all the smaller items of furniture, and carpets, curtains, and small general fittings must be taken from store, and arranged in their places about the house; with these matters I have nothing to do in this address, they will be good or bad, artistic or common-place, as the taste of the individual purchaser may direct. But in these he may now-a-days, when taste in design has so materially improved all furniture, crockery, silver, pottery, and glass, safely trust to the numbers of excellent manufacturers who are supplying their various specialities to the public. And as the taste of the public and the sense of sight becomes more educated, and the common-sense of the people insists, first of all, that comfort and fitness are essential elements in all those fittings of the house which are not absolutely luxuries or ornaments, we may rest assured that there will be gradual artistic improvement in all the trades which are specially cognate to art; and we shall, when this knowledge and common sense is applied to our everyday surroundings as it is to our daily work, no longer be content to change and follow a mere fashion and order of the day, and to live in dread of the time when a new fashion, a new caprice, or a new fancy shall compel us to a change which is to be condemned on every ground artistic and common sense.

I cannot understand why so many common-sense people are content to stock their houses with all kinds of unsuitable ready-made furniture. I am told that some people buy ready-made clothing, and perhaps in the smaller things they get very well fitted, but I fancy in dress, most sensible people choose their own cloth and colours, and have their clothing made to suit them, and adapted to particular seasons and purposes. Why not apply the same common sense and thought to the furnishing of a house? It is all very well to say that almost any kind and character of fittings can be bought nowadays, but so far as my experience goes, most of the furniture offered to us is made after some particular fashion, good, bad, or indifferent, without reference to its suitability for the place each piece may have to occupy, with all kinds of expensive and unnecessary trimmings in the shape of carving, notching, or constructed ornament, and without regard or thought to its providing inaccessible ledges and resting-places for dirt and filth of all sorts.

I unhesitating assert that greater comfort, greater convenience, greater economy of space, greater artistic character, and considerable saving in cost, may be effected by more thought and less hurry in the furnishing of both old and new houses.

It seems to me that we cannot leave old grooves in the finishing of our houses, and modern builders are content to ignore, to a large extent, all modern improvements. We still have locks and door and window furniture which are a disgrace to a civilised community; composition handles, trumpery finishings, unwieldy sashes with no means of lifting them; boxing shutters which are either never shut, or if they are, necessitate the moving of every piece of furniture in the windows, and which practically often will not shut at all, owing to the arrangement of curtains or window blinds. We accept the same miserable arrangement of lighting, of bell wires, and of the hundred and one small matters which make up the comfort or discomfort of the house. Either those who run up our houses prefer to keep in the old grooves, or do not take the trouble to ascertain and adopt the many inventions which have been brought out in the last twenty years. To do so involves extra trouble, and perhaps a trifling additional expense; but if the public are content to accept the old order of things, the builders perhaps can hardly be blamed for not providing the new. In the present day there are innumerable small fittings which should be insisted upon in every house, many of them—especially in such small matters as locks, door springs, sash fastenings, and shutter bars—the invention of our ever-progressing and ready-witted brethren across the Atlantic, but all to be obtained at almost the same cost as the old inferior and should-be obsolete fittings to which we have been so long accustomed.

I have no intention of advertising these special wares, and do not, therefore, allude to them in detail, but anyone who has visited the various exhibitions of building appliances which have been held during the past few years, will, no doubt, have noticed for themselves the various articles to which I especially refer, and which, if used, will materially add to the comfort of the dwelling. Where plate-glass is used for glazing, shutters are rarely required and where they are fitted are rarely used; but if they are wanted, surely we might adopt some of the more modern systems of light wooden revolving instead of the old-fashioned lifting and folding shutters, which are often as inconvenient as they are ugly; but this means thought and anxiety to make everything about the house as good, as convenient, and as practicable as possible, elements which I fear do not enter into the heads of the ordinary speculative builder, whose sole anxiety is to run up in the cheapest possible way a given number of houses, and to get rid of them entirely, or to let them on lease to the unfortunate househunter, who has then to provide for himself all the modern improvements which ought, to my mind, to have been provided for him.

What can be worse, in most houses, than the wretchedly constructed decoration, plaster cornices, and centre flowers of the paltriest design, and the cheapest of cast enrichments. What can be worse than the trashy mouldings, the heavy skirting boards, or the cheap plaster decoration crowded everywhere for the sake of show and effect. What can be more vulgar or less artistic than the cast-iron staircase balustrading in imitation of wrought, which fences in our badly constructed stone staircases. What more dreary or monotonous than the everlasting rows of cement balustrading that form the parapets of our roofs, or the common-place imitations of stone or other construction which nearly every mere builder's house in London is bedaubed and bedizened with in Portland cement; or what more trumpery than the cast brass bell pulls, the flimsy gas-fittings, the composition door knobs, and finger plates; or what more terrible and heartrending to good servants than the polished steel fire grates with stuck-on ormolu, or cast brass ornaments, or the vulgarity of the "Brummagen" fenders with rows of turned ballusters, all involving endless labour in cleaning and polishing; yet, seemingly, all these shams and absurdities of false construction go on, like Tennyson's brook, "for ever." Let us hope that, with improved taste and better knowledge of the people, these may soon be delegated to that bourne from whence, let us hope, there is no return.

If ornamental ceilings are wanted, why not dispense with the old-fashioned lath and plaster, and use more extensively fibrous plaster, which can be modelled to any design, and be screwed to the joists. All this sort of work is infinitely better than the old system of lathing and daubing two or three coats of heavy plaster on to our walls and ceilings; for, owing to its strength and tenacity, it has no liability to crack, is virtually fireproof, is rapidly fixed, and can be decorated within a few weeks, and saves all the dirt and mess, which, unless great care is used, absolutely destroys all floors if they are required to be stained after, for the spots formed by the dropping lumps of wet plaster practically will show through any amount of stain or varnish: this canvas plaster is about one-quarter the weight of ordinary plaster. Both fibrous plaster and papier maché adapt themselves to the ornamentation of ceiling and walls, and can be successfully applied to many purposes in the building of a house, for instance, for skirtings, door architraves, and cornices, where wood or common plaster are now used.

I am no advocate for the copyism of any particular type of work, but I confess I should like to see London ceilings, especially in good houses, carried out somewhat after the manner of the delicately designed and beautifully modelled examples of the Brothers Adam, as carried out by them in the end of the last century. Nothing can be more graceful than some of these designs, with their modelled figure and flower enrichments, in very low relief, suggesting all the grace and beauty of delicate Greek ornament, with a treatment essentially fitted for large flat surfaces, and capable of the purest decoration in soft tones like Wedgwood ware.

All this kind of work can be done at comparatively small cost in canvas plaster, and when expense is an object can be repeated with reversible designs in all the principal rooms of a town house; and to a great extent some of this low relief decoration might legitimately be applied in the friezes of the various rooms, in the panels of doors, and in the saffits of staircases.

Messrs. Jeffreys and Co., of Islington, have made some charming leather papers, in low relief, tinted and gilt, adapted from the designs of old Spanish and Italian leathers, which are admirably adapted for wall and ceiling decoration, and would form a pleasant change to the generally perfectly flat surfaces; the ornament being in very slight rounded relief is not likely to hold dust or dirt, and can be cleansed easily with the ordinary feather brush.

The material known as "Lincrusta Walton" may fairly be used for wall surfaces, and some of the designs furnished by the company are very delicate and good.

Thin marble and onyx slabs, and coloured and glazed faïence, may also be introduced into London halls and staircases, as cleanly, healthy, and decorative; but with the knowledge that every house designer of the present day ought to have of the great increase of beautiful materials and useful inventions which are ready to his hand, there should be no difficulty, with proper care and thought, in improving the interiors of our houses, and making them artistically beautiful, as well as more cleanly and more healthy in their design and treatment.

But all this is hopeless if people are content to live under the present condition of things, to look at sanitation, comfort, and art in the house, as mere hap-hazard luxuries.

I can only hope that the views I have set forth in my three addresses may not at least be thought Utopian and impracticable by the bulk of my hearers, and that at least I may have scattered seed which, if it be good seed, shall find a resting-place in some of your minds, and in the progress of time germinate and bring forth good fruit.

In the best Renaissance houses, almost invariably the decoration, furniture, and fittings were designed by the architect, and were made more or less elaborate as the taste and luxury of the age required; and in many of the older towns in France, Italy, and Germany, there are still innumerable examples of the vigour and force of external design in the decoration, panelling, and furniture of the houses, showing the same characteristics as the building, and generally good and harmonious in composition. The fireplaces, ceilings, and panelling of many of our English houses still remain to show how intimately the design of the internal fittings was connected with that of the exterior, and I cannot see why the architects of the present day should not make the interiors, as regards decoration and fittings, as much a part of their study as the mere outside shell work which enframes the rooms; and I am quite certain the taste and knowledge of design which marks the work of every educated architect, fits him especially for the proper completion of the internal fittings, whether in furniture or decoration, and that it will be hopeless to expect truth and unity in any work wherein the construction is entrusted to one man, the decoration to another, and the furniture to another. The same master hand and mind should at least have the general control of the work from "find to finish," as a foxhunter would say; and I believe, if this system pertained now as it did in the best periods of art, we should have better and more satisfactory results in the interiors of our houses, with no material difference of cost to the client. If the architect be, as he should be, the chief or head builder, working in association with the sculptor, the painter, and the upholsterer, the art work of his building will, if he be himself an artist having delight in his work, speak more surely than any words, and we may then hope for better buildings, for higher art work; but he must be able to associate himself with those who can and will aid him in carrying out his thoughts, for, as Mr. Ruskin truly says:—

"Either his own work must be disgraced in the mass of collateral inferiority, or he must raise his fellow designers to correspondence of power. If he have genius, he will himself take the lead in the building he designs. . . . It rests with him either to repress what faculties his workmen have into cunning subordination to his own, or to rejoice in discovering even the powers that may rival him, and leading forth mind after mind into fellowship with his fancy and association with his fame."

And by the example thus set, and the higher knowledge thus created, by association with his fellow-workers in the world, he may help to foster a more healthy feeling of art in home life; and in teaching, with honest endeavour and loving thought, those who are associated with him, exercise an influence over all who come in contact with him, and help, in the progress of time, to provide for higher artistic excellence in all trades cognate to art, and to the carrying into all houses, to some slight degree, the grace and preciousness of beauty and refinement.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON METEOROLOGY IN ITS RELATION TO PUBLIC HEALTH. BY DR. MANN, F.R.C.S.

Several well-known makers of meteorological instruments have contributed to the collection contained in the annexe of the east corridor, and designed to illustrate the science of meteorology, so far as this bears upon matters affecting public health. Watson and Sons, Dring and Fage, Stanley, Denton, Negretti and Zambra, Casella and Hicks, are represented amongst these contributors. They all exhibit the well-known standard forms of instruments devised for meteorological investigations, in conditions of finish and excellence which seem to leave very little to desire, and which certainly do not invite invidious comparisons where all are so unexceptionably good. Instruments for measuring the pressure, temperature, moisture, and movements of the air, the radiation of the sun and earth, the amount of rainfall, the evaporation from the ground, and the generation of ozone, are shown in almost identical forms, and in very considerable numbers, by all these firms. Great ingenuity is also displayed in the attempt to cause all variations in such conditions to record themselves without the tedious and somewhat uncertain intervention of human eyes and hands. Permanent records are now made automatically, at all the leading meteorological stations, of the oscillations of the barometer, the daily march, and maximum and minimum rangings of the temperature, the occurrence and duration of sunshine, the direction and velocity of the wind, and the conversion of oxygen into ozone. These are all important factors in the health-sustaining conditions of meteorology, and therefore appropriate objects for study from the point of view which is taken up by this Exhibition. Several kinds of self-recording instruments are shown by various exhibitors, but not in operation, with the exception of an electrical anemometer set up by Negretti and Zambra, in which a hand upon a large clock-face-like dial may be seen making a spasmodic jump every time the wind has blown over the hundredth part of a mile. The various meteorological instruments in general use are, however, so well known, and have been so recently exhibited again and again, that no sufficiently good reason arises for attempting to repeat an already thrice told tale so far as they are concerned.

But there are some few amongst the instrumental fraternity, possessing a more or less direct application to physiological and sanitary science which call for, or admit, some special attention being drawn to them. Foremost amongst these stands the serviceable little instrument now well known as the clinical thermometer, of which specimens are shown by all the exhibitors. This instrument, as most people are aware, is a short mercurial thermometer, having a scale which extends only from 95° to 113° of Fahrenheit, and a column of mercury which expands under the application of heat, but remains stationary in the glass tube as a permanent register when the heat is withdrawn, to indicate the exact temperature to which it has been exposed. Mr. Casella first constructed a serviceable thermometer of this character, some few years ago, by the happy expedient of introducing a small quantity of air into a fine column of mercury, in such a way that it constitutes a gap in the continuity of the column, which on that account remains in the position into which it has been pressed by expansion under increments of heat when the temperature is once more lowered. When in use, the bulb of the thermometer is placed in the arm-pit, or some other convenient recess of the living body, and is allowed to remain in that position for a few minutes. A somewhat novel form of this instrument is exhibited by Mr. Hicks, in which what should be the bulb is a lengthened out cylindrical and very narrow receptacle of mercury, that takes up the full temperature of the surrounding parts with which it is placed in contact very quickly, and so effects a not inconsiderable saving of time to the observer. Other forms of the instrument have oval and ring-shaped tubes of small calibre in place of bulbs. A notable illustration of the refined care which it is thought worth while to devote to the perfecting of these serviceable instruments, is furnished in the circumstance, told by the Royal Meteorological Society in a digrammatic form, that whereas some eleven years ago about 1,200 of these clinical thermometers were examined annually, and certified as to their character, by the Observatory at Kew, as many as 8,500 are now passed through the ordeal in the same interval of time. The important fact that the construction of this useful instrument has been very materially improved within the last fourteen years is also diagrammaticably indicated.

The clinical thermometers of the best makers are graduated to the fifth part of a degree. A standard thermometer, with the more extended scale for air temperature, is exhibited by Mr. Hicks, in which the graduation is carried to the fiftieth of a degree of Fahrenheit. Mr. Denton furnishes another illustration of the careful work that is now given to meteorological instruments. Some fifty thermometers, which had been examined at Kew immediately after their construction, were inclosed under seal for twelve months, and then tested again, and the Kew certificate attached to them states that their readings had not in any way changed from alterations of internal capacity. All meteorologists will be aware that this constitutes a very severe test of excellent workmanship.

Negretti and Zambra construct their clinical thermometers with the column of mercury and the graduations of the scale brought into very prominent relief against a back-ground of white enamel; this is a great practical advantage where the varying length of a fine column has to be noted. Most of the eminent makers have recently introduced a further advantage in the same direction, by the ingenious plan of fashioning the glass tube which contains the mercury, so that it acts as a magnifying lens when the liquid column is looked at. Some very fine air temperature thermometers are here shown, in which sensitiveness is secured by giving the reservoir in one form the shape of a gridiron of light parallel bars, and in another that of a cork-screw like spiral. Mr. Watson exhibits in his case a curious form of what he terms a "balanced thermometer," in which the extremity of the stem travels along an arc-shaped scale, under the shifting of the position of the weight as the mercury expands into, or shrinks back from, the elongated stem of the tube, and so affords an indication of the varying temperature that can be at once read off by a rapid glance from the opposite side of a large room.

There is one of the self-recording instruments that appears in this department of the Exhibition which has hardly yet lost its claim to rank as a novelty; the beautiful piece of apparatus, namely, which has been contrived to register the occurrence and duration of sunshine. It essentially consists of a transparent globe of glass which acts as a burning lens, however the sunshine may fall upon it, and so leaves a charred track upon any combustible substance spread out at a proper distance from the opposite portion of the sphere. The attempt to get a permanent register of the occurrence of sunshine by this device was first made by Mr. J. F. Campbell, of Islay, something like thirty years ago, but in those early days the instrument was of a very rude form of construction. It consisted of a hollow sphere of glass, filled with water, and supported within a bowl of wood at such a a distance from it that, whenever the sun shone upon the globe, a charred track was branded in upon some portion of the wood. This instrument was brought into use by the Board of Health in London, in 1857, and a new bowl of wood was provided for the sunshine to burn every six months, the old one being laid up as the record of the burning capacity of the sunshine during the period it had been in use. The water-filled globe was, however, very soon superseded by a solid sphere of glass. The very beautiful and perfect form into which this originally rude instrument has developed, is shown in a case standing on the left-hand side of the annexe, where it is marked as the sunshine recorder exhibited by Mr. Lecky. The instrument has there assumed a form which was suggested by Professor Stokes, in 1880, and which has been well worked out by its exhibitor. It will be observed that a globe of glass, four inches in diameter, rests upon a pillar of brass, in such a way that sunshine falling upon it throws its burning focus upon a strip of cardboard carried in a concave brass frame. A four-inch sphere of glass forms a focus for parallel rays, just 0·89 of an inch away from its outer surface. The cardboard is, therefore, held at this distance away from, and concentric with, the surface of the sphere, whilst the sun is performing its diurnal march across the sky, and a charred track corresponding with its duration is left upon the card in the form which is exhibited in Mr. Leeky's case. The cardboard is blue tinted, and scored by white graduation lines which mark half-hourly progresses of the focal spot, and the carrier permits the strip which is to receive the focal mark to be inserted in grooves higher or lower in the frame, accordingly as the sun reaches a lower or higher noontide altitude in the sky at each particular season of the year. A fresh strip of cardboard is inserted in the carrier for each day. The ingenious way in which the grooves are arranged in the frame, so that six grooves permit a zone 48 degrees broad, corresponding with the highest summer and lowest winter noontide of the sun in the sky, to be brought into play, is well worth the visitor's notice. The simplicity with which this essential condition is secured without in any way interfering with the fixed stability of the instrument is a great triumph of constructive ingenuity. The instrument may be seen burning its track upon the cardboard, and accomplishing its appointed work on any sunny day in the typical climatological station of the Royal Meteorological Society, which has been established in the south-east corner of the open garden which intervenes between the Central Gallery and the Albert-hall.

The practical use to which this sunshine recorder is capable of being put, is well illustrated in some large wall-charts exhibited by the Royal Meteorological Society. In one of these, transverse red tracks indicate the prevalence of sunshine for every day for three years, extending from 1881 to 1883. The ruddy spaces in this chart which catch the eye, draw the attention to the times when sunniness was predominant at Apsley Guise, in Bedfordshire, the place where the records were made. Thus, for instance, the last week in March and the first week in April, 1881, are seen at a glance as having constituted a period of almost uninterrupted sunshine. It is not possible to overrate the importance, in a meteorological and sanitary sense, of having comparative records of sunniness at different stations and times, such as this instrument supplies. During the short period in which the instrument has been at work, Hastings has proved to be the South of England station most favoured by sunshine. Southbourne, a sea-cliff district, situate midway between Christchurch and Bournemouth, stands next. It will scarcely surprise the *habitués* of London to learn that its purlieus in the matter of sunshine fare the worst. It appears that during the last year, 1883, there were 1,825 hours of sunshine at Hastings, 1,647 at Southbourne, 1,504 at Marlborough, 1,484 at Kew, 1,368 at Croydon, 1,241 at Greenwich, 1,228 at Brixton, and only 974 in the City of London. The number of hours of possible sunshine at Kew, or in other words the number of hours during which the sun is there above the horizon in a year, is 4,380. Thus it may be roughly said that Hastings gets nearly one-half its possible hours of sunshine, and the City of London very little more than one-fifth.

It should be remarked that Negretti and Zambra exhibit the same form of sunshine-recorder that has here been described, and that Casella has sent a somewhat different form in which the carrier of the registering strips of cardboard is adjusted to the seasonal altitude of the sun for each day.

The Royal Meteorological Society indicates the mean temperatures of the months of January and July in London for one hundred years. The lowest mean for January occurred in 1795, and was 25·5° Fahrenheit. The highest mean for January 47°, in 1796. The lowest mean temperature for July was 55·5° in 1816, and the highest 68° in 1778 and 1859.

The Society also marks in a similar way the mean annual temperatures, and the lowest and highest temperature for several important and well-known places. The mean annual temperatures in this interesting series of records most worthy of note are for Ferozepore, in the Punjaub, 95°; Calcutta, 81°; Hongkong, 75°; Cairo, 71°; Rome, 60°; Constantinople, 58°; Pekin, 53°; St. Petersburg, 40°; Hammerfest, 35°; Fort Enterprise, 14°; Boothia Felix, which upon this ground should surely be rather marked as "infelix," 5°; and Melville Island, zero.

The highest temperatures recorded for the several stations are for Murzouk, in Fezzan, 135°; Bagdad, 120°; Cairo, 116°; Jerusalem, 102°; Greenwich, 97°; Moscow, 90°; Falkland Isles, 75°. The lowest recorded are, for Barbadoes, 72°; Singapore, 66°; Bombay, 53°; Jerusalem, 25°; Constantinople, 17°; Greenwich, —10°; Chicago, —30°; Moscow, —53°; Melville Island, —65°; Fort Reliance, —70°; and Werchsjansk, —81°, which outlandishly named, and hard to identify, place, so far seems to possess the unenviable distinction of being the coldest spot upon the earth; unless a station nearer home may be inclined to contest with it the frozen supremacy, upon the ground of an observation that has been made since these comparative records were drawn up. On the evening of the 13th of June last, in the Lecture Theatre of the Royal Institution of Great Britain, in Albemarle-street, a temperature of—252° Fahrenheit, with alcohol turned into a kind of viscid ice, and with oxygen gas congealed into a liquid, was recorded. In this instance, however, it must in meteorological fairness be said the result was brought about by human as well as by natural agency; the spell of boiling solid carbonic acid having been used in the final depression of the temperature. The event is, nevertheless, worthy of a passing mention in this place, as it is probably a record of the greatest cold that has ever yet been brought under the rigid examination of science.

Amongst the other illustrations submitted by the Royal Meteorological Society, is a chart drawn up by one of its Fellows, Mr. Edward Mawley, the author of the annual digests of "Weather observed in the neighbourhood of London," and showing in a graphic form the relation of low temperature to high rates of mortality. A black tracing, or so-called curve in his diagram, expressing the death-rate in London, is seen to rise, as a red tracing, expressing the temperature during the period of exceptional cold which prevailed from November, 1878, to October, 1879, is seen to fall. The highest monthly mortality, consisting of 2,085 deaths, appears to have immediately followed the greatest cold occurring in February. When the mean monthly temperature rose to 45°, the monthly death-rate fell to 1,600.

The Meteorological-office has covered the wall opposite to the one occupied by the Royal Meteorological Society with a series of large charts, some of which not inaptly illustrate the direction in which meteorological science is moving. The first of the series shows the eleven districts into which the British Islands are distributed for climatological purposes. The next five furnish a record of what are termed the weekly increments of accumulated temperature expressed in day-degrees. In reference to these charts some words of explanation are certainly needed. They are drawn up for five out of the eleven climatological districts. On looking at these maps the observer is perplexed by a series of red step-like squares sidling away from the left corner below to the right hand corner above, where, if he takes for his examination the one which relates to the South of England district, he will find that they mount up by weekly stages to a height which is marked as 3,200 day-degrees at the end of the year. This upward ascent is made from a transverse line which represents 42° of temperature according to Fahrenheit's scale, and which is distinguished upon the chart as the base-line. Below the base-line there is a somewhat similar display of diagonally descending blue steps. The explanation of this hieroglyphical record is, that it is an attempt to express what is ordinarily spoken of as mean temperature in a more exact and serviceable form. The transverse base-line is to be taken to represent the degree of temperature at which, according to De Candolle's researches, the growth of vegetable structures is started in European climates. The amount of the excess of temperature above this initial line is expressed in a quantity arbitrarily fixed, and termed a day-degree, in reference to the mechanical engineer's analogous unit of a foot-pound. The day-degree means a temperature of one degree Fahrenheit sustained throughout a period of twenty-four hours. An elaborate mathematical investigation has shown that the quantity of temperature which is so maintained may be ascertained by taking the difference, in degrees, of the highest and lowest temperature of twenty-four hours, and by multiplying that difference by a fixed co-efficient calculated out for each month. The red quadrangular space in each vertical column of the chart gives the accumulated temperature of seven days arithmetically calculated out in this way, and fused together into the day-degree equivalent for the week. The red space is thus the measure of the temperature for the week, which was available for the maintenance of vegetable growth. The next column towards the right shows the amount that was added to the first, in a similar way, in the second week, and so for the succeeding columns, until the 3,200 day-degrees indicated at the top of the last column on the right is reached for the sum-total attained at the end of the year. Three thousand two hundred such units of heat, uniformly maintained through twenty-four hours, were supplied during the year for the stimulation and maintenance of vegetable growth. The blue spaces below the base-line indicate, in a similar form, the degrees of heat maintained uniformly for the day, which were below the intensity required for the stimulation of vegetable growth, and which were furnished during the colder portions of the year. There are no blue spaces, it will be observed, for the portions of the year during which the temperature does not fall below 42°. The day-degree is thus, it will be understood, one degree Fahrenheit of either excess or defect of temperature above or below 42° that is continued for 24 hours, or the number of degrees that have been continued for any proportionally less number of hours.*

The charts thus require some little exertion of thought before they can be understood, but the information which they convey, when this thought has been given to them, is of a very valuable kind, and capable of being turned to good practical account. Thus, for instance, each particular crop grown under

* The foot-pounds of mechanical work, it will be remembered, may be expressed either as the number of pounds that have been raised one foot high, or as the number of feet that one pound has been raised. So the number of day-degrees of accumulated temperature may be expressed as the number of days one degree of increment of temperature has been maintained, or the number of degrees that have been maintained through one day. The full explanation of the process, by which the day-degrees of accumulated temperature may be calculated out, is given in a paper by Lieut.-Gen. Strachey, R.E., F.R.S., printed in the second appendix of the "Quarterly Weather Reports" for 1878.

cultivation for food purposes has its own base-line, at which productive assimilation of nutritive matters begins, and its own number of accumulated day-degrees of heat which corresponds with the occurrence of its harvest. By marking and comparing the relative march of accumulation of heat at different districts or stations, the time when harvest may be expected at each may consequently be anticipated and predicted.

The diagrams also show that there was about 1,500 hours of bright sunshine, and 28½ inches of rainfall in this district in the year, for which the register of accumulated temperature is given.

The remaining twelve charts from the Meteorological-office represent the temperature of the surface of the sea immediately surrounding the coast of the British Islands, for each month of the year. The temperatures are given from the lowest found in February, 27°, to the highest found in August, 64°; and they are expressed by a deep blue tint for the coldest, shading off gradually into lighter, and ultimately passing into deep red for the highest.

EDINBURGH FORESTRY EXHIBITION.

Part III.

Mention has already been made of the establishment, in 1862, of a department of Forest Conservancy for the whole of India, under Dr. Brandis as Inspector-General. The department now consists of an inspector-general, 10 conservators of forests, 51 deputy conservators, 34 assistant conservators, 22 sub-assistant conservators, and 113 rangers. The department includes British Burmah. There are separate establishments for the Governments of Madras and Bombay as follows:—Madras—2 conservators, 14 deputy conservators, 8 assistant conservators, 8 sub-assistant conservators, and 44 rangers; Bombay—3 conservators, 6 deputy conservators, 19 assistant conservators, 13 sub-assistant conservators, and 26 rangers. The area of reserved forests in India is about 46,000 square miles; that of the unreserved has not yet been determined; while there are large nurseries and plantations for the rearing of trees to be employed in reafforesting denuded districts.

The cost of the establishments in salaries, travelling allowances, contingent expenses, &c., is £190,000 per annum; and the net revenue, after deducting all charges for salaries, working expenses, &c., is over £300,000.

The trees chiefly cultivated in the different provinces are as follows:—Bengal—toon and teak; North-West Provinces—deodar, walnut, and horse-chesnut; Punjaub—deodar, sissu, kikar, ber, and mulberry; Bombay—teak; Burmah—teak; Assam—caoutchouc; Madras—teak, red sanderswood, casnarius, and eucalyptus; Coorg and Mysore—teak and sandalwood; Berar—teak and babool; Oudh—sal.

The Government of India has sent to this Exhibition an *Index Collection*, embracing no fewer than 1,064 different exhibits, which is divided into six sections:—First, gums and resins; second, dyes, tans, and mordants; third, fibres and fibre-yielding plants; fourth, oils, seeds, perfumery and soaps; fifth, medicinal products; and sixth, timbers—the latter alone numbering 800 different species.

Sir George Birdwood writes:—"We have an illustration in Northern Afghanistan of how misgovernment may convert a once fertile and wealthy country, such as Afghanistan was under the commercial rule of the Buddhists, into an inhospitable desert, and all India, within the solstitial line, would probably have, by this time, been reduced to the same condition, but for the English conquest of the Peninsula. When, about ten years ago, Mr. Griffin W. Vyse was executive engineer at Dheera Ghazee Khan in the Punjaub, he planted over a million timber trees along the frontier joining India to Afghanistan and Beloochistan, and scattered five tons of their seeds broadcast everywhere; and in 1877, at least fifty per cent. of these seeds had sprung up into flourishing young trees. Great zeal was also shown by Mr. E. E. Gladstone, who was an assistant commissioner in the Punjaub at this time, in encouraging the planting of trees along the base of the Sulieman range. The Punjaub Government have also formed a forest of trees several miles in extent at Chunza Munza, near Lahore; and the result of all this planting on our Indian north-west frontier is already being felt in the gradually increasing annual rainfall in the Southern Punjaub, Southern Afghanistan, Northern Beloochistan, and Northern Scinde."

India is very fully represented at this Exhibition, in fact the whole of the southern division of the central transept has been devoted to the display of the forestal productions of that great country, which have been arranged under the direction of Colonel Michael, C.S.I., the Commissioner from the Indian Government. The walls have been hung with more than a hundred maps, containing the results of the survey of the forests of India, executed under the direction of Major Bailey, R.E. When completed, these maps, done on a scale of four inches to the mile, will enable the forest officers not only to put their hand on every tree of importance, but they will form an important instrument in the hands of the conservators in the details of forest management. With the maps are hung large photographs of full-sized specimens of all the important trees of the Continent. Then there are pictures showing the woodmen at work in the forests, of elephants working in removing large logs, and of the rafts of teak, &c., being towed down the large rivers, such as Rangoon, to the sale yards. There is also a large collection of carved Indian work in the shape of cabinets, inlaid boxes, gong stands, doors, panels, furniture, book racks, and vases, contributed by the South Kensington Museum, the Museum of Science and Art, Edinburgh, Messrs. Proctor and Co., and others. There are many specimens of the tapestry and carpets of the Punjaub; but the bulk of the space in the courts is taken up with the collections having more direct reference to forestry. Each province sends a complete assortment of the woods found in the indigenous forests, together with sets of the implements employed in forest work by the natives. Some of them have been built up as trophies; all of them show the grain of the timber in its natural state, and also as polished.

In the island of Ceylon much injury has been caused to the dense woods and jungles by reckless clearings for coffee and other gardens; but forest reserves are now being formed, and a Department of Conservation has been organised to stop further devastation. Mr. J. Alexander sends complete collections of the products of the cocoanut and palmyra palms, and of cinchona barks with specimens of flowers.

Although the island of Singapore is remarkable for its luxurious vegetation, a large area of its indigenous forests has been sacrificed to the demands of the pepper and gambier planters, and the climate has consequently deteriorated. The Government of Singapore sends a collection of specimens of woods from the Malay Peninsula.

His Highness the Maharajah of Johore sends a complete representation of the forest products of the Singapore Straits Settlements and the Territory of Johore in the Malayan Peninsula, which form a special attraction of the Exhibition. The specimens of timber trees from the Johore forests number 350, and embrace teak, eaglewood, the sago palm, camphor, gambier, gutta-percha, which was originally discovered in the forests of Johore, rattans, &c. Of forest products there are the gum from the camphor tree, which fetches about £25 per lb. for the finest samples in the Chinese market; Dammar gum, from which a valuable varnish is manufactured; incence gums, gambier, caoutchouc, pepper, oils, seeds, and barks, tea, coffee, and cocoa. Methods of Malay forestry are illustrated by a complete set of native tools and implements, some of them very curious, and the rattan canes with which the natives build their houses and boats.

Of other Asiatic countries which are represented at the Exhibition, special mention must be made of the large display from Japan, which fills both divisions of the eastern annexe. A system of forestry has been practised in Japan for centuries, and when the Dutch first landed in that country they found that wherever a tree was cut down another had to be planted in its place. Now the forest laws have been codified, and a Forest Department established at Tokio, with sub-offices in each of the forty-four districts into which the Empire is divided. The German system of cropping has been introduced, and hard-wooded trees from Europe and other parts of the world have been acclimatised.

The Japanese exhibit is divided into six classes; in the first are drawings illustrating the mode of felling trees and transporting timber, tools, machines, and models; in the second, timber specimens with pressed leaves, and a chart illustrating the natural distribution of forest trees in Japan; in the third, gums and resins, lacquer juices, drugs, spices, fruits, barks, &c.; in the fourth, specimens of ornamental woods, fencing materials, &c.; in the fifth, wood-carving blocks for wood engravings, specimens of forest flora, insects, &c.; and the sixth, parasites, lichens, young shoots of trees introduced from foreign countries, and a chart illustrating the geological formation adapted to the growth of trees in Japan. On the centre tables are disposed blocks, slabs, and sections—many hundreds in number—of all the indigenous trees of Japan. Many are in the rough, others are planed smooth. The display of ninety-six cabinet-making woods of firm texture and beautifully figured has been greatly admired. Some of these are thus described—The *Magnolia Kobus*, white speckled with little brown spots; *Temstronia Japonica*, a rich purple; *Phellodendron aumsense*, with a yellow ground and brown curls and rolls; *Rus*, a deep orange; six varieties of maples, with the figures on as many different ground colours; the *Cryptomeria Japonica*, waved, curled, eryed on yellow and darker grounds; *Juniperis Chinensis*, with rich brown veins and curls on a red ground; *Podocarpus*, a wavy drab; *Fagus sylvatica*, like white marble streaked with the purest black; *Zelkowa Keaki*, wonderfully mottled and of the most varied figures.

Of the various British Colonies represented at the Exhibition, mention must be made of British Guiana, the Cape, British Columbia, Cyprus, Gambia, Guatemala, Honduras, Mauritius, New Zealand, St. Vincent, Sierra Leone, Tobago, &c. The Borneo Company also sends collections of timber and ornamental woods. The Government of Canada was merely represented by two maps showing the limits of its forest trees. The value of fir logs annually exported from British North America is nearly a million, of oak a quarter of a million, and other timber about £200,000; while the sawn fir from the same territory reaches nearly three millions sterling. New Brunswick shows a collection of native woods in rough and finished state, and loan collections of polished woods and forest leaves, as well as tools, &c. There are $17\frac{1}{2}$ million acres in the colony, two-thirds of which are said to be virgin forest, consisting of spruce and pine, black birch, maple, beech, ash, elm, and oak. As yet no system of conservation has been introduced, and a great part of the forest land has been acquired by the New Brunswick Land and Lumber Company.

Denmark, which next to the United Kingdom is the worst wooded country in Europe (see *ante* p. 995), was almost alone among European countries in exhibiting its forestal resources on this occasion. In 1805, effective measures were taken to institute a proper system of forest management. The total forest area is only 498,000 acres, of which 26 per cent. is under the crown, 9 per cent. belonging to public institutions, 29 entailed estates, and 36 per cent. freehold estates. From 1790 to 1880, the Crown forests have been increased by planting from 58,000 acres to 112,000 acres. The 435,300 acres of older woods consist of 60 per cent. of beech, 7 per cent. of oak, 6 per cent. of other hard wood, and 21 per cent. spruce and fir. Nearly the whole of the forests consist of large trees. Of the total yield of the forests, 19 per cent. is used for implements, furniture, buildings, &c., and 81 per cent. for firing. Denmark is, next to England, the country which consumes, per individual, the largest quantity of foreign wood in Europe. Of hard wood for implements, furniture, &c., it can export a portion, but it does not produce 10 per cent. of the spruce or fir wood it uses.

Most of the countries which exhibit send examples of forest literature, and the manufacturers of wood pulp for paper in England, France, Germany, Norway, Sweden, Denmark, and New Brunswick, show specimens of their products, models of pulping mills, and the paper made from the pulp.

The grounds adjoining the Exhibition buildings contain a large number of sheds for machinery, foresters' huts, and collections of growing trees, mostly conifers. In a remote corner is the Manitoba farm, shown by the Canadian Pacific Railway Company, which contains a pioneer's tent and his log home, with two rooms and a stable. Samples of wood, of fencing, of household furniture, and all the necessaries required by the settler are here exhibited.

RUSSIAN PRODUCTS AND INDUSTRIES.

The following particulars relating to the products and manufactures of Russia are extracted from a report, by the Belgian Consul at Moscow, on the late Industrial Exhibition held in that city.

Fuel.

Peat.—Vast peat deposits are met with in Poland, and in the governments of Moscow, Vladimir, Nijni-Novgorod, Riazan, Tambov, and Orel. The peat is found by analysis to contain as much as 45 per cent. of carbon.

Lignite, containing 40 per cent. of carbon, is met with to a considerable extent in the governments of Kiev and Cherson. The quantity extracted yearly amounts to 16,320 tons, but would be much greater if it were not for the distance between the deposits and the main roads.

Coal.—The production of the Polish basin, entirely consumed in the country, was 1,142,400 tons in 1880; it is capable of great extension on the completion of the railway between Dombrova and Ivangorod. The sub-Moscovite coalfield, in which there are twenty collieries, is only worked at present in the governments of Toula, Riazan, and Kalouga. The coal is not, as a rule, of good quality, as it readily crumbles when exposed to the air; it is not therefore capable of transport, but is consumed on the spot. The best, containing 71 per cent. of volatile matter, is found in the mines of Mouravina and Pobiedino, in the government of Riazan. The total production of the sub-Moscovite coalfield was 587,520 tons in 1880. In the Donetz basin, containing coal of great purity, there are more than 200 collieries. Anthracite, containing 90 to 94 per cent. of carbon, is worked to a considerable extent in the south-west of the basin, and in the government of Ekaterinoslav and the Don Cossack provinces. The production of the Donetz basin in 1880 was 1,403,520 tons, including 473,280 tons of anthracite. The coal of the Oural basin, worked only to the north, in the government of Perm, contains 69 per cent. of carbon. The production amounted, in 1880, to 114,240 tons. Although the Russian collieries generally are worked more and more actively every year, the development of the Donetz basin is still retarded by the insufficiency of means of transport, and the absence of markets in certain districts, where coal is found on the spot and sold at a lower rate, beside the effect of foreign competition at the principal seaports. According to official statistics, no less than 1,876,000 tons of coal—more than one-third of the total production of the empire—were exported during 1880.

Mineral Oil.

In 1860, the production of raw naphtha was 500,000 poods (8,000 tons), which increased to 3,500,000 poods (56,000 tons) in 1880, while the price per pood (36 lbs.) fell from 0·4 to 0·1 rouble (1s. 3d. to less than ½d.). The naphtha of Baku generally contains only from 25 to 35 per cent. of illuminating oil; so that, in 1860, no more than 10,000 poods (160 tons) of petroleum were produced; but in 1880 the figure rose to 7,000,000 poods (112,000 tons), the price per pood falling from 4·9 to 0·4 rouble (15s. 9d. to 1s. 3d.).

The residue from the distillation is used for firing the boilers of the steamers on the Volga and the Caspian Sea, and also for making gas; while from the tar left by the gas are obtained benzole, lubricating oil, anthracine, and asphalte.

The petroleum is sent by steamers from Baku, Astrakan, whence it is conveyed in flat-bottomed barges up the Volga to Tsaritsine. The working of naphtha is stopped during the winter months, on account of the interruption of the Volga navigation, so that large depots are necessary. The increase in the production of naphtha is due to various causes—the discovery of new springs, the discontinuance of State working, and the abolition of the tax on distillation per retort per day. When the railway between Baku and Batoum is finished, the petroleum can be sent without interruption to the various ports of the Black Sea.

