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SUPPLEMENT

TO

DR. URE'S

DICTIONARY OF ARTS, MANUFACTURES, AND MINES.

London:
Printed by A. Spottiswoode,
New-Street-Square.

RECENT IMPROVEMENTS

IN

ARTS, MANUFACTURES,

AND

MINES:

BEING THE

SECOND EDITION OF A SUPPLEMENT

TO THE

THIRD EDITION OF HIS DICTIONARY,

BY

ANDREW URE, M.D.

F.R.S. M.G.S. M.A.S. LOND.; M. ACAD. N.S. PHILAD.; S. PH. SOC. N. GERM.
HANOV.; MULH. ETC. ETC.

LONDON:
PRINTED FOR
LONGMAN, BROWN, GREEN, AND LONGMANS,
PATERNOSTER-ROW.
1845.

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PREFACE

TO THE SECOND EDITION.

Having been unexpectedly called upon by my publishers, at the end of about three months after the appearance of this Supplement, to revise and improve it immediately for a fresh edition, as the whole impression had been sold off, I have used all diligence in the brief period allowed me, to make such emendations as seemed most beneficial and consonant to the spirit of the work. The present additions are given in the second Appendix. No exertions on my part can adequately recompense the public for the favour bestowed on this humble compilation; nor can words duly express the gratitude which I feel. By an auspicious coincidence, if it be nothing more, the sentiments, and almost the language used by me in the preface to this Supplement, written about the middle of last October, in portraying the dwarfish and rickety condition of the glass manufactures of this kingdom, under the swaddling-bands of the excise, have been employed by our prime minister, in his masterly speech on the 14th February, on presenting his Budget to the House of Commons. The views therein developed by Sir Robert Peel are worthy of a great statesman, and give promise of the dawn of a wiser and more liberal legislation for this manufacturing empire, which, rightly administered, would be the workshop of the world.

"Your export of earthenware was last year," said he, "double that of glass; it was to the value of 751,000*l.*; but the export of glass, subject, as I have said, to the duty, and the constant, vigilant, and annoying interference with the manufacturer, in order that it may be collected, was only to the extent of 388,000*l.* I am about to state another important fact in regard to glass; there is no excise duty on glass, in France, Belgium, or Bohemia; and what was the consequence? That in Bohemia, in particular, the manufacture by the application of the chemical arts, has been brought to a state of admirable perfection. There, glass under the application of the most beautiful chemical principles, is exposed at different stages to various degrees of heat, and thereby contracts a diversity of colours that produce the most beautiful effects. We have peculiar facilities for accomplishing the same ends; we command the alkali and the coal, and yet we cannot compete with foreigners in the manufacture of glass. There is a great import of foreign glass into the bonded warehouses of this country, to be afterwards exported, and it is now beating our own manufacture, not only in foreign markets, but even in the markets of our own colonies. If you permit this article to be free of duty, it is difficult to foresee, in the first place, to what perfection this beautiful fabric may not be brought; and, secondly, it is impossible to say to what new purposes glass, manufactured by our skill and capital, may not be applied. I have read in a French newspaper, the *Courrier de l'Europe*, within the last month, that in France they are now manufacturing glass pipes for the conveyance of water, which cost nearly 30 per cent. less than pipes manufactured of iron, and which will bear a greater external pressure than iron pipes. They are luted together by a species of bitumen, and as far as health is concerned for the conveyance of water, glass pipes are greatly entitled to the preference. It is to be borne in mind, that the cost of collecting the duty on flint glass is not less than 57 per cent. In order to prevent fraud, it is necessary that you should have a series of most minute and troublesome regulations as to the melting of glass; notice must be given to the excise officers respecting annealing and other parts of the process, which so encumber it as to make the application of additional skill and ingenuity almost impossible. My belief is, that with this change, if we do not supply almost the whole world with glass, we shall at least be able to enter into competition with other nations, who have hitherto had the benefit of that supply."*

These forcible observations constitute a justifying commentary upon the remarks on the excise nuisance of our manufactures, hazarded by me four months before. The slight technical mistakes in Sir Robert's statement, it would be ungenerous in a chemist to criticise, after the above splendid eulogium pronounced on his magic art.

> " Verum ubi plura nitent in carmine, non ego paucis
> Offendar maculis."

The Bohemian glass owes its rich diversity of colours not so much to alternations of temperature, as to the skilful use of a diversity of metallic oxides. Water pipes are not, generally speaking, endangered by external, but by internal pressure; and if iron pipes be found in France not so strong or so wholesome for the conveyance of water as glass pipes, the fact proves French iron to be still weaker and more impure than even we knew it to be. English cast-iron pipes are at least 152 times more cohesive, or more capable of resisting pressure, than glass pipes, as has been proved by the concurring experiments of Tredgold, Professor Robison, and George Rennie, Esq., F.R.S.†

I hope and pray that Sir Robert Peel will go onwards in the career, glorious for a statesman, of emancipating the industry of this kingdom from the shackles fastened upon it for many years by class legislation; that purblind policy of the land Lords, pursued under the notion that in evading the direct and simple operation of a property-tax, and throwing the onus of taxation on the whole consumers of our manufactures at

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* Hansard's Parliamentary Debates, 1845. No. III., p. 490.
† Philosophical Magazine, Vol. I., and Philosophical Transactions for 1818.

home and abroad, they were not counteracting the prosperity of the state, and of consequence their own well-being, as the most considerable members of it.

There is a second manufacture, of great interest to the health and comfort of the people of this country, which stands much in need of the minister's untrammelling hand; namely, that of soap; a manufacture for which, in an export point of view, this country possesses peculiar facilities, in the boundless productiveness of its alkali works. It is remarkable, that the consumption of this necessary of civilised life has not increased with the increasing wealth and commerce of the country; that the quantity used by the manufacturers of silk, linen, and wool has not increased in proportion to the progress of these manufactures; that the export trade is in a ruinous state; that the duty is from 40 to 50 per cent. on the prime cost; that one fourth (240,119*l.*) of the whole amount collected is returned in drawbacks; and, finally, that another large proportion of that amount is wasted for the treasury in the costs of collection, in maintaining the immense army of officers required to watch and stand guard over each trader.

London, 13. Charlotte Street, Bedford Square,
26th March, 1845.

PREFACE

TO THE FIRST EDITION.

In laying this Supplement to my Dictionary of Arts, Manufactures, and Mines before the world, while I gratefully acknowledge the indulgence with which that work has been received, may I be permitted to advert very briefly to some of my present endeavours to render it less undeserving of public favour, though, after all my efforts, it will by no means realise either my own wishes and intentions, or the expectations of all my readers?

To investigate thoroughly any single branch of art, we should examine it in its origin, objects, connexion with kindred arts, its progressive advancement, latest improved state, and theoretical perfection. The general principles on which it is founded, whether belonging to the mechanical, the physical, the chemical sciences, or to natural history, should be fully expounded, and tested by an application to its practical working on the great scale. The maximum effect of the machinery which it employs, and the maximum product of the chemical mixtures and operations which it involves, should in every case be calculated and compared with the actual results.

Such have been my motives in the numerous consultations I have had with manufacturers relatively to the establishment or amelioration of their factories, and when they are kept steadily in view, they seldom fail to disclose whatever is erroneous or defective, and thereby to lead to improvement. It will not be denied by any one conversant with the productive arts, that very few of them have been either cultivated or described in this spirit. It is to be hoped, however, that the period is not remote, under the intellectual excitement and emulation now so prevalent in a peaceful world, when manufactories will be erected, and conducted upon the most rational and economical principles, for the common benefit of mankind. Meanwhile it is the duty of every professor of practical science to contribute his mite towards this desirable consummation.

It is under a sense of this responsibility that I have written the leading articles of this Supplement, having enjoyed some peculiar advantages in my profession for making the requisite researches and comparisons. I trust that not many of them deserve to be regarded as trite compilations or as frivolous novelties, with the exception of a few of the notices of recent patents, which I have intentionally exhibited as beacons to deter from treacherous quicksands, not as lights to friendly havens. I have sought sincerely to make them all conducive, more or less, to utility;

being either new contributions to the old stock of knowledge, or additions and corrections to the miscellaneous volume, of which the present is the sequel.

ARROW ROOT is here for the first time treated as a well organised manufacture, in conformity with my quondam definition; "Manufacture is a word which, in the vicissitude of language, has come to signify the reverse of its intrinsic meaning, for it now denotes every extensive product of art which is made by machinery, with little or no aid of the human hand; so that the most perfect manufacture is that which dispenses entirely with *manual* labour.*

Arrow root being the purest and most agreeable variety of *fecula*, and therefore one of the most powerful nutriments, deserves more attention from the colonial planter than it seems hitherto to have received. As it has been now so judiciously prepared in the island of St. Vincent, by the proprietor of the Hopewell estate, it will, I hope, amply repay his enterprising and liberal spirit, seeing that he supplies us with an article equal if not superior to the best from Bermudas, at two thirds of the price.

To ARTESIAN WELLS an interesting notice has been added of the successful labours of MM. Arago and Malot at Grenelle, near Paris.

I doubt not that should cockneys happen to read what is here said of BAVARIAN BEER, they will feel no little surprise, mixed with scorn and incredulity, when told that the mystery of brewing is more philosophically studied and incomparably better understood in Munich than in London, and indeed throughout all Bavaria, than in Old England; but such is certainly the fact, as every delicate stomach will experience which is cheered with the beverage of the former capital, and loaded with the *heavy-wet* of the latter. The brief outline here offered to my readers has been carefully drawn from the best sources of information, obtained during several excursions into Germany. It will, I hope, induce the brewers of this country to set more value on chemical science than they have heretofore done, and thereby eventually lead to *a radical reform* of our colossal establishments for extracting from malt a beverage more akin to that of fermented grape-juice, in its freedom from vinegar and gluten, so abundant now in the greater part of the British porters and beers.

Under BISCUITS will be found a complete description, with figures, of the grand automatic bakeries of Deptford and Portsmouth, which provide our hardy tars with the staff of life in the soundest state.

The perusal of the article BREAD will prompt the wish that our land-holding legislators would consent to let the people under their domination get, at a moderate cost, some of the wheat of southern Europe, much richer than that of our average home growth in the azotised glutinous principle, so essential to the formation of our blood and muscles; a wheat adapted to make a superior bread, such as that called *pain du gruau*, in Paris, and also a superior macaroni, like the Neapolitan. In this department of industry, so important for the welfare of

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* "Philosophy of Manufactures," page 1.

the population, the French have set us the example of applying to it the economical resources of the factory system, having organised a self-acting bakery, in which bread of the finest quality is made on the great scale, in smokeless ovens of a nicely regulated temperature. Meanwhile, the mass of her Majesty's subjects are dependent for their bread upon a multitude of tradesmen of slender means, who earn a scanty livelihood by hard labour, and who work up a weak inferior flour into a bad bread, which they are too often tempted to whiten with alum and other unwholesome drugs. The penalty liable to be inflicted upon bakers for having alum on their premises, is commonly evaded by letting it be added to the flour in the mill. Why do not our wise legislators enact a law for the summary conviction and punishment of a baker selling bread with alum in it; a saline compound most easily detected by chemical analysis?

I was lately called upon professionally to examine the very white bread of a fashionable baker of high pretensions, and found it to contain a notable quantity of alum; so much so, as to have been directly offensive to the stomachs, and hurtful to the health of several individuals in the family using it. This is no solitary case, but is, I believe, that of a large proportion of the bakers in London and suburbs, who operate upon a partially damaged flour, as one may easily surmise from the disagreeable odour exhaled from the hot loaves in too many of their shops. Yet what individual will be Quixotic enough to attack the numerous and ever changing arms of this Briareus? Who would choose to incur the trouble, responsibility, and expense of prosecuting a frequent misdemeanour of this kind, relatively to which the want of fine wheat in the market is a principal motive and apology?

From these evils our grandees are exempt, as they bake their bread at home of the best materials. Though they are apparently regardless of the injury suffered by the public from this source, they are, however, quite alert in the execution of the game and excise laws, the stringent penalties of which are inexorably inflicted against petty transgressors, exposed to temptations often too strong for the infirmity of human nature to resist.

In every well governed state of continental Europe there exists a Board of Health, or *Conseil de Salubrité*, composed of eminent physicians, chemists, and engineers, appointed to watch over whatever may affect injuriously the public health and comfort. In France, this commission consists, for the capital, of seven members, who have the surveillance, in this respect, of markets, factories, places of public amusement, bakeries, shambles, secret medicines, &c. This tribunal has discharged its functions to the entire satisfaction of their fellow citizens, as appears from the following authentic report:—"*Non seulement une foule de causes d'insalubrité disparurent, mais beaucoup de moyens, de procédés nouveaux furent proposés pour assainir les Arts et les Métiers, qui jusque là avaient paru inséparables de ces causes d'insalubrité; la plûpart de ces moyens eurent un plein succès. Il n'y a pas d'exemple que les membres du Conseil appelés à donner leur avis sur des plaintes* *formées contre des fabriques, aient jamais répondu qu'il fallait les supprimer sans avoir cherché eux-mêmes à aplanir les difficultés, que présentait aux fabricants, l'assainissement de leur art, et presque toujours ils sont parvenu à resoudre le problème. Le Conseil de Salubrité, que l'on ne saurait trop signaler à la reconnaissance de publique, est une institution que les nations étrangères admirent, et s'efforceront d'imiter sans doute.*"*

From this confident hope of emulation by other nations, the author of these excellent observations would have excepted the United Kingdom, had he known how little paternal care is felt by the government for the general interests of the people. In Germany, indeed, where the *fatherland* feeling is strong in the breasts even of those rulers whom we are apt to consider despots, similar boards of health are universally established, whereas our legislative oligarchy frames laws chiefly for the benefit of its own class and dependents; as happened in the old time, when there was no king in Israel to regard alike the interests of the poor and the rich.

The Prussian municipal law (*Allgemeine Landrecht*) contains the following enactments with regard to the sale of spoiled or adulterated victuals. Th. II. Tit. 20.; Abschnitt 11.; §§ 722 to 725. "No person shall knowingly sell or communicate to other persons for their use, articles of food or drink which possess properties prejudicial to health, under a penalty of fine or bodily punishment. Whosoever adulterates any such victuals in any manner prejudicial to health, or mixes them with unwholesome materials, especially by adding any preparation of lead to liquors, shall, according to the circumstances of the case, and the degree of danger to health, be liable to imprisonment in a correction-house, or in a fortress, during a period varying from one to three years. Besides this punishment, those who are found guilty of knowingly selling victuals which are damaged or spoiled (*verdorbener*), or mixed with deleterious additions, shall be rendered incapable for ever of carrying on the same branch of business. The articles in question shall be destroyed, if incorrigibly bad, but if otherwise, they are to be improved as far as possible at the cost of the culprit, and then confiscated for the benefit of the poor. Further, whosoever mixes victuals or other goods with foreign materials, for the purpose of increasing their weight or bulk, or their seeming good qualities, in a deceitful manner, shall be punished as a swindler."

It is singular how, amid the law-making mania which has actuated our senators for many sessions, that not even one bill has been framed for the protection of the people from spoiled and adulterated foods and drinks.

For the article on BRICK-MAKING, my readers are indebted to a valuable communication to the Institution of Civil Engineers, and the judicious remarks on it by several of its members. At its conclusion, a notice is inserted of one of those abuses which too often recur in our courts of judicature, in consequence of scientific witnesses merging the

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* "Dictionnaire Technologique," tom. ii. p. 293.

dispassionate philosopher in the mercenary partisan, and striving to mislead the judge and jury, by giving a one-sided view of the matter submitted to their candid examination. Such procedure is injurious not merely to the individual casuist, but to the cause of science. What a close affinity is there between these quibblers and the venal philosophists so graphically portrayed by Lucian!

In addition to the sectional view of the four-coloured calico-printing machine, given in the Dictionary, an outside view of this admirable mechanism is now presented to my readers; the two together constituting the only good representation of it hitherto made public.

The production, properties, and manufacture of caoutchouc are treated here in considerable detail, peculiar facilities having occurred to me for the thorough investigation of this novel branch of industry. If, along with the account now given, the articles BOOKBINDING, BRAIDING MACHINE, and ELASTIC BANDS of the Dictionary be consulted, the student will possess a pretty complete knowledge of caoutchouc.

CHOCOLATE is also a new contribution to my work, which I have been enabled to make in consequence of extensive experimental researches. It is to be hoped that our intrepid sailors will be allowed to reap the full benefit of the investigations which I made in their behalf, by desire of the Lords Commissioners of the Admiralty, and that their daily breakfast beverage will be for the future more soluble, emulsive, and nutritious, than I found it to be on commencing my researches, at which time about three-fourths of the cocoa was so coarsely ground, for the service of the navy, as to be left in a state altogether unfit for digestion.

The various new modes of producing pictorial impressions by the agency of light on chemically prepared surfaces are described under the titles, CALOTYPE, DAGUERREOTYPE, PHOTOGRAPHY, &c. The somewhat kindred copying art by electricity is treated under the article ELECTRO-METALLURGY.

FERMENTATION will be found a useful companion to the account of Bavarian beer; both being calculated to invite brewers and distillers to look more narrowly than they seem to have done into the interesting world of organic chemistry, so successfully explored in Germany and France, but so little studied in this country.

GAS LIGHT has been contributed by a most intelligent friend, and deserves to be regarded as a standard treatise on this important branch of engineerîng, condensed into the shortest possible space consistent with perspicuity.

GUANO, destined ere long to become the chief pabulum of British agriculture, and thereby to emancipate our landholders and farmers from their *exositophobia*, their dread of the importation of foreign corn, has been discussed at considerable length from peculiar sources of information.

Under IRON and SMELTING are given descriptions, with figures, of the best plans of the apparatus for the hot-air blast, and for feeding the blast furnace with mine, limestone, and fuel; both being original contributions from an eminent engineer.

The Seed-Crushing oil manufacture is, I believe, now for the first time in this country represented by a complete set of figures, exhibiting the various parts of the wedge stamping-mill; the oldest and probably still the best plan of extracting oil from seeds.

Pepper presents an instructive example of the fallacy of chemical evidence, sometimes too inconsiderately given in a court of justice. Were the solemn sanctity of an oath rightly impressed on the minds of scientific men, they would not testify to anything but what they did *most surely know*, and would escape the remorse and obloquy consequent, in feeling minds, on having borne false witness against their neighbour.

The Saccharometer table printed at first for the Dictionary, but omitted along with some other articles of less importance for want of room, is now given with certain improvements.

Smoke-prevention is a matter of such moment to the comfort and salubrity of all our large towns, and even of many semi-rural districts, that in promoting the publicity of Mr. Charles Wye Williams's unexceptionably simple and successful plan for effecting a consummation so earnestly to be wished for, I am conscious of merely discharging a professional duty.

Spinning exhibits a short but systematic view of the admirable self-acting system invented by Mr. Bodmer, whereby all the operations in a cotton factory are linked together in regular succession, and co-operate, with little or no manual aid, towards turning out a perfect product. This invention constitutes a true automatic era in textile factories. I trust the author of these inventions will be duly recompensed for the ingenuity and labours of very many years.