Metals.

Iron.—The iron ores of the Moscow basins, which are generally brown peroxides, contain from 50 to 60 per cent. of metallic iron, with a small per-centage of sulphur, phosphorus, and manganese. They are worked in the governments of Nijni-Novgorod, Toula, Kalouga, and Riazan, while, in that of Vladimir, a carbonate of iron is found containing from 35 to 40 per cent. of iron with no sulphur or phosphorus whatever. Carbonates and peroxides are present in the south; and red hematites, containing from 59 to 67 per cent. of iron, in the Cherson district. Masses of magnetic iron are also found on the eastern slope of the Oural mountains. At Blogodatt, the ore contains from 52 to 58 per cent. of metallic iron, while those of Vissokaia and Magnitnaia contain from 63 to 69 per cent. At the Imperial Ironworks in the government of Perm, and those of Prince Demidoff, the ore is smelted with charcoal, but without flux, and yields a pig-iron of such excellent quality that it may be at once run into castings.

Copper.—The quantity of copper ore raised in 1880 amounted to 195,518 poods, or 128 tons. The rich ore in the government of Perm contains from 6 to 8 per cent. of copper, and the poor ores about 3 per cent.; while those in the governments of Oufa and Orenbourg do not exceed 3½ per cent. Only 195,500 poods, or 3,128 tons, of ingots were produced in 1880.

Zinc.—Ores containing from 8 to 14 per cent. of zinc are found at Bendzizi in the government of Petrokoff, and at Kousch in that of Keltzel, in Poland. The mines have not, however, been worked very actively, owing to their slight yield of metal. Since 1880, a deposit of blende has been worked in the government of Abo, in Finland.

Lead.—The production of lead in 1880 only amounted to 1,142 tons. In fact, lead ores are only worked for the copper, silver, and gold with which they are associated. Some specimens from Perm were found to contain 10 per cent. of lead, and 3 per cent. of copper, while 100 poods (1 ton 12 cwt.) of ore contains 1½ zolotnick (92½ troy grains) of silver; and 1½ lbs. of gold is extracted from a pood (36 lbs.) of silver. Lead ore is also met with in the North of Russia, in Finland, and in the government of Archangel. The largest mines are situated at Laghlin, in the Provinces of the Terek Cossacks, in the Caucasus.

Quicksilver.—In 1881, a deposit of cinnabar was discovered in the district of Bacmuth, in the government of Ekaterinoslav, which was found by analysis to contain 12 per cent. of mercury; and a Russian company has been formed for working it.

Silver.—The quantity of silver extracted from argentiferous lead ores at the Government works, near the Altaï mountains, in Siberia, was 616 poods (under 10 tons).

Platinum.—The platiniferous sand from the mines of Prince Demidoff, contain from 1½ to 2 zoltnicks (92½ to 123½ troy grains) per 100 poods (1 ton 12 cwts.) of sand; but the production in 1880 was only 179 poods (under 3 tons) for the whole of Russia. The manufacture of articles in platinum is a new branch of industry in this country.

Gold.—Traces of gold are found in Irkoutsk, about 20 ft. below the surface, where 100 poods (1 ton 12 cwt.) of sand yield 1½ zolotnick (92½ troy grains), while at 24 metres as much as 2½ zolotnicks (154 grains) are obtained from the same quantity. At another deposit, in Siberia, nuggets have been met with weighing from 70 to 90 zolotnicks (9 to 11½ troy ozs.). Auriferous sand, in strata of 45 to 90 centimetres (1 ft. 6 in. to 3 ft.) thickness, also exists in the Oural, the richest being those in the government of Orenbourg. In the government of Perm there are auriferous quartzites of great richness, 100 poods (1 ton 12 cwt.) of ore containing as much as 5 zolotnicks (308 grains). The quantity of gold obtained in 1856 was 1,733 poods (27¾ tons), and in 1880, 2,641 poods (42¼ tons), the total quantity from 1856 to 1880 inclusive being 47,852 poods (765½ tons).

Cast and Wrought Iron and Steel.

This branch of industry has greatly increased in importance of late years on account of the raising of import dues, the construction of numerous railways, and the orders and subventions of the Government. The country is, however, far from supplying its own demand; and large quantities of manufactured iron and steel are exported, notwithstanding the Customs' dues, which are almost prohibitive. The excellent quality of the Oural ores give the irons produced in that region a marked superiority over those of the rest of Russia. The Oural is, besides, the chief centre of the Russian iron trade. The nail trade has made great progress during the last few years. The works are, as a rule, well stocked with plant; and hand-made nails are now only produced at a few of the Oural works.

Machinery.

The workshops of the Imperial Technical School at Moscow were founded with the special object of giving pupils the means of practically studying construction; and all the railway companies have also their technical schools. At the end of 1880, the 21,240 versts (14,082 miles) of way were provided with 5,690 locomotives, 7,230 carriages, and 112,000 goods wagons. Most of the machines made in Russia are imitations of those in other countries. Many of the works are able to produce engines up to 30 horsepower, but not larger, while the prices are very high. The production of machines has greatly increased of late, owing to the subsidies and prizes given by the Government. The number of works increased from 155 with 46,025 hands in 1876, to 237 with 856,105 hands in 1880. The value of the locomotives made in 1880 was 7,099,953 roubles (£1,124,159); and that of those which were imported in the same year, 2,673,385 roubles (£423,286). The value of machines imported in 1880 is 18,748,939 roubles (£2,968,582); and that of parts only of machines, 21,355,786 roubles (£3,381,333).

There are 340 works where agricultural implements are made, to the value of 5,000,000 roubles (£791,666) annually; but these are not sufficient for the requirements of the country. In 1881, implements to the value of 4,487,861 roubles (£710,578) were imported free of duty.

Ceramic Ware and Glass.

Earthenware and Porcelain.—The raw materials for the manufacture of porcelain are imported from England and Finland, while clays for earthenware are found in the governments of Tchnernigov, Novgorod, Cherson, and Ekaterinoslav. The chief markets are Moscow, St. Petersburg, and the fair of Nijni-Novgorod. According to latest statistics, there are fifty-one potteries, employing 9,000 hands, for a production of over 3,000,000 roubles (£475,000).

Glass.—Crystal manufacturers try to imitate the productions of Baccarat, without, however, having succeeded up to the present time, as their wares are deficient in whiteness and purity. The raw materials are found on the spot, except soda, which is imported. The products are sold in Russia and in Eastern countries. There are only three manufactories of looking-glasses, as the want of trained workmen and foreign competition hinder the increase of this industry. In the process of silvering, nitrate of silver is substituted for mercury, thus effecting a great saving. Window glass is not made in large quantity, nor is it very good. A small quantity of coloured glass is made for church windows.

OLIVE CULTIVATION IN TURKEY.

Consul Heap, of Constantinople, in his last report, states that olives grown in Turkey receive little cultivation after the young trees reach maturity. At the end of the autumn, or early in winter, a trench of two to three feet in diameter, and from eighteen to twenty-seven inches in depth, is dug round each young tree, and filled with manure, more or less rich, according to the age and strength of the tree. The manure is well covered with soil, so as to prevent it being disturbed, and to keep it as long as possible in the position best fitted to feed the roots of the tree. The ground between the trees is generally neglected. The olive tree generally comes into full bearing about its twenty-fifth year when it has been grown from slips, but when grafted it yields abundantly between its eighth and twelfth year. In both cases it continues to produce largely, every alternate year, for about fifty or sixty years, and if cultivated it will continue to yield, though less largely, up to the age of one hundred years. Under ordinary circumstances a young healthy tree that has reached maturity will produce about eighty-two pounds of fruit in a poor year, and with careful cultivation the same tree will yield in a good year double that quantity. The trees vary in yield every alternate year. An acre will contain 120 trees, and each tree will yield an average of 100 pounds of fruit, so that the produce per acre will be about 12,000 pounds, and as it takes about sixty pounds of fruit to produce one gallon of oil, the yield per acre would be two hundred gallons. When olives are intended for pickling, a small portion is plucked while green to be pickled in that state, but the larger portion of the fruit intended for preserving is gathered when it has fully ripened and has turned black; in Turkey it is preferred in this state, and there is a very large consumption of black pickled olives. To preserve black olives for the table, the fruit is packed in casks or boxes with a large layer of common salt, three quarters of an inch thick at the bottom. On this is laid a layer of olives, about two and a-half to three inches in depth, upon which a light covering of salt is sprinkled, and so on until the cask or box is filled, the upper layer of salt being deeper than the others except the lower one. The staves of the cask are left loosely bound to allow the bitter water from the olives to drain off. In preserving green olives, the fruit after being washed is packed in cases in its natural state. The casks have a small hole bored in the bottom to allow the water to run off slowly. They are filled with olives to about three inches of the top, and the cask is then filled to the brim with fresh water once in twenty-four hours, until the bitter taste of the fruit has almost passed off. The hole in the bottom is then plugged, an aromatised pickle is poured on the fruit, and after the pickle has taken effect, a little oil is added, to soften the olives and reduce any bitterness that may remain in excess of what is required to give them piquancy or an agreeable flavour. In extracting the oil, the method practised in the interior of Turkey is the same as was employed in the earliest ages. The fruit is collected in a large receptacle near the mill where the crushing is done; this mill is simply a large circular shallow tank with an upright beam in the centre, which runs through a large stone and serves as a pivot around which the stone revolves. A horse harnessed to a horizontal pole attached to the stone sets it slowly and laboriously in motion. An improved apparatus has lately been introduced; this consists of two stones attached to the horizontal pole, and which are dragged round with it. When a sufficient quantity of the fruit has been thrown into a tank the machine is set in motion, and a man precedes the horse with an iron pole to push the olives under the stones. After a short time, about two gallons of water at boiling heat are poured in to assist the action of the stones, and more is added as required, until the mass acquires the consistency of a thick paste. The mass is then put into a large jar and conveyed to the press, where it is kneaded with more hot water into a square cloth of coarse material, which will bear the greatest power of the press without bursting. The paste is then formed into a square flat mass, the cloth being folded neatly over it, and tied with a string attached to each corner, and it is then replaced in the press. The press is turned down by means of a hand lever, and when more power is required, a rope is carried from the lever to an upright rotary beam at some distance, which is rapidly turned. The oil and water which are expressed run into a trough roughly hewn from wood. This trough is divided into two parts longitudinally by a partition, which comes up to about two inches below the level of its sides, so that when the oil and water run in together on one side of the partition, the oil coming to the surface floats over to the other side, while the water is conveyed away by a pipe, placed at the level at which it is desired to maintain the water within the trough. After the press has been screwed down as far as it will go, it is loosened, and hot water is poured upon the pile to wash off any oil that may remain on the cloths, and they are kneaded without being unfolded. More boiling water is poured upon each package, and they are again placed in the press, to be again removed and undergo for a third time the same process until no oil remains. The oil comes out a light green colour, and is poured into a large jar near the press whence, after depositing any water or dirt it may contain, it is poured into skins. It is next emptied into large earthenware jars four or five feet in height, where it remains for at least two months until all impurities are deposited.

Correspondence.

HOUSE DRAINS.

Seeing the utter uncertainty which exists as to the position and nature of "house drains" generally, would it not be well if, in any future legislation on the subject, a clause in the Act were inserted, compelling any person selling or letting a house to supply the purchaser or hirer with a proper plan of the drains?

W. E. Bartlett.

Westgate, Guisborough,
September 30, 1884.

As the albumen obtained from eggs costs too much to be regularly employed as a mucilage on a large scale, Herr Muth, of Carlsruhe, has substituted that from caseine, which is of the same composition. Though it is but little soluble in pure water, this caseine readily dissolves in water made slightly alkaline, and by preference ammoniacal.

General Notes.

The Swiss Cotton Industry.—According to the *Berliner Börsen Zeitung*, there are at present 1,809,303 spindles occupied in the Swiss cotton industry, the average for each establishment being 19,046. Two-thirds of these are for coarse numbers, (up to No. 60), and the others are making from No. 60 upwards. The annual production of coarse numbers is 16,800 tons, and that of fine numbers, 2,900 tons. Cotton weaving occupies 15,783 looms, of which 11,102 are engaged upon heavy tissues, calicoes, percales, &c., and 4,681 upon fine goods, muslins, jaconets, &c. The annual production of heavy goods is 7,457 tons, and of fine goods, 1,385 tons. The weaving of coloured goods employs 6,967 looms, using yarns to the extent of 3,264 tons annually.

Water-melon Oil. — Experiments have been made by M. Lidoff, with a view to defining the quantity of oil contained in the seeds of the *cucumis citrullus*, a water-melon plant extensively grown in the South of Russia. According to a description of the process in the *Corps Gras Industriels*, the seeds are dried at a temperature of 266° Fahrenheit, after which the oil is extracted in a Tharn apparatus. By this method there was obtained a quantity ranging from 24 to 25 per cent. of a lubricating oil, with a density at 64° Fahrenheit of 0·9298. It absorbs atmospheric oxygen very rapidly, an augmentation of about ¼ per cent. taking place within three days. M. Lidoff thinks water-melon oil suitable for culinary purposes, but fears that its extraction would be too costly to allow of its coming into general use.

Electric Telegraphy in Australia.—The extent of Electric Telegraph wire in New South Wales, in actual use during 1882, was 15,901 miles, 47 chains, 13 links; the number of stations was 345; the revenue for the year, £120,265 13s. 4d.; and the expenditure (exclusive of interest on cost of construction of lines), £142,534 13s. 6d. In 1883, the extent of electric telegraph wire in actual use was 17,272 miles, 41 chains, 35 links; the number of stations, 368; the revenue, £134,643 2s. 4d.; and the expenditure (exclusive of interest on cost of construction of lines), £163,328 16s. 11d. 2,107,288 telegrams, of the value of £165,276 14s. 10d., were transmitted from the Colony; and 2,102,044 telegrams, of the value of £159,095 2s. 1d., were issued in the Colony. The New South Wales receipts on local and intercolonial (exclusive of New Zealand) business were £122,891 0s. 7d.; on New Zealand business, £1,898 15s. 1d.; and on international business, £3,049, making the total receipts £127,838 15s. 8d.

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Proceedings of the Society.

CANTOR LECTURES.

RECENT IMPROVEMENTS IN PHOTO-MECHANICAL PRINTING METHODS.

By Thomas Bolas, F.C.S.

Lecture I.—Delivered January 28th, 1884.

New Developments of the Woodbury-type Process.

The printing press has been the main factor in bringing about that interdiffusion of thought, which has resulted in the widespread and complex civilisation of to-day; and it is especially of interest to note that the productions of the printing press have, even from the first, been permanent: that is to say, the ink used has been one made with a basis of lamp-black, the pigment which, of all others, seems best able to resist the continual breaking strain of time, while writings may be—and indeed often are—gone in the course of a few years.

The introduction of block printing into Europe, the discovery of a new world, and the construction of the camera obscura by Leonardo da Vinci, are events which mark the latter end of the 15th century, a period memorable in the history of our civilisation of to-day; the beginning, indeed, of that active fermentation of thought which has made the world what it now is.

When Leonardo da Vinci looked upon the wonderful nature-picture in his camera obscura, and dreamed of the possibility of fixing this shadow, it is difficult to imagine that his wildest thoughts could have led him to suppose the possibility of converting that shadow into a printing block, and making copies in the then new printing press.

The honour of first fixing the camera image belongs to Nicéphore Niépce, who, in or about 1816, first transferred and fixed the image of the camera upon paper, and not only this but Niépce actually made printing plates by photographic agency before the year 1827. Those pictures and printing plates, which represented landscapes or general views, were very imperfect it is true, but, some years before 1827, he made true camera pictures, which were fixed in the technical sense, that is to say, would bear subsequent exposure to light without disappearing, and he thus laid the foundation of those more perfect elaborations of his processes developed by Daguerre and by Talbot.

The perfection of united photography and printing is thus to make the shadow into a solid substance, and so to obtain a plate or block from which impressions can be taken on the printing machine, and in this direction much practical progress has been made since the time when it was my privilege last to address you.

One point to which allusion has just been made may perhaps be again mentioned. The printer, whether he work from type, from an engraved block, or from a printing surface obtained by the aid of photography, can select his pigment, and, as a matter of fact, he generally selects one of which the basis is lamp-black; consequently, exposure to light and air will not cause the print to fade. The photographer, who makes his pictures by a photo-chemical method, has to content himself with such a colouring material as he can get—generally metallic silver or a mixture of this metal with gold. The consequence is that the earlier photographs are now mostly faded, and one may safely say that not a single copy of Fox Talbot's "Pencil of Nature" can be said to have altogether survived the forty years or so which has elapsed since its publication. Notice the copy which is lying on the table, and see if you can find a single picture which shows no sign of fading. The first photo-mechanical process, however, which gave really good representations of scenes of nature, is the photoglyphic method of Talbot, and although the gradations of tone are not represented in quite the same degree of perfection as is the case with Talbot's pictures by his calotype or silver-printing process, we have the enormous advantage of permanency.

Here are some examples of Talbot's photoglyphic method, printed in ordinary carbon ink from the intaglio plate, and issued with the *Photographic News* in 1858. Where, indeed, will you find silver print a quarter of a century old which shows no sign of fading?

To unite the permanency of the press-print and its rapidity of production with the exactness of the camera picture is the aim of the photo-mechanical experimentalist; and let me now pass on to some of the advances made since the date of my last lectures.

During 1878, Dr. Eder, of Vienna, published a most comprehensive monograph upon the "Reactions of the Chromium Acids and the Chromates on Organic Bodies;" and, considering how largely progress in matters of actual practice is dependent upon sound theoretical knowledge, one is not likely to be wrong in attributing much of the recent progress to the labours of Dr. Eder. The series of articles in question will be found in the volume of the *Photographic News* for 1878. One of Dr. Eder's latest discoveries may be mentioned here. He finds that ferricyanide of potassium tends to make gelatine insoluble, and that exposure to light tends to restore solubility. Possibly useful methods of working may be founded upon this observation.

Great progress has been made during the past five years in the application of photography to lithography and type-block printing; indeed, at the time of my last lectures, it was the exception to find a London printer who made use of photo-transfers for litho work, or of photo-etched zinc blocks for type-printing; but now it would be difficult to find a large London printing house where these are not in regular use.

From the general to the particular, that is to say, to the special subject of this evening's lecture—printing by the Woodburytype method.

The old Woodburytype method, in which the mould is made by the hydraulic press, has not been improved to any notable extent, but new modes of working have been devised, in which the mould is made without the aid of the hydraulic press; indeed, more than this, for Mr. Woodbury has quite recently devised a method of working in which the gelatine relief is itself the printing surface, this gelatine being covered with a sheet of thin tinfoil, cemented down by means of india-rubber; but before describing this the newest and most successful modification, let me call your attention to some of the modes of making a printing mould from a relief without the help of the hydraulic press.

What is now going to be demonstrated will illustrate to you a process for moulding the relief, which was devised by M. Gustave Re. A compressible box, placed upon the bed of this small hand-press, is filled with plaster of Paris in a dry form, and a sheet of tinfoil having been laid over this, the gelatine relief is placed on the tinfoil, and pressure is applied. It is easy to understand that under these circumstances the tinfoil will be forced into all the details of the relief; but in order to produce a solid mould suitable for printing from, it is necessary to take means to cause the backing to consolidate itself together, and for this purpose some water is poured into an outer casing which surrounds the moulding box. Soon after the water has penetrated into the compressed powder, setting takes place, and as this is always accompanied by expansion, the metallic foil is still more closely compressed against the gelatine relief. It is scarcely necessary to say that the press is kept closely screwed up until the plaster has thoroughly set. It is my impression that no commercial use has been made of this ingenious method of moulding, but it, like many other processes, rests ready to hand for any person who may wish to make use of it or to improve it. Methods of making the printing mould by rolling pressure, instead of the direct pressure of the hydraulic press, have only been decidedly successful when extremely thin sheets of metal, such as tinfoil, has been used, as a thick plate of lead, or other soft metal, extends considerably in one direction, when under the action of the rolling press. Casting a printing mould from the relief in sulphur, or in what amounts to about the same thing, the so-called Spence metal, has been suggested, and Mr. Warnerke has carried the method into practice with success. By melting sulphur at a low temperature, and stirring in about one-sixth of its weight of black lead, a very good casting material is obtained, and this can be easily illustrated to you. Here is a relief which has been developed on a piece of thick glass, and warmed up to a temperature of nearly 50° Centigrade, and having placed a metal rim round the relief, the next step is to steadily pour over it the mixture of sulphur and black lead, so as to form a cast about an inch thick. When this is cold, Mr. Barker will separate it from the glass, and make a print from it by the usual Woodburytype method, that is to say, by pouring on to the mould a pigmented gelatinous solution, laying on a sheet of paper, and then pressing out the excess of the coloured gelatine solution by bringing down a rigid and truly flat slab of metal on the paper. When the gelatine has set, the cast in pigmented gelatine will prove to be a perfect picture, showing all the gradations of the original photograph by various thicknesses of the tinted gelatine.

It will interest you to see some casts which Mr. Barry has made in brass and iron from the Woodbury relief, and although these do not appear to possess that perfect evenness of surface which is an essential in printing by the Woodburytype process, they are likely to have considerable value for decorative purposes.

Now, as to Mr. Woodbury's new development of his process, which he calls stannotype. There are two stannotype processes—the old and the new; but the former can be summed up in a very few words, especially as it has been altogether eclipsed by the latter.

The gelatine relief is developed on a rigid support, such as a slab of plate glass, and when the relief is dry, a sheet of tinfoil is made to adhere to it, and at the same time to take a perfect impression of the details, by pressure under a rolling machine. The next step is to deposit copper by the electrotype method on the tinfoil, the thickness of the copper thus deposited amounting to about three or four times that of the original tinfoil. The copper backing is now washed and dried, after which a warm sheet of glass, covered on one side with a layer of resinous matter, is laid—coated side downwards—on the coppered plate, and by the application of a steady and prolonged pressure, the softened resinous matter is made to accommodate itself to all the inequalities of the electrotyped surface. The whole being now allowed to cool, the complex cast is removed from the gelatine relief, and this cast is used as the printing surface. If you have followed my remarks, it is needless to remind you that the cast consists of the tinfoil facing which was moulded directly against the gelatine original, then the backing or stiffening of electro-deposited copper, next the resinous cement, and finally the rigid plate of glass intended to give strength or body to the whole. Mr. Barker will make a print in a mould of this kind.

The new stannotype process necessitates the use of a transparency, as the original photograph, under which the gelatinous tissue is exposed; and as regards the preparation of the sensitive gelatine, its exposure and development, there is no need for me to say anything, as this matter was fully treated of in my previous lectures. Carbon transparencies made direct from the original negative are used, and the representative of Messrs. Woodbury, Treadaway and Co., who is about to demonstrate the whole process, has just developed such a transparency in hot water, and he will now proceed to intensify it by means of a solution of permanganate of potassium.

A sheet of gelatinous tissue, which has been exposed under a similar transparency, is now soaked in water until flaccid, and laid face downwards on a slab of glass, perfect contact being established by the use of the squeegee. The glass to which the tissue now adheres is next placed in hot water, where the paper backing is stripped off, and all that gelatine which has not been rendered insoluble by the action of light is washed away. In this way a negative relief is obtained on the glass, the high portions corresponding to the light shades of the original subject, and the low portions to the deep shadows. When dry, this gelatine relief itself forms the mould in which pictures are cast or moulded by the ordinary Woodbury method; but before the gelatine mould can be used to print from, its surface must be coated with tinfoil. To do this, a thin solution of india-rubber in benzole is run over the plate, and a sheet of tinfoil being laid on, intimate contact is established by passing the whole between rubber-coated rollers—in fact, an ordinary wringing machine.

All is now ready for the printing. Mr. Woodbury's assistant takes the mould, adjusts it on the bed of a small press, oils the face slightly by a pad of oiled flannel, pours on the gelatine solution charged with colouring matter, lays on a sheet of paper, and closes the press, taking care to leave it closed until the gelatine is thoroughly set, when he will strip off the print.

This, then, is the new stannotype process, as adapted to the requirements of the general photographer who may wish to make fifty prints or more from a negative.

Another application of the Woodburytype method is the so-called photo-filigrane process, in which the water mark of paper is imitated by rolling a Woodbury relief against the paper with a considerable degree of pressure, the paper being rendered more or less transparent according to the degree of pressure, or in other words, according to the thickness of the relief at any one particular point. In this way photographs of all kinds can be reproduced in water-mark form, and Mr. Barker will show you how very rapidly impressions of this kind can be made on the paper. The method in question is worked commercially by Messrs. Brown, Barnes, and Bell, of London and Liverpool, this firm having been good enough to send me the interesting specimens which are before you.

The Woodbury process is specially adapted for making transparencies to be exhibited by means of the optical lantern, and Mr. George Smith, who has been exceptionally successful in executing work of this kind, will now demonstrate to you the whole process of making slides by the Woodburytype method. Instead of laying a sheet of paper on the mould after flooding with gelatine, a glass plate is used, and the cast in tinted gelatine is thus made directly on the glass. Mr. Smith will use a hydraulic press of his own construction in making the relief, and those of you who have studied the construction of appliances of this kind will know how to admire the excellence of the design.

The translation of the Woodbury relief into a line or stipple, suited for lithographic or typographic printing, is a matter of considerable interest and importance, but it must be considered in another lecture.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

The Library.

A sub-committee was appointed in February last, to supervise the library and reading-room which it was decided to establish in connection with the Exhibition. The original intention was to collect together the exhibits comprised within the class of literature in the different groups; but, subsequently, a request was issued by the Executive Council to Government Departments, learned societies, authors, publishers, and others, for the loan or gift of works, reports, and papers dealing with the two subjects—Health and Education. A liberal response was made to this appeal, and the result is that about 5,000 volumes have been collected, arranged, and catalogued, and are available for use by any visitor to the Exhibition, in two rooms of the Royal Albert Hall. Additions are constantly being made, and besides the books, in the library proper are files of the daily papers, and English and foreign sanitary and educational journals. The library was opened to the public on Monday, the 16th of June, and is available for purposes of reference and study from 11 a.m. to 6 p.m. A visitor requiring a book fills up one of the application tickets which is supplied to him, and on returning the book he receives the ticket back.

The books have been arranged in accordance with the plan adopted in the Exhibition itself, the two main divisions being Health and Education. The catalogue thus gives an indication of the bibliography of these subjects.

I. Health —The first group contains Acts, Laws, and text-books, and includes manuals respecting sanitary law, laws of quarantine, vaccination, &c. Census reports follow, and chiefly relate to the British Islands and India. Of foreign countries there are only the Tenth Census of the United States, and those of Vienna and Buenos Ayres. The Guide Books to Health Resorts form an interesting group, and their description in the catalogue occupies eleven double-columned pages. Besides the numerous places in Great Britain which are described, there are guides to German, French, and other foreign watering places. Then follow medical and other treatises on health, of which there are a considerable number, and reports of Sanitary Commissions and Medical Officers of Health, &c. This is a large group, and includes works on vital statistics. The transactions, reports, &c., of societies and journals, include the publications of the Ladies' Sanitary Association, Manchester and Salford Sanitary Association, National Association for the Promotion of Social Science, Sanitary Institute, Society of Arts, and some medical societies, besides journals and transactions of German, Hungarian, and Italian Societies. Food includes cookery and the various questions connected with adulteration. The description of the books in this class occupy ten columns of the catalogue. There are a few works on Dress, and then follow books on the Dwelling House, with which is joined the literature of Water Supply and Drainage. The heading of Ambulance (in which are works on nursing and hospitals), completes the first division of the catalogue devoted to Health.

II. Education.—The first group in this division is devoted to works on pedagogy, examination papers, educational journals, reports on and history of education. In this class the various European countries are well represented; there are nineteen works in French, twelve in German, twenty-three in Hungarian, two in modern Greek, one in Dutch, twenty-seven in Italian, nine in Portuguese, one in Spanish, two in Russian, forty-eight in Swedish, and five in Norwegian. The description of this class occupies twelve pages of the catalogue. The next class contains books, English language and literature, especially prepared for school use. Works on domestic economy follow, then those on classical languages and literature, modern languages and literature, and works used in foreign schools for teaching the native languages and literature. After these classes we come to history and biography, theology, church history and liturgiology, and a few books on mental and moral philosophy and political economy. Mathematics, writing (including shorthand and book-keeping), drawing and painting, and music are well represented. The books on technical instruction in arts, manufactures, and trades, handbooks on industrial arts, form an important class. Then come the following classes—geography, astronomy, geology, and mineralogy; zoology, botany, and general natural history; chemistry, electricity, physics, &c.; and physical training, gymnastics, &c. The last class of all contains books of reference, such as dictionaries, encyclopædias, peerages, almanacs, calendars, catalogues, &c. The list of English and foreign medical, sanitary, literary, educational, and other journals, the current numbers of which can be seen in the reading-room, is a long one, commencing with the *Academy*, and ending with the *World*. It contains as many as 231 titles of newspapers, journals, &c. The hon. secretary of the Library Sub-Committee is Mr. J. L. Clifford Smith, and the librarian who has compiled the catalogue is Mr. Carl A. Thimm. Besides the books in the library, there are many educational works shown in the foreign section of the Educational Department in the Central Institution of the City and Guilds of London.

PRIME MOVERS AND BOILERS AT THE TURIN EXHIBITION.

By P. Le Neve Foster.

The progress that has been made in Italy during the last quarter of a century in mechanical industry is clearly demonstrated by the excellent show of prime movers at the Turin Exhibition. It has been too much the fashion to suppose that Italy could not compete with other nations in the construction of machinery; and although there may be little or no danger of immediate competition in her export trade, it is clear that England must use every effort to hold her own with regard to finding a market for her machinery in Italy. At the present time it is an undoubted fact that the imports to Italy of engines and machinery made in England are sensibly diminishing, and from the intelligent labour displayed during late years by Italians, affords reason for believing that before long in this respect she will be completely independent of other countries.

In 1861, at the first Italian National Exhibition, held at Florence, the largest of the seven steam-engines exhibited was that of Messrs. Ansaldo, of 32 horse-power. Three years ago, at the Milan Exhibition, the most powerful motor shown was that of 150 horse-power, by the "Società Veneta di Costruzione Mecchaniche;" whilst at the present Exhibition at Turin the power of some of the engines is from 200 to 250 nominal horse-power, and reaches, in the case of the fine engine of Messrs. Neville and Co., to 310 indicated horse-power, from diagrams taken when driving part of the machinery for the electric lighting of the grounds. Most of these engines, as regards workmanship, design, and price, can compete very favourably with those constructed in other countries.

Great attention has been paid of late years by Italian mechanical engineers to the economical use of steam, a matter of vital importance in a country like Italy, where fuel is relatively expensive. Hence we observe, in all the engines exhibited, that mere rule of thumb has been set aside, and that in designing them the utmost care has been bestowed on all the details, and more especially so to those parts relating to the distribution of steam to the cylinders.

The motive power to the gallery of machinery in motion is furnished by eight engines, supplied with steam from eight boilers of various types. The class of boiler most in favour in Italy is the "Cornish," but of late years, and as is seen at the present Exhibition, the "Ten-Brink" type is gaining ground. These boilers are fixed side by side in a boiler house specially constructed for the purpose.

The first boiler is of the Fairbairn type, with double flue, by Messrs. Miani and Venturi, of Milan. Its heating surface is 100 square metres (1,076 sq. ft.), and grate surface 2·40 square metres (25·83 sq. ft.). The working pressure is 5½ atmospheres (82½ lbs. the square inch).

The next boiler is of the Lancashire type, with double flue, by Messrs. Tosi and Co., of Legnano. The heating surface is 97 square metres (1044·23 sq. ft.), grate surface 2·75 square metres (29·60 sq. ft.). It is furnished with Sulzer water-heating tubes, and a grate adapted for burning small coal and dust, an advantage to be appreciated in Italy. The fire bars, instead of being fixed longitudinally, as is usually the case, are fixed across the furnace, to which air is supplied by a Körting blower.

The third boiler is one of the marine type, constructed by the "Società delle officine di Pietrarsa e Granali," of Naples. It is cylindrical, with "Fox's" corrugated furnaces. The diameter is 2·38 (7·80 ft.), and 4·55 m. in length (14·92 ft.) The tube plates contain 60 tubes. The heating surface is 89·59 square metres (967·77 sq. ft.), and grate surface 1·73 square metres (18·61 sq. ft.). The working pressure 6¼ atmospheres (97½ lbs. to square inch).

The fourth boiler is shown by Messrs. G. Rochette and Co., of Turin, and is of the "Ten-Brink" form, consisting of three cylindrical shells placed one above the other. The heating surface is 56 square metres (602·80 sq. ft.), and grate surface 0·87 square metres (9·36 sq. ft.)

The fifth boiler, also of the "Ten-Brink" form, is exhibited by the "Fonderia Fratte," of Salerno, and in which certain modifications have been introduced. This boiler has double flues, a heating surface of 65 square metres (709·67 sq. ft.), and grate surface 1·70 square metres (18·30 sq. ft.)

The largest boiler in the Exhibition is that shown by Messrs. Odero, of Sestri Ponente; it is of the "Ten-Brink" type, with double furnace, the heating surface being 111·60 square metres (1201·30 sq. ft.), and grate surface 2·30 square metres (21·85 sq. ft.) This boiler is fitted with an apparatus for consuming smoke.

Messrs. Cravero and Co., of Genoa, furnish two boilers of the Cornish type, with Sulzer water heaters. The first, with double flues, has a heating surface of 80 square metres (861·14 sq. ft.), and grate surface of 2 metres (21·52 sq. ft.), whilst the second, with a single flue, has 44 square metres (473·55 sq. ft.) of heating, and 1·12 square metres (12 sq. ft.) grate surface. This boiler is adapted for burning the "spent" bark from tanneries, and is supplied automatically with fuel from a hopper placed above the furnace.

A second group of eight locomotive boilers supply steam to the engines in the electrical department, and have been furnished by the administration of the Alta Italia railway.

The water for the condensors, for watering the grounds, and for general purposes, is pumped up from the River Po, by an engine of 40 nominal horse-power, constructed by Messrs. Cerimedo and Co., of the Elvetica works of Milan, who have recently furnished a similar pumping engine for the new water works at Venice. The engines, pumps, and boilers, are placed in a building at the river edge, near the mediæval castle, and the water is forced at the rate of 60 litres per second (13·20 gal.) to a vertical height of about 25 metres, through a length of 430 metres of cast-iron mains to an ornamental tank near the south entrance to the gallery of machinery in motion.

The boiler is of the MacNichol type, with a total heating surface of 60 square metres (645·85 sq. ft.), and 2·72 square metres grate surface (28·25 sq. ft.) The working pressure is 6 atmospheres (90 lbs. to sq. in.)

The engine is of the horizontal compound condensing type, the cylinders being placed parallel to each other, and are respectively 0·24 m. (9⅜ in.), and 0·44 m. (17⅜ in.) in diameter, with 0·50 m. (24 in.) stroke. The air pump is worked direct from the piston rod of the low pressure cylinder. The expansion gear is automatic. The crank shaft carries a pinion which gears into a spur wheel on another shaft placed at a lower level, the former making 80 revolutions per minute to 12 of the latter, from which the pumps are worked, and advantage this way is taken of high pressure of steam, rapid piston stroke, and a large degree of steam expansion, whilst the pump plungers move relatively slow with a minimum of reversals.

The pumps are of the Girard type. The four barrels are placed in pairs horizontally, with one plunger to each pair, actuated by a piston-rod with crosshead working in slides with connecting-rod from crank pin. They are 0·425 m. (16¾ in.) in diameter, with 0·70 m. (2 ft. 3½ in.) stroke. Between each barrel is a tank filled with water, inorder that the plunger glands shall always be submerged. The plungers, which are of cast-iron, are hollow, and their weight being equal to the quantity of water that they displace, friction is reduced to a minimum.

From the ornamental tank, the water is forced by another set of Girard pumps placed in a building near the entrance to the gallery of machinery in motion. Important modifications have been introduced in the design of these pumps by the makers, Messrs. Bosisio, Larini, Nathan, and Co., of Milan, and as a sample of Italian hydraulic machinery, is unrivalled in the Exhibition, and would do credit to the best constructors in England.

The pumps are four in number, placed in pairs, with one plunger to each pair, the glands being submerged in the same way as those just described. They are 0·60 m. in diameter (2 ft. 11⅝ in.), and their stroke can be varied from 0·70 (2 ft. 3½ in.), 0·85 (2 ft. 9½ in.) to one metre (3 ft. 3⅜ in.), by altering the position of a pin on disc, which is used instead of a crank, for actuating the connecting and plunger-rods. The main shaft carries a large spur wheel, and makes 9½ revolutions per minute, and is driven by a pinion on a counter shaft, connected by suitable gearing with the main shafting in the electrical department. Each pump is completely independant of the other, and can be put out of work without interfering with the action of the others; the valves are of india-rubber, and the chambers in which they work are easily accessible. The delivery of the pumps is 166 litres (35½ gals.) per second. The air vessel is of boiler plate and provided with an automatic regulator, by means of which the pressure is maintained constant, whilst, at the same time, the introduction of air into the mains is prevented.

The "Stabilimento Forlivese di Costruzioni Meccaniche" furnish a horizontal non-condensing engine of 20 horse-power with variable expansion; the valves are worked by excentrics. The expansion valve is on the Rieder plan, and controlled by the governor.

Messrs. Luciano and Co., of Turin, also exhibit a single cylinder non-condensing engine of 20 nominal horse-power, with variable expansion. The slide and expansion valves receive a reciprocating motion from a disc fixed at the end of a shaft driven at right angles to the crank shalf by mitre gearing. The expansion valve is tubular, working in a cylindrical chamber. The ports are spiral, and the governor is so coupled up to the valve spindle, that at the slightest change of speed, the latter is partially rotated and so shifts the tubular expansion slide at right angles to the direction of its motion, and by the relative position of the spiral ports of the valve and chamber, the amount of "cut off" is varied, and the admission of steam to the main slide is regulated.

The "Fonderia Fratte" of Salerno have furnished an engine of 100 nominal horse-power, which, as regards beauty of workmanship and design, is unrivalled in the whole Exhibition; it is of the horizontal "compound tandem" type, with cylinders 0·32 m. (12⅝ in.) and 0·49 m. (19¼ in.) in diameter, and 0·80 m. (2 ft. 7½ in.) stroke. They are fitted with equilibrium valves, those for the admission of steam, which are placed on the upper side of the cylinder, being actuated by excentrics fixed on a shaft driven at right angles to the crank shaft by bevel gearing, whilst the exhaust valves placed on the under side of the cylinders are worked by cams, and, by a special arrangement of levers, the degree of expansion in the higher pressure cylinder is controlled by the governor, whilst that in the low pressure one is regulated by hand.

Both cylinders and intermediate receiver are steam jacketted; the condensor and air pump are placed below the level of the flooring, the latter being worked by a rocking lever connected with the end of the piston-rod, which passes through a stuffing-box in the cover of the low-pressure cylinder.

All the principal parts of the engine are under the control of the engine-driver, who from a stand can handle the starting valves, injection cocks, feed to boiler, and the four drain cocks of the cylinder; the gauges showing the pressure in the boiler and cylinder, and vacuum in the conductor, together with a mercury gauge, being conveniently placed within sight, so that everything can be regulated from one place.

The fly-wheel is 4 m. (13 ft. 1½ in.) in diameter, with five grooves. The engine is furnished with automatic lubricators; a tubular "swan neck," revolving in bearing with the crank, conveys the oil from the lubricator to the pin, so that it can be kept oiled without stopping the engine. A speed indicator is placed at the end of the excentric shaft, and an ingenions arrangement is provided for taking indicator diagrams. The engine makes 70 revolutions per minute, with a working pressure of 5½ atmospheres (82½ lbs. per square inch).