In the spinning of fine flax yarn by machinery, the greatest mechanical conquest which our factories have made in our own days over the industry of rival nations, a capital improvement has been recently made by Mr. Westly of Leeds. His former invention, the screw gill or spiral comb described in the Dictionary, under Flax, is now universally employed. His new contrivance is called the Sliver Roving, of which a description will be found in the Appendix, having come too lately to hand for insertion in its proper place. It promises to be a still more valuable improvement in this difficult branch of manufacture than even the spiral comb.

The table entitled Spirits exhibits the correspondence between the technical nomenclature of our excise as reckoned in over-proof and under-proof strengths, and the simple scale of specific gravity as understood and agreed upon all over the world. Since alcohol alone, and not water, is the subject of taxation, why not have an alcohol-meter, like that of Gay Lussac, which shows at once the proportion of taxable stuff in any spirit? (See Alcohol in the Dictionary.) As, however, our excise laws, like those of the Medes and Persians, are not likely to be changed in conformity with any scientific remarks, the above table is a desideratum to practical chemists.

Sugar of Potatoes, being a recent manufacture in this country, is fully investigated from my own professional resources.

Tobacco is discussed at considerable length, valuable materials for this inquiry having been afforded in the Report of the recent Committee of the House of Commons. While this plant is a rank weed, conducive neither to the sustenance nor health of man, and therefore a most fit object for deriving from its consumers a fiscal revenue, it affords instructive lessons on the influence of our fiscal administration on arts and manufactures.

When the duty on an article is more than ten times its intrinsic value, it must become the subject of perpetual and enormous frauds, and engender innumerable misdemeanours and crimes. Towards the prevention and punishment of these transgressions of the fiscal laws, a cumbrous, complex, costly, somewhat arbitrary and despotic system of espionage and prosecution must be organised. The working of this vast machinery is well shown in the Committee's Report, and must excite uncomfortable feelings in every honourable mind. We here see, on a somewhat magnified scale, the system of interference with, and prying into, processes of art and manufacture which accompanies and characterises all the operations of the excise. This device for collecting revenue for the necessities of the State, is the Pandora's box of the dethroned Stuarts, and should have been expatriated with that ill-starred family. We may say of it, *Quicquid tangit, deornat.* No branch of industry can acquire its due development under its wiry training and fastening. Had the *incubus* of the excise overlaid our textile manufactures of wool, cotton, flax and silk, how dwarfish would their stature have remained, and how meanly would they have quailed under the unrestrained labour of rival nations ; whereas now they afford employment, with food, raiment, and lodging to millions of our people. For the manufacture of glass in all its useful and ornamental branches, this country possesses indigenous resources superior to those of every other one, in its stores of fuel and vitrifiable materials of every kind, and yet it is surpassed by France, Switzerland and Bavaria, in glass for optical purposes, and by Bohemia in the quality and execution of decorative glass. Our scientific chemists have been obliged to get all their best glass apparatus from Germany, *via* Hamburgh.

Surely our glass-makers are the same race of people as our manufacturers of iron, fine cotton yarn, muslin, bobbin-net, broad silks, &c., which defy the competition of the world, and if unshackled by the excise they would ere long turn the scale against their foreign rivals, now their superiors. The incessant and vexatious espionage of the excise is a bar to all invention in every art under its control. Who would expend thought, science, labour, and money in maturing any discovery or improvement, by experiments necessarily conducted under the eyes of needy excisemen, who would tell all they have seen for a trifling bribe? Perhaps the gigantic scale of our spirit distilleries may be appealed to in proof of the fostering care of the excise, under which they have been reared. But this overgrowth, when well looked into, is no evidence of a sound constitution, but merely of the depravity of a grovelling uneducated people. In fact, our distilleries produced until very lately a very impure and offensive spirit, strongly imbued with noxious *fusel-oil*, or oil of grains (see Alcohol in this *Supplement*), and but for the recent introduction of Mr. Coffey's still into some distilleries. they would all have been yet sending forth a similar crude spirit. But though Mr. Coffey was for many years an officer of excise, and therefore did adapt his patent invention to all the just requirements of the revenue laws, he has met with very vexatious obstructions in the erection of his stills and on the most frivolous pretences.

As a general corollary from my long experience in the conduct of arts and manufactures, I feel warranted to declare, that the excise system is totally incompatible with their healthy growth, and is in itself the fruitful parent of fraud, perjury, theft, and occasionally murder. The sooner this portion of the revenue, so oppressively, so expensively, and so offensively collected, is replaced by an equitable tax on property, the better for the welfare of this great country. I have no quarrel with the gentlemen who administer the excise laws ; several of them with whom I have been professionally conversant I esteem very highly as intelligent and upright men, who do what they deem their duty in a conscientious manner. But in concluding a very extensive survey of the great branches of our national industry, this vile obstacle to their progressive growth became so manifest, that it would have been pusillanimous to shrink from the task of pointing out the magnitude of the evil.

Ventilation describes the plan now organised in the Reform Club House, which I inculcated in the Philosophy of Manufactures, published in 1835, as also in a paper read before the Royal Society in 1836, and which was copied into several of the scientific journals of that period. About the same time, Dr. Reid was erecting a huge factory furnace and chimney for the ventilation of the House of Commons, which would have been accomplished more effectually at one half of the expense, and without any architectural disfigurement, by my method of ventilating fans, which was, in fact, that long practised in our great textile factories. The Doctor has, I understand, renounced his chimney draughts in ventilating the Court of Exchequer at Westminster, and adopted a similar system to that of the Reform Club House. I hope he will pursue the same plan in the new Houses of Parliament, as it may be mounted at a very small cost, and without occasioning the least unsightly appearance or any annoyance.

I have subjoined in an Appendix a brief treatise, entitled Chemistry Simplified, which, being duly studied, will prove a useful guide to practitioners in testing alkalis, acids, and bleaching substances, in several departments of the chemical arts.

A few of the articles marked in the Dictionary for reference to the Supplement, were, on reconsideration, not found susceptible of useful annotation. Most of these references were, indeed, statistical details, which are given from the latest and best sources in Mr. M'Culloch's excellent Dictionary of Commerce.

London, 13. Charlotte Street, Bedford Square,
28th October, 1844.

A
SUPPLEMENT,
&c. &c.

ACETIC ACID. *Rapid acetification*, or the quick formation of vinegar, was practised upon malt worts in this country long before the rapid conversion of alcohol into vinegar was introduced into Germany. In the year 1824, Mr. Ham obtained his patent for an improved method of making vinegar, like that described in the Dictionary. His son, Mr. F. Ham, of Norwich, civil engineer, states that for some years, four of the largest country manufactories in the kingdom have been at work upon his father's plan, and that they are now in successful competition with the great London establishments. The apparatus consists of a huge vat, in the centre of which is a revolving pump, having two or more shoots pierced with holes, whereby a constant shower of the fermented wort, called wash, is kept falling from the top. The underpart of the vat contains the wash; the upper part, birch twigs properly prepared, which are so placed as not to interfere with the revolving shoots. Between the surface of the wash and the rafters which support the twigs, a space of a few inches is left vacant, into which one or more holes in the side of the vat admit the air spontaneously or have it forced in. The wash is maintained, by steam pipes immersed in it, at a temperature of from 90° to 100° F., so that, in consequence of the extensive application of the atmospheric oxygen during the trickling through the twigs, it may be made sour in the course of 48 hours; but, in general practice, it is completely acetified in from 15 to 20 days. By this apparatus, a wort brewed from raw grain, with only one seventh of malt, will produce a vinegar equal to that from malt alone; and the acetifying process may be arrested whenever it is completed, thus preventing the risk of the vinegar running into the putrefactive stage, as happens occasionally in the slow plan of fermentation. The admission of air is so moderated as not to dissipate the alcohol of the wash by evaporation. A wort of 24 lbs. gravity per Richardson's instrument, equal to 1·066 sp. gravity, will in this way yield an acid of revenue proof.

This old-going process is essentially the same with that for which John W. Neale and James Edouard Duyck obtained a patent in September, 1841, with this difference, that they employ the expressed juice of beetroots instead of corn wort.

The total number of vinegar factories in the United Kingdom was a few years ago only 48, of which 5 of the principal are in London, 4 being on the Surrey side of the Thames. In these, malt-vinegar-making is associated with the manufacture of British wines, called "sweets" by the excise. The fermented wort or wash is acetified either by "stoving or fielding." By the first plan, casks containing the wash are arranged in close rooms, heated by steam-pipes or stoves. By the second plan, the casks, each holding somewhat more than 100 gallons, are laid on their sides, with the bung-holes up, and distributed in long parallel rows, two or more deep, with narrow lanes between. A flexible pipe or hose, in connection with the great wash tun in the brew-house, is laid alongside of the casks, for the purpose of filling them, and keeping them supplied in case of leakage or evaporation. The wash requires usually several months for its complete acetification, during which time the bung-holes are left open in fine weather, but covered with a tile in the time of rain. When the acetous fermentation is completed, the contents of the casks are transferred by a syphon into a shoot laid on the ground, whence it is drawn by a pump into a store vat within doors. It is next clarified in very large vats, called "rapes," because in them it is filtered slowly and repeatedly through a compacted heap of the stalks and skins of raisins, called rape, which is the refuse of the British wine manufacture.