Messrs. Cravero and Co., of Genoa, exhibit a horizontal compound condensing engine of the "tandem" form, of 40 nominal horse-power. The valves are controlled by an arrangement of levers worked from four excentrics fixed to a shaft driven at right angles to the crank shaft.

Another engine is also exhibited by Messrs. Luciano, of Turin, of the horizontal compound "tandem" form, of 100 nominal horse-power. The high pressure cylinder is 0·305 m. (12 in.) in diameter, and the low pressure 0·54 m. (21⅞ in.), with 0·86 m. (2 ft. 9⅝ in.) stroke. The valve gearing is a modification of the "Corliss" plan, which would be impossible to describe without drawings.

Messrs. Nicola Odero, of Sestri Ponente, contribute a horizontal condensing engine of 100 nominal horse-power. The cylinder, which is 0·53 m. (20⅞ in.) in diameter, and 1·10 m. (3 ft. 7⅝in.) stroke, is steam-jacketted. The valves are of the equilibrium form, and worked from excentrics on a shaft running at right angles to the engine.

The "Stabilimenti d'Industrie Meccaniche di Pietrasa e Granili, of Naples, show a compound condensing engine of 60 nominal horse-power. The cylinders are horizontal, placed side by side, and are respectively 0·34 m. (13⅜ in.) and 0·50 (19¾ in.) diameter, the stroke being 0·75 (2 ft. 5½ in.). Both cylinders are steam-jacketted, and the steam passes from the high to the low through a receiver containing 34 tubes heated by steam from the jacket of the high pressure cylinder. The valve gear is a modification of the Sulzer plan. The expansion in the high pressure cylinder is controlled by the governor, whilst that in the low pressure one is adjusted by hand.

The engine exhibited by M. Enrico, of Turin, is by far the most original in design of any shown; it is a horizontal high-pressure single cylinder condensing engine of 60 nominal horse-power. Its originality consists in the application of an incompressible fluid, viz., "oil," for working the valves, in the place of the usual rigid rods and levers as is the case with the gearing of ordinary steam-engines.

The two steam valves, which are placed upon the upper side of the cylinder, are controlled by means of a force-pump filled with oil, which is worked from an excentric fixed upon the crank shaft, the oil being forced by the pump through pipes communicating with small cylinders fitted with pistons which raise or lower the steam valves. The exhaust cocks, which are adapted to the lower side of the cylinder, are actuated by levers connected with a separate excentric in main shaft. The steam cylinder is not steam jacketted. The air-pump of condensor which is placed below the engine-room floor is rotary, and is driven by a belt from a pulley on crank shaft.

This enginc, which appears to work smoothly, has been purchased by the proprietors of a cotton spinning establishment at Pincrolo.

The total motive power of these eight engines is 500 nominal horse-power.

Two lines of shafting run nearly the whole length of the gallery, and are supported by a strong framing of cast-iron which carry the bearings. This shafting is put in motion by grooved pulleys, ropes being used instead of the usual leather belting, and this system appears to answer admirably, and must be advantageous, not only because of their cheapness as compared with leather, but also because they can be readily replaced, and it is almost impossible that all should break at once, and, lastly, because slipping on the driving pulleys is next to impossible on account of the great tension that they exert.

AMSTERDAM INTERNATIONAL EXHIBITION, 1885.

The enlarged buildings rendered requisite by the increased demands from foreign countries are being proceeded with. Many of the large Indian houses in London, such as Proctor and Co., Liberty and Co., Vincent Robinson and Co., and others, will exhibit, and the Calcutta papers are urging the

Indian Government to send a collection of raw materials. Nearly every foreign European state will take part. It is expected that the Dominion of Canada will be well represented, and that the British section of 3,000 square metres will be well filled. Mr. Simmonds, in a tour in the manufacturing districts, obtained many adhesions from the principal manufacturing and engineering firms. The extensive manufacturing industries of Belgium will also be well represented.

Mr. J. C. Humphreys has been ordered to prepare, for the reception of royal visitors, a pavilion similar to that of the Prince of Wales at the Health Exhibition. This will be furnished and decorated by the leading London firms. The Technical Committee, of which M. Delpaire is President, are about to form a Commission of practical men to test, examine, and report, at the request of the exhibitors, on all objects shown, whether metallic, chemical, or industrial, and to furnish a certified report, which the exhibitors can publish, or not, as they choose. The Government will place at the disposal of this Commission all the machines and appliances necessary for testing which are in the depôt of the State railway at Malines. These will enable a determination to be made, with mathematical precision, of the extension, compression, flexion, and tension of all materials. Trials can thus be made of steel, iron castings, bronze, chain cables, wire or hemp-rope, bricks, lime, wood, stone, and all constructive materials.

At the chemical laboratory can also be determined the lubricating properties of oils, the heating properties of coal, the illuminating power of gas, &c.

The King of Cambodia is desirous of showing some of the products and curiosities of his country, and the space of 40 metres by 25 metres which it will occupy, will be surmounted by a representation of the grand stand of the racecourse of Pnom-Peut.

In the maritime section will be shown a curious collection of all the boats and vessels of the far East, including the Annamite junks.

Austria is erecting a pavilion in the gardens for the use of the Arch-Duke Rodolph, the President of the Austrian Commission. From America, the United States, Brazilian and River Plate Governments have promised extensive contributions. As regards Africa, besides the French Algerian collections, the King of the Belgians is using his large staff on the Congo to make an exhaustive collection of African products and ethnological specimens, and to the attraction of the show, it is intended to set up a model African village in the Exhibition grounds, and people it with representative specimens of the principal races on the Congo.

TANEKAHA BARK OF NEW ZEALAND.

Consul Griffin, of Auckland, states that the tanekaha bark is a product peculiar to New Zealand, and is found in no other country in the world. During the last few years large quantities have been exported to Europe, where it is highly prized on account of its superior dyeing and tanning properties. Recent tests have established the fact that it is one of the best vegetable dyes in the world, and especially for yellow, pink, and fawn colours. The tree producing the bark belongs to the genus *Phyllocladus*, comprising the trees known as the "celery leaved pines." It belongs to the same section of the conifers, as the well-known yew of Europe and North America, although it differs widely from it in habit and appearance. Only five species of the genus *Phyllocladus* are known to exist. Three of these are peculiar to New Zealand, one is a native of Tasmania, and the other inhabits the mountains of the island of Borneo. The New Zealand species are as follows—the *Phyllocladus trichomanoides*, known as the tanekaha of the Maoris; the *Phyllocladus glauca*, or *toa toa*; and the *Phyllocladus alpina*, or mountain tanekaha. The two species found out of New Zealand are but little known, and are not applied to any economic purpose. The Tasmanian plant, the *Phyllocladus rhomboidalis*, is found in the hilly parts of the island, and grows to a height of forty or fifty feet. The Borneo species is called *Phyllocladus hypophylla*, and rarely attains a greater height than twenty feet. The New Zealand tanekaha at its full growth is from sixty to seventy feet high, and the trunk is about three feet in diameter. The timber from the tree is remarkable for its strength and durability; it is very close in the grain, and is of a reddish white colour. The tree has a peculiar appearance. It throws out its small thin branches with great regularity, almost at right angles with the trunk. The foliage consists of coriaceous, obovate, toothed phyllodia, so nearly resembling leaves that they are often mistaken for them; in fact, the so-called leaves of the tanekaha tree are composed of the flattened and expanded small branches of the tree growing together. The actual leaves are seen only on the seedling plant, and are linear and sharply pointed, but they soon drop off, and their places are taken by the small branches which are expanded horizontally and are variously lobed. An interesting fact connected with the tanekaha tree is that it makes a most beautiful walking-stick. The bushmen bruise the bark of the sapling at regular intervals, and after a few days cut the sapling down and peel off the bark. The stick then presents a mottled surface, and of a permanent bright red and white colour. In obtaining the bark of the tanekaha for exportation, the following is the method employed. The tree is stripped of its bark by making a transverse incision with a knife round the trunk at the bottom, and a similar cut just below the junction of the branches. Vertical incisions are then made with a very sharp knife, and the bark removed in long narrow strips, and all the branches large enough to contain bark of any value are stripped in the same manner. The tree, if not too large, is generally cut down, and the bark removed more easily, it being useless to endeavour to save the tree, as removing the bark invariably kills it. The tannin is deposited by the sap, principally in the inner portion of the outer bark, and the outer portion of the inner bark, or liber. In New Zealand, the bark is usually gathered in the winter, but Consul Griffin states that it is preferable to undertake this work in the spring, as the tannin is most abundant at the time of the greater flow of sap, which always occurs at this season. The bark, when peeled, is put up in bundles from 4 feet to 5 feet in length, and is then ready for shipment, usually to London, whence it finds its way to Grenoble, where it is largely used for the purpose of colouring kid gloves. It is only of late years that tanekaha bark has been exported from New Zealand, and owing to its valuable properties it is expected that the trade in this article will largely increase; in 1873, the amount exported was 24 tons, while during the first six months of 1883, the latest date for which returns are available, it exceeded 575 tons, with a value of £4,000.

TURQUOISE MINES AND PEARL FISHERIES OF PERSIA.

The United States Minister at Teheran says that turquoise mining has for ages been an important source of wealth to Persia. There appears to be no historical record of turquoise mining in Persia before the 10th century, but after that the industry seems to have rapidly developed. The mines which are now in operation are the same as those worked 800 years ago, and are situated in Kerman and Khorassan. The former are now almost abandoned, the light green colour of the stones found there fading easily, and being but little prized. The mines of Khorassan are near Nishapoor, and are of great depth. Access to them is very difficult. The number of small or seed turquoises of light tint found in these mines is enormous. Mr. Benjamin states that last January a pound and a-half of the better grade of second class stones were sold in Teheran for about £7 sterling. Stones of a dark sky-blue tint are comparatively scarce. The best turquoise mines in Persia, and indeed, in the world, are at Aboû Riâh. All the mines of Khorassan are farmed by the Mohpered Dowlet, the Nasirè Dowlet, and one or two other officials connected with the Government. For this privilege they pay 18,000 tomâns annually to the Shah, a sum equivalent to £6,000. The best stones are sent to Europe, and there is at present no evidence of exhaustion in the Persian mines. The pearl fisheries, on the contrary, appear to be in a languishing condition. Formerly a very large source of revenue, they are at the present day probably not worth to the Government more than 50,000 tomâns or £16,000 per annum. The pearl beds are farmed by the chief men of the adjacent towns, and, instead of being distributed in Persia, are for the most part sent to Europe by the steamers plying to the Persian Gulf. The reason for the present condition of the Persian pearl beds is that they have been allowed no rest, but have been constantly worked. In Ceylon, the pearl oysters are allowed a rest for intervals of two years, during which they are allowed to mature. Mr. Benjamin says there is reason to believe, however, that the beds at the island of Karâk, near Bushire, which have not been worked for some time, are now in a condition to repay capital expended there, especially if diving is extended to a depth of fifty to sixty fathoms. As the ordinary depth reached by pearl divers is rather less than this, the Persian Government have recently sent to England for diving dresses of the latest invention, and an experienced diver has been engaged at a high salary. With the assistance of these, it is expected that the pearl fisheries of Persia will regain their former importance.

SILK CONDITION HOUSES OF FRANCE.

Consul Peixotto, of Lyons, gives an account in his last report of silk conditioning in France, and says that Italy was the first country to discover and apply the method which now almost universally forms the basis for conditioning silk. It was at Turin, about the middle of the last century, that the first silk conditioning or assaying house was established. In 1779, this institution was transferred to Lyons, where it has been exceedingly prosperous. There are different processes of conditioning, all, however, having for their object to determine the weight of the silk after desiccation. Water, however, is not the only heterogeneous substance which increases the weight of textile fibres; other substances are also mixed more or less with wool, cotton, and silk, which disappear after washing or scouring the threads. This foreign matter is sometimes natural, and sometimes the result of fraudulent practices. Silk, for instance, while still enclosed in the worm, is a compound substance, a fibre wrapped up in an impervious envelope, the chemical composition of which, as shown by analysis is analogous to *osséine*. This envelope is technically termed *grés de la soie*. By the processes of boiling, the silk is divested of the *grés* which it contains. The operation, termed *décreusage*, or *cuite*, is applied for removing the *grés*; if prolonged, it gives a silk *cuite* or boiled, and it is this operation which is generally employed, as, if any other treatment were used, only a portion of the *grés* would be removed. The commercial value of textile fibres is only really ascertained and determined when the threads have been assayed or conditioned, that is, only after the operation of weighing and *décreusage* or boiling, which determines mathematically the thickness and the regularity of the thread. The test of the regularity of the silk thread is now perfectly determined by the "serigraph," an invention of an American engineer.* These tests may be made by every person interested in silk, private individuals as well as corporations. In Lyons, St. Etienne, Rheims, and Roubaix, where the manufacture of silk, wool, and cotton is extensively carried on, public condition houses have been for a long time established. The Lyons condition house became the property of the Chamber of Commerce, by a decree of Napoleon I., in 1805. Its transactions amount to above £24,000 per annum. In 1882, its business, after deducting expenses amounting to £8,000, showed a net profit of £16,000. The public condition houses of France are authorised by the Government, and are administered by the chambers of commerce, or municipal authorities. Their transactions are carried on by tariffs fixed by the Government which, however, are moderate, and have the advantage of possessing an official character as between seller and buyer. In France there are thirteen authorised silk condition houses. These consist, arranged according to the amount of business transacted, of houses at Lyons, St. Etienne, Avignon, Roubaix, Paris, Marseilles, Aubenas, Privas, Nîmes, Montélimar, Tourcoing, Amiens, and Valence. During the year 1883, these establishments received 104,049 bales, and conditioned 14,958,000 lbs. of silk. Lyons alone conditioned 70,528 bales, weighing rather over 10,500,000 lbs.

Obituary.

Sir Charles James Freake. — Sir Charles James Freake, of Fulwell-park, Middlesex, and of Bank-grove, Kingston-on-Thames, Surrey, who died at his residence, Cromwell-house, South Kensington, on Monday, 7th inst., had been a member of the Society of Arts for many years. He was a member of the Council in 1873, and a Vice-President of the Society from 1874 to 1877. When the National Training School of Music was formed, through the exertions of the Society, Mr. Freake, who was then a member of the Council, undertook at his own cost and risk to erect the necessary buildings for the school; and the first stone of these buildings was laid on the 18th December, 1873, by H.R.H. the Duke of Edinburgh, K.G., Chairman of the Committee of Management of the School. Sir Charles Freake was born on the 7th of April, 1814. The baronetcy was conferred upon him in 1882, and his son, Mr. Thomas George Freake, succeeds as second baronet.

* See *Journal of Society of Arts*, vol. xxx., p. 1022.

General Notes.

German Association.—The annual meeting of German naturalists was opened at Magdeburg, on September 18th. Among the addresses delivered may be mentioned:—On the relation of micro-organisms to the infectious diseases of man, by Prof. Rosenbach (Göttingen); on the importance of German colonisation in Africa, by Dr. Gerhard Rohlfs; various medical addresses by Drs. Schwarz (Cologne), Paetz (Alt-Scherbitz), Finkler (Bonn), and Prior. Strasburg was fixed upon as next year's meeting-place, with Profs. Kussmaul and De Bary as secretaries.

Separating Wool from Mixed Rags.—M. Heddebault finds that when rags, of cotton and woollen mixed, are subjected to the action of a jet of superheated steam, under a pressure of five atmospheres, the wool melts and sinks to the bottom of the receptacle, while cotton, linen, and other vegetable fibres stand, thus remaining suitable for the paper manufacture. The liquid mud which contains the wool thus precipitated is then desiccated. The residue, which has received the name of azotine, is completely soluble in water, and is valuable on account of its nitrogen; moreover, its preparation costs nothing, because the increased value of the pulp, free from wool, is sufficient to cover the cost of the process.

Plumbing.—The Plumbers' Company has arranged for holding a conference of metropolitan and provincial plumbers at the Health Exhibition, from the 15th to the 20th of October. The following syllabus of subjects was decided upon:—1. The technical instruction of plumbers. 2. Apprenticeship, the duration and condition of indentures suited to the present state of the plumbing trade and to the modern system of technical instruction. 3. The establishment of metropolitan and provincial boards of examiners of plumbing work. 4. The registration of journeymen plumbers. 5. The suitability of materials used in plumbing, and particularly of those materials recently introduced as substitutes for lead. 6. The desirability of fixing upon a system by which uniformity in the quality of material used in plumbing may be insured. 7. The formation of district associations of plumbers to investigate and secure, as far as practicable, correction of evils and abuses arising in connection with the trade. 8. A general and executive committee to be formed for the purpose of receiving reports from district associations of plumbers and others, with a view to the preparation of a general report of the Plumbers' Company, to form the basis for an appeal to Parliament for necessary amendments and extensions of the law relating to plumbers' work under the Building and Health Acts, and otherwise.

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Proceedings of the Society.

CANTOR LECTURES.

RECENT IMPROVEMENTS IN PHOTO-MECHANICAL PRINTING METHODS.

By Thomas Bolas, F.C.S.

Lecture II.—Delivered February 4th, 1884.

Type Blocks from Line Drawings or Half-tone Subjects.

Any impression in a fatty ink, of the nature of printers' ink, which may be transferred to stone or zinc for printing after the lithographic method, may be considered as the germ of a typographic printing block, as, if such an impression is transferred to a zinc plate, the uncovered parts may be etched away so as to leave the covered parts standing in high relief. The details of the method of this etching a zinc plate were given in one of the lectures of my previous series, and, therefore, it is needless to repeat them here. Let us take the reverse case. One has a typographic block, and it is more convenient to print impressions by the lithographic machine than from the block; it is only necessary to make a print from the block, and transfer it to the stone. Thus it will be seen that lithographic printing and typographic printing are very closely connected, so closely, that when a subject is prepared for one it may be printed by either, as convenience may indicate. The "Official Gazette" of the American Patent Office is set up in type, but the printing of all, excepting the index sheets and the covers, is done on a litho-machine.

These remarks bring us to the point where photo-lithography and photo-typography may be considered together, and that the making of a fatty transfer is equivalent to the production of a printing surface suitable for printing by either method. Still it seems to me that there is a large future before the litho-machine for commercial work, and that English printers are only beginning to see the real importance of Senefelder's discovery, for the production of commercial one-colour work.

Now, as to the making a photo-litho transfer from plain black and white work, some progress has been made of late by the introduction of the velvet roller as a means of inking the exposed gelatine paper; the application of the velvet roller to this purpose being due to Mr. F. Butter, of Woolwich Arsenal. The ordinary litho-roller sticks to the paper, and drags off the coating; so much is this the case, that, until the introduction of the velvet roller, but few persons attempted to ink up the image on the exposed gelatine paper with the roller; the usual practice being to follow the plan demonstrated in my last lecture—that is to say, to lay a ground of ink all over the paper, and, after softening the gelatinous film by soaking in water, to remove the excess of ink by dabbing, or some such process.

Mr. Newland will now assist in the demonstration of the mode at present adopted for making a transfer by the velvet roller method.

The sensitive paper was prepared by floating thin bank post paper on the following solution—the solution being, of course, warm:—

Gelatine	3 ounces.
Water	50 ,,
Bichromate of potash	2 ,,

An exposure of five or six minutes in the shade is sufficient, after which the paper is soaked for some minutes in cold water, and the excess of water is blotted off. All is now ready for the inking of the image, and Mr. Newland has clamped down one side of the paper to the front edge of a kind of table, formed out of a slab of thick plate-glass, after which he will apply the velvet roller; always rolling it away from himself, so as to keep the paper level and stretched. The exposed parts now take the ink, and a transfer of surprising fineness is obtained. The velvet roller is charged with an ink made by mixing commercial transfer ink with about one-eighth of its weight of olive oil, a little turpentine being added to thin the mixture, if required;* but it is well to avoid the free use of turpentine.

Mr. Frewing has been good enough to bring here some specimens of his line work, not only in the transfer but also put down upon zinc; moreover, he has brought some wood blocks upon which the fatty transfer has been impressed, as a guide to the engraver.

Wood-engraving has long held its own, but it is now very hardly pressed by the various processes, some of which are photographic and others not. Some years ago, the "graphotype" process made a little stir, but it did not compete with wood engraving to any extent worth mentioning, while, apart from the photographic methods, there are many others. Among the latest may be mentioned the glass etching process introduced by Mr. S. H. Crocker, of Sydney, and before you there are specimens of the *Australian Graphic* illustrated by this means. The resisting lines being obtained on the surface of the glass, hydrofluoric acid is used as an etching fluid, and, curiously enough, there seems to be scarcely any tendency to undercut under these circumstances.

So far we have only considered the use and production of transfers from such negatives as consist of only one gradation, clear white and intense black; and before passing on to the consideration of the means of obtaining transfers and blocks from ordinary negatives, in which every tint is reproduced more or less perfectly after the gradations met with in nature, let me point out to you some circumstances which will make it clear to you that we cannot, by simple photographic agency, produce representations from nature having quite the boldness of outline ordinarily met with in the most common kind of wood engravings; but there is now a movement among wood engravers to produce something better than was accepted twenty or thirty years ago—in fact, something more resembling a photograph.

Here is an engraving taken from the *Illustrated London News* of the year 1851—the year of the Great Exhibition—and here, on the other hand, is a quite corresponding subject from the number published last Saturday. In the older engraving the figures are outlined by bold black lines, and the attempts at reproducing the exact shades or gradations of lighting, which we may suppose were visible in the case of the originals, are crude in the extreme. To sum up, the outline is the essence of the engraving, and but little effort is made to reproduce the shades of the original. Now, look at the engraving taken from the last number of the *Illustrated London News.* We certainly have outlines of a similar character, but very much less clearly marked, and everywhere an attempt has been made to represent the lights and shades of the original by a corresponding closely packed collection of lines or dots. Now, look at a photograph of a strictly analogous subject. You see that the artificial outlines which the wood engraver uses to plot out his subject are altogether absent, and we only find that kind of shading which is altogether omitted in the less perfect example of wood engraving. To put the matter shortly, the second-rate wood engraver uses an outline as an index or pointer to his

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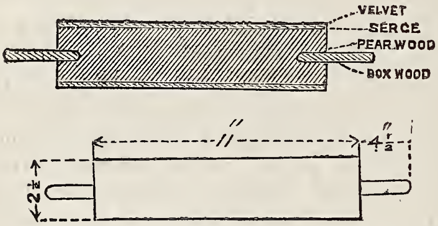
* The following sketches and description, extracted from the *Photographic News*, will enable those who did not attend the lecture to sufficiently understand the construction of the velvet roller:—"Here is a sketch showing it complete and



in section. The measurements specified are those to be recommended, and in the section we show the materials of which the roller is made. After considerable experience, it is found that the best silk velvet is most suitable for the purpose. The body of the roller is of pear-wood, a light material most favourable to the purpose, while the handles are of box-wood. Over the pear-tree block are sewn two layers of thick serge, and over the latter one thickness of velvet, the price of which is about 12s. a yard. A nice brisk nap is required in the velvet, and this cannot be obtained unless a good price is given. The serge, before it is sewn on, should be scalded in hot water, so that it will not ruck afterwards, and the velvet must be fitted by a skilled seamstress. The so-called carpet stitch is best adapted to the purpose, the ends of the velvet not overlapping, but drawn together so as to meet. In this way the seam is not a ridge, but perfectly flat, and the roller does not set-off at this spot. It need scarcely be said that this can only be attained with very fine stitches. The velvet is cut out exactly to size, and sewn on the block. The velvet roller is ready for use as soon as it is made. Unlike the leather roller, there is no need to get it into condition. In the same way, it may be put away in its linen bag as soon as done with, though, perhaps, it is best to clean first; the bag keeps away dust, and the grease in the ink will keep the velvet from becoming hard. Of course you can't scrape a velvet roller, to get the ink off, as you do a leather one; you can only free the velvet of its ink by rolling. The roller is passed over a clean slab, and this is scraped from time to time. The slab gradually pulls the ink off, and this is then removed from the slab by scraping. If you are not able to get off all the ink in this way, pass the roller over a thin sheet of soft paper, and apply a little turpentine. After a little practice, you will soon know when the roller is free from ink."

subject, and he often contents himself with this index or pointer alone, making no effort whatever to represent the true shades of the subject; and the public often prefer this index to the representation of the actual object, because it is easier to follow and to understand. Hence one of the main reasons why a typographic block made from an ordinary negative does not give satisfaction to those who have become accustomed to the mode of treatment adopted by wood engravers. In the photographic block there is no artificial outline, but only the shading. In addition to this, when any part of a figure has the same tone value as an adjacent part of the background, the photographic block makes no distinction between them—they merge into one another; while, in such a case, the wood engraver can make a distinction between the two parts, by making the shading lines incline in a different direction. The effect of photography in bringing about a more perfect system of wood engraving is to be observed in studying the wonderful specimens issued with the Transatlantic monthlies, *Harper* and *Scribner*. Here we often find the artificial outline or index lines either reduced to a minimum or altogether absent, and a fine shading introduced which, when viewed from a little distance, almost strikes the eye like the gradated tints of a photograph. Side by side with the wood-engravings in *Harper*, one often sees phototypic blocks made by the method of Ives; and in noting the great similarity of the effect to the eye, one hardly knows whether to congratulate the phototypist for his near approach to the most perfect examples of wood engraving, or to give praise to the wood engraver for his skill in so closely realising the gradated lights and shades of the photograph.

In making a type block from a photograph, the first step is to translate the evenly gradated tints of the latter into a line system, or a stipple of corresponding intensities. When a photograph is transferred to a wood block, this is done by the personal skill of the individual who engraves the block; but this is by no means to be regarded as photo-engraving proper, so my remarks will be confined to processes in which the translation is effected automatically.

There are many methods of so translating the tints into points, lines, or dots, that even to mention all would be impracticable. In now talking to you, there is no alternative but for me to assume considerable knowledge of the subject on your part, this course of lectures being of the nature of a supplement or appendix to my previous course.

In my last lectures the method of Asser was illustrated, a photo-lithographic transfer being made on a sheet of starched or pasted paper, made sensitive by means of potassium bichromate; and by putting down such a transfer on zinc, and etching into relief, excellent results may be obtained. It may also be mentioned that, as long ago as 1866, Messrs. E. and J. Bullock, of Leamington, obtained a patent for a mode of photo-lithography in half tone, and a print issued during the year in question with the *Photographic News*, shows that their work was equal to anything that has been done since. The print is before you, and you can judge for yourselves. Why, then, you may ask, did not the process become a great thing commercially, and make its mark? The answer is simply this—the invention came before its time, neither good litho-machining nor zinc-etching being practised at the time. The expired patent of Bullock Brothers, No. 2,954, 1866, will be read with interest, and its value is well illustrated by the fact that the essential points of it have been claimed by very many subsequent patentees. Bullock claims the production of reticulated transparencies, by copying a negative over which a grained surface is laid; this transparency affords the means of making a grained negative; but the method by which their best work was made is a second process included in the same patent. Ordinary or photographic paper is coated with a glutinous substance, and printed with a reticulated pattern. Let me now quote from the specification:—"In this case the specks of ink themselves form a medium, and by their aid excessive contrasts are avoided, and half-tones secured. Such picture, when so obtained, is passed to a lithographic stone or zinc plate, and a printed proof produced therefrom; by the aid of chromo-lithography, coloured proofs may be produced." The coating of the paper with a glutinous substance may "be conducted in connection with bichromate of potash or bichromate of ammonia." The said transfer paper may be used, "whether the impression be a lithograph, a zincograph, an impression from an electrotype, or from an engraved or etched plate."

Mr. Dallas' work you have seen before, and there are some specimens before you. He tells me that he supplied tint blocks for journalistic work (*The Garden*) as long ago as 1872.

By transferring a coarsely grained collotype to stone or zinc, a very good grain image is obtained, and the coarse reticulation of the gelatine is very much facilitated by adding chloride of calcium to the sensitive mixture. The following answers very well:—

Gelatine	6 parts.
Water	60 „
Bichromate of ammonia	1 „
Chloride of calcium	2 „

Printing surfaces thus obtained, whether lithographic or typographic, resemble those of Pretsch or of Dallas on the one hand, and those of Sprague on the other hand.

In speaking of the work done by Messrs. Sprague and Co., in which the gradations of the original photograph are translated into a vermicular grain, suited for printing by means o the litho-machine, one must fully recognise the fact that this firm was the first to put photo-mechanical printing from the ordinary gradated negative on a large commercial basis in this country; while the great extent and variety of work executed by them during the last two years, abundantly proves that there is a large and rapidly extending field for work of this kind. Before you are numerous examples of their work, and in the extensive commercial application of this method, we have a very decided advance since the date of my previous lectures.

In order to obtain a transparency in which the tints are translated into points, lines, or dots, Algeyer and Bolhoevener have recently suggested a method in which a collotype plate is exposed under a negative; and after this plate has been soaked and inked up in the usual way, the fatty image is reinforced by dusting with an opaque powder. This method is of course dependent on the reticulation of the gelatine for the production of a grain. From such a transparency a negative may be made by contact printing, and from this a photo-litho transfer by any one of the well-known methods.

Meisenbach, of Munich, has recently obtained a patent, in which he claims some details as to well-known methods of breaking up the grain of a photograph by means of a network, and he more especially claims the shifting of the network during the time of exposure. As regards this point, something similar was described by Bertschold in the volume of the *Photographic News* for 1859. Notwithstanding the fact that one cannot find any very striking features in the patent of Mr. Meisenbach, this gentleman has produced some typographic blocks of surprising excellence, examples of which are now before you.

Having now touched on a few stray points, we come to an important feature in connection with the subject, that is to say, the direct translation, by mechanical means, of the gradations of depth existing in the Woodbury relief into corresponding shades of stipple or granulation; but before entering into these, let me call your attention to a method of granulating the relief itself, which Mr. Woodbury has made the basis of a method by which excellent printing blocks have been made.

Mr. Woodbury exposes his ordinary relief tissue under a transparency with a piece of network interposed, the effect of this being to produce a decided grain all over the high portions of the resulting relief, and no grain over the deep parts, intermediate portions being grained to an intermediate extent. A reverse cast from the grained relief thus obtained is the printing block. This mode of procedure is subject to one disadvantage in actual practice, as the various printing parts of the resulting block do not lie accurately on one plane, as is the case with a block made by etching a plate of zinc into relief. Mr. Woodbury, however, informs me that he has recently overcome this objection, by a modification of the process in which a transfer is obtained directly from the relief. The specimen before you will show what good work this method is capable of yielding.*

* The following quotation from Woodbury's specification of 1873 will serve to fully elucidate the nature of the process referred to:—"I prepare sheets of bichromatized gelatine snch as is used in the process called 'Woodburytype,' and expose these under a photographic positive to the action of light, but interposing between the positive and the gelatine film a transparency on collodion or mica, of what is known as mosquito netting, Brussels net, tulle, and so forth, which has the effect of breaking up the resulting relief into a multitude of fine square hexagonal lines; or for some subjects I interpose a transparency on mica or collodion of any design of a similar nature that will have the same effect, such as an impression from a grained stone, or the same from a number of fine ruled lines. The sheet of gelatine, when washed, will give a relief having the positive photograph represented by a number of lines, instead of the simple half-tone it originally possessed; I then take an impression from this by means of hydraulic or other pressure in any soft metal, and use the block so obtained for printing at a type press where only a few copies are wanted; but where large numbers are required, I electrotype the same in the ordinary way. I prefer to use diffused daylight or sunshine through ground glass or tissue paper to produce the relief, as in that case the light in the parts that represent the white creeps round the lines, thus partially obliterating them in that part, and leaving them strongest only in the parts printing dark. I sometimes adopt another method. I take a negative of the network by transmitted light, and copy this together with the negative to be

Mr. Fred. E. Ives, of Philadelphia, published, in 1878, a method of translating the smooth photo-relief into stipple, and this method may be regarded as a new departure. According to the method of Ives, as described by him in 1878,* and patented in the United States, the essential features of his method consist in inking the Woodbury relief, and pressing against paper which has been grained or embossed, somewhat after the fashion of bookbinders' cloth. Under these circumstances the projections on the paper become completely crushed down by the inked relief where the gelatine is thickest, and a solid black results, while the more shallow parts of the relief only tip the projection on the paper with ink. Intermediate thicknesses of relief produced a medium effect. You will now please note the effect of pressing this sheet of grained paper against the inked Woodbury relief, a picture in black and white resulting, the shades of the original being represented by the varying extent of the closely packed dots which constitute the picture. The translation into stipple thus obtained may be used as a transfer for putting down on stone or zinc, but if preferred, it may be re-photographed. Ives also made printing blocks by casting from the grained surface which had been compressed by the gelatine relief, although these were not found to be quite equal in quality with those obtained by the first mentioned method. A subsequent modification of Mr. Ives's method gives results much more easily and economically, as he has succeeded in substituting a "swelled gelatine" relief for the more expensively produced Woodbury relief. In a letter to me, Mr. Ives says:—"The relief which I now employ is a plaster cast from swelled gelatine, which is secured so easily that an apprentice seventeen years of age makes them acceptably for Crosscup and West. On the relief the lines and stipple are impressed by means of a printing film of elastic V-shaped stippled lines, in a manner which gives the operator considerable control of the effect. The line and stipple picture on the plaster relief is then stripped off for lithographic transfer or etching, by a method so simple and perfect that it astonishes all who see it done. Formerly, I had to reproduce the impression by photography in the camera, and by this operation could not avoid losing much or the delicacy of the original, which is wonderfully delicate, sharp, and clear in line. I have to secure ruled plates for moulding closer lined printing films before I can apply the transfer method of reproduction for fine work; so it may be months before I shall show you what fine results I can secure in this way."

The broad principle of the Ives method, which consists in pressure of the relief against a grained or stippled surface, has been the subject of several subsequent patents and inventions. We find that, in 1879, Petit, of Paris, took out an English patent for a method nearly identical with that of Ives, and soon after another patent by Dredge followed; this latter, however, indicating novel methods of working. A process of quite a similar character is the "Crayontype" of Ad. T. Eggis, which was published in the *Photographic News* a short time ago. Mr. Eggis, instead of inking the relief, takes an inked film, such as manifold copying paper, and lays this on the relief. The grained paper is now placed over and pressure is applied. If the grained paper sold for producing crayon effects in lithography is used, very excellent transfers are obtained. Mr. Barker will illustrate the process to you.*

Other modes of effecting the translation of the

reproduced, thus producing a positive with the lines already thereon, from which I proceed to make a relief and blocks, as stated."

* The following reprint of Ives' original declaration will be of interest:—Ithaca, N. Y., Aug. 12, 1878. I, the undersigned, have, to-day, invented a method of obtaining relief plates for the typographic printing press, from ordinary photographic negatives, which may be described as follows:—1st. From an ordinary photographic negative, a relief in gelatine, similar to that used in the Woodburytype process, but perhaps in lower relief, is obtained. 2nd. This relief is carefully and uniformly inked with fine printers' ink, and pressed between two flat surfaces (or between rollers), against paper or other material, upon which is stamped, or otherwise produced, a fine grain, or other suitable surface. The inked relief being highest in the black parts, presses down the grain of the paper on the corresponding parts, and the removal of the ink by the paper from those parts of the relief produces a black impression, while upon those parts where the relief of the gelatine is lower, the grained surface is pressed less, and the ink taken up in spots, the size of which depends upon the grain of the paper and the amount of pressure, and producing an effect similar to that of crayon sketches made upon such a surface. 3rd. Relief plates may be made from this impression, either by the usual phototypographic processes, or, perhaps, by obtaining a cast or electrotype of the impressed surface of the paper or other material used to receive the impression from the gelatine relief.—Fred. E. Ives.

* Mr. Eggis, writing in the *Photographic News*, thus describes the method:—"This process gives results good enough to have allowed the taking of a patent, but I find it preferable to describe it for the public benefit. I call it crayontype, for the images it produces are much like those obtained by the artist with a lead pencil (crayon in French). This is how I proceed. I procure or produce, to begin with, a gelatine positive on best plate glass (*glacé*) obtained by the known ways, in relief. The highest point, when dry, should not have more than one millimetre. The other necessary implements are—1st, grained (or lined) paper, of same

relief by pressure on grained surfaces have been patented by Mr. Zuccato, and some of these will be demonstrated to you by Mr. Barker.

The first method consists in first planing a piece of type metal or similar surface in a series of ridges, or a series of pyramids, as the case may be. The plate is then inked, and instead of pressing the relief directly on the inked plate, a piece of very thin paper is interposed; the relief crushes down the pyramids in proportion to its depth. The pyramid of type metal is spread out, and forms a sharply cut outline on the paper, and in this way a transfer is obtained which has a remarkable clearness of outline, almost like the cleanest cuts of the graver.

It will illustrate the matter better if, instead of inking the plate first, the relief is pressed directly against it, and you will then be able to see the flattening of the lines or pyramids.

Two other modes of working have also been patented by Mr. Zuccato. In one he interposes between the relief and a sheet of transfer paper a piece of gauze, or a piece of silk which has been inked with transfer ink. Of course what then takes place is similar to what happens in the case of the plate; the threads of the gauze get crushed out to a greater or less extent, and form lines of greater or less width, but this method in which the gauze is crushed down is not nearly so perfect as the method with the plate of type metal.

A third mode of working, which Mr. Zuccato also claims in one of his specifications, is the pressing of the relief upon a lithographic or zincographic surface on which an ink stipple has been impressed. The stipple gets crushed out more or less, according to the extent of the pressure; this of course depends on the thickness of the relief.

Messrs. Brown, Barnes, and Bell, of Liverpool, have recently made some excellent blocks, and, judging from the appearance of the prints, they appear to me to be likely to have been produced by some method more or less resembling the Ives' process; still I have no knowledge on this point. These gentlemen have made certain patent claims, but as various methods are referred to, one cannot judge from the specifications as to what process is actually employed.

Before you go, perhaps you will look at some reproductions of phototype blocks, which Mr. P. Barry has made by casting in brass. The details are wonderfully preserved, but it does not appear to me that this process of reproduction is likely to supersede electrotyping.

kind as is used by the artists for their drawings destined to be etched; 2nd, a few sheets of blue or black transferring paper (*papier à calquer*, thin paper coated with a greasy substance and coloured); 3rd, a small press. Having these at hand, I take the gelatine positive, lay it on the stone or metal table of the press; on the relievo I place a sheet of transferring paper, the prepared face turned upwards. On this I lay the stippled or grained autographic paper, face downwards, touching the greased sheet. Over all this I place a fine polished steel sheet, well planed. I put the whole under the press, and slowly pull down the lever in such a manner as to give a smooth and graduated impression. Afterwards separating the whole, I find on the grained paper a good and often a perfect stippled reproduction of the gelatine relief. This reproduction being formed by a greasy substance, I am able to transfer it at once directly on stone, for lithographic purposes, or on metal, to be etched in the usual manner. The production of such an image will be easily understood; it is much the same as the direct drawing with a pencil on the paper. Instead of the artist pressing more or less his graphite on the paper, the gelatine relief (which corresponds more or less to the lights or shadows of the photo) presses more or less on the paper, and gives the true gradation of the original. The work of the hand is mechanically imitated very closely indeed. The crayontypes present a different grain, which may be chosen according to the work to be done. It is at least more artistic than the usual regular stippling."

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON PRESERVED MEAT. By J. J. MANLEY.

Though the exhibits of preserved food at the Health Exhibition are very numerous, and, it may be added, excellent after their kind, it can hardly be said that, generally speaking, they show much novelty, or suggest that any great advance has been made of late years in the art of food preservation. At the same time, however, the great variety of exhibits brought together at South Kensington may have the effect of drawing additional attention to preserved substances, and developing a greater appreciation than exists at present of this particular form of our food supply.