In 1838, 2,628,978 gallons of vinegar paid duty in England; in 1839, 2,939,665;

and in 1840, 3,021,130; upon which the gross amount of duty was, respectively, 21,908*l.* 3*s.*; 24,488, 17*s.* 6*d.*; and 25,978*l.* 12*s.* 9*d.*

In Scotland, in the same years, 15,626 gallons; 14,532; and 12,967; on which the duty charged was, respectively, 130*l.* 4*s.* 4*d.*; 121*l.* 2*s.*; and 111*l.* 19*s.* 7*d.*

In Ireland, in the same years, 48,158 gallons; 50,508; and 56,812; on which the duty charged was, 401*l.* 6*s.* 4*d*; 420*l.* 18*s.*; and 489*l.* 13*s.*

In the German process of Schützenbach for the rapid formation of vinegar, 180 measures (of 2 litres, or 2 quarts each) of water are added to 20 of alcohol of from 44 to 45 per cent. by Tralles, and 6½ of vinegar, containing 3½ per cent. of acetic acid. These 206½ measures produce on the average 203 to 204 of vinegar of the above strength. The process of acetification in the graduation tubs (*gradirfässer*) is finished in about 48 hours, and furnishes a vinegar of only 2·75 per cent. of acid strength. The liquid still contains some unchanged alcohol, and it is therefore transferred into tuns, where it completes its oxygenation. The heat of the chamber being about 90° F., occasions the stream of air that is passed through the above materials to carry off unproductively one tenth of the alcohol at least. Of the air that passes through the apparatus, only 3 per cent. of its oxygen is converted into carbonic acid.* An increase in the proportion of alcohol in the mixture is not found favourable to increased production of vinegar.

The theory of the acetification of alcohol was first fully cleared up by the researches of Liebig on aldehyde. For the production of 100 pounds of hydrated acetic acid, 53 pounds of oxygen are required, which are contained in 227 pounds of air, and oxygenate 77 pounds of absolute alcohol.

The conversion of the alcohol of fermented liquors into vinegar may be chemically represented as follows: — Alcohol is a compound of 4 atoms of carbon, 6 of hydrogen, and 2 of oxygen, or in symbols $C^4 H^6 O^2$. In certain circumstances (as the first stage of acetification) it loses 2 atoms of hydrogen, and becomes *aldehyde*, or dehydrogenated alcohol, $C^4 H^4 O^2$. This body readily absorbs 2 atoms of oxygen on exposure to air, and thus forms 1 atom acetic acid; in symbols, $C^4 H^3 O^3 + 1$ atom water ($H\,O$). These results are obtained in the exposure of vapour of alcohol to platinum sponge, or *platinum mohr.* In all cases it is presumed that aldehyde is first produced, then vinegar. The quick vinegar process has been in this country advantageously applied to the acetification of a solution of starch sugar made by the agency of either malt or sulphuric acid. But as our excise laws are adverse to the spirituous fermentation of such sugar, the starch liquor, after being boiled with 1 per cent. of sulphuric acid, is directly fermented into a crude wash, which is then acetified by the following method: —

A very large slightly conical tub or tun, 14 feet wide at bottom, 15 at top, and 13 high, turns out in a given time as much vinegar as is in Germany obtained from 6 tubs 8 feet high and 4 feet wide. Our larger mass of materials generates and maintains so much heat in the oxidation of the spirit, as to require no stove-heating in a properly constructed chamber. Two and half feet above the bottom of the above tun, a false bottom is laid. The space above this bottom is filled with coopers' wood shavings and chips, and the space beneath is destined to receive the liquor as it trickles down on the true bottom, in order to be pumped up in continual circulation. At a moderate height above the tun, the reservoir of the wash is placed, which discharges itself through a regulating stop-cock, or valve, into a pipe in its bottom, which passes down through a pretty large hole in the middle of the lid of the tun, and terminates a few inches under it, in a cross pipe shut at the ends, which is made to revolve slowly by mechanical power, in a horizontal direction round the end of the vertical pipe. This cross pipe is long enough to reach nearly to the sides of the tun, and, being pierced with small holes in its under side, delivers the fermented liquor, in minute streams, equally all over the surface of the chips of wood. It thence falls into the lower compartment of the tun, through holes round the circumference of the false bottom, whence it is pumped up again, under certain modifications, to be presently described.

The air for oxygenating the alcohol into vinegar is supplied from two floating gasometers, which are made to rise and fall alternately by steam power. The ascending one draws its air from a pipe which passes into the centre of the tun, immediately under the false bottom, and as it re-descends it discharges that air through a pipe into a cistern of water, which condenses, and retains the alcoholic vapour drawn off with the air. This water is used in making the next acetifying mixture. The fresh air is admitted in the top of the tun by the sides of the vertical liquor pipe, which is somewhat smaller than the hole through which it passes. Proper valves are placed upon the pipes connected with the gasometer pump, whereby the air drawn from the bottom compartment is prevented from returning thither. A small forcing-pump is employed to raise

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* *Knapp*, Annal. der Chem. und Pharm. xlii. 113.

the liquor continually from the bottom of the tun to the cistern overhead. By this arrangement good vinegar may be made in a few days, without any perceptible loss of materials. The progress of the acetification in this apparatus is ascertained by testing the air for oxygen as it is slowly drawn into the gasometers, or expelled from them. For this purpose a bundle of twine, which has been impregnated with solution of sugar of lead, and dried, is set fire to, and plunged into a bottle filled with the air. In general, it is so well disoxygenated and carbonated, that the ignition is immediately extinguished. By regulating the warmth of the apartment, the motion of the gasometer, and the admission of air, the due progress of the acetification may be secured. The vinegar has an average strength of $5\frac{1}{2}$ per cent. of acetic acid hydrate, and is immediately ready for the market.

Hitherto it has been generally imagined that the formation of vinegar is accomplished by a peculiar fermentation, which has been called the *acetous*, in contradistinction from the vinous, the panary, the putrefactive, &c. But this doctrine is doubtful. The experiments which serve as its base, and which should reveal the nature of its peculiar ferment, as also the chemical reactions which take place in its progress, all seem to place this phenomenon somewhat out of the sphere of fermentation properly so called. Every fermentation operates by resolving a body into compounds less complex than itself. But the so-called acetic fermentation serves to combine, on the contrary, two bodies, viz. alcohol and aldehyde, with the oxygen of the air; and this is the only case where fermentation produces such an action, which is a true combustion.

Yet it must be confessed that the acetic seems to possess all the characters of the other fermentations; namely, the union of an organised body or ferment with a fermentable organic matter. The former is found in that mucous substance called *mother* of vinegar, and which is seen floating on the surface of vinegar in the act of its generation. It begins to appear with the acid fermentation, and it continues to be formed during its whole progress. It is at first a pellicle composed of globules much more minute than those which constitute yeast; and they are often irregularly grouped. The pellicle becomes afterwards thicker in body and consistence, exhibits more distinct granular forms, and acquires a tendency to be distributed in stripes or narrow bands. The mode of the reproduction of these globules is quite unknown; but they seem somewhat akin to the slimy deposit of sulphureous mineral waters called *baregine*.

If the study of the acetic ferment be mysterious, it is, however, clear that the conversion of alcohol into vinegar never takes place in the common process without the presence of an albuminous substance, and of the conditions favourable to all fermentations, besides the necessary access of air, not only at the commencement (as suffices for the vinous) but during all its course. Hence every weak spirituous liquor which contains an albuminous matter or any ferment may, with contact of air, and a temperature of from 60° to 90° F., give birth to vinegar. If the mixture be too rich in alcohol, or if the azotised matter be absent, or if the temperature be much above or below these two points, the phenomenon of acetification stops. There are, therefore, several indications of the existence of a peculiar vinegar fermentation; though it should be observed that the production of lactic acid (as from fermenting cabbage, starch, &c.) has sometimes misled chemists into the belief of an acetic fermentation. I shall, on this account, point out here briefly the distinction between the two processes.

The acetic fermentation requires the presence of ready formed alcohol and of the air; the lactic, on the contrary, proceeds with starchy or saccharine mixtures, without the intervention of alcohol or of atmospheric oxygen; and when once begun, it will go on of itself. The acetifying process presents, moreover, a striking analogy with the phenomenon of nitrification, in the necessity of an elevated temperature and the influence of porous bodies to divide the particles of the liquids and the air. Thus gaseous ammonia mixed with oxygen, when passed through a tube containing spongy platinum slightly heated, becomes nitric acid; when sulphurous acid gas and oxygen are passed through hot pumice-stone they become sulphuric acid; and when lime or potash, diffused through porous matter, is placed in contact with ammoniacal emanations, in the artificial nitre beds, or nitrifiable soils, nitrate of lime or potash is formed. In like manner, under the influence of spongy platinum, alcohol ($C^4H^4O + H^2O$) and air may, by a true oxidisement of the ethereous part of the alcohol (C^4H^4O) produce aldehyde ($C^4H^4O^2$), which passes afterwards into acetic acid ($C^4H^3O^3 +$ water, HO). On these principles we may conceive that vinegar must be readily formed when alcoholic wash, at a proper temperature, is extensively exposed to atmospheric air, by being spread over the surfaces of wooden twigs, or chips in the German *graduators*. In some districts cyder is rapidly acetified by being made to trickle cautiously along strings suspended vertically between two vats. See Acetic Acid and Graduator in the Dictionary.

AGRICULTURAL CROPS, composition of, by M. Boussingault. — *Ann. de Chim. et Phys.* III. S. p. 234.

Substances.	Ashes inclusive.					Exclusive of Ashes.			
	Carbon.	Hydrogen.	Oxygen.	Azote.	Ashes.	Carbon.	Hydrogen.	Oxygen.	Azote.
Wheat - - -	46·1	5·8	43·4	2·3	2·4	47·2	6·0	44·4	2·4
Rye - - -	46·2	5·6	44·2	1·7	2·3	47·3	5·7	45·3	1·7
Oats - - -	50·7	6·4	36·7	2·2	4·0	52·9	6·6	38·2	2·3
Wheat straw - -	48·4	5·3	38·9	0·4	7·0	52·1	5·7	41·8	0·4
Rye straw - -	49·9	5·6	40·6	0·3	3·6	51·8	5·8	42·1	0·3
Oat straw - -	50·1	5·4	39·0	0·4	5·1	52·8	5·7	41·1	0·4
Potatoes - - -	44·0	5·8	44·7	1·5	4·0	45·9	6·1	46·4	1·6
Beetroot (field) - -	42·8	5·8	43·4	1·7	6·3	45·7	6·2	46·3	1·8
Turnips - - -	42·9	5·5	42·3	1·7	7·6	46·3	6·0	45·9	1·8
Jerusalem artichokes -	43·3	5·8	43·3	1·6	6·0	46·0	6·2	46·1	1·7
Yellow peas - -	46·5	6·2	40·0	4·2	3·1	48·0	6·4	41·3	4 3
Pease straw - -	45·8	5·0	35·6	2·3	11·3	51·5	5·6	40·3	2·6
Red trefoil hay - -	47·4	5·0	37·8	2·1	7·7	51·3	5·4	41·1	2·2
Jerusalem artichoke stems	45·7	5·4	45·7	0·4	2·8	47·0	5·6	47·0	0·4

ALCOHOL, as obtained by the distillation of wine, of fermented corn wort, or potato syrup, possesses different flavours, which arise from what the Germans call Fusel oil, and which oil differs in those several spirituous liquors. That of wine has been called Onanthic ether. It is resolvable into ether (oxide of ethal), and a peculiar fatty acid, the Onanthic.

The œnanthic ether of corn spirit contains an additional oil, called corn oil, which has a most offensive smell. The potato fusel oil differs from that obtained from grain spirit. It has, at the first impression, in its pure state, a strong, not disagreeable smell, which afterwards becomes extremely nauseous, and excites an acrid burning taste. The inhalation of its vapour causes a feeling of oppression, and vomiting. All these fusel oils are readily soluble in alcohol, but not in water, whence, when poured into the latter, they make a milky mixture. The potato fusel oil contains no *solanine* from the potatoes, as has been alleged, though this noxious principle exists in all potatoes, especially after germination. It is not a volatile product.

Corn damaged by rain in harvest time affords, after mashing and fermentation, a most offensive fusel oil, which irritates the eyes and nostrils, and smells like a solution of cyanogen in alcohol. Spirits so contaminated intoxicate more powerfully than purer spirits, and are apt to bring on temporary madness and subsequent indisposition. This noxious substance does not combine with gases; and, being more volatile than alcohol, it may be drawn off by distillation in a concentrated state. It is separated to a considerable degree in Germany by diluting the foul spirits with water, mixing in a portion of olive or other bland oil, letting the oil gather on the top, drawing off the spirituous liquor from below, and subjecting it to rectification. When the spirit so rectified is kept for 2 or 3 months in a cask, corked, but not too closely, the noxious œnanthic compound disappears, in some measure by its spontaneous decomposition. For statistics and Excise-proof table, see SPIRITS.

The high price of alcohol in this country, in consequence of the heavy fiscal duties, and its low price in most other countries, where it is nearly duty free, has led to its contraband importation under various disguises. Sometimes it is introduced under the mask of oil of turpentine, from which it can be sufficiently freed by rectification for the purpose of the gin manufacturers. Sometimes it is disguised with wood naphtha, or wood vinegar; from the latter of which it may be separated by distillation in a water bath; but from the former it is more difficult to extricate it, as alcohol and wood spirit are nearly equally volatile. It has also been disguised with coal naphtha; but from this it may be easily separated by distillation, on account of the great difference between the boiling points of the two liquids; besides, coal naphtha will not combine with water, as alcohol does.

When the object is to discover whether wood spirit contains alcohol, we may proceed as follows: — Add to the suspected liquid a little nitric acid, of specific gravity 1·45. If alcohol be present, in even small proportions, an effervescence will ensue, from the evolution of etherised nitrous gas, with its characteristic ethereous smell. On treating the mixture with a nitrous solution of mercury, as in the process for fulminate of mercury, an effervescence will take place, the dense vapour of etherised mer-

Albumen of Eggs. Ovalbumin. & Seralbumin. (F.T.)

curial gas will appear, and a certain proportion of fulminate will be formed, corresponding pretty closely to the proportion of alcohol in the wood naphtha mixture.

As the boiling point of wood spirit is only about 145°, while that of alcohol, of like specific gravity (0·825), is 173° F., a good criterion of the proportion of the two liquids present in the mixture may be found in its boiling temperature.

Pure wood spirit, when mixed with the above nitric acid, becomes of a ruby tint, but remains tranquil. Alcohol continues colourless, but enters into violent ebullition, and is nearly all dissipated in fumes.

Alcohol diluted with water has a less resultant density than wood spirit of like strength similarly diluted. While alcohol thus becomes of 0·920, wood spirit becomes 0·926 or 0·927.

If wood spirit be contained in alcohol, it may be detected to the greatest minuteness by the test of caustic potash, a little of which, in powder, causing wood spirit to become speedily yellow and brown, while it gives no tint to alcohol. Thus 1 per cent. of wood spirit may be discovered in any sample of spirits of wine. For further details upon this analytical inquiry, see my pamphlet, entitled *The Revenue in Jeopardy.*

ALGAROVILLA. This substance is called by the Spaniards *Algaroba*, from the resemblance it bears to the fruit of the Carob (*Ceratonia siliqua*), which is a native of Europe, in the southern countries of Spain and Portugal. The substance lately analysed by me is the fruit of a tree which grows in Chile, of which the botanical name is *Prosopis pallida*, according to Captain Bagnald, R. N., who first brought a sample of it to this country in the year 1832. It consists of pods bruised and agglutinated more or less with the extractive exudation of the seeds and husks. According to a more recent determination, algarovilla is said to be the product of the tree Juga Marthæ of Santa Martha, a province of New Carthagena.

It is an astringent substance replete with tannin, capable, by its infusion in water, of tanning leather, for which purpose it possesses more than four times the power of good oak bark. Its active matter is very soluble in water at a boiling temperature. The seeds are merely nutritive and demulcent, but contain no astringent property. This resides in the husks. The seeds in the entire pod constitute about 1-5th of the weight, and they are three or four in number in each oblong pod. Alcohol of 60 per cent. over proof dissolves 64 parts in 100 of this substance. The solution consists chiefly of tannin, with a very little resinous matter. Water dissolves somewhat more of it, and affords a very styptic-tasted solution, which precipitates solution of isinglass very copiously, like infusion of galls and catechu. Its solution forms with sulphate of iron a black precipitate, which is kept floating by means of the gum present, and thereby constitutes good ink. My report to the merchant was written with a combination thus made, in proportions taken at random; and there is no doubt that by using a stronger decoction of the algarovilla. along with a proper proportion of copperas, an excellent black ink might be prepared without any other addition.

I find that a decoction of the algarovilla affords with cotton cloth, mordanted with tin solution, as also with acetate of alumina liquor, a brilliant yellow die; the former being the brighter and fuller of the two.

A tincture of algarovilla might be used as an astringent in medicine; or probably a decoction of the whole substance would be preferable, on account of the demulcent quality of the seeds when bruised. As an article of commerce it cannot be rated at a high price, nor should it pay much duty till its value as an article of manufactures or medicine be fully ascertained.

ALMONDS. Imported in 1839, 28,261 cwt.; in 1840, 27,566. Retained for consumption, 9785 and 7935, respectively.

ALUM. In the alum works on the Yorkshire coast, 8 different liquors are met with.

1st. "Raw Liquor." The calcined alum shale is steeped in water till the liquor has acquired a specific gravity of 9 or 10 pennyweights, according to the language of the alum-maker.

2d. "Clarified Liquor." The raw liquor is brought to the boiling point in lead pans, and suffered to stand in a cistern till it has cleared: it is then called clarified liquor. Its gravity is raised to 10 or 11 pennyweights.

3d. "Concentrated Liquor." Clarified liquor is boiled down to about 20 pennyweights. This is kept merely as a test of the comparative value of the potash salts used by the alum-maker.

4th. "Alum Mother Liquor." The alum pans are fed with clarified liquor, which is boiled down to about 25 or 30 pennyweights, when a proper quantity of potash salt in solution is mixed with it, and the whole run into coolers to crystallise. The liquor pumped from these rough crystals is called "alum mothers."

5th. "Salts Mothers." The alum mothers are boiled down to a crystallising point, and afford a crop of "Rough Epsom," which is a sulphate of magnesia and protoxide of iron.

6th and 7th. "Alum Washings." The rough crystals of alum (No. 4.) are washed twice in water, the first washing being about 4 pennyweights, the second about $2\frac{1}{2}$, the difference in gravity being due to mother liquor clinging to the crystals.

8th. "Tun Liquor." The washed crystals are now dissolved in boiling water, and run into the "roaching tuns" (wood vessels lined with lead) to crystallise. The mother liquor of the "roach alum" is called "tun liquor:" it is, of course, not quite so pure as a solution of roach alum in water.

The alum-maker's sp. gr. bottle holds 80 pennyweights of water, and by 10 pennyweights he means 10 more than water, or 90.

The numbers on Twaddle's hydrometer, divided by 2·5, give alum-maker's pennyweights.

The alum-maker tests his samples of potash salts comparatively by dissolving equal weights of the different samples in equal measures of alum liquor at 20 pennyweights, heated up to the boiling point, and weighing the quantity of alum crystals produced on cooling.

For the above information I am indebted to my friend Mr. Maurice Scanlan, who superintended for some time the Mulgrave alum works.

He informs me that $61\frac{1}{2}$ tons of the alum rock at the Mulgrave Works to the north of Whitby, yield, after calcination, &c. one ton of alum.