Confining my remarks for the present to preserved meat, it is evident that in this department of food preservation no very great improvement has been effected in the class of "tinned" or "canned" goods during the last ten years or so, except as regards the application of pressure, first practised in America, we believe, whereby the meat preserved is rendered more solid and capable of being cut into thin slices, and thus more presentable in appearance. But there is still the great drawback in the "overcookedness" of this class of preserved meats, which militates against their general acceptance amongst us, particularly in the southern districts of this country, the northern districts, and especially the mining populations, patronising them more freely. As a rule, the contents of the tins may be depended on, the great "packing" firms, especially those on the other side of the Atlantic, vieing with each other for popularity, not only by a competition in price, but also by a competition in the excellence of their products, well knowing that a good "brand" will establish itself in the market. The specialties produced mainly by firms at home, more as articles of luxury, and as food for invalids, leave little to be desired, though here, again, what at present seems to be the unavoidable "overcookedness" in order to ensure perfect preservation, detracts from their palatableness, if not from their nutritive value.

The preservation of meat has engaged the attention of mankind from very early times, ancient tribes having soon learned the process of drying animal food, and, later on, the Greeks and Romans having freely employed salt, after the modern fashion, and vinegar and honey, and other antiseptics, for the preservation of meat in enclosed vessels. But the ancients had little necessity for the preservation of fresh meat, as a more or less abundant supply of it in its natural state was always at hand. The case is different now, in the more thickly populated countries of the civilised world, and we have to reverse the well-known Mahomet experiment, and as we cannot go to the "mountain" of supply, the mountain is to some extent brought to us from countries where the meat supply is for the present practically inexhaustible. The methods of meat preservation may, in a general way of speaking, be said to be four, and these include all possible methods, viz., by dessication or drying; by the use of chemical antiseptics: the exclusion of atmospheric air, mainly by the application of heat or pressure, or a combination of both; and by refrigeration or the application of cold, though of course, strictly speaking, what we term "cold" is only a low degree of "heat." As long ago as 1689, in this country John White and William Porter obtained a grant from the Crown "to hold and enjoy for fourteen years" the sole right of preserving animal food, which they warranted would keep sweet for any number of years in any climate; but their process does not seem to have brought about any great result. Only three patents for food preservation were described in the 18th century, but over one hundred were described in the first half of the present. Since then this number has been greatly added to, though in very many instances the patents only vary from one another in detail, and not in principle. We shall only here briefly allude to the desiccation and antiseptic processes, because at the Health Exhibition they are hardly represented at all, except in the form of the familiar "provisions," such as hams, tongues, sausages, and so forth, which are more or less a combination of both, salt being the chief antiseptic used, and they hardly come within the scope of the present notice. The "charqui," or South American dried beef, however, was exhibited, as was also "powdered" meat. A specimen of the latter from Queensland was some years ago submitted to the Food Committee of the Society of Arts; but no form of simply dried meat is likely to secure a large demand, for animal matter is not well preserved by desiccation, as it loses its flavour, and becomes more or less indigestible; the fat has a tendency to become rancid; and the lean in damp weather, absorbing moisture, to become mouldy and sour.

It is with the preservation of meat by heat and cold (to use popular terms) we have here to do; and with examples of these processes the Exhibition abounds. Preservation by means of heat is effected by driving out the atmospheric air, and creating a vacuum round the substance preserved, in tin or other vessels. Hence the method is often called preservation *in vacuo*. The first simple process consisted in putting meat, with a charge of water, into a tin case with a small aperture or "pin-hole" at the top, and then placing it in boiling water nearly up to its top, and when the steam had displaced the air, stopping the hole with solder. This process dates back as far as 1829, but the first patent for it was granted to M. Pierre A. Augilbert, in 1823. An improvement was effected by Wertheimer, in 1840, and again by Gunter in the following year, when Goldner and Wertheimer obtained patents for using a bath of muriate of lime for heating the vessels. This is called the chloride of calcium process. But perhaps it is only fair to give M. Appert, of Paris, the credit for first preserving meat by the application of heat, though he did not use the "pin-hole;" and Messrs. Donkin and Gamble were, I believe, the first English firm which made a business of preserving meat on this principle. This is not the place to enter into a discussion whether the presence of oxygen is the sole cause of decomposition or putrefaction, or whether these are brought about by living "microscopic germs;" whether preservation by heat is effected solely through the expulsion of the atmospheric air, or by the actual destruction of the "microscopic germs;" but it may be taken for granted that, without a perfect expulsion of the air, and the creation of a perfect vacuum in the vessels, preservation is not effected. A moderate degree of heat, such as that of boiling water, is not sufficient to expel all the air from the vessel, and effect a perfect vacuum for preservation. Hence an extra temperature is required.

The four methods of applying heat to vessels containing meat (or fish) are known by the names of (1) the ordinary Aberdeen process; (2) the Steam-Retort process; (3) the Chloride of Calcium process; and (4) Jones's Patent Vacuum process. These, though varying in detail, are practically the same in principle; but Mr. Jones added the use of an external vacuum chamber, with which the tins are connected by pipes, to further assist in getting the air out of them. This was certainly the most successful method as regards its result, the meat preserved being much firmer, but the comparative complication of the process, and the fact that the contents of the tins lost more weight than when subjected to the other processes, prevented it being adopted by meat-preserving firms. It is by one or other of the first named three methods, with certain modifications in detail, but all on the vacuum principle, that almost all the solid meats, fish, poultry, vegetables, soups, stews, the variety of "odds and ends," such as kidneys, tripe, sausages, minced meats, and the several "made dishes," both in this country and abroad, are preserved.

The methods of drying, refrigeration, and use of antiseptics, and combinations and modifications of them, more or less important methods of preservation in themselves, are either too costly, or are not, strictly speaking, methods by which animal food can be preserved for any lengthened period, for the practical purpose of its being brought to this country as a substantial and cheap addition to our food supply. It is by heat alone, as applied in the above-mentioned processes, that it can fairly be said the food preservation question has hitherto been solved, and then only in a certain modified sense. By all the above methods, however, preservation—simply as preservation—is perfect. As long as the tins or other receptacles in which meat or any other substance, has been successfully preserved by the creation of a perfect vacuum through the application of heat, remain sound and air-tight, so long will their contents remain perfectly sound also. Tins with the meat perfectly sound in them, though preserved 50 years ago, are still in existence. At the London Exhibitions of 1851, 1862, and 1873, tins of meat which had been "put up" from 25 to 40 years ago, were exhibited, and when tested were found perfectly sound. Stores of preserved meats, &c., in tins, have been left in the Arctic regions for years, annually exposed to a temperature of 92° below, and 80° above zero. They have been brought back to this country, and the contents of the tins found to be as sound as the day they were "put up." As a matter then of mere preservation, the heat processes are an unquestionable success, and by their agency we have, in this country been able to obtain a large supply of sound, edible and cheap beef and mutton from the very ends of the earth.

It may here be well to repeat the instructions often given to purchasers of tinned meat, to the effect that the tins which are bulged out at the top or bottom, or in other words showing a convexity, give warning that the contents are bad, as the tins have become defective and let in atmospheric air, while what are called the "collapsed" tins, of which purchasers are often afraid on account of their irregularly indented sides, show that their contents are sound, the "collapsing" being caused by the very perfectness of the vacuum within them. A word here also may be useful in reference to the alleged poisoning, of a more or less serious character, which, it is said, has resulted from eating various kinds of preserved meats, fish, vegetables, and fruit from tins. But the instances are very rare, indeed hardly worth serious consideration, when compared with the millions of tins used annually all over the world. Some tins themselves are originally imperfect, or, for some reason or other, become so after keeping in stock; and consequently their contents become more or less unwholesome; but it need hardly be said that this is no more valid an objection to tinned goods than it would be to any other articles, liquid or solid, which require to be kept air tight. In some cases injurious effects may follow the consumption of tinned food, when the consumer has a predisposition to gastric, hepatic, or other internal derangement. But, perhaps, the most important consideration in the matter is the chemical action which may sometimes take place on bad metal after a tin of sound food has been opened, and the contents left in it exposed to atmospheric air. Any danger, however, from this is easily obviated by turning the contents of the tin into some glass or earthenware receptacle, if they are not all wanted for immediate use. But, after all, the danger of using tinned food is so infinitesimal, and the cases of injurious effects reported have been in most instances so grossly exaggerated, that it is hardly necessary to pursue this matter further. Practically, there is no more danger in eating tinned food than food in a great variety of other forms. In confirmation of this view there has just come to hand a report of Major-General Hawkins, of the United States Army, in which he says that the army outposts throughout the States have for nearly twenty years been largely supplied with "tinned" meats, vegetables, and preserves, and that he has never known a case, either among officers or men, or their families, of injurious effects from eating these goods. He further adds that the Medical Directory of the army corroborates this statement.

Among the exhibits of tinned meats those shown by Messrs. Chase and Co., of Adelaide-buildings, London-bridge, comprising a variety of American productions; by J. S. Laurie and Co., of 14, St. Mary-axe, E.C.; by Messrs. Dickson and Renwick, of 39, Lombard-street, E.C.; by Messrs. Libby and Co., of Chicago; and several other firms are well worthy of notice. The show of Australian, New Zealand, and other meats, by Messrs. Huckvale and Co., of Billiter-street, E.C., is an excellent one, the firm being one which deals in none but the best and most reliable "brands." The tongues they exhibited deserve special commendation, as also do the "potted" meats, mostly of English production, which would be welcomed at the breakfast and luncheon tables of the most fastidious.

CHINESE MUSIC, AND WEIGHTS AND MEASURES.

Chinese music can now be heard by all who desire to hear it at the Health Exhibition, and more may be learned on the subject from the pamphlet published by the Commissioners for the Chinese department. A curious account of the common origin of Chinese weights, measures, and musical notes is contained in a paper read some years ago before the German Asiatic Society of Japan by Dr. Wagener. The story is based on native legends, and is also to be found among the Jesuit "Mémoires concernant les Chinois." Dr. Wagener says there is not the slightest doubt that the Chinese system of weights and measures is more than 4,600 years old; and it is a highly remarkable circumstance that, quite irrespective of the fact that it is more scientific and exact, it possesses all the advantages for which the French metrical system is so much praised. In the first place, it starts from a basis supplied by Nature; secondly, the decimal arrangement is almost consistently employed throughout; thirdly, linear and dry measure proceed directly from the same unit as the measure of weight; and lastly, what the metrical system does not do, it regulates in the simplest manner the relations of musical notes, which latter form the starting-point for the whole system of weights and measures. The following account of the origin of this system (says Dr. Wagener) contains fact and fancy mingled, but it is easy to distinguish between them. In the reign of the Emperor Hoang-ti, who ruled over China in the twenty-seventh century before Christ, the scholar Lyng-lun was commissioned to complete the musical system which had been discovered 250 years earlier, and particularly to lay down fixed rules for making musical instruments. Naturally he had to commence with the bamboo, which had already been long used to give the note for other instruments. He, therefore, betook himself to the province of Siyung in North-Western China, where, on the northern slope of a range of high mountains, a species of bamboo grew, which, on account of its uniformity and its structure, being neither too hard nor too soft, was exceedingly suitable for a wind instrument. He cut one down and tried it. Tradition says that it gave the same note as his own voice when he was excited by no emotion; and the rippling of the sources of the great Hoang-ho, or Yellow River, which were in the vicinity, followed in the same tone. At the same time the fabulous bird Fung-Hiang, accompanied by his mate, flew to the place. Both perched themselves on a neighbouring branch, and commenced a song, in the course of which each of the birds gave six separate notes. These are the notes which are called the six male and six female tones in the scale discovered by Lyng-lun, and which correspond to the ancient doctrine of the male and female principles in Nature. As a matter of course, the deepest of the male notes was the one already discovered by the philosopher himself. He now endeavoured to reproduce the other notes with the help of bamboo pipes, and succeeded. His task was now to lay down fixed rules as to the length of the pipes, so that thenceforth they could be easily constructed everywhere. For this reason, and also because such a scale of notes depends upon slight differences of length, and there were scarcely at this time instruments to divide great lengths, he necessarily arrived at the notion of passing from the less to the greater, and of laying down an adequately small natural unit for his measurements. That could be nothing else but a grain of seed; and now the point was to get seeds of the greatest possible uniformity. He chose a sort of millet, the *Sorghum rubrum*, the seed of which is of a dark brown colour, and which is said to possess the advantages of greater hardness and uniformity than that of the grey and other kinds. The seed is pointed at the ends, and from one point to the other the length is somewhat greater than in the direction at right angles. Lyng-lun now fixed the length of the pipe, which gave the keynote at 81 grains of the seed placed lengthwise in a row. But when the grains were placed breadthwise it took 100 grains to give the same length. Thus the double division of 9×9 and 10×10 was naturally arrived at. According to the dimension in question, it was called a musical or an ordinary foot, the latter being introduced with the decimal subdivision as a measure of length. The breadth of a grain of seed was 1 *fen* (a line), 10 *fen* = 1 *tsun* (an inch), 10 *tsun* = 1 *che* (a foot), 10 *che* = 1 *chang*, 10 *chang* = 1 *ny*. In subsequent times the line was divided into tenths, hundredths, &c. Lyng-lun also laid down rules for the breadth as well as for the length of the pipe, because, although the note is essentially dependent on the length, it is nevertheless necessary for its purity that the pipe should be neither too broad nor too narrow. He therefore fixed the circumference on the inside at 9 grains laid lengthwise. With these dimensions, namely, a length of 81 grains, and an internal circumference of 9 grains, the pipe which gives the keynote contains just 1,200 grains, and this volume accordingly was made the unit of dry measure, and was called a *yo*; 2 *yo* = 1 *ko*, 10 *ko* = 1 *cheng*, 10 *cheng* = 1 *ten*, 10 *ten* = 1 *hu*. So far we see how the units of length and dry measure were connected with the musical keynote. The twelve notes of the scale are all derived from the keynote, and are to a certain extent comprehended in it. Hence, if the 1,200 grains contained in the pipe are divided among the twelve notes, it gives to each 100, and the weight of these 100 grains was made by Lyng-lun the unit of weight. This was divided and subdivided on the decimal system until a single grain became the lowest weight of all. At a later period even the coinage became connected with this system, for one of the weights, the *leang*, corresponding to our ounce, became the weight of metal put into a coin, so that the modern *tael*, in which mercantile quotations are found every day in the *Times*, is merely an ounce of silver, and is thus directly connected with the musical scale. Finally, says Dr. Wagener, it appears from this account that, in China, weights, measures, coinage, and the tuning of musical instruments have been derived quite consistently from a constant unit supplied by Nature herself, and that the essentials of this system are over 4,600 years old.—*Nature.*

PINE FORESTS OF NORTH CAROLINA.

Consul Walker says that little change has taken place during the last three quarters of a century in the preparation for market of the far-famed products of the pine trees of Carolina. The resinous product of the pine is of six sorts, turpentine, scrapings, spirits of turpentine, resin, tar and pitch. Turpentine is the sap of the tree obtained by making incisions in the trunk. It begins to distil about the middle of March, when the circulation commences and flows with increasing abundance as the weather becomes warmer, so that July and August are the most productive months. When the circulation is slackened by the chills of autumn, the operation is discontinued, and the remainder of the year is occupied in preparatory labours for the following season, which consist in first making the boxes, this being done in January and February. In the base of each tree, about three or four inches from the ground, and generally on the south side, a cavity is formed, large enough to hold about two pints, but proportioned to the size of the trunk, of which it should occupy a quarter of the diameter. Next comes the raking or the clearing of the ground at the foot of the trees from leaves and herbage, by which means they are secured against the fires that are often kindled in the woods, as if the flames gain the boxes, already impregnated with turpentine, they are rendered useless. At the sides of the box two oblique gutters are made about three inches long, to conduct into it the sap that exudes from the edges of the wound. At the expiration of a fortnight the first boxes are filled with sap, an iron implement called a "dipper" is used to transfer it to pails, which in turn are emptied into casks placed at convenient distances. To increase the product, the upper edge of the box is clipped once a week; the boxes fill every three weeks. The chippings extend the first year a foot above the box, and as the distance increases, the operation is more frequently repeated, to remove the sap coagulated on the surface of the wound. The closing of the pores, occasioned by continual rains, exacts the same remedy, and it is found that the produce is less abundant in moist and cool seasons. After five or six years, the tree is abandoned. It is estimated that 250 boxes yield a barrel containing 320 lbs.; and in general, 3,000 trees yield, in ordinary years, 75 barrels of turpentine, and 26 barrels of "scrapings," the scraping being a coating of sap which becomes solid befoie it reaches the boxes. The manufacture of spirits of turpentine is largely carried on in North Carolina. The turpentine is distilled in copper stills; formerly iron stills were used, and the method employed is as follows:—A 15 barrel still, the barrel weighing 280 lbs., is charged early in the morning, gentle heat being first applied, until the mass is liquified, and a coarse wire skimmer being used to remove the chips, bark, leaves, and other foreign substances that may rise to the surface, the temperature meanwhile rising until it reaches 316° Fahr. All the accidental water that is contained in the crude turpentine as it comes from the forest, having been distilled off, a small stream of cold water is then let in, so that the heat is kept at below 316° Fahr. the boiling point of oil of turpentine. The oil of turpentine and water now run over, and the mixture is caught in a wooden tub. The distiller tests the quality of the flow from time to time, in a proof glass, and the distillation is continued until the proportion of water coming over is nine of water to one of oil of turpentine. At this stage the heat is withdrawn, the cap is taken off, and the hot resin is drawn off by a valvular cock at the side of the still, near the bottom. This resin passes through a strainer before it reaches the vat, to rid it of foreign substances which may not have been previously removed by the skimmer. The yield of oil of turpentine from "virgin dip,"—that is, the first exudation from a newly boxed tree—is about five gallons to the barrel, about 20 per cent. being left in the resin, since the removal of a larger proportion would darken the colour, and consequently depreciate its value. The yield from "yellow dip" (the running from the second and subsequent years) is about four gallons to the barrel; that from "scrapings" is from two to three gallons and a-half. Tar is made from dead wood of the long-leaved pine. As soon as vegetation ceases in any part of the tree, its consistence changes; its sap decays, and the heart, impregnated with resinous juice, becomes surcharged to such a degree as to double its weight in a year: the accumulation is said to be much greater after four or five years. To procure the tar, a kiln is formed in a part of the forest abounding in dead wood. This is first collected, stripped of the sap, and cut into billets two or three feet long and about three inches thick, a task which is rendered long and difficult on account of the knots. The next step is to prepare a place for piling it, and for this purpose a circular mound is raised, slightly declining from the circumference to the centre, and surrounded by a shallow ditch. The diameter of the pile is proportioned to the quantity of wood which it is to receive; to obtain 100 barrels of tar it should be eighteen or twenty feet wide. In the middle is a hole, with a conduit leading to the ditch, in which is formed a receptacle for the tar as it flows out. Upon the surface of the mound, beaten hard and coated with clay, the wood is laid and arranged in a circle. The pile, when finished, may be compared to a cone truncated at two-thirds of its height and reversed, being twenty feet in diameter below, twenty-five or thirty feet above, and ten or twelve feet high. It is then strewed with pine leaves, covered with earth, and contained at the sides with a slight cincture of wood. This covering is necessary in order that the fire kindled at the top may penetrate to the bottom with a slow and gradual combustion, as, if the whole mass was rapidly inflamed, the operation would fail, and the labour in part is lost. As the tar flows off into the ditch it is emptied into casks containing about thirty gallons each. Consul Walker states that the quantity of spirits of turpentine exported from North Carolina now averages about 5,300,000 gallons, and of resin about 550,000 barrels annually.

MECHANICAL STENOGRAPHY AT THE TURIN EXHIBITION.

By P. Le Neve Foster.

Amongst the most important novelties at the Turin Exhibition, the stenographic machine of Signor A. Michela merits special notice.

Signor Michela has succeeded in grouping into various series, and in representing by means of certain combinations, all the phonetic sounds emitted in any language, and has formed a notation of language perfectly similar to that of musical sounds. As soon as they are pronounced, the different words, so to speak, are decomposed by the ear of the operator at the instrument, and a graphic representation of the syllables is printed upon a slip of paper which is drawn through the machine, and from this they can be read afterwards, and transcribed into ordinary writing, in order to reproduce the speech, such as it has been delivered, in whatsoever language it has been spoken.

The machine, which in form somewhat resembles a small harmonium, is about 18 inches in length, by 10 inches in width, and 8 inches in depth, and is mounted on a portable stand. It consists essentially of two parts. 1st. The printing mechanism. 2nd. That referring to the automatic drawing forward of the paper. The first consists of two keyboards, similar to that of a pianoforte or harmonium, arranged in a symmetrical manner, and having each 10 keys (6 white and 4 black). These keys, when depressed by the fingers of the operator, press on 20 studs, and through them a similar number of corresponding rods, and these lower the ends of 20 metallic levers, the arms of which have a constant ratio, and at the same time the opposite end, which carries a style, is lifted upwards, and a sign or character engraved upon it is reproduced upon the slip of paper. It is, therefore, only necessary to depress one of the keys in order to raise the style corresponding to it, and if several keys are depressed at one time, the corresponding combination of signs will be printed upon paper. The machine may be arranged as an "embosser," or as an "ink writer," which latter is the most preferable form, as the printing can be read off quicker, and with less fatigue to the eyesight than is the case when the signs are produced in relief.

The mechanism referring to the drawing forward of the paper is also exceedingly simple, and this motion can be produced in a variety of ways. In the machine exhibited, however, it consists of a small lid placed horizontally underneath the twenty keys, and which, when any one of them is pressed down, moves the end of a lever, which acting by means of a catch on a ratchet wheel causes it to revolve; a spring on the underside of the lever brings this latter back to its original position when the pressure is removed. The ratchet wheel, which is fixed on the same axis with a friction roller, gives motion to another roller placed above it, so that the paper band on another roller placed between the two keyboards, when caught between the two friction rollers which pull it forward, is moved automatically at each impulse of the ratchet wheel caused by depression of one or more of the keys. The pressure of these friction rollers on the paper is regulated by a screw, and guide bars are provided for the printing styles.

The essential feature in this invention is the manner in which the graphic representation of the various phonetic sounds is obtained, and the various combination of signs which correspond to the different syllables and words could not be explained clearly here without special diagrams. The manipulation of the keyboard of this instrument differs from that of an ordinary piano, inasmuch as the same finger always operates upon the same two keys, a circumstance tending to facilitate its use, especially amongst the blind. A skilled operator can take down 200 words per minute in any language he knows, which speed is more than sufficient to follow the fastest orator, as the delivery of speech varies from 80 to 180 words, or averaging 130 words per minute.

This machine has been lately adopted in the Italian Senate.

It will be readily seen that this apparatus can be applied with telegraphy to the rapid transmission of shorthand messages; and from experiments that have been made, there is every reason to believe that the paper bands can be printed with the same rapidity at distant stations, by the simple manipulation of the keyboard at the one end of the line, as they are now printed at the Exhibition.

THE SILK HARVEST OF 1884.

Consul Peixotto, of Lyons, states that the silk crop in France for the present year is now gathered, and, according to the most reliable accounts, will fall short short to the extent of about 25 per cent. compared with that of last year. As the harvest of last year gave but 611,000 kilogrammes of silk, the present will scarcely yield more than 460,000 kilogrammes of *grège* silk, which will thus prove inferior to any of its predecessors for the past six years, except that of 1879, when the total crop reached only 375,000 kilogrammes. The deficiency has been owing in great measure to the reduced quantity of eggs for incubation, and the unfavourable weather during the latter period of development. The Italian crop is found to be inferior by from 15 to 18 per cent., compared with that of 1883, as to quantity, while the quality is reported to be much inferior. The crop in 1883 reached 3,200,000 kilogrammes, but it is doubtful whether it will exceed 2,700,000 kilogrammes for this season. In Spain the crop is deficient to the extent of about 10 to 15 per cent. as compared with that of 1883, when it yielded 95,000 kilogrammes. The crops in the Levant, especially in the Broussa district and in Syria, have been in general excellent, and in production considerably superior to last year. Silk culture in these countries is greatly developing, each season witnessing an increased production. The crop of 1883 exceeded 600,000 kilogrammes, in 1879 it only amounted to 345,000 kilogrammes. This year it is estimated to be about 700,000 kilogrammes, and may even exceed that figure. The quality of the cocoons and the silk produced is remarkably good, and grows in favour. In China, it is estimated that the export crop will amount to 60,000 bales. In 1883, Shanghai exported 2,491,000 kilogrammes, and Canton 1,156,000 kilogrammes, and these figures, it is estimated, will be greatly exceeded this year. As regards Japan, a fine crop is reported, and it is estimated that the amount exported will surpass 30,000 bales. During the year 1883, the exports from Yokohama amounted to 1,612,000 kilogrammes. In India it is stated that the crop is considerably superior to that of last year, when 536,000 kilogrammes were exported from Calcutta. In Georgia and Persia the amount of silk consumed and exported in 1883 amounted to 250,000 kilogrammes, and though the news respecting this year's crop is contradictory, it is expected that the result will be quite equal to that of last season. Consul Peixotto estimates that the *grège* silk crop of the world for the year 1884 will amount to 10,000,000 kilogrammes, or but 7 per cent. less than that of the harvest of 1883.

General Notes.

ANTWERP INTERNATIONAL EXHIBITION, 1885.—Portugal has applied, through its Minister of Marine, for a space of 250 square metres in the grounds, for a pavilion to show the products of its colonies. The Presidency of Bombay will make a display of its artistic productions, and the Lieut.-Governor has ordered the Director-General of prisons to have carpets made specially for exhibition. He has also appealed to the native princes to participate. Calcutta is expected to forward a good collection of its raw products. In the last number of the *Journal* the notice of this Exhibition was by mistake headed Amsterdam Exhibition.

BRIGHTON ELECTRIC RAILWAY.—The extension of this line having now been in operation for six months, a few particulars may be interesting as showing the capabilities of a light line of this description. The car mileage amounts to 15,600 miles, or 100 miles per diem; and the number of passengers, in round numbers, to 200,000. These figures would have been increased, but for the fact that at certain hours the would-be passengers exceeded the capabilities of the car, which seat thirty persons only. No accident has occurred to either the general public or to passengers by the car. The consumption of gas in the gas-engine has been 300,000 cubic feet, or $1\frac{1}{2}$ cubic foot per passenger per mile. The total cost of traction, including the interest and depreciation on engine, dynamo, and motor, cost of gas, oil, and attendance, has amounted during that period to 15s. 6d. per day (100 miles run), say 2d. per mile. The car service has only been stopped for one day, through the tyres of the wheels giving out, owing to the heavy pressure of the holiday traffic, when there was no second car available.—*Electrician.*

CORAL INDUSTRY.—The best coral grounds, yielding the most and best coral, according to the *Times*, are still those on the Algerian coast, fished for that purpose from the middle of the 16th century, the others being the coasts of Sicily, Corsica, Sardinia, Spain, the Balearic Isles, Provence. Over 500 Italian boats, manned by 4,200 men, are employed in the coral fishery, 300 of these boats being from Torre del Greco, in the Bay of Naples. The quantity gathered by these 500 boats amounts in all to about 56,000 kilogrammes annually, valued at 4,200,000 lire; that by other boats, Spanish, French, &c., to 22,000 kilogrammes, at 1,500,000 lire—total for the year, 78,000 kilogrammes, at 5,750,000 lire. The taxes paid to the Government for the liberty of fishing on the African coast are very high, 1,166 lire per boat for the summer season, and half as much for the winter, so that in consideration of the toils and risks undergone, the profits are but very moderate. The gross gains, per boat, may be set down at 8,000 lire for the season, and the expenses at 6,033 lire, leaving only 1,967 lire net profit. In Italy are 60 coral workshops, of which 40 are in Torre del Greco alone, employing about 9,200 hands, mostly women and children. The principal markets are Germany, England, Russia, Austria, Hungary, and Poland, a large part going to Madras and Calcutta.

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CANTOR LECTURES.

RECENT IMPROVEMENTS IN PHOTO-MECHANICAL PRINTING METHODS.

By Thomas Bolas, F.C.S.

Delivered Monday, February 11th, 1884.

Intaglio Plates. Collotypes. Photo-Mechanical Methods, as applied to the Decoration of Pottery. Miscellaneous Processes.

Perhaps the most perfect mode of printing is from an incised or "cavity" plate, as by this method the most minute markings can be reproduced with a degree of perfection which is not attainable either in the case of lithography or typography; but what is, perhaps, of more importance, is the circumstance that by adjusting the depth of the cavities to the requirements of the subject, not only can the engraver of the plate determine which portions of the print shall be covered with ink, but he can also determine how much ink shall be devoted to each part of the subject. To put the case in another way, not only can the engraver plot out his subject in black and white, but, within certain limits, he can determine how black the lines shall be.

Intaglio plates made by the aid of photography have been produced in great perfection by several methods, but up to the present time there has not been a very large market for them; partly, perhaps, from the considerable expense attending the work of printing from them. Intaglio plates are, even in the present day, generally printed from by hand; and this notwithstanding the fact that very excellent machines have been constructed for the purpose of plate printing.

One may generally put it that any transfer method for the production of a lithographic or typographic surface may also be applied to the production of intaglio plates, it being merely necessary to make a transfer in which the whites and blacks are reversed, to put this down upon a copper or steel plate, and to etch away the uncovered parts by suitable means.

It will be thus seen that, by the Ives method and its modifications, intaglio plates may readily be made; but there is but little inducement to do so, as such plates will not give much better impressions than the typographic or lithographic surfaces produced by similar methods, so that the great expense of printing from the intaglio plate steps in as a determining circumstance. There is, however, an exception in the case of printing surfaces to be used for pottery decoration. For this purpose intaglio plates are generally used, the method of printing being so rough and simple that the impressions cost about the same as prints from a type block. Hence it happens that intaglio plates made by means of photography have a special value to the potter. On the bed of this little press is a Woodbury relief made from a positive, that is to say, just such a relief as is used for the stannotype method, those parts of the relief corresponding to the whites of the original being high, and those parts of the reliefs corresponding to the darks of the original being low. Mr. Barker has uniformly inked it by means of an ordinary printer's roller, and let me now take an impression from the inked relief on a sheet of paper which has been grained in relief by means of pressure against a ruled plate. You see that a negative transfer in stipple is thus obtained, and when this is transferred to a copper plate, it serves as a resist to the etching fluid, a solution of perchloride of iron in water being one of the best mordants.

An extremely simple and expeditious method of engraving line subjects upon copper plates is the bichromated albumen process, practised with much success by Gobert and others. A plate is covered with a film of bichromated albumen, and exposed under a transparency, until the whole of the ground—that is the part not covered by the lines of the transparency—is rendered insoluble. The plate is next washed with cold water, so as to remove the albumen from the lines, after which the etching is effected by an alcoholic solution of ferric chloride.

The following details will be sufficient to enable the method to be carried into practice. One hundred cubic centimetres of albumen are mixed with a solution of two and a half grammes of bichromate of ammonia in fifty cubic centimetres of water, and after having been well beaten, the mixture is filtered. A carefully cleaned plate of copper is now coated with the mixture, and after the excess has been well drained off, the plate is dried at a very gentle heat, it being retained in a horizontal position meanwhile. The exposure required is by no means a long one, half a minute in moderate sunshine being sufficient in ordinary cases; but this must, of course, be learned by experience. Instead of developing (washing away the unaltered albumen) in plain water, it is better to use a weak solution of aniline red or magenta dye, as under these circumstances the ground becomes tinted, and the progress of the development can be watched. When the plate has been dried, nothing now remains but to varnish the back and edges with an ordinary black varnish, such as the so-called Brunswick black, and to etch. The etching bath is made by dissolving one part of perchloride of iron in five of alcohol, and ten minutes is generally a sufficient time for etching to the required depth.

On the table are some early specimens illustrating the photo-engraving method of Mr. Woodbury—now so successfully carried into practice by Messrs. Goupil and Co., of Paris. A gritty powder—crushed glass answers well—is incorporated with the gelatine used for making the Woodbury relief, and a leaden reverse being taken by pressure from the rough relief, the leaden reverse is reproduced by a twofold electrotyping. This reproduction of the leaden reverse is the printing plate.

The method which Major de La Nöe calls typogravure is in reality an intaglio process, but the printing is conducted as in the case of ordinary zincography. The details are as follows:—A prepared zinc plate is coated with a film of sensitive bitumen by well known means, and exposure is made under a transparency or a tracing, so that when development is carried on with turpentine or benzole in the usual way, the lines alone are bare. The plate is now etched with dilute nitric-acid (1 and 40) until a depth of about a 250th of an-inch is reached, after which the plate is dried and once more coated with bitumen. The ground is now polished off with a stick of charcoal, leaving the bitumen in the lines; after which the plate is gummed and printed from by the usual zincographic method. This process is admirable for map work, although it is obviously inapplicable for the reproduction of subjects with widely extended blacks; and it has the advantage that the lines show no tendency to spread.

Before going any further, you may with advantage look back at some of the older examples of photo-engraving in half tone. Here are some specimens done by Talbot's etching process, over 25 years ago, and they are admirable; while yonder is an example done by Mr. Dallas, in 1864, and issued with the *Photographic News* of that year. These examples of work done by Pretsch about 20 years ago are quite sufficient to prove that good work is not altogether a thing of to-day. Among the newer methods, that of Klic deserves special mention; and this specimen, which was issued with the "Year Book of Photography for 1882," will serve to show you how perfectly this method can render the lighter or more delicate shades of a photograph. Messrs. Annan Brothers, of Glasgow, are working the process commercially in this country, and they have turned out some admirable plates. Klic has not published his method, but it is said to be an etching process, and the following details are given in a recent number of the *Photographic News*:—

"The process itself was a secret at first, but we are informed that the principle of working is as follows:—A copper plate is dusted with powdered asphalt, and the plate is heated, so that the asphalt becomes nearly melted. A negative carbon print is now transferred on to the copper plate, and the plate, now covered with the negative in carbon, is etched, at first by a strong solution of per-chloride of iron, which penetrates only the thinnest parts of the picture; then by a weaker solution of the same salt, the solution etching through the thicker parts. By employing more and more diluted solutions, it is possible to etch through thicker and thicker layers of gelatine, so that only the high-lights remain unetched."

On the table are some exquisitely fine plates made by Messrs. A. and W. Dawson, the managers of the Typographic Etching Company, these being reproductions of subjects after nature, and of difficult drawings in wash.

Major Waterhouse has been remarkably successful, during the past few years, in making intaglio plates, and he has published the details of his method. The process is a modification of one introduced some time previously by Geymet, and it is based on the mechanical reticulation or breaking up of the Woodbury relief.

A Woodbury relief is developed upon a plate of silvered copper (but the relief need not be nearly so high as that required for the Woodbury process; in fact, an ordinary carbon print will answer), and when the relief is taken out of the developing water, it is dipped into a solution of potassium bichromate, drained and dusted over with fine sand; this sand having been previously waxed by being heated in an iron pot, and stirred up with a small proportion of wax. The layer of waxed sand is allowed to remain on the film until it is quite dry, when it is brushed off, leaving the gelatine granulated or pitted all over; the pits being deepest in the thick parts. The plate is now blackleaded, and a cast is made in the electrotype bath; this cast being the printing plate.

The specimens on the table will show you what excellent work can be done with this method, and you must remember that Major Waterhouse has not only published full working details,* but he has demonstrated the process before several gentlemen interested in the matter; moreover, he has not patented the method.

Before you are some fine examples of the application of photo-engraving to pottery decoration, by Mr. F. S. Emery, of Burslem—and one photographic method which this gentleman adopts for the reproduction of pottery designs is of special interest. He coats a plate with sensitive bitumen, puts down upon this surface a transfer from the plate to be reproduced, and exposes to light until the ground is insoluble. Development is now effected with the usual solvents—say, a mixture of turpentine and benzole; only those parts of the ground which were protected by the transfer dissolving. The etching is affected by perchloride of iron.

As regards collotype printing, the progress to be reported is principally as regards extension of work and some minor details; while as far as this country is concerned, the Autotype Company practically hold the thing in their own hands. Excellent as the specimens of foreign work may be which are placed before you to-night, you will find nothing better than the specimens shown by the Autotype Company. In Germany, the steam press is largely applied to the rapid production of collotypes, and before you are drawings of the machine collotype press constructed by Messrs. Schmiers, Werner, and Stein; the most striking feature being the large number of rollers, used in order to ensure equal inking and damping. The transfer of collotypes to porcelain has been practised to a small extent, vitrifiable colours being dusted on afterwards, but the results obtained have not been very satisfactory.

* *Photographic News*, p. 1880, p. 568.

Collotyping in colours from several plates has been introduced to compete with chromolithography for fine work, but the only examples exhibited in this country are, I believe, some shown by Mr. Meyerstein, and a selection of which is now before you.

Before you go, do not fail to look at some intaglio plates intended for the decoration of porcelain as made by Mr. Dallas, and you will also find some prints from them. Mr. Dallas does not tell us how he makes them.

As you may well suppose, the things omitted from this short course of lectures are more numerous than the things discussed; far more progress having been made than can be described in three hours.

You will, before you go, allow me to express the obligation we are all under to Mr. Barker, who has so ably assisted me in showing you what you have seen.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

Report on Preserved Meat. By J. J. Manley, M.A.

Part II.

In adding a few words to the report on preserved meat in the last number of the *Journal*, mention may be made of the various essences and extracts of meat, semi-liquid and solid, which are shown at the Health Exhibition. They are very numerous. Baron Liebig, as is well known, was the original producer of extract of meat, and has had many followers, the popularity of his production increasing year by year. At South Kensington we see, among others, Kemmerick's extract of meat, and concentrated beef tea, both of excellent quality; Kopf's extract of meat; and the productions of Messrs. Brand and Company, of Mayfair, and of the firm of the same name in Vere-street, Oxford-street; as also those of Mr. George Mason, who, though comparatively a young beginner in this business, gives us an essence of beef which, after its kind, leaves nothing to be desired. He also shows some meat lozenges, which Messrs. Brand, of Vere-street, combine with milk. But while acknowledging the excellence of the exhibits in question, it must not be forgotten that the more solid extracts are obtained by the boiling down of lean meat, which involves the loss of fat, and as much of the gelatine and albumen as can be taken away, so as to render the preservation of the residuum possible. This residuum consists of fibrin, osmazone, and the extractives of flesh—or in other words, the flavouring matters and salts of meat—thus leaving out most of all that is popularly regarded as nutritious and strengthening in the shape of nitrogenous matter. Still, this substance has its value, as an addition to other foods, as a flavourer, and as a stimulant most acceptable to invalids. Liebig himself publicly declared that "it was not a nutriment in the ordinary sense."

Semi-fluid meat is also well represented by Cibil's (Buenos Ayres) fluid beef extract, and the liquid meat of the Kreochyle Company, of Leytonstone. Fluid meat differs from the various extracts of meat in retaining the fibrin, gelatine, and coagulable albumen—in fact, all the constituents of lean meat—and is therefore a convenient as well as valuable food. On an average, one pound of fluid meat is obtained from four pounds of lean meat. By the process pursued, all the constituents are brought into a condition in which they are soluble in water, and are not any longer coagulable on heating, in which state they have been designated "peptones." This change is effected, as in ordinary digestion, by means of pepsin and hydrochloric acid.

The exhibits of preserved meat in the foreign sections of the Exhibition are not numerous, and without wishing to pay a bad compliment to foreigners, not very important. Japan, China, and Siam send some curious preparations; and France, Belgium, Austro-Hungary, Italy, Sweden and Norway, and Venezuela are represented.

But even a brief report of preserved meat at the Exhibition cannot omit notice of the exhibits of frozen mutton from Australia and New Zealand, and of the "refrigerating chambers" which enable the carcases to be preserved, both on their voyage hither and after their arrival. "Refrigeration" is, of course, only a temporary method of preserving meat, and not, strictly speaking, a preservation process as is that in which extreme heat is used for the expulsion from vessels of atmospheric air; but we are indebted to it for a large and increasing portion of our meat supply. Not very many years ago, the entire body of a mammoth was found in the frozen soil of Arabic Siberia, where it had probably been for many thousands of years; and its flesh, when thawed, was found perfectly fresh. In like manner carcases of animals and men have been found embedded in ice, and without the slightest signs of decomposition during many years of their glacial interment. But meat can be preserved for a lengthened period in a temperature much above that of "freezing point," about 40° being sufficient to maintain preservation even in the hottest weather.

The first patent for the preservation of meat by refrigeration was taken out by John Lings, in 1845, and since then a variety of expedients have been employed by the use of ice, and by artificial processes of lowering the temperature of evaporation, in order to bring fresh meat from Australia and elsewhere to this country. It was at the Melbourne Exhibition of 1872-3 that Mr. James Harrison made most successful experiments in keeping fresh meat for forty days in a refrigerating chamber; and this led to his attempt to ship to England in the latter year several tons of meat in a similar chamber on board. The venture failed owing to the faulty construction of the chamber, and the want of sufficient ice; but very shortly afterwards successful shipments were made from Canada, Texas, and elsewhere. Several French inventors, among whom may be mentioned M. Tellier and M. Poggiale, had most ingenious refrigerating chambers, constructed both for shipping and other purposes; inventors and adaptors also came forward in this country, and a large number of ships are now fitted up with refrigerating chambers, and a regular trade in refrigerated meat has been established, good mutton from Australia and New Zealand being obtainable at from 7d. to 8d. per lb. When it is stated that during the months of January and February of this year 149,371 cwt. of beef, 87,929 cwt. of mutton, and 15,000 cwt. of pork were imported into this country by the aid of refrigeration, some idea may be formed of the business already being done; and it may be noted that the above figures show an increase of 72,864 on the quantity imported in the corresponding months of last year. The development of this trade depends mainly on the cost of refrigeration, and this will probably be lessened as different systems are improved upon, as we may reasonably expect they will be. There is no question as to the source of supply; Australia alone, it would seem, is able to send us nearly all the meat we want to supplement our home-grown supply. In a paper read before the Royal Colonial Institute in December, 1882, by Sir Francis Bell, the Agent-General for New Zealand, he stated that frozen meat in any quantity could be placed upon our markets at 6d. to 6½d. per lb., leaving a good profit to the grower. This, he added, ought ultimately to make meat cheaper here, or at least prevent the further rise threatened. Australia and New Zealand can in fact export 700,000 tons of meat a year, or 2,000 a day, which is not much more than we want in England even now, without reducing even the present capital number of their sheep and cattle; and they are able to send on sheep to Smithfield with greater ease to-day than the Tweed farmers could 100 years ago, when meat was selling at 1d. per lb. in Scotland, against 10d. in London. At the Victoria and other docks large cold-air storehouses are now constructed for the reception of the meat as it comes out of the ships, so that the market may be supplied according to the demand. I see it stated in a City paper that retail butchers of the metropolis last week actually paid at the Central Meat Market a higher sum for New Zealand than for English-grown mutton. I note also that from some statistics just come to hand, it appears that the import of refrigerated meat during last September was 66,519 cwt., as against 14,170 cwt. in September of 1883

There are at South Kensington several most interesting exhibits, illustrating the various principles of refrigeration and preservation of meat in large quantities, for instance that of J. and E. Hall. They show two of their cold-air producing machines, and a small chamber or store in which frozen mutton is constantly kept. One of these machines can deliver 2,000 cubic feet of air per hour, at 30° below zero (Fahr.), and the other 5,000, at 35° below zero. The general principle on which all cold-air machines act is this. The air is compressed in holders by means of pumps, driven by a steam-engine; the compression of the air generates a great deal of heat, which is abstracted by cold water circulating in tubes, similar to those of a surface condenser, and contained in the holder. When the air has cooled down, it is allowed to expand into the closed store-room, the work done in expanding absorbs all the heat left in the air, and consequently leaves it in an extremely cold condition. The Haslam Foundry and Engineering Company, Limited, also exhibit a dry-air refrigerator, to discharge 18,000 cubic feet of air per hour, at 60° (Fahr.) below zero, in connection with a freezing or chilling chamber in which meat is stored. Near this the committee of importers of Australian frozen mutton exhibit a freezing-chamber and meat store. It may be here mentioned that it is mainly to Mr. Kent (also an exhibitor at South Kensington), the well-known refrigerator maker, of 199, High Holborn, that we are indebted for the perfecting of refrigerating or cold storage-chambers on board ship and elsewhere. He has constructed such chambers on a large number of ocean going vessels, and by the application of the "downward draught" system of ventilation, of which he was the pioneer, has never failed to secure the object in view. It is this principle which he applies to all his "domestic" refrigerators. Visitors to the Exhibition not only see the carcases of refrigerated sheep hanging in the cold-air chambers, and even exposed as in Mr. Tallerman's exhibit, but a frozen Australian or New Zealand mutton chop, with bread or vegetables and attendance for 8d., can be obtained, and experiment made as to the excellence of the meat.

TURIN EXHIBITION.

The Executive Committee have decided to postpone the closing of the Turin Exhibition until the 10th of November.

Extensive purchases of machinery have been made, during the last few days, by the Ministers of Marine and Public Works, amongst which may be mentioned the engines in the electrical department of Messrs. Tosi and Co., of Leguano, of 200 horse-power, for the railway workshops of Verona; that of Messrs. Neville and Co., of Venice, 250 horse-power, for the Royal Arsenal at Spezia: the engine of 100 horse-power in the gallery of labour of the "Fonderia Fratte," Salerno, and that of the same power of Messrs. Luciano and Co., of Turin, for the new railway workshops now in course of construction at Turin; the engines of Messrs Calzoni, of Bologna, Cravero, of Genoa, and several others. The machine tools of Messrs. Güller, of Iritza; the Società Veneta, of Treviso; Fogliano and Co., of Turin; the water motors of Bossardt, of Turin; dynamos of Rivolta, of Milan, besides a variety of machines, &c., from other exhibitors.

A proposition has been made by various exhibitors to the Executive Committee to allow the Exhibition to remain open for a few days after the 10th of November, in order to hold a fair to enable them to sell off their goods.

TRADE SCHOOLS OF WURTEMBURG.

The following notes are taken from a report by Mr. Alfred Harris, printed in *The Textile Recorder:*—

Wurtemburg is one of the smallest of the South German kingdoms, containing about the same number of inhabitants as Yorkshire. The system of trade education in Wurtemburg is the work of the last thirty years, and it has been established and brought to its present state of success by the efforts principally of one man, Dr. von Steinbeis, of Stuttgart, who has had the liberal support of the State, and the active co-operation of an intelligent and well-educated people.

First, as regards national elementary instruction. In 1831, daily attendance at school had become universal; excellent State seminaries, as well as good private institutions for the training of teachers, had then existed for thirty years; and in 1836 the present complete system of national education was founded. In the year 1858, out of 41,000 recruits called to military service from all ranks of the people, there were only eight who could neither read nor write, and in all of these cases either mental deficiency or parental neglect were the proved causes of this slight residuum of ignorant persons. Attendance at elementary schools is compulsory to the fourteenth year, inclusive, except by special exemption of clever children who have attained the prescribed knowledge earlier. On leaving school, every child undergoes an examination, and if not found up to the mark, is sent back to school for another year. In these schools the subjects taught are of a generally useful character. There are very few schools in which drawing is not taught, although the subject is not compulsory. The masters are specially taught in drawing, however, and it is looked upon as a necessary part of elementary education, and is encouraged by a special grant of money to the teachers. All teachers have come to the conclusion that in elementary schools freehand and outline are indispensable. In 1860, the Central Office for Education started a National School Exhibition, in order to ascertain whether the teaching at the schools was such as to lay a good foundation for the various trades and occupations which the pupils would be likely to follow in after life. Besides the ordinary national schools, there are about fifty of a more advanced nature, in which art, science, and different branches of drawing, as applied to trades, are taught to the children who are capable of this higher knowledge. These schools receive extra grants from the State.

After leaving the national school, attendance at the Sunday school for secular and industrial training until the eighteenth year is compulsory, but this attendance is dispensed with on the part of youths who attend evening classes. The Sunday school was the real foundation of the industrial and trade schools of Wurtemburg.

The trade schools of Wurtemburg are in two leading divisions — (1) Agricultural Progressive Schools, and (2) Industrial Progressive Schools. I will speak first of the Agricultural Schools. The general management is controlled by the Central Department for Education, in Stuttgart, and the local superintendence by a committee chosen from the school authorities in the various places, and by the guilds of agriculture, of which there are sixty-five in the kingdom. The following are the institutions under this section:—

An agricultural academy for young farmers.

Agricultural schools for peasants.

Schools for vine-growers.

Schools for females, where house-keeping and domestic usefulness are taught.

Agricultural winter schools.

Voluntary agricultural progressive schools.

Evening meetings for adults.

Reading-rooms, libraries, distribution of pamphlets, &c.

Special classes for various branches of agriculture.

You will observe how wide a field is covered by these various institutions for the technical training and instruction of the agricultural population of this small kingdom.

To sum up this subject, there are in Wurtemburg:— 97 progressive schools for agriculture, with 2,094 scholars; 610 compulsory evening schools, with 12,283 scholars; 74 Sunday-schools, with 1,373 scholars; 27 evening schools for adults, with 960 scholars; 56 agricultural reading-rooms, with 2,400 members; 844 libraries, with 143,000 members.

We now come to the industrial progressive schools, the management of which is very similar in its functions and arrangements to that of the agricultural schools. The central authority first turned its attention to the question of teachers, who were trained in the Polytechnic Institute, at Stuttgart, and were generally practical men with a good knowledge of trade. They sent them to foreign countries to learn the best and newest methods, and then spread them over the country to give instruction at the various places in which their individual capacity enable them to teach special trades and industries peculiar to the localities. Classes were established everywhere, both for the young and for adults. Exhibitions of machinery, museums of tools and utensils, libraries of useful works on trade were established and thrown open free of charge to all who resorted to them. The various localities worked hand in hand with the practical efforts of the Central Department, and public funds were granted liberally, but with great judgment and care, in furthering local exertions. Emulation sprung up between different places, and in a few years the whole country was dotted over with centres of industrial teaching adapted to the special requirements of the places. Drawing schools were everywhere established, and whilst technical perfection was not aimed at in all the schools, yet technical practice was adopted wherever it was found necessary; and in many important centres of industry the progressive classes have gradually attained the importance and deserve the name of technical schools. In some of these, weaving is taught, and the pupils earn their own living by their work whilst at school. In other places wood-carving is taught, with successful results; also engraving, modelling in wax and clay, chasing metal, house decoration, &c. There are also special schools for commerce, and for female domestic management.

The details of this great network of schools, which is spread over this small but busy country, are far too numerous for me to attempt to enter upon, and I must sum up my subject by stating that they are carried on in 162 towns and villages, and they have 12,700 pupils. These include the female progressive schools with 3,243 pupils. There are 738 teachers, being one to every seventeen pupils. The work which is thus being done in Wurtemburg may be taken as an example—perhaps altogether the most complete example—of a similar work which is being carried out in the whole of Germany.

MANUFACTURE OF GAS FROM OIL.

Dr. Armstrong's paper on this subject has been published in the last number of the *Journal of the Society of Chemical Industry*. In his first part he deals with "Certain bye-products of the Manufacture of Gas from Oil by the Pintsch process," and concludes with these remarks:—

"The recent attempts to recover much that has hitherto been lost in coking coal are of the greatest importance, and have already led to results of high interest. In a recent paper in our Journal, Mr. Watson Smith has given an accouut of his preliminary examination of the tars from the Jameson and Simon-Carve's ovens, and has pointed out that the former contains but small quantities of the characteristic constituents of coal tar. I can endorse these statements, having had an opportunity, thanks to Mr. Jameson, of examining his oil. Evidently the Jameson oven gives a product which closely resembles shale oil in composition, and hence is at present of comparatively little value; in comparison with the Simon-Carve's oven, however, it has the great practical merit of cheapness. I have recently had the opportunity of seeing the two systems in operation, and am satisfied that the proposed adoption of the ordinary beehive oven has not yet received the attention it deserves, and that the arrangements which have been made for condensing and collecting the products are insufficient.

"The time must come when coal tar will not be regarded as a mere bye-product, and when attention will be paid, not only to the manufacture of gas, but also of coke, and of particular constituents of coal tar; when, in short, the material latent in coal will be progressively utilised. It may be that then the coal will first be coked, the oil which distils over being carefully condensed, and that the 'weak gas' thereby produced will be utilised as fuel; at the same time the ammonia and sulphur will be recovered. The paraffin, and whatever else of immediate value it may contain, having been separated from the oil, the residue will be utilised in the production of oil gas, and of benzene, anthracine, &c. Gas is daily becoming a more important article of consumption, and we may look forward to its use by the public in the near future, not only as an illuminant and in gas-engines, but also as a heating agent. The late Sir C. W. Siemens powerfully advocated a double supply, one of heating and one of illuminating gas, of which the former would necessarily be inferior, the latter superior in quality to the present supply, if the system he advocates were adopted of collecting in separate holders the gas given off at various periods during the distillation of coal. And this would also be the case if water gas came to be employed for heating. Such a system would involve a double set of mains, and that for the heating-gas would have to be of enormous size if gas were to be generally used as a heating agent. The proposal to introduce a gas rich in carbonic oxide for general household use, which the supply of water gas would involve, might also meet with considerable opposition, and it must be admitted that the mass of evidence on this subject recently collected in the inquiry at Massachusetts is not altogether reassuring. Lastly, I am of opinion that a gas of lower heating power than that at present supplied would be of little use to the general public, as distinct from manufacturers. It is impossible, with the stoves hitherto contrived, and with the present gas supply, to raise a surface to such a temperature that it will radiate sufficient heat to render it possible to use gas with economy in heating rooms in the manner which probably will always be preferred in this country, and, therefore, I venture to think that it will be better to have but a single set of mains, and to supply a gas of much higher illuminating power than that we now have. By combining the present system with the manufacture of oil gas, and systematically separating certain of the liquid bye-products, and re-incorporating them with the gas, this could readily be done, and the oil required might well be that obtained in coking coal."

VEGETABLE CULTURE IN BERMUDA.

Consul Allen says that onions, potatoes, and tomatoes comprise almost the entire production of Bermuda, and give employment to the greater portion of the inhabitants, and the prosperity of the colony depends largely upon the success of the crop and the demands of the markets. In onion growing the seed used is grown in the Canary Islands, and is imported in the months of August and September; it is sown in the months of September, October, and November, thickly in beds, the ground having been heavily manured with stable manure two or three months before sowing. The white seed is sown first and produces the earliest crop, the shipment of which commences in March. When the plants are sufficiently large—about 6 to 8 inches high—they are transplanted into beds about 4 feet wide, the plants being set about 7 inches apart each way. The plants from the white seed are transplanted as soon as they are large enough, but those from the red seed are not usually transplanted until the beginning of January, and the ground requires to be only moderately manured. If transplanted too early, and the soil is too rich, the bulb is likely to split into several pieces and is worthless. After transplanting, the soil requires to be lightened once or twice, and the weeds removed before they mature. As soon as the top begins to fall, the onions are pulled and allowed to lie on the ground two or three days, when they are cut and packed in boxes of fifty pounds each and sent to market. All the onions are delivered at the port of shipment in boxes, ready for the market, and for the past two years the producer has been compelled by law to place his name or initials conspicuously on each package. It is estimated that a large profit on the outlay is realised, when the crop is large and the market good, an acre of ground sometimes returning as much as £120 to £170. For the cultivation of potatoes the seed was formerly nearly all imported from the United States, but of late years has come largely from New Brunswick, Nova Scotia, and Prince Edward's Island. The ground for potatoes is usually ploughed or broken up with the spade and raked, the seed cut into pieces with one or two eyes, and planted by forcing into the ground with the fingers to the depth of about four inches, in rows about twenty inches apart, and about eight inches in the rows. From six to eight barrels of seed are used to the acre. When the plants are a little above the ground, the soil is lightened between the rows with a fork, and when about six inches high the earth from between the rows is hoed round the plants, only one hoeing being required. For growing tomatoes the seed is imported every year, and is sown about October, and transplanted in December, into rows about six feet apart, and the plants are put about four feet apart in the rows. As soon as transplanted, the ground round the plants is covered thickly with brush—chiefly the wild sage which grows over the hills—not only to protect from the wind, but to keep the fruit from the ground. The brush is usually raised once by running a stick under and lifting it enough to clear the soil of weeds, no other cultivation being required. Six or seven quarts of fruit from the hill is considered a fair crop. The fruit is rolled in paper and packed in boxes containing about seven quarts each. Consul Allen says that the price of land in Bermuda varies from £30 to £40 an acre, and in some cases not more than one-eighth is susceptible of cultivation. It is estimated that there is an annual export of 350,000 boxes of onions, the box containing about 50 lbs., and of potatoes 45,000 barrels.

FISHING IN JALISCO, MEXICO.

Consul Lambert, of San Blas, gives the following account of the methods employed in fishing in Jalisco. The fibrous roots of a small shrub called *varlasco*, which grows wild in the neighbourhood, are procured, and after being well broken up, they are placed in the bottom of the canoes. At high tide the fishermen proceed to the mouths of the *esteros* (small creeks), and erect a wooden fence. They then partly fill their canoes with water, which produces an intensely white liquid from contact with the root. Arriving at the source of the *estero*, or in some shallow places beyond which the fish are not likely to go, the preparation is thrown into the water, which also turns perfectly white. The effect of this is that the fish are blinded, and in a very short time they are found floating on the surface of the water at the fence erected at the mouth of the *estero*. The larger ones are then gathered into the boat, and taken to market. Another method, which is more fatal in its effects, though it is performed less frequently, is the employment of the milk of the *ava* tree. This tree yields, when tapped, a white liquid very much resembling the juice of the india-rubber tree. It is used in the same manner as the *varbasco*, and not only blinds, but kills the fish instantly. Fish killed in this manner have to be used immediately. In neither case is there any visible sign of the manner in which the fish have been killed. There is a law in existence against the use of poisons in procuring fish or market, but it is practically inoperative and void, for the reason that there is no defined method for determining the death of fish by these liquids, and the natives who take them in this manner are careful that each fish shows a spear hole in the back before landing it; and in the absence of any method of detection, the spear hole is *primâ facie* evidence that they not poisoned. Consul Lambert says that, as far as he has been able to ascertain, no bad effects from eating fish killed in this way appear to be known.

EULACHON OIL.

Dr. A. B. Lyons, of Detroit, has lately been investigating the properties of the oil obtained from the candle fish as a substitute for cod-liver oil, and in his paper on the subject he says:—

"The bays and estuaries of the Pacific coast of British America and Alaska are annually visited by immense shoals of a small fish popularly known as the candle fish, or, adopting the vernacular name, as eulachon or outachon. This fish belongs to the family of the salmonidæ, and bears the scientific name *Thaleicthys pacificus* (Richardson) Girard. It is nearly allied to the capelin, which it resembles also in its habits.

"The Indian name is variously spelled eulachon, eulachan, hoolacan, oolachon, ootachon, &c., and is corrupted by the English settlers at Victoria into hoolakins.

"The fish is also frequently confounded with other species, and in Oregon is generally known as smelt. Its habitat is the northern part of the Pacific Ocean. In spring it approaches the shores to deposit its spawn, entering the bays and estuaries in countless numbers. It never goes far from the ocean, however, although multitudes of the fish are taken near the mouths of the large rivers, particularly in Frazer's river and in the Naas.

"The candle fish is less than a foot in length. It is described as having a somewhat pointed and conical head, a large mouth, teeth on the pharyngeals, and the tongue rough; the lower jaw, palatines, and vomer destitute of teeth. Its colour is greenish yellow on the back, passing into silvery white on the sides and belly, sparsely spotted with dirty yellow. The spawning season is in April and the first half of May. During their run they furnish food not only to the Indians, but to thousands of sharks, halibut, porpoises, and other predatory fish. As a pan fish the eulachon is said to have no superior, but the fish is valued chiefly for its oil which is used as food by the Indians. So rich in oil is the entire fish, that when dried it serves the natives for torches, whence the name candle fish. The aborigines take the fish in immense numbers by the aid of a primitive contrivance, resembling a rake or comb, the moonlight nights being the most favourable time for carrying on the operation.

"The fish are submitted to a rude operation for 'rendering' the oil, or they are dried and smoked. In recent times the dried and salted fish have become an important article of export from Victoria, and there is now on the Naas river a manufactory for the oil, which has been employed to some extent as a substitute for cod-liver oil. It has been used medicinally to a considerable extent in British Columbia, but I do not find any record of clinical observations with regard to its therapeutic value.

"Chemical analysis, of course, cannot reveal the medicinal properties of any drug. Cod-liver oil itself is an example of this. While universally accepted as an agent of singular efficiency in promoting nutrition, particnlarly in strumous and tubercular patients, it has thus far guarded as a profound secret the cause of its efficiency, and the reason of its superiority in this respect over other oils, vegetable or animal. It has been frequently subjected to chemical analysis, and one wonderful discovery after another announced with flourish of trumpets, each supposed, for a while, to furnish the key to the mystery, but each in turn has been abandoned, and the medical profession generally regard the remedy as nothing more than a concentrated and easily assimilated food. Iodine, phosphorus, iron, biliary acids, cholesterin, and oxide of propyl are among the constituents of the oil, which have been supposed to give it its peculiar medicinal character, but none of these substances is present in a quantity sufficient to justify any such hypothesis, and, one after another, all have been abandoned as unsatisfactory.

"Some other animal oils, however, have been found to improve nutrition in much the same way as does the familiar cod-liver oil; only by clinical experiments can we determine the value of any new claimant for a share of the honours which cod-liver oil has monopolised."

After a comparison of the oils, Dr. Lyons says of eulachon oil:—"The oil was found to contain about 20 per cent. of palmitic and stearic acids, 60 per cent. of oleic acid, and 13 per cent. of an unsaponifiable substance, which is the most peculiar and interesting thing about it. This substance is of an oily consistency at ordinary temperature in summer, has much lower specific gravity than oleic acid, or any other constituent of ordinary fats, specific gravity ·865 to ·872, at 59° Fahr., and seems to resemble the unsaponifiable constituent of sperm oil.

"This interesting substance I hope hereafter to make the subject of further investigation to determine its chemical composition, and its behaviour towards reagents. At present it is enough to call attention to its existence as a considerable constituent in this oil, and to suggest the probability that it may give to the oil properties quite distinct from those of most animal oils. The low specific gravity of the substance, and its indifference to most reagents, remind one strongly of the paraffins, and now that petroleum and petroleum oil are recognised to have a positive influence in tuberculous complaints, we shall not be surprised if we find that eulachon oil owes any therapeutic power it may be found to possess to this peculiar body.

"Cod-liver oil, it is true, does not contain anything corresponding with this substance, or if it does the quantity must be very small. Cod-liver oil contains about 80 per cent. oleic acid, 8 or 9 per cent. of palmitic and stearic acids, and only 1·82 per cent. (Allen) of unsaponifiable matter, a considerable proportion of which is cholesterin."

Notes on Books.

DYNAMO-ELECTRIC MACHINERY: a Manual for Students of Electrotechnics. By Silvanus P. Thompson, B.A., D.Sc. London, 1884: E. and F. N. Spon.

This book is founded on the series of Cantor Lectures delivered by Professor Thompson before the Society in 1882. Considerable additions have been made to the original text of the lectures, and several entirely fresh chapters have been added. This new matter includes a consideration of "the Mathematical Theory of Dynamo-Electric Machines and of Electric Motors," and a description of "the Graphic Method of Calculation as applied to the Characteristic Curves of Dynamos." The various types of dynamos are fully described, and the theory of their action explained. The different motors proposed or brought into use are also described, and their relative efficiency compared. The book is fully illustrated.

OLD-WORLD QUESTIONS AND NEW-WORLD ANSWERS. By Daniel Pidgeon. London: Kegan Paul, Trench, and Co., 1884.

Mr. Pidgeon, whose book of travel, "An Engineer's Holiday," was favourably received a year or two back, gives, under the above title, the results of his observations during a short tour through the manufacturing districts of New England last year. He perceived, as all intelligent visitors to the United States must perceive, that many of the social and political problems which are now perplexing the Old World are being rapidly worked out in the new under the favourable conditions of a young and quickly changing civilisation. Possessed already of considerable experience in English manufacture, he devoted his holiday to an examination of the industrial condition of Massachusetts and Connecticut, and he presents his readers with a comparison of the state of the manufactures and the manufacturing classes on opposite sides of the Atlantic. So impressed was he with what he saw, that he has nothing but good words to say alike of employers and employed, and for almost every detail he has little but praise. Whether he was not in some cases unduly biassed, whether a longer experience would have modified the first favourable opinion, is a question which cannot well be answered without a knowledge of American institutions more complete than can be gained by a mere sojourn in the country. At all events it is pleasant to get, from so competent an observer, an account so satisfactory of the example we are ourselves to follow. A staunch free trader, Mr. Pidgeon sees in the reduction of the American tariff, and the consequent admission of the raw material of manufactures untaxed to her workshops, a great future for American industry—a future the approach which, it must be admitted, the American people seem in no mood to hasten; but with this sole exception, he sees little requiring improvement, little which he does not admire in the organisation of the New England factories or the condition of New England life.

ART YEAR BOOK, 1884. (AMERICAN ART.) Prepared and published by the New England Institute, Boston, Mass. 4to.

This volume is chiefly a record of the Art Exhibition of the New England Institute, and contains a catalogue and biographical notices of the exhibitors. It is fully illustrated with plates produced by a large number of the different processes now in use.

A TREATISE ON THE PURIFICATION OF COAL GAS, AND THE ADVANTAGES OF COOPER'S COAL LIMING PROCESS. By R. P. Spice, M.Inst.C.E. London: E. and F. Spon. 8vo.

Mr. Spice has given in his treatise the list of the various attempts to purify gas, and a special account of Cooper's process, which was described by Mr. J. A. Wanklyn in his paper on "The Manufacture of Gas from Limed Coal," read before the Applied Chemistry and Physics Section of the Society of Arts, on January 24th last. Mr. Spice has added a number of plates to illustrate the process.

ARCHITECTURE AND PUBLIC BUILDINGS, THEIR RELATION TO SCHOOL, ACADEMY, AND STATE, IN PARIS AND LONDON. By William H. White, architect. London: P. S. King and Son, 1884. 8vo.

The author of this book contrasts the treatment of architecture, and the education of the architect in France and in England. The first part is devoted to the history of the rise and foundation of the National Institute of France, the School of the Fine Arts at Paris, and the relation of the State and the Academy in France to the public of that country. The second part contains an account of the Royal Academy in London, and the Public Department of Works and Public Buildings. The last chapter treats of the profession of architecture, and the whole aim of the book appears to be to illustrate what is said in the first chapter:—"During my ten years' consecutive residence in Paris, the authorities seemed to know not only what the inhabitants wanted for the alteration and adornment of their city, but also to obtain for them what was wanted; during my ten years' consecutive residence in London, the authorities seemed not only to ignore the prevalent desire for improvements, but also quite unable to carry out the alterations they devised."

General Notes.

ST. LOUIS CATTLE CONVENTION.—The first National Convention of Cattlemen is to be held at Saint Louis, U.S.A., on the 17th, 18th, 19th, 20th, and 21st of November next, at which will be discussed the questions appertaining to the raising and improving the breeds of beef cattle in the states and territories, and other questions of kindred interest.

TRADE OF YUNNAN.—It appears from a report of Count de Kergaradec, French Consul, on the trade of Yunnan by the Red River (Songkoi), that the exports from Hanoi to Yunnan, during 1879, were as follows:—Salt, 120,000 fr.; tobacco, 680,000 fr.; raw cotton, 200,000 fr.; cotton goods (English manufacture), 50,000 fr.; cotton yarn (English manufacture), 24,000 fr.; light woollen cloths (German), 16,000 fr.; pedlers' ware (chiefly gilt buttons, &c., from England), 15,000 fr.; making total, with miscellaneous not mentioned, 1,700,000 fr. Exports from Yunnan to Hanoi:—Tin, 1,700,000 fr.; lead, 5,000 fr.; tea, 60,000 fr.; false gambier, 30,000 fr.; making a total of 2,055,000 fr. The excess of exports from Yunnan over its imports represents (the traffic being one exclusively of barter)—(1) cost of transport to and fro; (2) duties paid on the route to the Annamese interior customs; (3) duties levied by the Black Flags; (4) traders' profits.

FLAX CULTURE.—The culture has hitherto been much neglected, although it appears that flax and the various products of that plant can be cultivated in America quite as cheaply as in the various seed-producing countries of Europe. The imports of flax seed into the United States have reached as much as three million bushels in one year, the imports from India alone reaching 1,253,517 bushels in 1883-4, as compared with 558,249 bushels in 1882-3. The imports of raw flax into the United States during the nine years from 1871 to 1880 amounted to $10,987,549. The imports of flax manufactures during the ten years from 1871 to 1881 amounted to $177,747,371, or nearly $18,000,000 per annum. The average yield and prices of flax seed and wheat into the United States for the past ten years were as follows:—Wheat, 12¾ bushels per acre, cost 93½ cents.; flax, 9¼ bushels per acre, cost $1 44c. It has been ascertained that, with careful cultivation, an acre of flax can be produced for $24 98c., this sum covering use of land, seed, and all necessary expenses. The receipts from an acre of flax are estimated to be as follows—9¼ bushels of seed, at $1 44c. per bushel, $13 52c.; 350lb. long fibre, at 10 cents. per lb., $35; 350lb. flax tow, at 3 cents. per lb., $10 50c.—total, $58 82c. This shows a net profit per acre of $33 84c.

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FRIDAY, OCTOBER 31, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SOCIETY OF ARTS PRIZES.

The Council of the Society of Arts have awarded the following prizes in connection with the International Health Exhibition ;—

John Stock Prize, a Society's Gold Medal, or £20, for the best example of sanitary architectural construction, Classes 20, 28, 29, 30, 32, to Messrs. Doulton.

Shaw Trust, a Society's Gold Medal, or £20, for the most deserving exhibit in Classes 41, 42, 43, and 45, to the Compressed Lime Cartridge Company.

North London Exhibition Trust, a Society's Gold Medal, or £20, for the best set of specimens illustrating the handicraft teaching in any school, Classes 49 and 50, to M. Germain, on account of the Collective Exhibit from Belgian Norman Schools for Women Teachers.

Fothergill Trust, a Society's Gold Medal or £20, for the best exhibit in Class 26 (Lighting Apparatus), to Messrs. Noel Brothers (in Class 26).

Trevelyan Prize Fund, Five Gold Medals or five sums of £20), for the best exhibit in each of the following Classes—2, 3, 5, 7, and 11 (all comprised within Group 1. "Food"), to the San José Fruit Company (in Class 2); to Messrs. Moir and Company (in Class 3); to Mrs. Charles Clarke, of the School of Cookery (in Class 6); to M. Pasteur (in Class 7); to Messrs. J. and E. Hall (in Class 11).

The "Siemens" Prize, offered through the Council by Lady Siemens, a Society's Gold Medal, or £20, for the best application of gas to heating and cooking in dwellings, Class 25, to Thomas Fletcher.

The "Stacy" Prize, offered through the Council by Mr. J. Sargeant Stacy, a Society's Gold Medal, or £20, for the best exhibit in Class 30 (objects for Internal Decoration and Use in the Dwelling; Fittings and Furniture), to Messrs. Collinson and Lock.

Proceedings of the Society.

CANTOR LECTURES.

SOME NEW OPTICAL INSTRUMENTS.

By J. Norman Lockyer, F.R.S.

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Lecture I.—Delivered Monday, April 28th.

It is in accordance with the oldest traditions of the Society of Arts, that those interested in the use of any scientific instruments should come before the Society from time to time, to give an account of the progress which has been made in them. This does good to more than science, and it interests the Society from more than a scientific point of view. The history of many instruments is as follows.

The first is made roughly by the experimenter himself. Then some artist comes along almost as interested in its success as the inventor. At this stage, the instrument improves rapidly, and possibly some application turns up. Then comes the turn of the industrial arts. From this point of view, my subject is doubly interesting to this Society.

We begin with small spectacle glasses, charmed into a telescope by Galileo. We begin with a little prism, not much bigger than a finger nail, used by Newton, and the work of successive investigators and successive artists has shown the necessity and importance of lenses and prisms of colossal proportions, while the interest in the subjects which can be investigated by means of them is so continually on the increase, that the demand is in excess of the supply.

One would think that it was the time for the industrial arts to step in, but this is exactly what they have not done; and I for one believe that if the Society of Arts, or some such body, does not come to the rescue, the progress of astronomical science will be retarded in this country for many years, as it was before. If I am rightly informed, no optical glass of the size now required (for which almost fabulous prices are given) is being made in England. If I am again rightly informed, the only source of supply in the world now available for us will shortly run dry.

This, then, is my chief text in these lectures, and I shall try to prove my points by some references to history and detail, which I will endeavour to make as short and concise as I can. It is not, however, my only text, for I am aware that the members of the Society of Arts are not interested only in commercial processes.

That one of the improvements in optical arrangements, to which, perhaps, the greatest importance, having regard to the future of astronomy, attaches at the present time, is one the germ of which is to be found in the accounts of the earliest meetings of the Royal Society.

At the time the Royal Society was established, more than two centuries ago, in consequence of the then ignorance of any method for correcting the chromatic aberration of the lens, the aberration was kept down by an inordinate focal length; and lenses with focal length of 300 ft. were attempted to be used. Under such conditions, both observatories and even tubes were of course impossible, and the only movement was the movement of the observer with an eye-piece carried in the hand, and the only possible observation was that of a heavenly body rising or setting.

Hooke, the then Secretary of the Royal Society, pointed out how convenient it would be if, instead of thinking at all of having a tube and then moving it, a plane mirror might be made to move in front of the telescope, which might then be horizontal and fixed. This idea remained dormant until the year 1869, and the reason that it was resuscitated in 1869 was this. Two men, all unconsciously, had been working to the same end: Liebig,* the famous German chemist, had shown, in 1867, that it was possible to deposit a clear and bright film of silver on glass; and the illustrious Frenchman, Foucault, had shown that, by certain optical processes, a glass surface optically plane could be produced.

Here then at last we had the mirror of which Hooke had dreamed. This was not all. The ingenuity of Foucault found a way of mounting this mirror, so that, by means of clockwork, the light given out by any heavenly body could, from its rising till its setting, be poured into a horizontal telescope placed north and south, thus enabling an observer sitting at a fixed eye-piece to do his work quietly, free from any anxiety connected with the movement of either telescope, chair, or dome, so long as the heavenly body was above the horizon.

The extension of this capital invention of Foucault's, and what has come of it, forms one of the chief improvements upon which I have to address you.

The plane mirror in the "siderostat" (such was the name given by Foucault to the new instrument described by him to the Academy of Sciences in 1869) had a diameter of 12 inches. In consequence of the recent researches of M. Loewy and of the Brothers Henry, a mirror of 5 feet in diameter, optically plane, can now be constructed with the most absolute certainty and perfection.

Up to the present time, to satisfy preconceived ideas, it was believed that, to establish rapidly an equilibrium of temperature, it was necessary that the thickness of the mirror should be small. Then, under the influence of a tightening, however slight, or only a flexure, the mirrors were deformed unequally, and consequently produced an obvious diminution in the beauty of the images. In giving to the disc a sufficient thickness, the production of a

* Liebig, December, 1867, "Ann. de Chem. et Pharmacie" Sup., vols., 1865-68.

Note.—It may be convenient that I should give here a simple method of silvering glass :—

"Prepare two solutions.

"1. Argentic nitrate is dissolved in distilled water, and ammonia is added to the solution till the precipitate first thrown down is almost entiely redissolved. The solution is filtered and diluted, so that 100 c.c. contain one gramme of argentic nitrate.

"2. Two grammes of argentic nitrate are dissolved in a little distilled water and poured into a litre of boiling distilled water. 1·66 gramme of Rochelle salt is added, and the mixture boiled for a short time, till the precipitate contained in it becomes grey; it is then filtered hot.

"The glass having been thoroughly clean with (1) nitric acid, (2) water, (3) caustic potash, (4) water, (5) alcohol, and lastly distilled water, is to be placed in a clean glass or porcelain vessel, the side to be silvered being placed uppermost. Equal quantities of the two solutions are then to be mixed and poured in so as to cover the glass. This should be done while the glass is still wet with distilled water. In about an hour the silvering will be completed. Then pour off the exhausted liquid, carefully remove glass, wash it in clean water, rub off silver deposited where not required, allow to dry. The time required for the operation depends on temperature. If the solutions be warmed to about 30° C. the silver is deposited in a few minutes; but it is safer to use them cold."

plane surface is not more difficult than any optical surface whatever. The means of verification are so delicate that, in a mirror of 40 inches diameter, an error of $\frac{1}{50000}$th of a millimetre can easily be determined and eliminated. So if there be sphericity in the mirror, the radius of curvature will have at least 1,600 leagues, that is to say, about the radius of curvature of a bath of mercury; and in taking still greater pains, it will be possible to go further, and to reach an exactitude such that the radius of curvature might be twice as great. Under these conditions it is not possible, as one can readily see, that there can be any appreciable imperfection.

The attention of M. Loewy and the Brothers Henry, as will be seen, has been particularly directed to the thickness of mirrors. For a small mirror the thickness should be $\frac{1}{5}$ or $\frac{1}{6}$ of its diameter, but a larger mirror, say one of 40 inches, need only have a thickness of $\frac{1}{7}$.

With regard to the weight, a disc of 5 feet diameter of the proper thickness would weigh about a ton; a disc of 40 inches diameter, trimmed down to its proper thickness, weighs 380 kilogrammes.

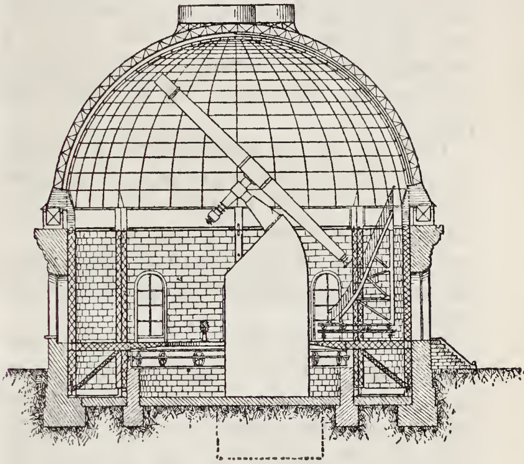
It is thus seen, then, that for our existing telescopes of 25, 26, and 27 inches aperture, we have already mirrors of which siderostats could be constructed to fill them with light at all usual inclinations; and that, if the definition is not effected detrimentally by the introduction of the mirror, Foucault's plan secures the almost complete realisation of Hooke's idea. There is this to be said, however, that with a siderostat the observation of the whole heavens is not secured. I have now, to direct attention to an instrument that does secure this.

The "equatorial *coudé*," an equatorial instrument in which two of these mirrors are used, to which I wish to draw attention, was designed by M. Loewy, and its construction was commenced in the year 1871, by Mr. Delaunay, who was then the Director of the Paris Observatory, who was much struck with the design. The construction was interrupted by the Franco-German war, and the premature death of the illustrious director of the observatory, and had it not been for the liberality of Mr. Bischoffsheim, it probably never would have been completed.

For modern instruments of existing dimensions—and it is certain that those dimensions will be increased—the construction of a dome is no easy matter. The conditions have to be sought for which will ensure a permanent and easy rotation of a circular roof of at least 60 feet in diameter. Two domes are now being constructed in Paris larger than this, that is, having a diameter of 20 metres. The old system of making the dome travel on wheels and circular rails, or cannon balls and gutters, and the like, has been abolished.