It has been computed that with sulphur at *6l.* per ton, sulphuric acid of spec. grav. 1·750 can be produced at *3l.* per ton, including the mere cost of making: this acid contains 2 atoms of water: 174 tons of this acid, and $87\frac{1}{4}$ tons of sulphate of potash, with the pipe-clay, will form 474 tons of alum; so that the neat cost would be *522l.* for the acid + 1047*l.* for the sulphate of potash, = 1569*l.*; which sum, divided by 474, gives a quotient of *3l. 6s.* for the neat cost of 1 ton of alum by the direct process.

At the pit 1 ton of alum — rock or mine, costs *3l. 4s.*; to which, adding the cost of the potash salt for 1 ton of alum, *3l. 15s.*, they constitute together an amount of *6l. 19s.* From the latter sum 1*l.* 10*s.* must, however, be deducted for the value of rough Epsom salt produced, leaving a balance of *5l. 9s.* for the cost of a ton of mine-alum, prior to evaporation and crystallization.

A patent was obtained in November, 1839, by Mr. William Wiesmann, of Duesburg, for improvements in the manufacture of alum. He subjects potter's clay to a moderate red heat, grinds it, and subjects the powder, in leaden pans, to the action of concentrated sulphuric acid (66° Beaumé), taking care to use excess of clay and a moderate heat. This mixture is to be stirred till it is dry, then treated with boiling water, in order to dissolve the sulphate of alumina formed. So far the process is old and well-known. The novelty consists in freeing the saline solution from iron by ferrocyanure of potassium (prussiate of potash). When the iron has been all thrown down in the form of prussian blue, the liquor is allowed to settle, the supernatant pure sulphate is drawn off, and evaporated till it forms on cooling a concrete mass, which may be moulded into the shape of bricks, &c., for the convenience of packing. He proposes to crystallise his alum; but he will find this process rather difficult. The prussian blue obtained may be reconverted by any alkaline solution into a ferrocyanide, and again employed on a fresh quantity of the raw sulphate. How he is to precipitate the iron by sulphate of lime, as he states, I cannot comprehend.

Dr. Turner's process for making alum from felspar is thus described by him in the specification of his patent, sealed October 8. 1842. If it be desired to make a potash alum, the best substance to operate upon is a potash felspar. This felspar is ground in a common edge-stone mill to the consistency of fine sand (a process which is much assisted by first heating it to redness, and then plunging it in cold water); it is then mixed with its own weight of sulphate of potash, and placed in the upper part of the inclined bed of a reverberatory furnace (being such a furnace as is known in the potteries as a frit furnace), and which furnace has previously been brought to a full white heat. When by the action of the heat a glass has been produced, and is observed to flow down the inclined bed of the furnace, to such glass is to be added gradually, at the lower end of the furnace, as much carbonate of potash as was before used of sulphate of potash. And this process of placing the mixture of felspar and sulphate of potash at the upper part of the bed of the furnace is to be repeated, adding at the lower part of the bed, gradually and proportionally, as the glass flows down from the upper part, the carbonate of potash, as before mentioned. This is continued until the sack of the furnace is filled with the glass; this glass is then fit for the next process. The preparation of the glass may also be effected in a reverberatory furnace with a flat bed; and the facility of removing the glass from such a furnace is an advantage. In this case no carbonate must be added to the mixture until the sulphate of potash is observed to be completely decomposed. On boiling in water the glass thus obtained, the same quantity of potash as was added to the felspar and two thirds of the silica contained in the felspar are dissolved, while the remaining one third of the silica and the alumina, and an equal quantity of potash as the felspar originally contained, are left in the form of a light porous substance, similar in chemical composition to the mineral commonly called elæolite; this porous substance is carefully separated from the said solution, and washed with water until freed from the silicate of potash, then placed in an open leaden cistern or boiler, and boiled with dilute sulphuric acid of the specific gravity 1·2 (one and two-tenths). This acid will contain about the quantity of water required for the solution and crystallization of the alum produced by the decomposition of the elæolite; the quantity of the dilute sulphuric must be such as will contain about 160 lbs. of dry sulphuric acid for every 285 lbs. of felspar rock (if that rock be used), and in like proportion to the silica and alumina contained in the substance, if any other substance be used, as it is important that the alum solution thus obtained should not contain an excess of acid. I recommend that only four-fifths of the proposed quantity of dilute sulphuric acid should be used in the first operation, which will leave a portion of the elæolite undecomposed; but by acting upon this undecomposed portion, after the solution has been drawn off, with the full quantity of dilute acid to be used in the next operation, it will be completely decomposed, and the alum thus formed becomes part of the next batch. In this way a neutral solution of alum is obtained at each process. The boiling solution, after the sediment subsides, is drawn into coolers, such as are commonly used for the crystallization of alum; here about four-fifths of the alum held in solution will form into crystals. The mother-liquor from the coolers is boiled in any convenient boiler to dryness, in order to render the silica it contains insoluble; the residuum is boiled either in water or in the mother-liquor from the roaching tubs, so as to dissolve the alum it contains, and the process of crystallization repeated. Had the above process been performed with the salts of soda instead of potash, a soda alum would have been formed. For this purpose the soda felspar or albite should be selected. The potash or soda (as the case may be) contained in the liquor, drawn as aforesaid from the elæolite (or nepheline, which is formed when soda is used), may be recovered by either of the following processes: — The strong solutions which are obtained, about the specific gravity of 1·2 are placed in any convenient vessel in which a stream of carbonic acid gas, obtained in any convenient method, may be driven through them, the carbonic acid becomes absorbed, and the solution assumes the form of a gelatinous mass: this mass consists of carbonate of potash or soda and hydrate of silica. On drying this mass in a furnace, which must never be allowed to rise to red heat even in the dark, the silica loses its water and becomes insoluble; the potash or soda may then be separated from it in the form of a sesquicarbonate of potash or soda, by solution and evaporation to dryness. The other process, which under most circumstances will be found more economical and convenient, is to allow the boiling solution of silicate of potash or soda to filter through a bed of caustic lime, when it will be found that the lime has combined with the silicate, and a caustic potash or soda ley is obtained. This process may be conveniently conducted in an apparatus similar to that used by soap-makers for the preparation of their caustic leys. The potash or soda may then be readily obtained as caustic potash or soda, or as carbonate, by the known processes used in making soda. The weak solutions of silicate of potash or soda are used to decompose another portion of the glassy substance.

Now I do not claim as new, or as my invention, any particular form of vessel or apparatus in which or with which my operations may be conducted; nor do I claim any particular proportions in which the alkaline salts may be used. But I claim as new, and as my invention, the improvements aforesaid, and the production of substances similar to elæolite and nepheline artificially, by the decomposition by water of the glassy substances produced by the fusing of felspar as aforesaid, or other mineral substances containing silica and alumina, with salts of potash and soda, as aforesaid, and the use and application of such artificial elæolite and nepheline in the production and manufacture of alum, as aforesaid. I also claim the process, as above described, for separating the alkalies from silica by means of caustic lime.

ANCHOVIES, ESSENCE OF. I insert this article to show on what slender pretence of invention a patent may be obtained. Mr. John Masters, of Leicester. makes his improved transparent preparation, by placing in a kettle any given quantity of anchovies in the state in which they are imported, along with their own weight of water, exposing the kettle to a simmering heat for two or three hours, removing the kettle, and straining its contents when cold, first by suitable pressure through a strong canvas bag, and next filtered through a flannel or paper till a clear liquor is obtained. If it be desired to render the essence thicker, the material used for this purpose should be transparent. He says that flour is used for thickening the common essence. I presume he would prefer gelatine, gum, or arrow root for his transparent thickening, though he does not specify any thing.

ANNOTTO or ANNATTO. Imported in 1839, 303,489 lbs.; in 1840, 408,469. Retained for consumption, 224,794 and 330,490, respectively.

ARCHIL has been lately the object of numerous chemical researches, but hitherto, it must be owned, without producing any results useful to the dyer, so as to promote the solidity of this beautiful and now cheap dye. The new experiments of Schunk, performed in Liebig's laboratory, tend to show that the whole matter is still involved in much mystery. By the action of ether on the *Variolaria lactea* (one of the archil lichens), in an apparatus of displacement, he obtained crystals, which he calls *lecanorine.* It is convertible into the *orcine* of Robiquet and Heeren by hot barytes water. When moistened with water of ammonia, and exposed to the air, it gradually assumes the archil tint. Liebig is of opinion, that this product, and some other analogous ones, vary according to the nature of the solvents and the temperature of the digestions, so that they probably are mere metamorphoses of the self-same one or two substances, pre-existing in the lichens. Since *lecanorine* is decomposed by boiling water into carbonic acid, and orcine, it may also undergo this change from the boiling alcohol employed in Schunk's researches.

When ammonia acts upon orcine, it gives it a dark blood-red colour, and converts it into *orceine,* a new compound containing azote, but in a different state of combination from what it is in ammonia. This orceine is the true colouring matter of the archil or orseille; and, according to Robiquet, it is here in the state of an *orceate* of ammonia, requiring for its production the co-operation of air and water. In these circumstances the orceine absorbs oxygen, and is transformed into orceate of ammonia, without any other product, even carbonic acid, being formed. *Variolarine, erythrine* and *pseudo-erythrine,* three products obtained by Robiquet and Heeren; the first from *Variolaria dealbata,* the second and third from *Parmelia roccella,* and *Lecanora tartarea,* are interesting merely in a scientific point of view. The last two are transformed into red colouring matters by ammonia and air. "Latterly," says Liebig, "Kane has made these two substances objects of a particular investigation; but the researches of this chemist are far, as appears to me, from clearing up their history."* I need not, therefore, give any account of these researches, which occupy a large portion of a recent volume of the Philosophical Transactions.

Tournesole, or litmus, consists, according to Peretti, of a red colouring matter, rendered blue by combination with ammonia.