Let me give you an idea, by means of the accompanying drawing, of the two domes to which I have referred. The system is the one suggested by M. Eiffel. The dome is a steel one of twenty metres diameter,

Fig. 1.



and hemispherical. At the bottom of the dome is a circular caisson, also of steel, and connected rigidly with the dome. To the dome, by means of vertical pillars constructed of angle iron, is connected the floor of the observatory. The dome, the caisson, the pillars, and the floor form one whole, entirely metallic, all being firmly knitted together. At the top of the cylindrical wall which forms the body of the observatory is an annular trough holding liquid, in which floats the annular caisson. It is this liquid which supports the whole system of dome and floor, the friction produced by the rotation of these being only that of a ring immersed in liquid.

Experiments have shown that the tangential pull of a few pounds will suffice to rotate the dome, in fact 5 grammes applied to a model, and corresponding to a weight of 5 kilogrammes on the dome, gives a rapid rotation to it.

Below the floor, and running on a rail supported by an interior ring of masonry, there is a system of wheels. The dome and floor are floated, so that the floor is within a few millimetres above this ring, which is only to be used as a resource in case of accident.

The liquid proposed is a solution of chloride of magnesium, which is used by M. Pictet in his freezing machines. It is stated that this liquid does not attack galvanised iron, and is only slightly volatile; with a density of 1·25, it only freezes at a temperature of 35° to 40° Centigrade below zero. The section of the caisson is about 1 square metre, and is made of galvanised iron. The surface of the base is 75 square metres. In taking the height of the liquid line at 85 centimetres, there would be 64 cubic metres immersed. This will support 80 tons, which is the estimated weight of the dome and floor.

As the floor moves with the dome, and as the observing chair rests on the floor, the observer will be carried round by the movement of the dome, at the same rate as the telescope is carried round by the movement of the clock, and this obviously is a matter of extreme convenience to the observer.

It can easily be imagined that a case like this must cost something. In fact it will cost nearly three times more than the fiddle—I mean the telescope.

The telescope is to cost 183,000 francs; the observatory nearly half-a-million francs; and I am particularly anxious, for reasons which you will see by-and-by, to dwell on this great expense.

Observations made with reflecting telescopes without domes necessitate the astronomer doing his work in very inconvenient attitudes. Lord Rosse's 6-foot, Lassell's 4-foot, Lord Rosse's 3-foot, and the new Paris 4-foot, are cases in point. The position of the observer with Lord Rosse's 3-foot is here shown by means of a model. (Fig. 2).

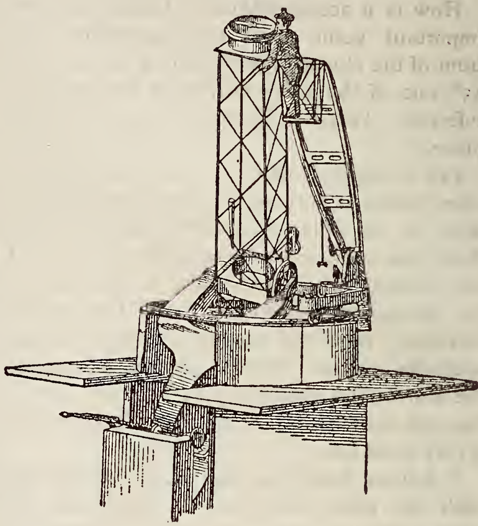
The great point of the equatorial coudé is, that the great expense of domes, and the risk and discomfort of the observer, are at once abolished. The observer can sit down in a comfortable arm-chair, in a warm room, in short, under all the best conditions for securing tranquillity of mind, which is so essential for all accurate observations.

The objects which M. Loewy proposed to himself, in his new instrument, are as follows:—

1. To produce a more stable instrument than the ordinary equatorial, and one enabling large angular measures to be made with certainty.

2. To perfect an arrangement which would enable the astronomer to observe any part of the sky, and to regulate all the movements of the instrument without quitting the observing chair.

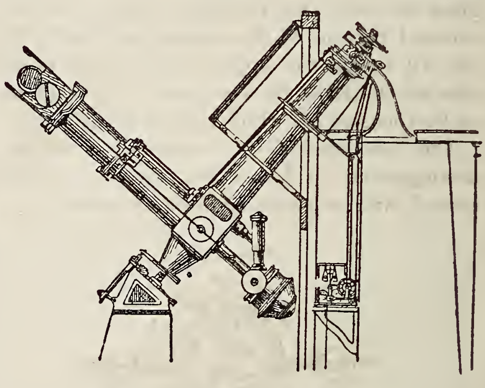
Fig. 2.



3. To avoid the necessity of rotating domes.

We next come to the manner in which M. Loewy has attempted to carry out these conditions (Fig. 3).

Fig. 3.



The polar axis is supported at its two extremities by two pillars. The upper part of this polar axis is hollow.

The principal part of the tube of the telescope is fixed at right angles to the polar axis. With an object-glass at the end of the tube, a right-angled mirror where the tube joins the polar axis, and an eye-piece (Fig. 4) at the upper end of the polar axis. While the instrument turns on its axis, the astronomer sees passing before his eyes the equatorial stars. With the instrument in perfect adjustment, the crosswire in a sweep marks the position of the celestial equator, and this is all that would be seen, but as I said before, the instrument is competent to observe the whole heavens.

How is it accomplished? This is the most important point about the instrument. In front of the object-glass is placed, at an angle 45°, one of the plane mirrors to which I have referred. This can be rotated from the eye-piece.

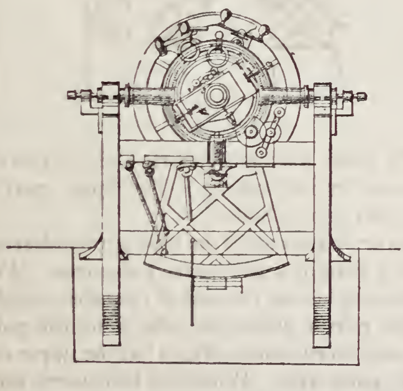
Let us suppose now that the tube with the object-glass is horizontal either to the east or west of the polar axis. The tube in both these positions extends beyond the sides of the building where the observer sits, and if the mirror be then rotated, the stars on the meridian, from the northern horizon to the southern one, are brought successively under the ken of the observer. In this position in fact, the instrument is a transit instrument, and a very good one.

It follows from what has been said that as both the polar axis and the mirror can be rotated through any angle, celestial bodies, in any right ascension and declination, can be observed.

There is this additional point about the instrument which M. Loewy very properly insists upon, that large angles are easily measured, and that the lenses of the object-glass are less liable to displacement. All the external portion of the apparatus, that is to say, all except the upper portion of the Polar axis which carries the eye-piece, is covered by an inexpensive hut which can be rolled away.

The best idea of the convenience of the arrangement, so far as the observer is concerned, will be gathered from the view of the

Fig. 4.



eye-piece. In the centre we see the micrometer with one of the eye-pieces. I shall have a word to say about this micrometer afterwards, as it is an improvement upon the ordinary form. The position circle and the vernier are seen above the eye-piece. Two other verniers on two other concentric circles are shown above, the outer one being the right ascension one. It will be seen, therefore, that the circles and verniers showing position angles and the right ascension and declination of any object visible in the field of view, are close to the observer's eye. Now, if we wish to sweep round the whole visible heavens in right ascension, all we have to do is to turn a handle. The observer, seated comfortably in his chair, not retarded by the necessity of any simultaneous movement of a dome, sees that part of the heavens which is above the horizon at the turn from east to west, having the same declination as the object at first visible in the field of view defiled before him. On the other hand, should he wish to observe bodies with varying declinations, he turns another handle; this causes the mirror in front of the object-glass to rotate, the telescope itself remaining at rest, except in so far as it is being driven by the clockwork at the time. One handle clamps in declination, and another below the eye-piece, is the clamp in right ascension. To the left of the clamp we have three handles: one handle for winding up the clock, another which gives a hand movement to the telescope when the clock is out of gear, while the third connects the tangent screw driven by the clock with the arc concentric with the circles. The eye-piece—indeed, the upper part of the telescope altogether—is fixed to the floor of the observing room by supports.

Two or three questions now present themselves:—What is the definition of this new telescope with the two additional mirrors? *A priori*, a long focus is an advantage, but the idea of two reflections from plane surfaces will frighten many. All I can say is that MM. Perrotin, Thollon, Trépied, Trouvelot, and Professor Newcomb, have all expressed their wonder at the definition, and that my wonder at it has not been less than theirs.

There has been severe, and in some respects unfair, criticism of the equatorial *coudé*. For instance, Mr. Grubb considers the great objection to lie in the necessity of an outside mirror, and states that no mirror of 40 inch, which would be necessary for a 27-inch object glass, has ever been attempted. This is an error, for such a mirror has been finished. And as he has also misread Loewy's statement of thickness, proposes finally a dialyte, an instrument in which the bi-concave is separated from the bi-convex, mounts this so that all the sky is not included, but retains the coudé arrangement, and uses a mirror with a differential movement to throw the light up the polar axis to an eye-piece in an observing room like M. Loewy's.

M. Loewy, with whom I have discussed this arrangement, objects that with the dialyte arrangement the useful field of view is always small, while it is obvious that astronomical precision is quite impossible with such an arrangement.

My own opinion with regard to the use of plane mirrors is that I should have no hesitation in using an equatorial *coudé* of 20 inches aperture, and mirror 30 inches, and I believe that this will be the form adopted for instruments of precision.

With an object-glass of 30 inches diameter for physical observations, I should certainly prefer the siderostat, thus reducing the cost of an instrument of this size to about one-third of the present price.

With regard to cost, the price of a plane mirror for an equatorial *coudé* is only about a quarter of the price of the object-glass, because although the diameter is much larger, the ratio being as 3 to 2 about, the glass of which the mirror is constructed is not optically pure, and there is only one surface to grind and polish instead of four.

Thus, the price an object-glass of 27 inches is 70,000 francs, while that of a plane mirror of 38 inches is 18,000 francs. For an object-glass of 40 inches, the price is 200,000 francs; the corresponding mirror of 58 inches only costs 40,000 francs.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON BEVERAGES. BY RICHARD BANNISTER, F.I.C, F.C.S.

Although foods, as a class, differ from beverages as commonly understood, yet the visitor to the Exhibition will soon make himself acquainted with certain commodities exhibited, which can with as great propriety be classed under one head as the other. Thus, for instance, chocolate, in its ordinary form of a confection, is consumed as a food, but when we approach liquid extracts of cocoa and coffee, they pass with propriety out of the category of foods, and ally themselves to beverages. It has been necessary to make these few introductory remarks, because, in the somewhat large exhibit of food and beverages, there has been considerable difficulty in dividing them into two distinct classes, on account of the many articles exhibited which stand on the border line of each class, and which may justly be placed in either class according to the definition of the terms "food" and "beverage." In the official catalogue the beverages are divided into three classes, viz., alcoholic, non-alcoholic, and infusions (such as tea, coffee, &c.). From a chemical or physiological point of view there would be little difficulty in making a report upon the lines thus laid down, for in two of the classes the presence or absence of alcohol would settle the matter, and little would have to be said, beyond recording the quantity of spirit or alcohol the articles exhibited contained. But in trade, alcoholic beverages such as wine, liqueurs, brandy, &c., do not depend upon the quantity of alcohol they contain as the criterion of value, but upon other qualities, such as fulness, flavour, aroma, &c., which, combined with the spirit in them, determine their value as articles of commerce. It will, therefore, be perhaps more convenient in this report to break down, to some extent, the distinction between alcoholic and non-alcoholic beverages, and bring the articles exhibited into their different commercial classes, without going into such details as are scarcely suited for general reading. It would, however, be scarcely just to the exhibitors to confine the remarks about to be made to the objects exhibited which strictly fall within the classes above enumerated; for there are exhibits of great interest which certainly demand a passing notice, and which cannot be classed. Thus in the South Gallery, amongst the tea exhibits, may be seen at one stall healthy coffee plants, and a series of illustrations showing the different stages of the process employed for curing Indian tea. At other stalls, in the tea and coffee section, can be seen specimens of tea and coffee of every description known in the European market; and although China tea, which forms the greater part of the tea sold in this country, is not fully represented, yet it is astonishing to see how many different sorts of tea and coffee are collected together in so small a space.

Passing down the gallery, there is reached the stall of the Austro-Bavarian Lager Beer Company, which attracts special attention on account of its being the first brewery in this country devoted to the sole manufacture of beer brewed on the German system. The German lager and other beers are now imported in large quantities to supply the growing demand for them, and as the price of the imported article is comparatively high, there is ample margin for the profitable brewing of similar home manufactured beer at a lower price. Healthy competition has already been of benefit to the consumer, and there is little doubt if the demand for this class of beer increases in future as it has in the last few years, we shall see this industry becoming established here on a somewhat large scale, to correspond with our national wants. Other English brewers have attractive exhibits which are deserving of praise, but the classes of pale, family, and strong ale are so well known and appreciated, that it is not necessary to dwell here on the merits of this national beverage.

In this gallery there are several excellent exhibits of Australian wines, the stalls on which they are placed being made to attract the attention of visitors, who will doubtless be struck with the quality and quantity of the wine which finds its way from this distant colony. Adjacent to these exhibits are several stands devoted to the display of Spanish wines, which have long been in favour in this country, and the method of arrangement of the specimens exhibited shows much taste and discrimination on the part of the exhibitors. Perhaps the stand which has attracted the most attention in this class is the "Weinlaube" or vineyard arbour, with its female attendant dressed in Dalmatian costume. Apart altogether from the display of Austrian and Dalmatian wines, there are exhibited here, among other curiosities to viticulturists, specimens of the *Phylloxera vastatrix*, the small insect which has caused such destruction in the vineyards of France and other countries. Vine roots are exhibited illustrating the method of attack of this pest; and it appears, from a close examination of the specimens, that the insects attack the young and tender shoots, and so puncture and wound them that they cannot supply nourishment to the vine. From want of sustenance the plants first cease to grow, and then sicken and die, without any apparent cause. A close examination of the root, however, soon reveals the presence of the phylloxera, which has not only appropriated the nourishment required by the vine, but also damaged the roots to such an extent that they cannot perform their natural functions. In France substantial rewards have been offered for the successful destruction of the phylloxera, but up to the present time no remedy has been perfectly successful. If the vineyards could be flooded at certain seasons of the year, the insects in question could be drowned without damage to the vines; but as the vineyards in France are generally on hilly ground, this remedy cannot be applied to them. In Austria and Dalmatia the vines are generally grown on level ground, and here the experiment of flooding has been tried with perfect success. Another suggestion has been made, that the vines should be trained high, on account of the difficulty the young insects would have in travelling from the upper branches, where they are hatched, to the roots of the plants where they obtain, their food. It has been said by the advocates of this plan that vines trained round dwelling-houses situated in districts infested with phylloxera are not injured, and the explanation of this immunity from disease is ascribed to the inability of the insects to travel from the high parts of the plant to the root. However exact this explanation may be, it is evident that in exposed districts the vines cannot be trained high, on account of wind and frosts, and that some other remedy must be found for the cure of the disease in plants growing in exposed situations. In France there seems to be a growing disposition to destroy the vineyards attacked, to cultivate the ground with care, and then to plant vines possessing very strong spreading roots, and afterwards graft on these stock vines the different varieties suitable for the district, and for the production of the special description of wine for which the district has been famous.

In this South Gallery are also numerous attractive stands for the display of aërated and other waters. Without giving undue preference to any of the exhibits, a careful inspection will convince even the most sceptical that in this large and increasing trade the efforts made for producing not only a pleasant, but also a pure article, are very great. At one stand the specialty is that the water employed is distilled with the greatest care; at another, that the filtration of the water before use is specially attended to; at a third, that the chemicals and essences employed are manufactured on the premises to secure purity; at a fourth, that the carbonic acid used for aeration is specially made so that it shall be quite free from the faintest taint of contamination, and all the exhibits show that the most scrupulous care has been taken that the liquids themselves shall be free from lead or other metallic contamination. Exhibitions, such as the present, where so many sections of the same commercial interests are brought together, must do incalculable good, for each manufacturer can see what his rival is doing, and by seeing improvements in some directions and blemishes in others, he is led to think out what improvements he can make in his own business, so as not to be left behind in the race.

The aeration of these beverages has led one exhibitor to show how bottled beer can be artificially charged with carbonic acid, and thus be ready for consumption as soon as bottled. This statement may appear very simple to those unacquainted with the bottled beer trade, but the initiated will understand the value of the problem to be solved by this process, which, if successful, will work a revolution in this particular branch of trade. Hitherto bottled beer has had to be kept until sufficient fermentation has been set up in the liquid to charge the beer with carbonic acid, and thus cause it to be somewhat effervescent and sparkling when poured out. During this fermentation certain matters are thrown out of solution and form a sediment. When the bottle is uncorked the pressure of the carbonic acid is removed, and almost instantly the sediment will be seen to become detached from the bottom of the bottle and diffuse itself through the liquid. The beer thus becomes muddy and unsightly, and displeasing to the eye and taste. The artificial introduction of the carbonic acid is set forth as a remedy for this defect, but whether in practice it will be found to possess all the advantages claimed for it, it is not for me to decide. At another stall milk has been submitted to the same treatment, and is sent out in syphons.

Another class of beverages is also very fairly represented in the South Gallery, viz., fruit cordials. Lime and lemon juice cordials have come prominently into use of late, as flavouring materials to be added to water for summer drinks. Preference is given to the class prepared from lime juice, on account of their greater stability; but, unfortunately, many of them possess such a distinct flavour of the chemical substances used to preserve them, that they are on this account rather objectionable, although not unwholesome.

As a step between the fruit cordials and effervescing wines of foreign produce, come two or three exhibits of wine of home manufacture, the basis of one being Devonshire cider, and of the other fruits and grapes of home growth. The names given to some of these productions are rather startling, they being so constructed as to lead the ignorant or thoughtless to believe that the liquids they represent partake of the character of certain well-known sparkling wines. One little exhibit in this section is apt to be overlooked, but as it is a novelty, it is here specially noticed. The samples in the exhibit are made of grapes which have been gathered from cottage vines, and as this is a somewhat new industry, it is deserving of attention, especially as the wine itself, considering its origin, is of very fair quality.

On passing from the south gallery to the foreign galleries, where the other portion of beverages is mainly exhibited, the stands of the Japanese section attract attention. Although late in their arrival, and collected and prepared with haste, the articles exhibited show the rapid strides made in the national life of the Japanese, and of the effect of the concord between the eastern and western nations, which now happily prevails. The statistics collected together, and printed either in the catalogue, or on sheets, are marvellous in detail, and the descriptions given of the different articles exhibited are unique. The national beverage is Saké, which is a kind of wine made from rice, and very similar to what is largely consumed in China. This saké is not of unpleasant flavour, and although very peculiar, would soon grow in public estimation. Probably the remark made by a friend who had lived long in China, respecting the Chinese national beverage, would apply to saké, viz., "That it is the most fitting drink to take with the kind of food we eat." A strong spirit made from rice, named Awamori, is also exhibited, as well as Shochiu, which is made by fermenting the saké residuum, and is said to be used as a medicine, and for dressing wounds. Homeishu, or life-keeping saké, is also exhibited. This spirit is a kind of liqueur flavoured with herbs, and is not at all unpleasant. In the exhibit are also found beer and wine made as in Europe. The wine has deteriorated by keeping, but the beer is of very fair quality, and compares favourably with the ordinary kind of ale brewed in this country. Specimens of tea are also exhibited, and they appear to be of very good quality. Taken altogether, this exhibition is an extraordinary one, and it is not too much to say that all who study it with care will be surprised to find that the Japanese are so far advanced in knowledge, or so well acquainted with what is necessary to produce a healthy, robust nation.

Near to the Japanese section are the stands representing the produce of Venezuela, and of the Cape of Good Hope. In the former exhibit there are scarcely any beverages, whilst the latter consists exclusively of wines. At one time the Cape wines were common in this country, and the Constantia deservedly commanded a very high price, but, from various causes the consumption has diminished, till at last the importation into this country is very small indeed. The wines are, however, well represented, and no doubt their quality will be properly appreciated. Near here are the Swedish, Danish, Swiss, and Russian exhibits. The Swedish beverages exhibited are of a highly alcoholic kind, as might be naturally expected; whilst Denmark shows beer and liqueurs, the latter being well known and esteemed in this country. Switzerland is represented by her champagne, and a medicine prepared from Alpine herbs; and in the Russian section is exhibited a very good selection of national beverages, some of which are very pleasant, and known on the English market. A medicine called wunderbalsam is also shown, which is said to possess extraordinary curative properties, and is in general use.

The Austria-Hungarian and the Italian Courts are made quite elegant by the rich display of wines natural to the countries, and some of the stands are costly, and prepared with very great taste. Altogether, the exhibits of beverages are very attractive indeed, and no doubt much pleasure has been given to the casual visitors by the taste shown in the arrangement of the goods exhibited; while the manufacturer and the student have been able to get much instruction from the different articles exhibited, and which otherwise could not have come under their observation, except at great cost of time and labour expended in visiting the countries from which the exhibits have been brought.

The survey of the products of different countries, brought together in the section of beverages, will not be satisfactory without trying to point out why it is that some of the countries which supply large quantities of such general beverages as wine, brandy, and rum, are scarcely represented. Thus, France, from whence we derive our large supplies of claret and champagne, Spain, which sends us in large quantities sherry and tarragona, Portugal, which provides us with port, and Germany, with hock, moselle, &c., are scarcely represented at all. All these wines are well known in the English market, and, therefore, are to a certain extent popular. Some of the vineyards of greatest repute either belong to Englishmen or are represented in this country by English houses who act as agents. In cases where the products are in good repute, there seems but little desire to exhibit. It is argued that as the goods are popular, that as they stand high in public favour, and command a high price, there is no necessity to bring them more prominently before the public. Again, it is said that it is useless to try to get medals or marks of honour for such products, because as public appreciation is the best of standards, so by submitting to competition there would be danger of loss rather than of gain. Which of these reasons may be right, or whether all are so, it is certain that in Exhibitions some of the oldest and best known houses do not exhibit, or if they do so, it is only to show what their products are, and not to enter into competition with others. This Exhibition is no exception to this rule, for in the case of France, there are but few entries of wines or other beverages either made by the makers themselves or their agents, and the same remark applies to Spain, Portugal, and Germany. There is no doubt that the difficulties to be overcome by shippers of wines from other countries to alter the taste of the British public for the wines now fashionable with them are well nigh insuperable. At the same time there is no doubt that wine consumers get their knowledge of wines of other growths than those in general use greatly increased by such Exhibitions as the Health Exhibition; and though the old wines may continue in favour, yet some of the new wines, possessing as they do a certain amount of excellence, may be used as adjuncts to the old standard sorts, and thus become better known and more appreciated.

It is only right to point out that some of the wines sold on the English market are not what they are said to be, but contain an abundance of other wines. Thus some of the sherry of the lowest class does not reach us from Spain, but from a free port in northern Europe, where it is made up of different kinds of wine, the greater proportion of which is not of Spanish manufacture. The same remark applies to the common descriptions of clarets, for during the last few years shippers of low class goods have been compelled to mix the very poor French wines with richer wines of the growths of other countries. It is fair to assume, therefore, that if some of the best wines which are used for mixing purposes get known here they will be properly appreciated and drunk, because they are sound and good. As has been before referred to, the Cape wines once in repute were brought into public notice through the energy of one or two individuals, and since that time Australian and Greek wines have also had a share of public favour. The present Exhibition has done much to make us familiar with the wines of Austria, Hungary, Italy, and Australia. All of them possess peculiarities of their own, but some of them improve greatly on acquaintance, and will no doubt come into general use. The great objection to many of them is that they are not so delicate as French wines of the same class, and that their palate flavour is faulty. But it must, at the same time, be considered that the growers of most of these wines are now seeking a new market, and that as soon as they are acquainted with the defects of the wine, they will try to remedy these defects, and strive to produce a typical wine which will be appreciated. To know what is wanted is half-way to success, and self-interest will, doubtless, spur on the wine growers to achieve the success they are now seeking for. Hungarian wines have been in favour here, and the description known as Carlowitz is the best known of them. Now, however, other wines are presented to us through the administration of the Weinlaube, who have done much for their country in showing the samples in such an attractive way, and Messrs. Palugyay and Sons have spared no pains in putting before the public the best wines of Austria-Hungary, among which tokay holds the premier place. From Graz, in Styria, are also exhibited champagnes, burgundies, hocks and clarets of Styrian growth, and from the varied assortment submitted there is little doubt but that some of them will come into favour.

The Italian wines are so numerous and varied that it is a matter of difficulty to know how to begin the description. The wines are contained in all sorts of bottles, some of which are quite unsuited for ordinary trade. The wine in flasks is, perhaps, known in England on account of its being exhibited in the windows of Italian cafés, &c., as an advertisement. A close inspection of such bottles shows the layer of oil on the top of the wine in the neck of the bottle, which is to keep the wine free from the air. When, however, the wine has to be used the oil must be got off, and the usual method of removing it must be seen to be appreciated. Though it may be carefully done, a small quantity of oil is left behind, which is sufficient to flavour the wine, and make it objectionable as a beverage to the large class who do not like oil as an ordinary drink. Fortunately, some of the exhibitors are fully alive to the fact that if the wine exhibited by them is to become popular, it must be contained in bottles of ordinary form and capacity, and that it must be bottled with care, and kept sound by ordinary means.

Several white wines of a low price are particularly pleasant and clean to the palate. They already command a fair sale, and are kept in stock by some of the largest wine dealers. Several red wines are also very good, but some are not as sound as they should be, and others have a flavour of sulphur, which is said to be obtained from the volcanic soil in which the vines are grown. Be this as it may, there is no doubt that the Italian exhibits show in special cases excellent value, and it is hoped that the Enological Society of Rome, Vitali, and other exhibitors, will do what they can to follow on with wines that shall exactly correspond in character and flavour with the wines now exhibited, to which distinctive names have been given. Wine is produced in almost every part of Italy, and as the country is now improving commercially, it is to be expected that wine will eventually be largely exported to other countries for direct consumption.

The Australian wines are so steadily making their way in the English market that they require but little comment. It will be a great gain to these wines if the alcoholic standard for the shilling duty on wines is raised, so as to include them in the lower rate. At present the wines are very full and heavy, but they have improved in this respect, and no doubt the improvement will continue.

With regard to whisky, gin, and other spirituous liquors exhibited, the two first classes are but poorly represented by manufacturers, but many different kinds are shown by dealers, and most of the exhibits are of very good quality. The whisky is chiefly blended whisky, each exhibitor having his own peculiar secret in making his blend. The large London rectifiers of gin do not exhibit, consequently this large and valuable industry is very sparsely represented. Spirituous liquors, such as cordials, liqueurs, &c., are exceedingly well represented. France, Germany, Belgium, Holland, Switzerland, Venezuela, Russia, Japan, Sweden, Denmark, Great Britain, and other countries, supply exhibitors, and some of the exhibits are of very great excellence. It must, however, be remembered that the aggregate quantity of liqueurs consumed is comparatively small, and therefore, though the exhibitors are numerous, the value of the exhibits does not fairly correspond with the large number of samples shown.

The number of exhibitors of malt liquors is not great, but the foreign exhibits are interesting as showing the different kinds of beer made in the countries they represent. The English exhibitors are, as before stated, very scanty, but the quality of the beer is good.

On the descriptions and qualities of the tea and coffee exhibited, a somewhat lengthy paper might be written. The specimens of coffee and tea shown are very numerous, but, unfortunately, there are very few specimens of China tea included in them, by far the greater part being India and Ceylon teas. The large increase in the mportation of India and Ceylon teas, and the falling off in China teas, point to the fact that the colonial teas are fast rising in public favour, and this appreciation of their good qualities is deserved on account of their strength and flavour, and their use in the blending of teas for home consumption. Some of them, such as the Darjeeling, can be used alone; but they generally pass into consumption as blended tea.

In the Chinese court only two specimens of tea are exhibited, but they are not for competition. They are sun dried, and contain flowers of the tea plant. The flavour of the tea in liquor is exquisite, but its character, appearance, and price preclude it from being a commercial tea, although it is greatly appreciated in China, and considered of the highest quality.

This report is necessarily very imperfect, on account of the difficulty experienced in bringing the different sections into one harmonious whole. Much might have been said on the properties of the different natural mineral and artificial waters exhibited, but the paper would then have been too long.

After a careful study of all the articles exhibited in the section of beverages, I am not surprised at the great success of the Exhibition. There is very much to be learned; and the regret of those who have devoted much time to study the lessons which can be taught by such an Exhibition is, that the time at their disposal is too limited to do justice to the privileges conferred on them by what can be with truth called a huge educational establishment.

Correspondence.

WATER STORAGE.

The late scarcity has brought before many the necessity for more water storage, and to which attention has been called in the *Journal*. My object now is to point to the storage of rainwater by house tanks. The late Sir Philip Rose was active as to this, and provided the cottages on his estate with the means for storage. Our kindred in Flanders have often been cited for their storage of manure, but their storage of water is also deserving of regard. Two months of the summer will sometimes pass with blue skies and no rain. The courses of the sluggish rivers and the canals they feed only give water for inferior uses. Large cities, such as in the Middle Ages held a hundred thousand people, are supplied with drinking water from the roofs. Each house has a tank under the house, and in some cases, a reserve tank. These tanks, dating from past times, in some cases three or four hundred years ago, are a valuable part of the national plant and resources. This position is also the reason for so many old houses of remote date being preserved from fire, for there is water on the spot. If those who are now concerned in building houses will, as Sir Philip Rose did, make provision, England would derive corresponding benefit.

HYDE CLARKE.

32, St. George's-square, S.W.
25th October, 1884.

It appears from recent statistics that 1883 was favourable for tea cultivation in Assam, the outturn being nearly 7,000,000 lbs. in excess of the yield of 1882. The total area of land held by tea planters in 1883 was 923,664 acres; the yield of tea was 52,171,207 lbs. There has been a steady increase in the production of tea in Assam during the past five years, from 31,386,636 lbs. in 1879 to 52,171,207 lbs. in 1883.

Journal of the Society of Arts.

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FRIDAY, NOVEMBER 7, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and and Thirty-first Session of the Society will be held on Wednesday, the 19th November, when the Opening Address will be delivered by Sir Frederick Abel, C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting.

Ordinary Meetings.

The following papers (among others) will be read:—

"The International Health Exhibition." By George Buchanan, M.D., F.R.S.

"Electric Lighting in America." By W. H. Preece, F.R.S.

"Education at the International Health Exhibition." By J. G. Fitch, M.A.

"The Employment of Hydraulic Machinery in Engineering Workshops." By Ralph H. Tweddell.

"The History and Manufacture of Playing Cards." By George Clulow.

"The Musical Scales of Various Nations." By A. J. Ellis, B.A., F.R.S.

"The Painless Extinction of Life in the Lower Animals." By B. W. Richardson, M.A., M.D., F.R.S.

"Marine Biological Laboratories: their Organisation, Work, and National Importance." By Prof. E. Ray Lankester, M.A., F.R.S.

"The Preparation of Butterine." By Anton Jurgens.

"Recent Improvements in Coast Signals." By Sir J. N. Douglass.

"Present and Prospective Sources of the Timber Supplies of Great Britain." By P. L. Simmonds.

"The Influence of Civilisation upon Eyesight." By R. Brudenell Carter, F.R.C.S.

"The Evolution of Machines." By Prof. H. S. Hele Shaw.

"Tempered Glass." By Frederick Siemens.

Foreign and Colonial Section.

The Meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 27; February 24; March 17, 31; April 28; May 19.

Applied Chemistry and Physics Section.

The Meetings of this Section will take place on the following Thursday evenings, at Eight o'clock:—

February 12; March 12; April 23, 30; May 7, 28.

Indian Section.

The Meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—

January 23; February 20; March 6, 20; April 17; May 15.

Cantor Lectures.

The First Course will be on "The Use of Coal Gas." By Harold B. Dixon, M.A.

December 1, 8, 15.

The Second Course will be on "Climate, and its relation to Health." By G. V. Poore, M.D.

January 12, 19, 26.

The Third Course will be on "The Distribution of Electricity." By Prof. George Forbes.

February 2, 9, 16.

The Fourth Course will be on "Artists' Colours." By J. M. Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King' College, London.

February 23; March 2.

The Fifth Course will be on "Carving and Furniture." By J. Hungerford Pollen.

March 9, 16, 23, 30.

The Sixth Course will be on "Photography and the Spectroscope." By Capt. W. de W. Abney, R.E., F.R.S.

April 20, 27.

The Seventh and concluding Course will be on "The Manufacture of Toilet Soaps." By C. R. ALDER WRIGHT, D.Sc., F.R.S., F.C.S.

May 4, 11, 18.

HOWARD LECTURES.

A Special Course of Lectures will be delivered under the Howard Trust, on "The Conversion of Heat into Useful Work." By W. ANDERSON, M.Inst.C.E.

November 27; December 4, 11; January 22, 29; February 5.

JUVENILE LECTURES.

The two Juvenile Lectures will be given on Wednesday evenings, December 31, 1884, and January 7, 1885. Special tickets will be issued for these lectures, due announcement of which will be made.

PRIZES FOR ESSAYS.

The Council of the Society of Arts have had placed at their disposal by Mr. William Westgarth, a member of the Society, a sum of £1,200, to be awarded in prizes for essays on "Dwellings for the Poor," and on the "Reconstruction of Central London."

The first prize will be a sum of £250 for the best practical essay upon the re-housing of the poorer classes, and especially of the very poorest classes, of the metropolis.

The second prize will be a sum of £500 for the best practical essay upon the whole subject of the sanitation, street re-alignment, and reconstruction of the central part of London.

In addition to the above, there will be three further prizes of £150 each:—1. For the best treatment of the engineering considerations. 2. For the best treatment of the architectural considerations. 3. For the best treatment of the sanitary considerations. Any of all of these last-named prizes may be awarded to the same essay as that to which the £500 prize may be awarded, or they may be awarded separately.

The essays must be sent in to the Secretary of the Society of Arts, not later than December 31, 1884. No essays can be received in manuscript.

The Council reserve the right of withholding any of the prizes, or of awarding the amounts, or parts of the amounts, in any manner which may seem to them desirable. They also reserve the right of publishing any essay to which a prize may be awarded.

Further particulars can be obtained on application to the Secretary, John-street, Adelphi.

INTERNATIONAL INVENTIONS EXHIBITION, 1885.

At the request of the Executive Council of the Exhibition, the Council of the Society has readily consented to the Society of Arts *Journal* being made the official record of the Exhibition, in order that it may serve as the medium for the publication of official notices, and of information about the Exhibition.

Proceedings of the Society.

CANTOR LECTURES.

SOME NEW OPTICAL INSTRUMENTS.

By J. NORMAN LOCKYER, F.R.S.

[The right of reproduction of these Lectures is reserved by the Author.]

Lecture II.—Delivered Monday, May 5th.

In my last lecture I referred to the use of the plane mirror, in connection with the necessity of movement in those instruments which have for their object chiefly the investigation of the physical constitution of the heavenly bodies. We saw that the use of such mirrors was not confined entirely to this kind of observation, but it was pointed out that wherever there was any necessity for the continued following of a celestial body, then the plane mirror came in, and enabled us to construct a telescope of enormous proportions, which combined not only the maximum of cheapness, but the maximum of comfort to the observer.

I have now to discuss, as briefly as may be, another exceedingly important use of these plane mirrors, and in doing so we must never forget, however large the astronomical refractor may become in time, that the germ of those monsters which are now becoming familiar to us was the one constructed by the lamented Thomas Cooke, of York. It was he who first dared to advance from an aperture of 16 inches to an aperture of 25 inches. How did

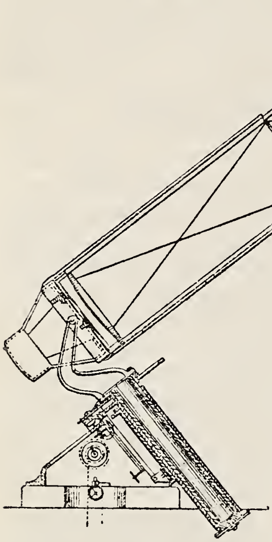
Cooke construct this object-glass? So soon as he had begun to work at it, he constructed a tower near the walls of the city, where his workshop was, and to this observatory, right away from his workshop, the lens or lenses, one or both of them, were taken when it was necessary to test them, because he imagined that it was absolutely necessary with such large surfaces to test them by observations on stars, and not by using artificial stars, which did very well with smaller lenses; so that, whenever it was a question of determining whether the surfaces were spherical, whether the curves of the crown agreed with the curves of the flat, whenever any aberration was in question, it was necessary to take down this object-glass from the chair on which it was being ground by the machinery, to put it in a cell, to mount it at the end of a tube, and then to go to work with this observing tower. Now it is true that other opticians, among them Clarke, of Cambridge, had shown beforehand that this was not absolutely necessary; that provided the optician had a sort of horizontal well, some 500 or 600 feet long, he could do without stars altogether; but horizontal wells 500 feet long are not common—it is not everyone who can command a dark chamber of that length.

Now, mark what happens the moment you introduce the use of the plane mirror. You mount this plane mirror vertically, put the object-glass vertically in front of it, and, at practically the focus of the lens you wish to test, make a little hole in a piece of wood or of metal, and let light through the hole from a lamp by means of a right-angled prism. Close to this hole mount another lens, by which you examine the image thrown by the lens after the light has travelled first through the little hole, then through the lens, then as a parallel beam from the lens to the plane mirror and back again, until at length it is received by the eye at the eye-piece. With an arrangement of this kind, which does not cost ten shillings, you can test every step of progress in any of your surfaces; and you may test it, whether it refers merely to the perfect sphericity of the surfaces, or to the under-correction or over-correction of the crown by the flint lens which you employ. So that the Brothers Henry, who are now using this system in Paris with object-glasses up to 20 inches in diameter, can deal with the four surfaces—the two surfaces of the flint and the two surfaces of the crown—at the rate of an inch a day. And if you say to them, "I want an object-glass of 16 inches in diameter," they will say, "You can have it in 16 days." Now that time for the construction of an object-glass of that size was not enough when it was a question of dismounting the lenses every time you wanted to test them, and putting them in a trial tube, and waiting for an image of a star during, probably, very cloudy weather. So that I think the future of this kind of optical work will show that the plane mirror is probably as useful in the construction of lenses as in the use of it to which I drew your attention in the last lecture. I told you, too, in that lecture, that I had just seen in Paris a plane mirror of 40 inches in diameter. This mirror really has been made with such an object in view. It was not made for use with the equatorial *coudé*, although of course it, or one like it, can be easily applied. The point that I had to bring to your attention in the last lecture was that it had been stated that such a mirror was impossible. This mirror is now made as a matter of business, not for any use directly of its own, but for its indirect use in enabling the very rapid testing of object-glasses to be accomplished. And I may say this particular plane mirror of 40 inches to which I have referred is wanted for those two object-glasses of 28 inches and 29 inches diameter to which I have also referred; and still having my text in mind, as the preacher should have, I have now to point out that that mirror is useless, and that those object-glasses are not being finished, because in the wide world the application of the arts has not succeeded in enabling opticians to procure crown glass of 30 inches in diameter.

Having the same ideas in our minds, let us change the *venue* of them slightly by passing on to reflectors. We discussed the mounting of reflectors in the last lecture somewhat, and it was pointed out that all the mountings which we have had, however good or bad they might be, have this terrible disadvantage connected with them, that the observer was hardly ever in the best possible conditions for making observations. I have now to bring to your notice another form of equatorial mounting of reflectors, which I think opens out a perfectly new use for that instrument. I do not mean to say that with this new mounting the observer will be absolutely comfortable, but I do say that it possesses an enormous number of advantages over the old forms, and it is one which, from our particular point of view, is well worth studying. By the kindness of Mr. Common, to whom this new form of mounting reflectors is due, I give two drawings, made to scale by him, which will give an idea of the difference between this form of mounting and the other ones to which I drew your attention.