ARROW ROOT. This plant has been lately cultivated with great success, and its root manufactured in a superior manner, upon the Hopewell estate, in the island of St. Vincent. It grows there to the height of about 3 feet, and it sends down its tap roots from 12 to 18 inches into the ground. Its maturity is known by the flagging and falling down of the leaves, an event which takes place when the plant is from 10 to 12 months old. The roots being dug up with the hoe are transported to the washing-house, where they are thoroughly freed from all adhering earth, and next taken individually into the hand, and deprived by a knife of every portion of their skins, while every unsound part is cut away. This process must be performed with great nicety, for the cuticle contains a resinous matter, which imparts colour and a disagreeable flavour to the fecula, which no subsequent treatment can remove. The skinned roots are thrown into a large cistern, with a perforated bottom, and there exposed to the action of a copious cascade of pure water, till this runs off quite unaltered. The cleansed roots are next put into the hopper of the mill, and are subjected to the powerful pressure of two pairs of polished rollers of hard brass; the lower pair of rollers being set much closer together than the upper. (See the accompanying figure.) The starchy matter is thus ground into a pulp, which falls into the receiver placed beneath, and is thence transferred to large fixed copper cylinders, tinned inside, and perforated at the bottom with numerous minute orifices, like a kitchen drainer. Within these cylinders, wooden paddles are made to revolve with great velocity, by the power of a water-wheel, at the same time that a stream of pure water is admitted from above. The paddle-arms beat out the fecula from the fibres and parenchyma of the pulp, and discharge it in the form of a milk through the perforated bottom of the cylinder. This starchy water runs along pipes, and then through strainers of fine muslin into large reservoirs, where, after the fecula has subsided, the supernatant water is drawn off, and fresh water being let on, the whole is agitated and left again to repose. This process of ablution is repeated till the water no longer acquires any thing from the fecula. Finally, all the deposits of fecula of the day's work are collected into one cistern, and, being covered and agitated with a fresh charge of water, are allowed to settle till next morning. The water being now let off, the deposit is skimmed with palette knives of German silver, to remove any of the superficial parts, in the slightest degree coloured; and only the lower, purer, and denser portion is prepared by drying for the

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* Traité de Chimie Organique, tom. ii. p. 477.

market. The drying-house on the Hopewell estate is constructed like the hot-house of an English garden. But instead of plants, it contains about 4 dozen of drying pans made of copper, 7½ feet by 4½, and tinned inside. Each pan is supported on a carriage, having iron axles, with lignum vitæ wheels, like those of a railway carriage, and they run on rails. Immediately after sun-rise, these carriages with their pans, covered with white gauze, to exclude dust and insects, are run out into the open air, but if rain be apprehended, they are run back under the glazed roof. In about 4 days the fecula is thoroughly dry and ready to be packed, with German silver shovels, into tins or American flour barrels, lined with paper attached with arrow root paste. The packages are never sent to this country in the hold of the ship, as their contents are easily tainted by noisome effluvia, of sugar, &c. By such a skilful series of operations, and by such precautions, the arrow root thus manufactured may vie with any similar preparation in the Bermudas or any other part of the world. I have found it, on analysis and trial, to be pure, powerful, and agreeable, and a most wholesome article of food.

Fig. 1. Plan of arrow root grinding-mill, and of 2 sets of copper cylinder washing-

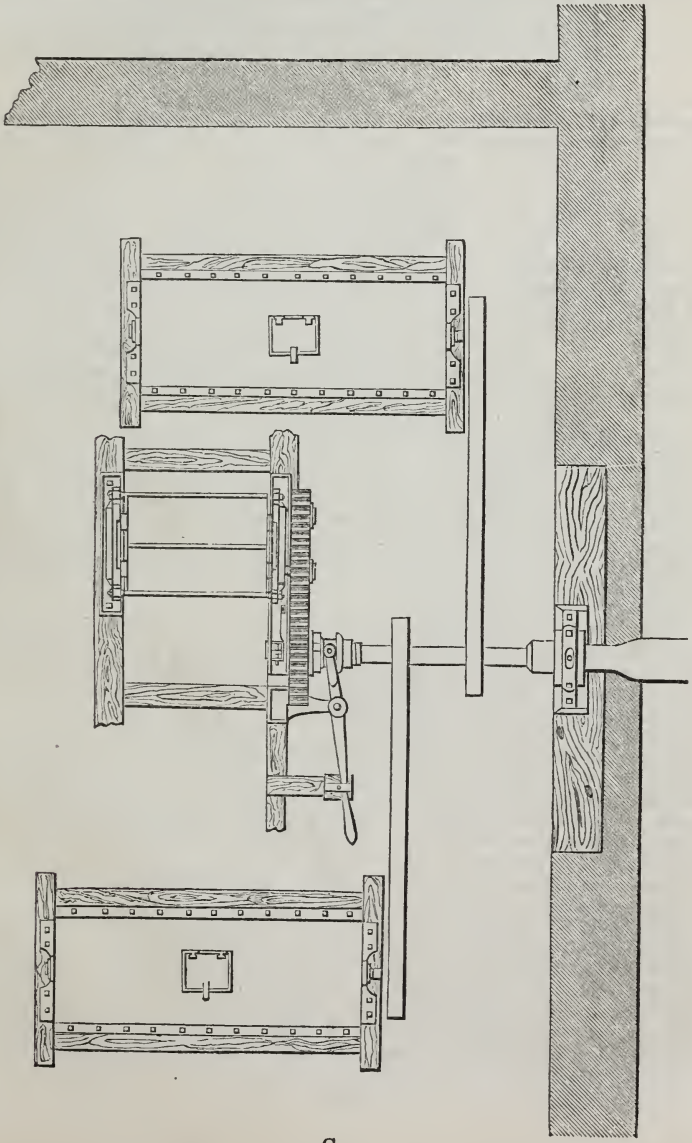

Fig. 1.

machines, with the connecting machinery for driving them; the washing agitator being driven from the connecting shaft with leathern belts. *Fig.* 2. End elevation of arrow-root mill, with wheels and pinions, disengaging lever, &c. *Fig.* 3. End elevation of copper washing-cylinders, with press-framing, &c. The washing-cylinders are $6\frac{1}{2}$ feet long and $3\frac{1}{2}$ in diameter. The mill-rollers are 3 feet long and 1 foot in diameter.

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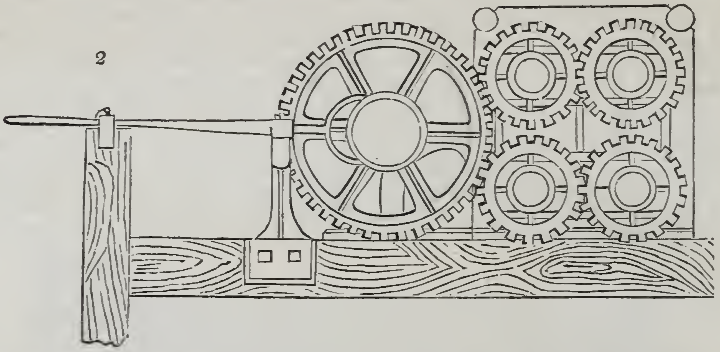

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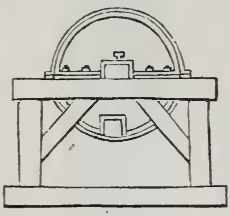

The uses of arrow root are too well known and acknowledged to require recounting here. It is the most elegant and the richest of all the feculas, and being now manufactured, with the advantage of excellent machinery, and abundance of pure water, in the fertile island of St. Vincent, it may be brought into our market at a much more moderate price than it has heretofore been supplied from less favoured localities. The Bermuda arrow root is treated necessarily with rain water collected in tanks, and therefore is occasionally soiled with insects, from which the St. Vincent article is entirely free.

The presence of potato starch in arrow root may be discovered by the microscope. Arrow root consists of regular ovoid particles of nearly equal size, whereas potato starch consists of particles of an irregular ovoid or truncated form, exceedingly irregular in their dimensions, some being so large as $\frac{1}{300}$ of an inch, and others only $\frac{1}{2000}$. But the most convenient test is dilute nitric acid of 1·10 (about the strength of single aquafortis), which, when triturated in a mortar with the starch, forms immediately a transparent very viscid paste or jelly. Flour starch exhibits a like appearance. Arrow root, however, forms an opaque paste, and takes a much longer time to become viscid. (*Dr. Scharling in Liebig's Annalen.*)

Arrow root may be distinguished from potato starch, not only by the different size of its particles, but by the difference of structure. Their surfaces in the arrow root are smooth, and free from the streaks and furrows seen in the potato particles by a good microscope. The arrow root, moreover, is destitute of that fetid unwholesome oil, extractable by alcohol from potato starch.

Liebig places the powers of arrow root, as a nutriment to man, in a very remarkable point of view, when he states that 15 pounds of flesh contain no more carbon for supplying animal heat by its combustion into carbonic acid in the system, than 4 pounds of starch; and that if a savage, with one animal and an equal weight of starch, could maintain life and health for a certain number of days, he would be compelled, if confined to flesh alone, in order to procure the carbon necessary for respiration, during the same time, to consume five such animals.

Arrow root imported in 1839, 303,489; in 1840, 408,469 lbs.; retained for consumption, 224,794 and 330,490 respectively.