Fig 1 is the mounting of a telescope of 3 ft. aperture, which is now at work in the neighbourhood of London, and the first point about it is that as Mr. Common had the very happy idea of floating its polar axis in mercury, the movement of its polar axis is perfectly easy, so that this telescope, although we have a distance of 3 ft. from

Fig. 1.

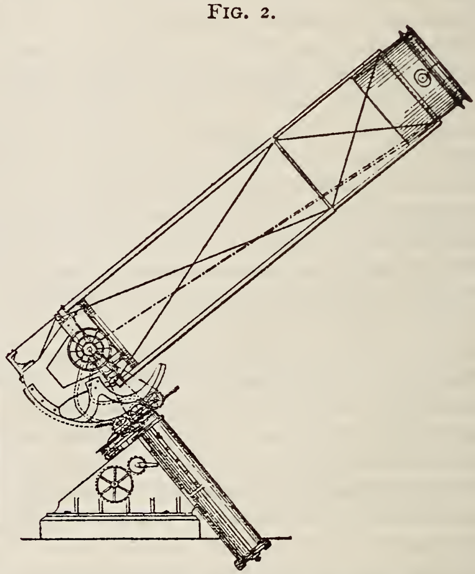


General View of Mr. Common's Method of Mounting, showing Floating Polar Axis.

side to side, and a distance of from 18 to 20 ft. from end to end, is moved with the most perfect ease. Another extremely important point about it is that the tube is reduced to a minimum. In the last lecture we saw a model of Lord Rosse's 3 ft. tube, in which the tube was certainly very simple indeed; it was almost a survival, as a naturalist would say, but it was not quite so much a survival as this one. Here we have simply four **T** pieces beginning with four angles, and the function of the whole thing is to carry the eye-piece, and the weight is reduced as much as possible, while strength and rigidity is retained by means of cross pieces. Why is it so important to reduce the tube in this way? For this reason, that practically the centre of support, and the centre of motion, lie in the mirror itself. That idea gives rise to another matter of very great importance, which is that, as the mirror can lie in the centre of motion, there is no necessity for any great mass of metal between the mirror and the eye-piece, either to abstract heat from the assembly of pieces or to give heat to it, so that one of the chief causes, I think, of the bad definition of reflectors generally has been abolished by this arrangement of Mr. Common's. With reference to that point, a comparison of the 4 ft. reflector at Melbourne will best point to the considerable difference in arrangements.

In that, although we have a lattice tube, the centre of motion does not lie anywhere

Fig. 2.



Showing Details of the Movement.

near the mirror, the result of which is that there is a considerable mass of metal between the mirror and the eye-piece, giving rise, in all probability, to convection currents—whether up currents or down currents does not matter at all for my purpose—and giving a very good reason why the disturbance of air between the eye-piece and the mirror should have a very considerable effect. I might have pointed that remark by showing you photographs of other reflectors, but I think I have said enough for the present purpose. Now, if you will think the thing out, you will agree to this statement, that with a mounting like Mr. Common's, or something like it, a mirror of 8 or 10 feet aperture is just as easy to mount as a mirror of

3 feet. We should get the maximum of rigidity, and with regard to counterpoising, and ease of motion, what is good so far as floating in mercury for 3 feet is good for the same reason for a mirror of 8 or 10 feet; and here, again, I come back to my text, and say that I believe the only reason in the world that we have not such a mirror at the present moment, is because the industrial arts have not yet succeeded in enabling opticians to obtain a disc of glass 8 feet or 10 feet in diameter to work upon. Now, before one makes a statement of that kind in the theatre of the Society of Arts, one ought to be sure of one's facts. Well, I have done my best to be sure of my facts in regard to that particular, and I will tell you what I have been told by those who are most likely to know. You remember we found, in the last lecture, that to get anything like good and permanent work without loss of definition with a plane mirror, the thickness of it for a diameter over 30 inches ought to be as one in six. Now, it is perfectly true that there is one place in the world—I am sorry to say, not in this country—where they can produce a disc of glass 8 feet in diameter, but that disc of glass can only weigh one ton, and if you come to work it out you will find that a disc of glass 8 feet in diameter, and weighing one ton, will only be 5 inches thick. Now we saw that was a fatal objection. It must be one-sixth; it must be more than one foot thick to be of any use to us as a mirror, whether plane or parabolised. It is thought by some who have studied the question that the matter may be got over for a reflector of the size I have indicated, namely, 8 feet in diameter, by getting two discs run each of one ton weight, grinding two of the surfaces so as to make them plane, then grinding the other surface so as to give it the required curvature, and then to make one mirror by fastening the two plane surfaces together. That is one way of getting over the difficulty, but then, practically, the mirror would be a little too thick, and it would weigh very nearly two tons, so that another method is now being considered, and it is this. Although with our present glass works it is not possible to run more than one ton of glass, it is possible to run very nearly two tons of porcelain, the density of which is very nearly the same as the density of glass; and one question being studied in France at the present moment is this, and it should be a very interesting one to many of you present—whether it is possible, having a disc of porcelain of the required diameter, and of the required thickness, for a large telescope, to put on this disc of porcelain a glass surface which may be subsequently parabolised to turn into a reflecting telescope. I need not tell you that that question is not yet solved, but it certainly is being considered. I should add that with the experience of the French astronomers, and I believe I may say also with that of Mr. Common, who is using mirrors of 3 feet in this country, one really need not consider the question of silvering the mirrors at all—the thing is perfectly simple. There are two or three ways of doing it. One obvious way which I believe, so far as the information which has reached me goes—I have no personal knowledge of the subject—is quite sufficient, is that the mirror, when you have once got it in a horizontal position, may be surrounded with cardboard, or anything which will hold a certain amount of solution; then the solution may be poured on to its first surface, as we saw it poured into the beaker in the last lecture, the old liquid being poured off, until at last one has a surface of sufficient tenacity and of sufficient brilliancy to be used for astronomical purposes. So that you see if we only have the glass, it looks very much as if at the present moment we might be utilising an instrument such as the world has never yet seen, that is to say, one of 8 feet aperture, with somewhere about 60 feet focal length.

Well, supposing this be so, should we be any better off than with the existing instruments? Should we be more likely to have these instruments multiplied? Yes, we should, for this reason. In these matters it is almost always a question of money. You have not got the thing because you want the money. The thing is multiplied when it is once shown to be possible, because it is cheap. Now this instrument to which I have referred, if we only had the glass, would, I am credibly informed, be produced in ten months for a sum of £10,000. Now that at first sight seems a great sum; but please remember the facts that I brought before you in the last lecture; and this is one of the reasons why I have brought them before you. The instruments of less than 30 inches aperture which are now being constructed in France—I am sorry to say none of those instruments are being worked here—are to have observatories put over them, which will themselves, without the instruments, cost between twice and three times as much as these instruments of 8 feet diameter would. The estimate for the observatory for this 30-inch telescope is about £35,000. We can get one of these 8 feet telescopes for less than £10,000. I make these statements with some certainty, because, in fact, during my official visit to France, a short time ago, I suggested the construction of such a telescope as this to the French astronomers, and the sums I have named, and the facts I have given you, are based upon actual estimates, and I have no doubt that before very long either in France, or let us say in America—the thing is quite hopeless here — such an instrument should be constructed.

Now, why this instrument is so valuable cannot, perhaps, be stated without reference to some more of these new optical methods to which I am bound by the title of my lecture to allude. The particular new optical methods and arrangements which make this telescope so desirable and feasible, are chiefly two, or rather two sets, the first has to do with the way in which we can now obtain permanent records of the spectra of the stars, and other heavenly bodies. The second has to do with the conditions under which we can obtain permanent records of the appearance of nebulæ, clusters, stars, and the like.

We will begin this, first, by referring to what may be included under the term "spectrum photography." In this we have to do naturally in the day with the sun, and at night with the stars and with the nebulæ. I have not much in this present lecture to bring before you with regard to the sun, because it is not necessary that such a large telescope as the one in question should be used for that body, for the reason that its light is so great that the small telescope will do just as well. Parenthetically, however, it is as well that I should refer to the sun somewhat, and draw your attention to some new optical methods and arrangements which are exquisitely beautiful in their way with reference to that body. The light of the sun is so very overpowering, and the light of the stars is so dim, that you may easily, without my telling you, come to the conclusion that the difficulties which have to be overcome in the two classes of research are of an entirely different character; and that is so. We have to succeed in solar photography by battling with the excess of light—we have to succeed in stellar photography by battling with its defect.

I have here, by the kindness of Dr. Janssen, what in France is called a trap, what we call a slide, and this instrument will give you an idea of the way in which the excess of light in the case of the sun has been dealt with, perhaps in the most satisfactory manner. It is a complicated instrument in appearance, but really it is simple when we look at it. It is intended to deal with the excess of light of the sun by only allowing that excess of light to fall upon the plate for an excessively minute portion of time. This apparatus, therefore, is placed in the telescope between the object-glass which collects the light and the photograph plate, and the only light which can fall on the photograph plate has to pass through an aperture. Now, in front of this aperture is arranged a sliding slit, the jaws of which can be regulated by means of a screw, so that I may bring the jaws together until they are almost in contact, in case the excess of light is very great, or I may separate them still more by moving the screw in the opposite direction. Then when I have got this slit as fine as I think it necessary to have it for that particular day, I can, by means of a trigger, allow this slit to snap very rapidly over this aperture through which alone the light of sun can fall on the photograph plate. There are several very beautiful contrivances in this instrument, one of them I will show you when I have again set the trigger. Here is the point at which is the opening which allows the light to fall upon the photographic plate, and this is the spring which produces the movement. Now you will see in a moment that if this spring were acting during the whole time that the light is passing over the aperture, the motion of the slit would be constantly accelerated, so that in passing through the solar image one part would be more exposed than the other, and in that way you would never get a proper photograph of the sun, because to get a perfect photograph you want the quantity of light passing through the slit to be always the same. Now that is managed by the length of this spring. The spring ceases to act the moment the slit is in front of the aperture, so that while the slit is passing over the aperture it only travels by means of its acquired velocity; its velocity is not being accelerated. I shall show you presently two or three photographs which Dr. Janssen has been good enough to give me, which show the magnificent results which have been obtained in this way. The most striking result is that he finds that an interval of two seconds is quite enough to change the physical distribution of the bright and dark portions of some parts of the solar surface near the spots. The instrument, in order to demonstrate that, must be so arranged that it will allow two exposures at an interval of two seconds. This is done very beautifully. I am now about to make one exposure; I have now made it, and want to make another; the slit brings with it a shield to prevent the light falling through the aperture until the trigger is again set; the instant that is done the shield flies back, and in that way it is possible to obtain photographic records over a part of the sun's surface, at an interval just long enough to enable you to do this. That then is the way by which the excess of light is got over.

The little patches of light and dark which on the photographs are something like half a second of arc apart, have a distinct existence on the sun, and have a spectrum of their own. That we learned from Sir William Herschel, although of course in his time he was not able to photograph them. But what we have learned from these beautiful photographs of Dr. Janssen, is that they are associated with cyclonic lines, and form part, in a great many cases, of thoroughly well marked and developed cyclonic curves. Dr. Janssen finds, and finds alone by this means—it is not a thing visible to the eye, the eye gets too tired and strained—that these markings, such as you see here, are distributed over the whole sun's surface, and that they vary frequently in exactly the same way as the sun's spots themselves vary. That is one of the results of that method of dealing with an excess of light.

You will understand, of course, that when we have to deal with the stars—and there Dr. Huggins has been as successful in one direction as Dr. Janssen has been in another—we have no longer to deal with an excess of light, but with its defect. And here comes in another beautiful optical method. For photographing spectra of stars, of course we want a spectroscope and a slit in the ordinary way, and what we have to do in order to get the best possible result, is to get it by reducing the part of the plate added on to the smallest possible extent. And while we reduce its exposure to the smallest possible extent, we use as large an instrument as we can, and then see that during the whole time the instrument is pointed to the star, that the light at the focus shall really be entering the slit. Now, it may be a familiar fact to most of you here, that if that exposure has to be, say for an hour, and some of Dr. Huggins's were for hours, no ordinary clock, controlled by electrical influences, will allow the image of any body to remain on slit or on a fine point for that time or anything like it. Dr. Huggins's method, therefore, was to use a Cassegrain reflector in an arrangement by means of which he could, with another telescope, observe the image of the star, and see whether it was on the slit or not; and if it varied however little from the slit, to bring it back at once to its proper line of duty. In that way you see the defect of light was battled with by the time of exposure. The more feeble your light, the longer the exposure; and that the longer exposure might be effective he wanted a process by which the light should be compelled during the whole time to pass through the slit, and through the system of prisms on to the photographic plate. Dr. Huggins has been good enough to allow me to show you to-night some of his beautiful photographs taken by this means, and I am sure you will be none the less glad to see them when I tell you that that part of the optical method which depended on keeping the image of the star on the slit for an hour together, was played not in all cases by Dr. Huggins, but very frequently by Mrs. Huggins.

This, in sum, is what we have learned of late years in spectrum photography in the case of a defect of light, and you see it is equivalent to what we have learned from Dr. Janssen, in the case of spectrum work, and ordinary work in fact when it is a question of excess of light.

But there are other things to do besides observing the spectra of these different heavenly bodies. We want to observe the heavenly bodies themselves. We want to see what they look like, and to know about them telescopically as well as spectroscopically. Now in this direction I have to refer to Mr. Common's photographs, which have recently been crowned, I am glad to say, by the Royal Astronomical Society by the award of their gold medal. The photographs of nebulæ and clusters which he has recently succeeded in bringing before us are just as valuable in their way, and are fully as important as a method of optical work, as those others to which I have just referred.

When we come to inquire into Mr. Common's work, we find that he is dealing, in some cases, with the very faint markings of nebulæ, and that some of his exposures have been upwards of an hour long; so that we may at once come to the conclusion that in his case also we are dealing with a defect of light. Now how does he get over it? You see there is a very great difference between using a spectroscope as Dr. Huggins did, and a slit; and using simply a photographic plate, as Mr. Common does, on which to receive an image. If we have our spectroscope, and the slit, if the image of the star does not fall fairly on the slit, it does not matter, except that you have to let the exposure go on for a longer time, because the image of the star must fall on the slit for a certain time to get a photograph. But Mr. Common's task was, so to speak, more heroic than that, because in his attempts to get images of nebulæ and clusters of stars, the nebulæ also of course including stars, it is a question absolutely of hit or miss. Dr. Huggins's star, if it were off the slit, did nobody any harm; but if Mr. Common wishes to take a photograph of a nebula with some stars in it, or of a cluster, if he cannot keep each star absolutely rigid on one point of the plate, it is perfectly certain we shall never get a photographic image, either of a nebula or of a star. Mr. Common therefore, having a clock perhaps no better and no worse than Dr. Huggins, was compelled to invent a new optical method or arrangement, and this is it. He has been so kind as to bring it here in order that you may see exactly what it is. In the photographs of spectra which you have seen on the screen, correction was made by altering the movement of the clock slightly, but Mr. Common, after a great deal of trial, found that that would not do; you must let the clock take its course, and you must get some other means of correction. What he did was this. On a plate which had two motions on the eye-piece of the telescope, you have separately first a photographic plate and then an eye-piece. Underneath the eye-piece is a piece of platinum supporting a system of cross wires, and then a system of rectangular screws by which, when you have once got the image of a star on the cross wires supported by the circle of platinum, you can keep that cross wire bisecting the image of a star for as long—in fact, as long as you can. Human effort probably would break down, generally in half an-hour; Mr. Common's human effort, I believe, has already extended to about an hour and a-half. You have then a fine delicate star, bisected by a still finer delicate web; your clock has to be going as well as it may, and your corrections are made by these two screws, with this important consequence, that if you can catch and keep your cross wire on your star in your eye-piece, you have kept the images of the stars absolutely rigid on the photograph plate which is beside the eye-piece.

In this way Mr. Common has obtained a photograph of the nebulæ in Orion. Of course we cannot determine the perfection of the method by the nebula, but we can determine it by the images of these smaller stars. This photograph was exposed for exactly one hour, that is to say, during sixty minutes, or sixty times sixty seconds, the eye-piece had to keep the image of some particular star (necessarily on one side of the photographic plate) by means of the two rectangular co-ordinates worked by the screws, exactly bisected by the fine cross wire, the cross wire being illuminated by a lamp.

This photograph I consider to be one of the greatest achievements of modern astronomy, and I have taken occasion elsewhere to say what I believe to be perfectly true, that if all the human efforts which have been directed, so to speak, to this group of nebulæ in Orion for two-and-a-half centuries were put in one scale, and this photograph were put in the other, it would weigh them down; in fact, that sixty minutes of nature are worth two-and-a half centuries of art. But that is not all. Not only has Mr. Common, by means of this photograph, shown us that his new method is good for taking a complete picture of that kind, but he has shown us that photography contains within itself, fortunately, the elements of its own correction. What do I mean? I mean that one of the points which now for 2½ centuries—for the work on the nebulæ of Orion began more than 2½ centuries ago—has occupied the minds of observers has been this. Does the nebula change, or does it not? And from their drawings astronomers have not been able really to determine whether there has been any change or not. Professor Holden, in one of the most voluminous and luminous and beautiful memoirs ever devoted to the consideration of one celestial object, a few months ago only, discussed every drawing which is extant, and his conclusion was that really you could not say from any one of those drawings whether the nebula was as it was first observed, or whether it had considerably changed. Now it will be obvious to everybody in a moment that by such photographs as these it will be quite easy to determine in one year, or one century, or a thousand years—art is long—if any change takes place. But we can do very much better than that. Mr. Common has shown that, by employing this method for different exposures, you have a perfect system of correcting the photographic record itself. If you change the salt of silver, which you use of course, you may change at any given time the picture you get. You may be using different kinds of light, and you may imagine a nebula of Orion painted by every wave length, you may get an entire belt of F light, G light, A light, *a* light, H^1 light, and so on; but without going into experiments on variation so far as wave lengths go, Mr. Common's method shows us that by a system which I have called a system of "contouring," to make things quite clear, you will be able in future times to get comparative results, quite independent or almost independent of the salt of silver which you employ. Let us see for instance, how Mr. Common has beautifully built up a nebula. We have here a photograph taken in one minute's exposure, one taken in 2½ minutes, one in 4 minutes, one in 10 minutes, one in 20, and then we have the one of 60 minutes exposure.

With an exposure of one minute we have nothing of the nebula, but we have simply a few of the brightest stars. That is the beautiful trapezium which has been a test object, time out of mind, for observers with small telescopes, and that beautiful line of three stars to the right. Now, passing to the one with 2½ mins. exposure we get them a little brightened: and just a little bit of the nebula round the brightest region. Now the 4 mins. photograph shows you some of the other stars coming out, which were not visible in the first photograph. The next brightens the nebula and also brightens the stars, and we have the nebula in full swing, so to speak. With the 20 mins. exposure it is again increased; and now with the 60 mins. we have the nebula in all its beauty. We have there established an absolute system of contouring, and that can go on quite independently of the telescope, independently of place; independently of everything except the salt of silver you employ.

There is one more photograph I wish to show you. You will see that this method is as good for clusters, as it is for nebulæ. This is not so good a photograph, the method has not worked quite so truly, but it will show us all how important it is for science that it should work well in subsequent cases. The stars should be quite round, and as a matter of fact they are a little elongated, but you see what an immense engine Mr. Common has placed us in possession of, if you take things as you find them; for an astronomer to measure a cluster of stars like that, and give the number of them, and the intensities is a matter which would take years; the photograph I suppose took, perhaps, thirty minutes.

These beautiful photographs have been taken by Mr. Common in a mirror with a 3 feet aperture. Now, if you were dealing with a mirror of 8 feet aperture, of course, we should be dealing with a quantity of light as 64 to 9, and as Mr. Common uses a flat, and as I have shown that a flat is not necessary, we may say practically that with an 8 feet telescope we get ten times more light, and, therefore, the exposure would be one-tenth, so that you see an exposure of sixty minutes would be reduced to six minutes, and, therefore, the labour of keeping the delicate star on the delicate cross wire would be reduced in the same proportion; further, with such a light grasping power as that to which I have referred, we may hope that some of the stars would give us absolutely instantaneous photographs, and if that were so, we might not only by this means get observations of spectra, but we might get observations of double stars. With regard to observations of double stars, there is just one point which may be argued, and it is this, Mr. Dawes, years ago, showed us that working gradually upwards from apertures of 1 inch to apertures of 30 inches, we enormously increased our separating power on double stars. For instance, he held that with an aperture of 1 in. we could only separate a double star with a distance of 4¼″; at 10 in. we could separate stars ½″ apart; and then he calculated that for 20 in. you could separate two stars ¼″ apart; 26 in., ·175″; 27 in., ·169′; and 30 in., ·152′; but what would that ·152′ become with an aperture of 96 in. We should get down to an exceedingly small fraction of a second indeed, and with a perfect mirror, and with Mr. Common's perfect system, I believe that the time will come when we shall get double star observations added, as a matter of course, to the observations which I have ventured to bring before you.

So that it comes to this, first with regard to the telescopic observations of the heavenly bodies, if we take the nebula of Orion as an example of them, we find that we have in this method certainly a better method than any eye method which the last two and a-half centuries has produced; that a system of contouring which we can apply in a few hours, will replace the work of months, and give us a record on which we can absolutely rely; while the work of months, and of years, and of centuries, has turned out to be absolutely unreliable, because it is human. In doing this, then, we establish nebula photometry, but we deal with stars in the field of the nebulæ. We must, therefore, deal with the photometry of stars in the field of the nebulæ, and if we can do that why should we be limited to that field;

why should we not take the average over the whole visible heavens, and bring star after star on the same plate, in the same way as has been suggested by Dr. Huggins and myself in other fields of work. It is absolutely unnecessary, so far as stellar photometry is concerned, that we should limit ourselves to any one nebula, or to any one hemisphere, and it is perfectly simple to get one photographic plate, and to put on it a dozen or twenty images of different stars which will give you, in terms of a certain salt of silver at one epoch, the different radiant energy of those stars for comparison in future time. Now, it is perfectly certain that if this is so, work like that is far superior to any work which any observer, however eminent, might accomplish, because the thing would be absolutely beyond all doubt, whereas one might doubt the observer. If we pass to spectroscopic work, the spectra might be chosen from every part of the sky, and you may have, as you have hypothetically for the intensities of the luminosities of the stars, the spectra of different stars culled, so to speak, from any part of the heavens you choose; and if you can get a dozen spectra of stars, culled from near or far regions of the heavens, on one photographic plate in a single night, is not that better than any work that one observer can do with that telescope? So that I would propose that, with this 8 ft. telescope, the observer should be absolutely abolished, that you should not allow the telescope's time to be wasted by being employed by an eye which can only see one thing at a time, and which after all may not be quite certain what it sees, or give rise to doubt when other eyes in future years come to examine what it has seen. This 8 ft. reflector I would make an instrument fitted only for such researches as those which Dr. Huggins and Mr. Common have shown us to be possible. I would then, by means of electro-magnets or what not—it is a perfectly simple thing to settle—get an arrangement by which a photographic plate could be sent up, capable of coming down again after a certain time, with ten, twenty, or thirty different images impressed upon it if you wished; if it came down with one photograph as good as those Mr. Common has enabled me to show you to-night, I, for one, should be perfectly content; but if you want quantity, it is quite easy to get it by lengthening your plate. Why do I insist upon this? For this reason, that the observatory is no longer necessary. This enormous instrument, with an 8 ft. aperture and 60 ft. focal length, can be sheltered by a hut costing £100, instead of being rendered useless by an observatory which would cost £40,000: and I, for one, believe that if we had such an instrument as that, made on such lines as I have indicated to-night—thanks to the specimens of work which Dr. Huggins and Mr. Common have allowed me to bring before you—one year's work with it would make the year's work with more expensive instruments absolutely ridiculous.

Then, to conclude, I refer to my text, and wish to bring pointedly before the Society of Arts the fact that this dream—this beautiful dream—lacks all chance of realisation at the present time for want of glass—for want of the applications of the arts to astronomical research.

A vote of thanks was passed unanimously to the lecturer.

Miscellaneous.

INTERNATIONAL HEALTH EXHIBITION.

REPORT ON PRESERVED VEGETABLES, FRUIT, AND MILK. By J. J. MANLEY, M.A.

The preservation of vegetables and fruit (using the ordinary nomenclature to distinguish between these commodities) was well represented at the Health Exhibition, and the different methods of preservation illustrated. The exclusion of atmospheric air from the vessels containing them is among these methods; and this was effected many years ago, by filling up the vessels containing the articles to be preserved with hot water or hot syrup. As long ago as 1807 Mr. Saddington obtained a premium from the Society of Arts for his method with hot water without sugar. He placed the fruit in a vessel of cold water, and heat was applied till it rose to the temperature of 160 to 170 degrees. After standing in this temperature for half an hour, the vessels were filled with boiling water to within an inch of the top, and then hermetically sealed. Fruit and vegetables are still so preserved, a little alum being generally added to the water in the vessel for the purpose of hardening the tender skin of the fruit. A process not very unlike the preceding is that which consists in the destruction of the oxygen air in the vessel by heating the substance in it. This was M. Appert's plan, who, in 1810, obtained the reward of 12,000 francs offered by the French Government for the best method of preserving food. In this process the vessels were wired and corked from the beginning, and kept so throughout. Another process was the artificial exhaustion of the air from the vessel. Various patents have been taken out to effect this, and in some cases arrangements were made for the admission of carbonic acid and other gases, or salt and water, or a warm solution of gelatine, into the vessel to supply the place of the exhausted air.

Vegetables are very successfully preserved by heat. Common kinds, such as carrots, turnips, onions, and parsneps, have been put up in large quantities for shipping purposes and exportation. It is to the French preservers, the disciples of M. Appert, that we look for the best productions in the higher classes. Beans, celery, spinach, artichokes, asparagus, and especially tomatoes, are so well preserved by the best French manufacturers, that though they lose somewhat of their flavour, they may be served by good cooks to the most critical company; while for soups, entrées, stews, and also for garnishing the tins of *macedoines* (mixed vegetables), are found most useful. But of all the vegetable preserves, the tinned peas hold the highest place. The best are preserved without any use of copper, their colour being retained, or rather restored, simply by a little spinach juice. At South Kensington, Messrs. D. A. McCorquodale and Co., of the Lochty Preserving Works, Carnoustie, N.B., exhibited carrots, onions, parsneps, and other vegetables preserved in tins. They were most excellent, and having been prepared in pure spring water, without the addition of anything whatever; many connoisseurs considered that their flavour was actually improved, the cause, probably, of this, being that the tins being pierced ("brogged") immediately after being taken out of the hot baths, as in the case of meat preservation, the air escapes, but the flavour and substance is retained by their being hermetically sealed up again. It is only within the last few days that newspaper correspondents in the Soudan have intimated that a large supply of such vegetables would be most acceptable "at the front."

The American preservers now send us, in tins, large quantities of preserved tomatoes, a vegetable (perhaps I should almost say "fruit") found, in some form or other, on the table at all meals across the Atlantic, but strangely neglected among ourselves. They are, perhaps, somewhat inferior in flavour to those produced in the South of France, but their cheapness should recommend them. From America we get, yearly, many thousands of tons of the various sweet products of Transatlantic gardens and orchards. In many parts of America, California, for instance, which seems likely to become "the garden of the world," fruit is a mere drug in the market, the supply of peaches, apricots, and pineapples, to say nothing of what we consider more common fruits, being unlimited.

The display of jams was, as might have been expected, very extensive; and one of the most attractive displays in the machinery in motion department was the admirable plant of Messrs. Pink and Sons, who showed the whole process of jam making with different fruits as they came into season. The products of this well-known firm are sufficient in themselves to recommend them to the public; but the method of production, as illustrated at South Kensington, will doubtless lead to a still further patronage of their most excellent preserves, to which have been awarded high honours. Among other jams most worthy of notice were those ("whole fruit") shown by Bloxall and Co., of 70, Lamb's Conduit-street, W.C.; and special attention should be called to their blackberry jam and jelly. Letters have recently appeared in more than one of our daily contemporaries reflecting on the general neglect of this "fruit" in many parts of the country. During a recent visit to Ireland I noticed that this neglect was very remarkable, no one apparently caring to take the trouble of gathering of the unusual abundance of these berries which hung exuberantly on every hedge, and on the brambles in the woods. In Yorkshire and Lancashire there is a great demand for them, and the poor gather them for the jam makers, who retail the preserve at about 6d. per lb., and seldom can obtain a sufficient supply of fruit to meet the demand for jam. It is more than probable that the bramble, if cultivated, would yield per acre a greater profit than any other fruit shrub or tree. The systematic cultivation of fruit for jam-making had attention directed to it by the display of the jams of Mr. T. W. Beach, who has in hand a fruit farm of some 500 acres, on the property of Lord Sudeley, at Toddington, in Gloucestershire. I regret that, not having had an opportunity of tasting the preserves, I am unable to speak personally as to their quality. The establishment, however, of such an enterprise may be taken as an augury of the future development of jam farms, in accordance with the advice given, not long ago, by Mr. Gladstone to the British farmer. Well made jam is a most wholesome and nutritive article of consumption.

The process of desiccation or drying is far better adapted to the preservation of vegetable than of animal substances. In this country, the first recorded patent for the preservation of vegetables by desiccation was granted in 1780 to John Graefer, who dipped his vegetables in boiling salt and water before drying them. In November, 1850, Masson obtained his patent for drying and compressing them, so that they were reduced to one-seventh of their original bulk, a cubic yard containing rations for 16,000 men. The French, with M. Cholet at their head, have been very successful in this line of preservation, which has been followed by several English firms. C. Prevet and Co., of 134, Fenchurch-street, E.C. (who have now succeeded to M. Cholet's business) had one of the most interesting shows in the Exhibition, comprising chiefly dried vegetables, either as "chips" or in a compressed form, the whole dried savoy cabbage being a marvellously good exhibit. These dried vegetables, and especially those compressed in tablets, have become indispensable to sportsmen in wild districts, and to all in camp or at sea, having been largely used in all campaigns all over the world, since the Crimean war down to the present Soudan expedition. Cholet's "Julienne," which is composed of no less than nine kinds of vegetables and seasoning herbs, according to the recipe of the late *chef*, A. Soyer, is a most useful and tasteful combination: and the condensed vegetable soups of the firm are in every respect most admirable productions. And it may not be out of place here to mention their compressed "Bologna meat," known by the name of "Mortadella," which is all that the most fastidious *gourmet* can desire. Another admirable vegetable preservation at South Kensington was Edward's desiccated potatoes, exhibited by F. King and Co., 6, Bishopsgate-avenue, E.C., which are easily converted into dishes of "mashed potato" without any loss of mineral salts and acid, as testified to in a Blue-book recently presented to Parliament, and containing a report of the committee on the outbreak of scurvy in the Arctic expedition, which shows the necessity of the potato element in diet. This preparation and the desiccated soups of the same firm were largely used in Mr. Stanley's African expeditions, and have been abundantly supplied to the troops on the Nile expedition. Considering the high price generally charged by greengrocers for vegetables, and the waste in utilising them in almost every household, all housekeepers, even the poor, would probably do well to turn their attention to dried vegetables, and experimentalise upon them. When soaked and carefully boiled, they will be found not only economical in their use, but excellent in soups and stews, and even for eating with roast or boiled meat in lieu of ordinary fresh vegetables.

A few words must be added in reference to preserved milk, as even brief reports on the preserved food exhibited at South Kensington would be incomplete without these, especially as preserved or condensed milk is now an established article of consumption in hundreds of thousands of households in this and other countries, notwithstanding the prejudice which existed against it on its first introdnction.

M. Appert—whose ingenuity and perseverance in the cause of food preservation has been already mentioned—recommended that milk should be boiled down to about half its bulk before putting it into bottles; and in 1847, Bekaert tried to improve the process by adding carbonate of soda to the milk. Later still, in the same year, Martin de Leignac, a Frenchman, obtained a patent for preserving milk by evaporating it to one-sixth of its bulk. This was probably the process which Mr. E. D. Moore, a medical man attached to our Court, adopted, and by which he produced concentrated milk, and also a combination of it with cocoa. In 1857, Mr. House, on the retirement of Mr. Moore, whose manager he had been, took up the business on an improved patent. He has continued to manufacture his article ever since with great success, though he has confined himself mainly to the shipping trade. It was from Mr. House, through a Captain Fletcher, that Mr. Gail Borden, of New York, got his idea, though he conducted his evaporation of the milk in closed vacuum pans, whereas Mr. House used open ones. It was with Mr. Borden's process, and perhaps with some improvements on it, that several American gentlemen established a milk preserving manufactory at Cham, in the canton of Zug, in 1866. The product of this manufactory has ever since been well known in the English market, and to the English public, as the "Anglo-Swiss milk," and has most deservedly established for itself a world-wide reputation, finding its way, as it does, to the very remotest countries, as well as being largely consumed among ourselves. In 1870, a company was established in this country under the name of the "English" or "Aylesbury Condensed Milk Company," and, being composed of some of the old members of the Anglo-Swiss Company, became, in a certain sense, rivals to it for public favour. Their first factory was established at Aylesbury, and they afterwards added another at Middlewich, in Cheshire, both of which I visited, in order to observe the process of milk condensing from beginning to end. Thus the English public had offered to them the two well-known brands, the "Milkmaid" of the Anglo-Swiss, and the "Lion" of the English company, to say nothing of one or two other brands, the products of other companies both abroad and in the United Kingdom. Eventually, however, the Anglo-Swiss Company acquired the business of the Aylesbury Company, with its factories at Aylesbury and Middlewich, in addition to which it has other manufactories both in this country and abroad.

The method of condensing and preserving the milk is substantially the same at all manufactories; and when all the conditions of successful manufacture are duly observed, the result is always satisfactory, and the products of the Anglo-Swiss Company and other recognised manufacturers can always be depended on. In the manufacture of condensed milk, the greater proportion of the original 80 to 85 per cent. of water is evaporated, but the casein, butter, or fat, and other solid and nutritive substances of the milk remain intact, in their original form. The colourless and almost tasteless stream which runs continuously from the condensing pans during the process of condensation is evidence that nothing but water is taken from the original milk. Thus we have an article which is in reality pure milk—not an article made *from* milk. It is hardly necessary to observe that it is next to impossible to adulterate condensed milk by adding any substance to it, except sugar, for the purpose of increasing bulk. The introduction of any foreign substance, for the purposes of adulteration, would at once defeat the one great object, namely, the preservation of the milk. The fact that a tin of the preserved milk may sometimes be found unsound is not to be attributed to any attempt to tamper with it in its manufacture, but to some undetected unsoundness in perhaps a very small portion of the milk delivered to the farmers; to a failure in some part of the condensing operation, which is a very delicate one; or to a flaw in the material of the tin itself. To object to the "tinned," or condensed, milk because it may be sometimes found bad, is not more reasonable than to object to ordinary milk because it is sometimes delivered sour. Baron Liebig, in his recorded analysis of the Swiss preserved milk, says:—"It consists of nothing but cow's milk and the best refined sugar, and possesses all the properties and qualities of a perfectly pure milk." Dr. Hassall, who made a very careful investigation into the matter, and watched the whole process of milk condensation at Aylesbury, from the receiving of the milk from the farmers till it was soldered up in small tins, said that "the milk used was the whole milk of the best and richest description;" and, referring to examinations made by him of condensed milk at different times, says:—"We have always found it to be both genuine and in a perfect state of preservation." It is in the power of anyone to test its genuineness without being a chemist. If sufficient water is added to the condensed milk to bring it back to its original state, *i.e.*, to re-establish the original proportion between the water and other constituents, cream will rise from it in the ordinary way; only it must be stood in open flat vessels, and not in high-class columns, called graduated test-tubes, because the sugar to some extent prevents the cream readily rising. Again, if the condensed milk, mixed with the proper proportion of water, be raised to a temperature of 70°, it will churn into butter like ordinary milk. These two simple tests will show that the condensed milk is real milk, and not an article made *from* milk.

The value of this milk for infants and children, especially during the prevalence of infantile diarrhœa, which in the opinion of the majority of medical men is to be attributed to the badness of the milk supplied to the poor in large centres of population, is greater than some suppose. Many medical men, and mothers who have had the courage to try the condensed milk for infants when the natural sources have failed, can bear testimony to the fact that infants will thrive well on the condensed milk for many months, without any other addition to their food; and I cannot help thinking that Mr. Edmund Owen, in his admirable lecture at the Health Exhibition, on the "Rearing of Hand-fed Infants," did injustice unconsciously to preserved milk as a food for them. In the first place I think it was unfair to class this milk as an "artificial milk," and incorrect to speak of it as "evaporated almost to dryness," which it is not; and in the second place to speak of it contemptuously as "soldered down in tin pots, sent on a long journey, and then stored for an indefinite time in the shop window of an oil and colourman," is not argument and teaching, coming though it does from so eminent an authority. If the article is sound when "put up" in the tin (in reality iron) pots, it does not matter a straw how long a journey it may take, even if it be to the North Pole, or the Antipodes, as long as the "tin pot" remains sound, nor whether it is "stored for an indefinite time in the shop-window of an oil and colourman," or in a private apotheca. "The proof of the pudding is in the eating," and in addition to the many instances which have come under my observation of the successful use of "tinned" milk as food for "hand-fed infants," I am in a position to state that one of my own children, now a healthy boy of fourteen, had nothing pass his lips from the age of five weeks to seven months but "tinned" milk and water. Dr. Cuibourt, of the French Academy of Medicine, says that cows' milk, with the addition of one-fifth of its weight of water, and a little sugar, is as nearly as possible the same as woman's milk, and has, moreover, the advantage of being a well-known substance, easy to be administered. It follows, therefore, that condensed milk, when diluted with seven to nine parts of water, scarcely differs from mothers' milk. It might be further added that condensed milk is even superior to cows' milk, from its uniformity. Being made from the combined milk of a large number of cows, practically it never varies in its quality and uniformity; hence it has an additional value as a food for infants, for, as is well known to physicians, the change from one cow's milk to another, even though both are excellent, disarranges the digestion of infants and young children.

The combinations of coffee and cocoa with the condensed milk, are very successful, and it is always handy for housekeepers to have tins of them in stock; while for sportsmen and travellers they are most useful companions.

But, of course, the above remarks apply only to the recognised "brands." Some recent cases of prosecution under the Food and Drugs Adulteration Act, in reference to the sale of condensed milk, show that some irregularities, to use a very mild term, exist in this business. Separated milk, *i.e.*, milk from which the cream has been taken by the now well-known "centrifugal-force" method, is certainly condensed and put up in tins, but when this is sold as condensed separated milk, and does not purport to be more than this, there is nothing to complain of. The brands of the recognised manufacturers of "pure condensed milk," *i.e.*, whole milk, can be depended on.

Ordinary preserved milk was shown at South Kensington by the Anglo-Scandinavian Condensed Milk Company, of Victoria Warehouses, Mansell-street, E.; the Swiss Alpine Milk Express Company, and by the Irish Company of Lansdowne, whose production I have always found most reliable. But the feature of the milk exhibits was the unsweetened preserved milk. This was shown by the Swiss Milk Company, represented by A Moos, of 84, Basinghall-street, E.C, its "Edelweiss" brand being put up in patent adjustable stoppered bottles; and by W. Müller, of 15, Abchurch-lane, who represented the Swiss Dairy Company, of Lucerne. The milk of the last-named company purports to be pure condensed milk, reduced to one-fourth its original volume, and preserved without the addition of sugar or any antiseptic chemical. Certainly no trace of salicylic acid, boracic acid, or any other chemicals used for the temporary preservation of ordinary milk can be found in it; nor can the addition of any foreign ingredient be detected on the most minute analysis. It is not improbable that the unsweetened form of condensed milk will supersede that to which we have been accustomed, especially for culinary purposes. For these it has been in constant use at the School of Cookery at the Exhibition.

In a brief survey like the present, of preserved food at South Kensington, it is impossible even to mention the majority of interesting exhibits; but in connection with preservation of food by "cold," I should wish to draw attention to the admirable dry air refrigerator and cold air chamber (Lightfoot), exhibited by Messrs. Siebe, Gorman & Co., of 187, Westminster-bridge-road, which is as practical as it is ingenious in its construction. Among the exhibits of tinned meat, I should certainly have mentioned that of McCall's Paysandu ox tongues, the annual sale of which reckons by hundreds of thousands. They are put up in South America, and are among the most successful of such productions. Another interesting exhibit was that of pemmican, by Messrs. Christy & Co., of 155, Fenchurch-street. This is dried meat in powder; and it is said that one pound of it, specially prepared by Dr. Bancroft, of Brisbane, is equal in nutritive power to four pounds of fresh beef.

Messrs. J. Moir and Son's exhibits embrace all these classes of preserved food, and consist of vegetables and fruits, cocoa and milk, and soups, and meats and game in tin and glass.

Several well-known firms of miscellaneous food preservers were conspicuous by their absence from South Kensington; and it is a matter for great regret that Messrs. Crosse and Blackwell, whose various productions cannot be excelled by those of any other house, were not represented.

Speaking of curries and chutnees, there was a large show of these in the Exhibition, especially in the Indian section; but Mr. Edmunds, of Stonefield-terrace, Liverpool-road, N., most deservedly obtained the Gold Medal in this section; in which another exhibitor, C. Wix and Sons, of Mitre-street, Aldgate, E.C., is entitled to the highest commendation, as all the productions of this firm are of the very best quality.

France, Japan, Venezuela, and some other foreign countries, notably Siam, contributed to the preserved food exhibits.

It is satisfactory to learn that, at a recent meeting of the Preserved Food Trades Section of the London Chamber of Commerce, it was resolved to appoint a vigilance committee, which should take cognisance of the selling of inferior tinned goods, and of the use of spurious and misleading labels on the tins and other vessels.

PLUMBERS' CONGRESS.

This Congress, in connection with the International Health Exhibition, was opened on Monday, 20th October, at the Technical School, South Kensington, under the presidency of Mr. George Shaw, Master of the Plumbers' Company.

Mr. Ernest Hart read a paper in support of the extension of the existing statute law as to house drainage in order to provide for the more efficient regulation and registration of plumbers.

The first subject for discussion was "The Technical Instruction of Plumbers," On this subject, Mr. W. Eassie, C.E., Mr. C. T. Mills, of the Technical College, Finsbury, Mr. J. W. Clarke, and Mr. E. G. Mawbey, read papers.

The following resolution was then passed:—"That, in the opinion of this Congress, it is desirable that in future architects should not include plumbers' work in builders' contracts."

The next subject discussed was "Apprenticeship, the duration and condition of indentures suited to the present state of the plumbing trade, and to the modern system of technical instruction." Mr. W. R. Maguire (Dublin), Mr. Frederick Fell (Worcester), and Mr. Smeaton, read papers.

Mr. Scott-Moncrieff thought that five years would be a good period, with perhaps another two years as a term of probation in other workshops. He moved: —"That, in the opinion of this Congress, it is desirable that the apprenticeship system should be continued, and modified, if necessary, to suit the improved course of technical education," This was seconded by Mr. Stolder, and agreed to.

The third question discussed was "The establishment of Metropolitan and Provincial Boards of Examiners of Plumbing Work." Mr. P. J. Davies and Mr. E. Knight read papers on this, after which the following resolution was carried:—"That this Congress is of opinion that in the event of the establishment of Provincial Boards of Examiners of plumbing work, such Boards (firstly) should be affiliated with a Metropolitan Board; (secondly), should consist chiefly of trained working plumbers; and (thirdly) should be in connexion with the provincial schools of plumbing."

The fourth subject was "The Registration of Journeymen Plumbers." Mr. R. Smith (Bermondsey), who read a paper, was opposed to the proposed registration, as it would open up a field for many abuses, and ultimately do great harm to the trade.

On the second day the following resolution was passed:—"That, in the opinion of this Congress, the registration of master plumbers and journeymen plumbers is expedient."

Mr. Webb read a paper on "The suitability of materials used in plumbing, and particularly of those materials recently introduced as substitutes for lead."

Mr. Buchan (Glasgow) read a paper on "The desirability of fixing upon a system by which uniformity in the quality of material used in plumbing may be insured."

After a paper on the same subject by Mr. Poole, of Norwood, the following resolution was passed:—"That the Congress is of opinion that it is expedient that the system of sealing or marking lead and solder of standard weight and quality be revived by the Plumbers' Company, and that the Plumbers' Company should be requested to consider whether the materials used in plumbers' work as substitutes for lead are suitable, and whether standards of quality for such materials could be advantageously fixed on and verified by a recognised mark."

Mr. F. Wells (Worcester) opened the question of "the formation of district associations of plumbers to investigate and secure, as far as possible, corrections of evils and abuses arising in connection with the trade."

After papers by Mr. Emptage and Mr. T. H. Court had been read, the following resolution was carried:—"That the resolutions and conclusions set forth in the preceding paper [by Mr. T. H. Court] be referred to the Plumbers' Guild, with a request that they will confer thereon, with a view to take such action as may seem best."

The Chairman, in summing up the work of the Congress, expressed the hope that it would result in the formation of a representative committee to carry out the recommendations and suggestions that had been made.

THE ANTWERP INTERNATIONAL EXHIBITION.

The public administrations of Belgium will, it is said, take an active part in this Exhibition; the necessary space has been reserved for the different Ministerial Departments, who will make their several arrangements as at the National Exhibition of Brussels in 1880. Owing to the great extension arrived at, the Belgian Commission has been increased from 400 to 1,100 members, to carry out the arrangements of the sub-committees. All the principal towns are making active preparations to have their separate industries properly represented. The outline of the Exhibition building begins to be perceptible at a distance with its entrance of 60 metres of height and its long avenues, the principal four central ones of 335 metres, and the others of 110 metres. The special pavilion of 1,000 square metres is being erected for the French Colonies. From the objects to be shown, and the style of its architecture and decoration, this will be a very attractive feature of the Exhibition.

Although Austria is much occupied with the approaching Exhibition at Buda-Pest, yet the various chambers of commerce are making strenuous exertions to have the empire well represented, and are voting large sums for the decoration of the Austrian section. A subscription has been set on foot to send workmen to visit the Exhibition, and the President of the Olmutz Chamber has headed the list with £100; the Prince Imperial Rodolph, and the Archduke Charles Louis are actively engaged in promoting the measures taken. The Marquis Maffie, Italian ambassador, and the Italian consul at Antwerp, have paid a visit of several hours to the building, to determine and arrange the site and decoration of the Italian section. A delegate of the Ministry of Commerce and Industry has been sent to the Turin Exhibition to select and arrange for objects to be sent to Antwerp.

The Minister of Marine at Lisbon has been instructed to subsidise for the transmission of objects from the Portuguese colonies, and 250 square metres has been taken for their display. A vessel of war has also been deputed to visit all their African settlements, to receive and bring over all objects, which will be sent free of charge to Antwerp.

The Brazilian Government has secured 300 metres, and the Committee of Agriculture and Commerce of Rio Janeiro is charged with the collection and transport of the objects.

The Antwerp Exhibition will differ somewhat from those of Paris, London, and Vienna, in having in view chiefly the promotion of the import and export trade, an important question at the present time, when so many industries are suffering.

MANUFACTURE OF PERSIAN CARPETS.

Consul General Benjamin, of Teheran, in his last report on the carpet manufacture of Persia, which he states is one of the most important features of the industries and commerce of the country, says that the carpets in question are rarely of large size, and they are woven chiefly by the women and children of the peasantry in the villages; thus a countryman will have a rug made in his own house, and when it is done, he takes it to the nearest town and sells it for what it will fetch. The rooms of the peasantry are small, and this may be given as the reason for the smallness of the rugs in the Persian market. Of late years, however, through European enterprise a very much larger carpet has been manufactured for the foreign market. The carpet industry is divided into three classes, the large-sized, and the small carpets or rugs, and the *ghilems*, to which may be added a fourth, consisting of the *umads*, or felt carpets. Most of the carpets intended for covering floors of whatever size, are produced in the central province of Irak, and chiefly at the city of Sultanabad, and in the districts of Sarravend, Garrouste, and Malahir. These carpets are known by the generic name of *pharaghan*. They are more solid and massive than other Persian carpets, and are adapted for rooms of large size. During the last ten years *pharaghan* fabrics have been exported in large and increasing quantities. Large Persian carpets, which deviate from the usual oblong shape, are made to order, and cost from three to four krans a square yard above the usual charge, the kran being equivalent to about elevenpence. This is partly owing to the increased difficulties of weaving such dimensions with the simple appliances in use, and the size of the rooms in the houses of the peasantry. Besides the *pharaghan* carpets, floors are also carpeted with fabrics from Kerwanshab, Hawadan, and the district of Lauristan, and for this purpose the carpets of Mech-Kabad, in Khorassan, are available, although they are of inferior texture to the *pharaghan*. The carpets of Kerwan have also the texture fitted to the rough usage required in floor coverings, but while of inferior quality to the *pharaghan*, they are always small and proportionately more expensive. There are numerous varieties of Persian rugs. In some classes, such as Turkowan, there is general similarity of design, although no two rugs are altogether identical. In other classes, such as the rugs of Kerwan, Dyochegan, or Kurdistan, there is endless variety in design and texture. The colours formerly used in the rugs of Persia were imperishable, and rugs one hundred years old show no deterioration in tint. The introduction of aniline dyes at one time threatened to ruin the manufacture of textile fabrics in Persia, but the law against the employment of these dyes enacted by the Persian Government is enforced with some vigour. The Turkoman rugs, which are in some respects unsurpassed for texture and beauty of design, are not within the Shah's dominions, although they are included among the classes of Persian rugs, as Turkomans until recently were under Persian rule. There is a description of rug called *ghileem*, which is largely made in the province of Kurdistan, and has the following peculiarity—the pattern is identical on both sides. The colours are at once firm and brilliant, and the designs often of extraordinary beauty. The lightness and flexibility of these carpets qualify them for *portières*, table and sofa covers, and at the same time render them easy for transportation; consequently a large sale is found for them in European countries. The *namâds*, or felt carpets of Persia, are made by forming a frame of the thickness required, or excavating a space in the ground-floor of the size and depth equivalent to the *namâd* intended. The hair is laid in this and beaten with mallets until the original disjointed mass is reduced to the dimensions of the frame, and a design of coloured threads is beaten into the upper surface. The best quality of *namâd* is made at Isfahân, but the most massive are produced at Yezd. Consul Benjamin says there is one species of rug peculiar to Persia, often spoken of, but rarely to be seen. This is the rug made of silk, though it is not uncommon to see rugs of the finer types with silken fringes, and sometimes with a woof of silk in the body of the rug. All silk rugs are, however, rare, and much more so than formerly. They are generally very small, and are not adapted for heavy use. The prices realised by this description of rug are sometimes very high, and Consul Benjamin speaks of one, which was used to hang over a tomb at Teheran, being valued at over £70, though the size did not exceed two square yards.

Correspondence.

SANITARY INSPECTION OF HOUSES.

Adverting to my letters in the *Journal* of the 26th of January and 16th February, 1883, on this subject, perhaps the relation of a little further experience, showing the inutility of irresponsible sanitary inspectors, may be useful. Finding that I could not live in the house I then occupied, I took another, in one of the most open and healthy districts in South-East London; this time subject to a sanitary inspection and certifieate. My new landlord not objecting, I went to an apparently high-class sanitary engineering company, paid the fee for inspection, and obtained a detailed report, showing what their engineer considered it was necessary should be done, when my landlord employed the same firm to carry it out, at a heavy cost, which he paid, and received a certificate that the house was then in a perfectly sanitary condition. On this I occupied it, but very soon found it was quite the reverse, upon which I telegraphed and wrote to the sanitary company, who, having received their money, took not the slightest notice; and so, as the matter was urgent, I was obliged to employ a series of plumbers and builders, from time to time, at my own expense, to effect partial remedies, until at last matters became so dangerously bad, that I was compelled to resort to another sanitary engineering company, whose superintendent discovered that the drains were improperly laid, not properly joined, and so otherwise defective, and leaking in many places; that the soil at the back and under the house was completely saturated with sewage, of which some cartloads were removed, and after a deal of misery and inconvenience, new drains were brought and properly laid, at a cost of nearly forty pounds, since which the house has been habitable. My object in relating all this is to point out as strongly as possible the absolute necessity for the appointment of properly qualified sanitary inspectors, duly examined and certified by the Local Government Board as responsible and competent men for the purpose, in accordance with the plan indicated by me in the letters referred to—only with this difference, that the officers in question should be appointed by and be responsible to that Board instead of any local authorities. Perhaps there could not be a more suitable class of men for such appointments than pensioned sergeants of the Royal Engineers, who already possess most of the necessary qualifications, and would require very little training. A word in regard to house drains. In my opinion, a plan of the basement and drainage arrangements of every house should be deeply engraved on a large smooth slate, which should be let into the wall (say in the scullery), so as to be seen by everyone. The cost would be a mere trifle, and the convenience great.

JOHN WM. WOOD, H.M.C S.

34, Great St. Helens, E.C.,
October 29th, 1884.

Notes on Books.

INTERNATIONAL HEALTH EXHIBITION — CONFERENCES. London: W. Clowes and Sons, 1884.

The publications of the Health Exhibition consist of handbooks, reports of conferences, and lectures. The various subjects connected with the objects of the Exhibition were discussed at conferences arranged by the different London scientific societies.

Dwellings of the Poor. Mansion-house Council on the Dwellings of the Poor. June 4, 5, 6.

The following questions are discussed in this volume :—The population of London and its migrations, the treatment of the London poor, overcrowding, suburban dwellings and cheap railway fares, the creation of a building fund, some difficulties and some defects of sanitary administration of the metropolis, and suggestions to the Royal Commissioners.

Domestic Sanitation. Society of Medical Officers of Health, Sanitary Institute, Parkes Museum of Hygiene. June 9 to 11.

Industrial diseases, the spread and notification of infectious diseases, disposal of the dead, and cremation, were dealt with at this conference.

Meat Supply. Central Chamber of Agriculture. June 18.

The sources of our meat supply, the causes which have checked the development of our home supply, the increased production of home-grown meat, and the means of securing the supply of meat to largely populated centres, were the titles of papers read and discussed.

Sanitary Legislation. Social Science Association. June 26, 27.

The papers in this volume refer to the progress of sanitary legislation, conditions essential for healthy dwellings, the employment of girls and women in workshops and factories, notification of infectious diseases, and legislation respecting the duties of medical officers of health.

Oral Instruction of the Deaf and Dumb. Association for the Oral Instruction of the Deaf and Dumb. June 30.

Electric Lighting in Relation to Health. Society of Telegraph Engineers and Electricians. July 4.

Sanitary Construction of Houses. Royal Institute of British Architects. July 10, 11, 12.

The opening paper deals with the subject as illustrated in London during the last 120 years, and among other subjects treated of is the hygienic value of colour in the dwelling.

Food Adulteration and Analysis. Institute of Chemistry. July 14, 15.

Meteorology in Relation to Health. Royal Meteorological Society. July 17, 18.

The subjects here discussed are English climatological stations, equinoctial gales, influence of occasional winds on health and cumulative temperature.

Epidemic Diseases. Epidemological Society of London. July 22.

Health in India, change of type of epidemic disease, leprosy in India, typhus fevers, and aspects of cholera are the subjects of this volume.

Water Supply and Distribution. Society of Arts. July 24, 25.

This is the same report of the Conference as was printed in the *Journal.*

Bee Keeping. British Bee Keepers' Association.

This volume consists of two papers and discussion upon them; the subjects being "Foul Brood, its Propagation and its Cure," and "Adulteration of Honey."

CHRISTMAS AND NEW YEAR CARDS. London: Hildesheimer & Faulkner, 41 Jewin-street, E.C.

It is to the late Sir Henry Cole that we owe the Christmas card. In the second volume of "Fifty Years of Public Work of Sir Henry Cole, K.C.B.," just published, the first Christmas card, which was designed by John C. Horsley, R.A., in 1845, and published at Felix Summerly's Home, Treasury Office, in 1846, is reproduced. It shows a jovial family party in the centre, and examples of the relief of the poor and sick at the two sides. The inscription is, "A Merry Christmas and a Happy New Year to you." In a note in the first volume of his autobiography, Sir Henry Cole says that he was informed by Mr. Blackwood, Secretary of the Post-office, that in the year 1881 "the estimated number of extra letters dealt with was 12,500,000. The number of extra sacks of letters received was 3,704. The extra number despatched was 4,700."

Messrs. Hildesheimer & Faulkner have produced a large number of cards of different designs for the coming Christmas, and their catalogue of these occupies some five and twenty pages. There are many varieties of screens, designed by Messrs. Albert Bowers, C. G. Noakes, A. & F. C. Price, B. D. Sigmund, and E. Wilson; studies of trees, by Mr. A. Glendinning, jun.; the Dream of Patience, by Miss Alice Havers. Floral designs are numerous, as also are specimens of landscapes, rustic cottages, and river scenery, and studies of children and animals are not overlooked. The artists who have produced the designs, in addition to those mentioned above, are Miss Eleanor Manley, Miss Helena Maguire, and Messsrs. E. Carrington, H. H. Couldery, E. B. Driver, W. Duffield, Fred. Hines, W. J. Hodgson, Reginald Jones, W. J. Muckley, E. G. Noakes, M. Page, F. Noel Paton, A. Ramsthorn, and C. A. Wilkinson.

General Notes.

The International Inventions Exhibition, London, 1885.—In consequence of a request from several foreign countries, the time for receiving foreign applications for space has been extended up to the 1st December. In the case of the United States, applications may be received up to the 31st December. It will, of course, be convenient that intending exhibitors should apply at an earlier date when possible. Between 4,000 and 5,000 applications have come in from British exhibitors.

School of Art Wood-carving.—The School of Art Wood-carving, at the Royal Albert Hall, in connection with the City and Guilds of London Institute for the Advancement of Technical Education, has re-opened for the winter session, with improved accommodation for pupils. Full particulars of the classes and the lessons by correspondence, also as to work executed in the school, can be had from the manager. The school has been awarded a silver medal in the Educational Section of the International Health Exhibition, and the following students also gained honours:—Miss M. E. Reeks, silver medal; Miss H. E. Wahab, bronze medal; Mr. D. Chisholm, bronze medal. The sehool also gained the highest award for wood-carving—a silver medal—at the Art Exhibition held in September last at Eastbourne.

Turin Exhibition.—A large number of persons still continue to visit the Exhibition, and especially those of the working class. It is estimated that on Sunday, 19th October, the number of arrivals by rail at the Turin station was upwards of 18,000, comprising the representatives of forty-three workmen's societies, the greater number of whom were brought by the lines of Genoa, Cuneo, Milan and Chieri. It was also a great field day for the steam tramways, which brought to Turin a large contingent from the neighbouring towns and villages. The official returns of the 19th inst. give the number of visitors on that day at 42,722. A gold medal has been awarded by the jury to Signor Michela, for his stenographic machine described in *Journal*, p. 1097. In consequence of the general desire of the public, the Executive Committee, at a meeting held on the 25th inst., have decided to extend the date for the closing of the Exhibition until the 15th November. The date for the ceremony to be held for the distribution of the medals awarded to the various exhibitors has not yet been definitely fixed.

Leaves of Trees.—In some recent investigations on the growth of leaves, Messrs. Zöller and Rissmüller have shown that while in early summer the leaves of plants contain very considerable amounts of nitrogen, phosphoric acid, and potash, these substances are withdrawn into the wood of the tree with the advancing season; so that before the leaves fade they have lost the larger part of what was most valuable in them, which the tree retains for its future use. In some of these investigations on the leaves of the beech tree it was shown that in their water-free substance the highest "per-centage amount" of nitrogen, phosphoric acid, and potash is found when they open or expand in the month of May, and this per-centage quite regularly decreases till they ripen and fall, but the "absolute" amount of nitrogen, phosphoric acid, and potash, is greatest in July, and from that time on decreases.

Copper in New South Wales.—The Great Cobar Company raised, during 1883, 19,000 tons of ore, and smelted 18,096 tons, producing 2,401 tons fine copper, value £158,464. The total quantity of ore raised by this Company, since it started in July, 1876, is 98,916 tons, which produced 13,388 tons of fine copper, valued at £858,464, and it is estimated that there is sufficient ore in sight to keep the mine in full work for the next 25 years. The deepest shaft in the mine is 552 ft., and the deepest level is 324 ft., and the width of the lode is 60 ft. From the Great Central Company's mine, 1,139 tons of ore, raised in 1883, made 187 tons of copper, value £8,700. Total ore raised since starting in April, 1882, was 1,551 tons; ore smelted, 1,148 tons. There are in this mine nine shafts, the deepest 120 ft. The deepest level is 120 ft., and the width of the lode is from 3 ins. to 11 ft. At the Nymagee Company's mine, 10,236 tons of ore was smelted in 1883, producing 1,714 tons of fine copper, value £96,000. The depth of deepest shaft is 390 ft.; deepest level, 310 ft.; width of lode, 3 ft. to 18 ft. The total quantity of ore smelted since the mine was started in 1880, is 23,007 tons, making 3,717 tons fine copper, value £236,100

Journal of the Society of Arts.

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FRIDAY, NOVEMBER 14, 1884.

All communications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and and Thirty-first Session of the Society will be held on Wednesday, the 19th November, when the Opening Address will be delivered by Sir Frederick Abel, C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting.

Candidates proposed for election as members are privileged to attend the opening meeting.

The following arrangements for the Wednesday evenings before Christmas have been made :—

November 19.—Opening Meeting of the Session. Address by Sir Frederick Abel, C.B., D.C.L., LL.D., F.R.S.

November 26.—"The International Health Exhibition." By Ernest Hart.

December 3.—"Electric Lighting in America." By W. H. Preece, F.R.S.

December 10. "Education at the International Health Exhibition." By J. G. Fitch, M.A.

December 17.—"Present and Prospective Sources of the Timber Supplies of Great Britain." By P. L. Simmonds.

At the meetings after Christmas, the following Papers (among others) will be read.

"The Employment of Hydraulic Machinery in Engineering Workshops." By Ralph H. Tweddell.

"The History and Manufacture of Playing Cards." By George Clulow.

"The Musical Scales of Various Nations." By A. J. Ellis, B.A., F.R.S.

Sea Fisheries." By Prof. E. Ray Lankester, M.A., F.R.S.

"The Preparation of Butterine." By Anton Jurgens.

"Labour and Wages in the United States." By D. Pidgeon.

"Recent Improvements in Coast Signals." By Sir J. N. Douglass.

"The Influence of Civilisation upon Eyesight." By R. Brudenell Carter, F.R.C.S.

"The Evolution of Machines." By Prof. H. S. Hele Shaw.

"Tempered Glass." By Frederick Siemens.

Foreign and Colonial Section.

The Meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock :—

January 27; February 24; March 17, 31; April 28; May 19.

Applied Chemistry and Physics Section.

The Meetings of this Section will take place on the following Thursday evenings, at Eight o'clock :—

February 12; March 12; April 23, 30; May 7, 28.

Indian Section.

The Meetings of this Section will take place on the following Friday evenings, at Eight o'clock :—

January 23; February 20; March 6, 20; April 17; May 15.

Cantor Lectures.

The First Course will be on "The Use of Coal Gas." By Harold B. Dixon, M.A.

December 1, 8, 15.

The Second Course will be on "Climate, and its relation to Health." By G. V. Poore, M.D.

January 12, 19, 26.

The Third Course will be on "The Distribution of Electricity." By Prof. George Forbes.

February 2, 9, 16.

The Fourth Course will be on "Artists' Colours." By J. M. Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London.

February 23; March 2.

The Fifth Course will be on "Carving and Furniture." By J. Hungerford Pollen.

March 9, 16, 23, 30.

The Sixth Course will be on "Photography
"A Marine Laboratory, as a means of improving

and the Spectroscope." By Capt. W. DE W. ABNEY, R.E., F.R.S.

April 20, 27.

The Seventh and concluding Course will be on "The Manufacture of Toilet Soaps." By C. R. ALDER WRIGHT, D.Sc., F.R.S., F.C.S.

May 4, 11, 18.

HOWARD LECTURES.

A Special Course of Lectures will be delivered under the Howard Trust, on "The Conversion of Heat into Useful Work." By W. ANDERSON, M.Inst.C.E.

November 27; December 4, 11; January 22, 29; February 5.

ADDITIONAL LECTURE.

On Tuesday, December 16th, at 4 p.m., B. W. RICHARDSON, M.A., M.D., F.R.S., will deliver a lecture on "The Painless Extinction of Life in the Lower Animals."

JUVENILE LECTURES.

The two Juvenile Lectures will be given on Wednesday evenings, December 31, 1884, and January 7, 1885. Special tickets will be issued for these lectures, due announcement of which will be made.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

ANNUAL GENERAL MEETING.

The Annual General Meeting will be held on Wednesday, June 24th, at Four o'clock.

Miscellaneous.

THE FORESTS OF RUSSIA.

In a report which has recently been made by Mr. Herbert, Secretary of Embassy at St. Petersburg, on Russian forests, it is stated to be a matter of extreme difficulty to determine even approximately the area covered by forests in Russia, but the area for European Russia, including Poland, has been set down by competent authorities at 177,286,000 dessiatines, the dessiatine being equivalent to a little over two acres. The latest returns, however, have shown that this is an under-estimate, and for the 435,788,457 dessiatines in European Russia, exclusive of Poland or Finland, about 183,700,000 dessiatines, or 42 per cent., is represented as being covered with trees and shrubs, but of this only 79 per cent., or 146,460,000 dessiatines, are capable of bearing forest trees, so that not 42 per cent., but nearly 33 per cent., of the total area of the country may be reckoned as forest land. As compared with this extent, Austria has 29 per cent. of her area, forest; Germany 26 per cent.; France 19 per cent.; Italy 18 per cent; and Turkey 14 per cent. This great store of wealth in Russia is very unevenly distributed over the whole country, some governments having forests to the extent of 50 per cent. of their total area, and others not so much as 3 per cent., and it may be said that in four governments three-fifths of the whole forest land of the country is concentrated, which leaves but two-fifths to the other forty-five governments. Dividing the Empire into seven zones, it would be found that the northern and eastern governments have 54 per cent. of their area forest; those governments adjacent to the Volga 23 per cent.; the governments in the centre of the Empire, 15 per cent.; the Baltic provinces, 16·8 per cent.; the North-Western provinces, 23 per cent.; the Ukraine, 14 per cent.; and the Steppe Governments, 1·3 per cent. Of the total area under forests, viz., 183,700,000 dessiatines, 122,944,000 belong to the Crown, but of this 99,000,000 dessiatines can be taken as productive forest land. In Poland, 787,514 dessiatines belong to the Crown. Up to the 1st January, 1882, 10,872,000 dessiatines of the Crown forests, or only 8 per cent., were under properly regulated forest control. In the North and North-Eastern provinces the Crown possesses 79 per cent. of the forests; in the Volga, 33 per cent.; in the Baltic provinces, 27 per cent.; in the North-West and Ukraine, 22 per cent.; and in the Steppe country, 15 per cent. According to the population, Russia has 2 dessiatines of forests per head of population; Austria has 0·47; Germany, 0·33; and France, 0·2. Owing to the climatic conditions of the Empire, a great variety of trees thrive in the forests of Russia. If a line be drawn from Orenburg towards the west, through the governments of Samara, Pensa, and Tamboff, as far as Tula, then to Charkoff, Kieff, to Volhynia, it may roughly be said that south of this line deciduous trees will be found to predominate, and coniferous trees to the north of it. The *Pinus Sylvestris* is the predominating forest tree, as far as 67° north latitude. It is to be found over two-thirds of the extent of Russia in Europe, predominating in the north, and found in the south only in isolated cases. It is found, however, as far as 70° north latitude, and towards the east as far as the Petchora, 66½° north latitude. The southern boundary where this species is found is at 44½°, but passing over the Steppes it is found again in the Caucasus, at from 41½° to 43° north latitude. *Abies excelsa* takes the second place, and in Finland is found as far north as 68¾°, and extends to the south as far as the north boundary of the black earth country; in the east the variety *Abies obovata* predominates. The larch (*Larix Europœa*) is only found in Poland. The Siberian larch is found throughout the governments of Olonetz, Nijni Novgorod, and the Ural as far as the River Sakmara (51¾° north latitude), and yields excellent wood for ship-building. The cedar reaches in the north-east to 64½°, and in the northern part of Orenburg to 51° north latitude, and in the governments of Perm and Volgoda are large forests of this tree whose cones are exported very largely. Of the deciduous trees the following are found:—The birch and its varieties; the oak, which is not found further north than St. Petersburg and South Finland; the aspen, which, like the birch, flourishes almost throughout the country; the lime tree, which is chiefly to be found in the governments of Volgoda, Perm, Kostroma, Kazan, and Simbirsk, and is employed in the bast manufactories, and in the making of matting which is largely exported; the red beech, which grows largely in Volhynia, Podolia, Bessarabia, and in the Crimea, and flourishes at heights varying from 1,500 to 4,000 feet above the level of the sea; the white beech, which is chiefly found in the south-west of the Empire, and also in the Caucasus and the Crimea, and in the neighbourhood of Kieff and Poltava it constitutes whole forests; the elm, ash, maple tree, alder, and willow are also found in their different varieties throughout the Empire, as also the wild apple, pear, and plum tree. In the northern provinces the cutting down of trees and sawing them into planks forms a very large and exceptionally profitable trade, and a very large population is employed in floating timber or barges laden with firewood, down the rivers to the ports of export or to places unable to supply themselves with wood. Thus Kostroma, Yaroslav, Nijni-Novgorod, Kazan, and Viatka supply building timber for the Volga, and its lower tributaries down even as far as the Steppes of the Don. The principal use that the logs floated down the rivers as rafts or sawn into planks are put to in Russia, is that of house building, for which purpose it is reckoned that 30,000,000 cubic feet are annually used. According to Professor Stieda, out of 1,820,000 inhabited houses in the central agriculturial districts, that is in the governments of Riazan, Tula, Kaluga, Orel, Kursk, Voronetz Tamboff, and Pensa, only 74,000 are built with stone and mortar, and in the manufacturing districts, in the governments of Moscow, Tver, Yaroslav, Kostroma, Nijni-Novgorod, and Vladimir, out of 1,400,000 inhabited houses only 6,800 are built of stone. The amount of wood delivered from the forests of the Crown amounted in 1880 to 727,000,000 cubic feet, and the income accruing to the Crown from these forests for the same period exceed 13,600,000 roubles, or £2,100,000. Although the income from the forests has increased considerably, about 50 per cent. of the gross income is required to cover the expenses of administration, &c. In 1866, they were set down at 1,575,000 roubles, but in 1878 they had increased to 5,054,368 roubles. The organisation of the forest administration is as follows:—The Forestry Department, under the Ministry of Domains, has the management of all Crown forests, excepting those in the Caucasus, which are placed under the control of the Governor-General; those in the country of the Cossacks, under the War Ministry; those belonging to the Government works and mines, under the Finance Ministry; those situated in Finland, under the control of the Finnish Government; and those forming part of the Imperial appanage which are placed under the control of the Ministry of the Imperial Court. At the central administration there is a director, vice-director, eight heads of department, and 192 vice-inspectors, controllers, and valuers.

Correspondence.

PRESERVED MILK.

The lecturer on the rearing of hand-fed infants at the International Health Exhibition writes with respect to the remarks on his lecture in the report on preserved milk at the Exhibition (see *ante*, p. 1131):—"At the hospital for sick children, Great Ormond-street, amongst the little out-patients, I found that the most miserable, the most rickety, and the children with the most irritable stomachs, were those reared on lacteal jam—condensed milk. The fact of your reviewer having reared a healthy boy on condensed milk, though very much to his credit, does not affect my opinion, which is strongly this—the best substitute for mother's milk is cows' milk, freely diluted with hot water, with sugar and salt added, as the lecture suggests. It is very essential for infants that their food be fresh. With all respect to your reviewer, his statement that 'condensed milk, when diluted with seven to nine parts of water, scarcely differs from mother's milk,' though satisfactory to the analytical chemist, should not be so to the hygienist. The analytical chemist would be able to discover no difference between Gladstone claret and Chateau Lafitte (1868); to his tests, one 'scarcely differs' from the other; but I apprehend that your reviewer's son, though only fourteen, would say that they were not quite the same thing."

General Notes.

Antwerp International Exhibition, 1885.—The Lords of the Committee of Council on Education have received information through the Secretary of State for Foreign Affairs, that the Executive Committee of the Antwerp Exhibition have decided to extend the time for receiving applications for space to Saturday, the 15th November.

Alexandra Palace.—An International Exhibition is to be held at the Alexandra Palace next year, commencing about the 31st of March next, and remaining open for six months. It is proposed that ten per cent. of the gross receipts from admission money shall be set apart for distribution amongst the principal London hospitals. For this purpose a committee has been appointed, with Colonel Sir Herbert Sandford, R.A., as chairman, and Admiral Sir Edward Inglefield, C.B., as vice-chairman.

Paris Exhibition, 1885.—The International Exhibition of Manufactures and Processes (*Exposition du Travail*) will be opened on the 23rd July, closing on the 23rd November, next year. The Exhibition is under the patronage of the Minister of Commerce, the Minister of Public Instruction and Fine Arts, and the Minister of Public Works. It will be held at the Palais de l'Industrie, Champs Elysées, and is to include a Science Annexe and a Fine Art Annexe. The London Offices are at 1, Castle-street, Holborn where applications for the remaining available space, and all communications from British exhibitors, should be addressed to Mr. Edmund Johnson, *Commissaire Delégué.*

New Orleans International Exhibition.—Mr. de Fonblanque, Her Majesty's Consul at New Orleans and British Commissioner for the Exhibition, in a despatch to Lord Granville, has drawn special attention to the advantages likely to accrue to British manufacturers exhibiting. He writes:—"I do not think that any important efforts have been made of late years to encourage British trade in this city and the district of which it is the distributing centre. Owing to its French origin, and the number of its inhabitants of continental birth, it became committed to other markets than our own, and thus it remains. Most of the British firms here are exporters only, so that there is no natural inlet for British goods to compete (as I flatter myself they could do successfully) with French and German articles liable to similar duties. There is a superstition abroad, even amongst otherwise well-informed persons, that we cannot produce fine or fashionable goods, or objects of art." M. de Fonblanque further states that although the Exposition may open in the first week of December, it cannot possibly be in order till February, 1885, when the larger number of visitors will begin to arrive.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 17...London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The French Revolution." (Lecture I.)

Tuesday, Nov. 18...Civil Engineers, Great George-street, S.W., 8 p.m. Discussion on A. Jamieson's paper, "Electric Lighting for Ships."

Statistical, Royal School of Mines, Jermyn-street, S.W., 7¾ p.m. Sir Rawson W. Rawson, President's Inaugural Address.

Wednesday, Nov. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Frederick Abel, Chairman's Opening Address.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Hugo Leupold, "A New Method of Reading the Direction of the Wind on Exposed Heights and from a Distance." 2. A. N. Pearson, "Description of a Component Anemograph." 3. C. C. Walker, "The Injury by Lightning (April 28th, 1884) to the Monument to the first Duke of Sutherland at Lilleshall, Shropshire." 4. Col. the Hon. A. Parnell, "The Mechanical Characteristics of Lightning Strokes."

Geological, Burlington-house, S.W., 8 p.m. 1. Sir R. Owen, "Note on the Resemblance of the Upper Molar Teeth of an Eocene Mammal (*Neoplagiaulax*, Lemoine) to those of the *Tritylodon*." 2. A. T. Metcalfe, "The Discovery in one of the Bone-caves of Creswell Crags of a portion of the Upper Jaw of *Elephas primigenius*, containing, *in situ*, the First and Second Milk-molars (right side)." 3. Sir R. Owen, "Notes on the Remains of *Elephas primigenius* from the Creswell Bone-cave." 4. E. A. Walford, "The Stratigraphical Positions of the Trigoniæ of the Lower Jurassic Beds of North Oxfordshire and adjacent districts."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. C. H. Compton, "The Roman Bridge recently Discovered in the River Trent." 2. C. Lynam, "The Excavation of Hulton Abbey."

Thursday, Nov. 20...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. E. H. Holmes, "Remarks on Cinchona Ledgeriana as a Species." 2. H. L. Rott, "Notes on the Habits of Australian Hymenoptera." 3. C. B. Clarke, "Botanical Notes from Darjeeling to Tonglo and Sundukphoo."

Chemical, Burlington-house, W., 8 p.m. Ballot for the election of Fellows. 1. Dr. Bomanji Sorabji, "Some New Paraffins." 2. Drs. F. R. Japp and N. H. Miller, "Additive and Condensation Compounds of Di-ketones with Ketones." 3. Dr. W. Ramsay and Sydney Young, "A New Method of determining the Vapour Pressure of Solids and Liquids." 4. Dr. L. Dobbin and Orme Masson, "The Action of the Halogeus on the Salts of Trimethysulphine." 5. S. U. Pickering, "Notes on the Sulphates of Potassium and Lithium." 6. Dr. A. B. Griffiths, "Researches on the application of Iron Sulphate in Agriculture."

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The French Revolution." (Lecture I.)

Friday, Nov. 21...Philological, University College, W.C., 8 p.m. Whitley Stokes, "The Neo-Keltic Verb Substantive."

Saturday, Nov. 22...Physical, Science Schools, South Kensington, S.W., 3 p.m. A. M. Worthington, "Note on a Point in the Theory of Pendent Drops, and on a Capillary Multiplier."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year.

TRANSACTIONS, &c.

Aeronautical Society, Annual Report.
Amateur Mechanical Society, Journal.
American Chemical Society, Journal.
American Philosophical Society, Transactions.
American Society of Civil Engineers, Transactions.
Art Union of London, Report.
Bath and West of England Society, Journal.
Bayerische Dampfkessel-Revisions-Verein, Bayerisches Industrie-und-Gewerbeblatt.
British Association for the Advancement of Science, Report.
British Horological Institute, Journal.
Chemical Society, Journal.
Chemico-Agricultural Society of Ulster, Journal.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Gas Institute, Transactions.
Geological Society, Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
Index Society, Publications.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Liverpool Polytechnic Society, Journal.
Lyons, Société des Sciences Industrielles, Annales.
Manchester Literary and Philosophical Society, Memoirs.
Manchester Steam Users' Association, Monthly Report.
Musée de l'Industrie de Belgique, Bulletin.
Musical Association, Proceedings.
National Association for the Promotion of Social Science, Sessional Proceedings.
National Indian Association, Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia Engineers Club Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Report.
Royal Geographical Society, Proceedings and Journal.
Royal Institute of British Architects, Proceedings.
Royal Institution, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, The Life Boat.
Royal Scottish Society of Arts, Transactions.
Royal Society, Proceedings and Philosophical Transactions.
Royal Society of Edinburgh, Proceedings.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Nationale d'Acclimatation de France, Bulletin Mensuel.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Transactions and Proceedings.
Society of Chemical Industry, Journal.
Society of Engineers, Transactions.
Society of Telegraph Engineers, Journal.
South Wales Institute of Engineers, Proceedings.
Statistical Society, Journal.
Victoria Institute, Journal.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Commissioners' of Patents Journal.

Weekly.

Agricultural Gazette.
American Architect and Building News.
American Gas Light Journal.
American Pottery and Glassware Reporter.
Architect.
Athenæum.
Bradstreet's.
British Architect and Northern Engineer.
British Journal of Photography.
British Mercantile Gazette.
Builder.
Builders' Weekly Reporter.
Building and Engineering Times.
Building News.
Chemical News.
Chemiker-Zeitung.
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Draper.
Electrician.
Electricité, L'.
Empire.
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Journal d'Hygiène.
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Season, Lady's Illustrated Magazine.
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