ARTESIAN WELLS. *Fig.* 4.* represents the manner in which the condensed water of the heavens distributes itself under the surface of our globe. Here we have a geological section, showing the succession of the several formations, and the sheets or laminæ of water that exist at their boundaries, as well as in their sandy beds. The figure shows also very plainly that the height to which the water reascends in the bore of a well, depends upon the height of the reservoir which supplies the sheet of water to which the well is perforated. Thus the two wells A, *a*, having gone down to

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* At the end of the Volume.

the two aqueous expanses below, whose respective waters of supply are derived from the percolations M A′ and M B′, will afford rising waters, which will come to the surface; whilst in the well B, supplied by the sheet F, C′, D′, the waters will spout above the surface, and in the well C they will remain short of it. The same figure shows that these wells often traverse sheets of water that rise to different heights. Thus in the well C, there are five columns of ascending waters, which rise to heights proportional to the points whence they take their origin. Several of these will be spouting or overflowing, but some will remain beneath the surface.

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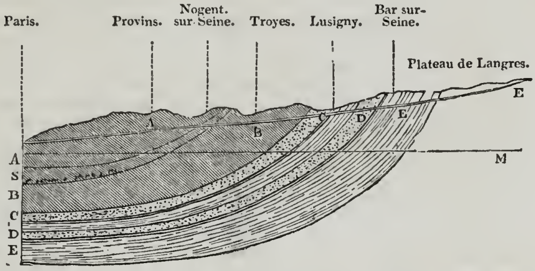

The older geological formations are seldom propitious to the construction of Artesian wells, on account of the compact massiveness of their rocks, of the few fissures or porous places in them, and of the rarity of filtering strata overlying retentive ones. It is therefore vain to attempt the formation of an overflowing spring, upon the above principles, in territories of granite, gneiss, mountain limestone, and basalt. Among transition and secondary formations, such wells will rarely furnish a supply of good water. The latter strata of alternating clay and variegated sandstone contain so much gypsum and rock salt as to impregnate therewith the waters derived from them to an unpalatable degree. It is in the sandy, calcareous, and argillaceous strata of the Jura limestone, indeed, that borings may most probably be made for brine springs. The hot springs which burst out of the ground in primitive rocky districts come undoubtedly from a great depth under the surface, and derive their temperature, and also probably their waters, from the vapours of deep-seated volcanoes in connection with the sea. A miniature representation of such springs is exhibited in the intermitting fountains of fresh water on the shoulder of Vesuvius. Springs of this kind, which vary with the seasons, may derive a portion of their water from the surface of the earth, from which it may sink through clefts in the primitive rocks, till meeting in its descent with stony obstructions and ascending steam, it is forced to remount in a heated state to the day, like the Geisers in Iceland. The most remarkable example of an Artesian well is that recently formed at Grenelle, a suburb at the south-west of Paris, where there was a great want of water. It cost eight years of difficult labour to perforate. The geological strata round the French capital are all of the tertiary class, and constitute a basin, like that shown in *fig.* 4. The bottom of this basin is chalk; A A are tertiary strata above the chalk; B B, chalk or cretaceous carbonate of lime; C C, D D, green sand and clay; E E, oolite and Jura limestone (*muschelkalk*); E A, general slope of the surface of the country from Langres to Paris; M A, the level of the sea. Over a circular space, of which Paris is the centre, and which is bounded by the towns of Laon, Mantes, Blois, Sancerre, Nogent-sur-Seine, and Epernay, these strata are found upon the surface, concealing the chalk; but on the other side of these towns, the edge of the basin being passed, the chalk is generally the superficial bed. By looking at the order of these tertiary strata, it is easy to perceive the obstacles that M. Malot, the engineer of the well, had to overcome, and the difficulty and hazard of his undertaking. The surface at Grenelle consists of gravel, pebbles, and fragments of rock, which have been deposited by the waters at some period anterior to any historical record. Below this layer of detritus, it was known to the engineer, by geological induction, as well as previous experience, that at Grenelle, marl and clay would be found, instead of the limestone which generally forms the immediately subjacent stratum. He was aware that he had to bore about 440 yards! deep before he should arrive at the sheet of water (S, *figure*) which flows in the gravel below the limestone, and supplies the wells of St. Ouen, St. Denis, and Stains. Underneath the marl and the clay, the boring rods had to perforate pure gravel, plastic clay, and finally chalk, which forms the bottom of the general tertiary basin, as we have seen. No calculation from geological data could determine the thickness of this stratum of chalk, which, from its powers of resistance, might present an almost insuperable obstacle. The experience acquired in boring the wells of

Elbeuf, Rouen, and Tours was in this respect but a very imperfect guide. But supposing this obstacle to be overcome, was he sure of finding a supply of water below this mass of chalk? In the first place, the strata C D below the chalk possessed, as we shall see, all the necessary conditions for producing Artesian springs, namely, successive layers of clay and gravel, or of pervious and impervious beds. M. Malot confidently relied on his former experience of the borings of the wells at Rouen, Elbeuf, and Tours, where abundant supplies of water had been found below the chalk, between similar strata of clay and gravel.

But one other condition is requisite to ensure the rising of the water in an Artesian well, namely, that the feeding level of infiltration should be higher than the orifice in the bore above which the water is to ascend. This, however, turned out to be the case with Grenelle. M. Arago had shown that the water of the spring here would necessarily rise to the surface, because in the well at Elbeuf, which is nearly 9 yards above the level of the sea, the water rises from 27 to 29 yards above the surface of the earth. and, consequently, from 36 to 38 yards above the ocean level. Now, as the orifice of the bore at Grenelle is only 34 yards above the same level, it follows, that if the identical spring be met with, the water must rise above the earth's surface at Grenelle.

The necessary works were commenced with boring rods about 9 yards long, attached to each other, and which could be raised or lowered by mechanical power, while an ingenious method was adopted for giving them a rotary motion. The diameter of the bore was about 6 inches. The instrument affixed to the end of the lowest boring rod was changed according to the different strata which were successively attacked; the form suited for passing through the softer materials near the surface being unsuitable for boring through the chalk and flint, as a hollow tube was used for the former, while a chisel-shaped tool was employed to penetrate the latter. The size of the rods was lessened as the depth increased; and, since the subterranean water was not reached so soon as was expected, it became requisite to enlarge five several times the diameter of the bore, in order to permit the work to be successfully prosecuted. Accidents occurred which tried the patience of the projectors. In May, 1837, when the boring had extended down to a depth of 418 yards, the hollow tube, with nearly 90 yards of the long rods attached to it, broke, and fell to the bottom of the hole, whence it became necessary to extract the broken parts before any further progress could be made. The difficulty of accomplishing this task may be conceived; for the different fragments were not all extracted until after the constant labour of 15 months. Again, in April, 1840, in passing through the chalk, the chisel attached to the boring rod got detached, and before it could be recovered, several months were spent in digging round about it. A similar occurrence created an obstacle which impeded the work for 3 months, but, instead of withdrawing the detached part, it was forcibly driven down among the stratum of gravel. At length, in February, 1841, after 8 years' labour, the rods suddenly descended several yards, having pierced into the vault of the subterranean waters so long sought after by the indefatigable engineer. A few hours afterwards, he was rewarded for all his anxious toils; for lo! the water rose to the surface, and discharged itself at the rate of 600,000 gallons per hour!

The depth reached down was 602 yards, or about three times the height of St. Paul's. The pipe by which the water reaches the surface has been recently carried to a height nearly level with the source of supply. The portion of the pipe above the ground is surrounded with a monumental pagoda of ornamental carpentry, and it discharges a circular cascade of clear water continually into a circular iron reservoir, to be thence conveyed by a lateral pipe to the ground. The water is well adapted for all domestic uses, and it will be unfailing, being supplied from the infiltration of a surface of country nearly 200 miles in diameter. The Artesian wells of Elbeuf, Rouen, and Tours, which were formed many years ago, overflow in never varying streams; and the ancient Artesian well at Lillers, in the Pas de Calais, has for about seven centuries furnished a constant and equable supply.

The opportunity of ascertaining the temperature of the earth at different depths, was not neglected during the progress of the works at Grenelle. Thermometers placed at a depth of thirty yards in the wells of the Paris Observatory invariably stand at 53° Fahrenheit. In the well at Grenelle the thermometer indicated 74° F. at a depth of 442 yards, and at 550 yards it stood at 79°. At the depth finally arrived at of 602 yards, the temperature of the water which rose to the surface was 81°, corroborating previous calculations on the subject. For a descent of 572 yards there is an increase of temperature equal to 28° F., which is 20·4 yards, or 61·2 feet for each degree of that scale. Now that the skilful labour of so many years is terminated, the Parisians regret that the subterranean sheet of water had not lain 1000 yards beneath the surface, that they might have had an overflowing stream of water at 104°, to furnish a cheap supply to their numerous hot-bath establishments.

ASPHALTIC PAVEMENT; see BITUMEN.

B.

BALSAM OF CAPIVI, or *Copaiva Balsam.* This substance, which is extensively used in medicine, is often adulterated. Formerly some unctuous oil was mixed with it, but as this is easily discovered by its insolubility in alcohol, castor oil has since been used. The presence of this cheaper oil may be detected, 1. by agitating the balsam with a solution of caustic soda, and setting the mixture aside to repose; when the balsam will come to float clear on the top, and leave a soapy thick magma of the oil below; 2. when the balsam is boiled with water, in a thin film, for some hours, it will become a brittle resin on cooling, but it will remain viscid if mixed with castor oil; 3. if a drop of the oil on white paper be held over a lamp, at a proper distance, its volatile oil will evaporate and leave the brittle resin, without causing any stain around, which the presence of oil will produce; 4. when three drops of the balsam are poured into a watch-glass, alongside of one drop of sulphuric acid, it becomes yellow at the point of contact, and altogether of a saffron hue when stirred about with a glass rod, but if sophisticated with castor oil, the mixture soon becomes nearly colourless like white honey, though after some time the acid blackens the whole in either case; 5. if 3 parts in bulk of the balsam be mixed with 1 of good water of ammonia (of 0·970 sp. grav.) in a glass tube, it will form a transparent solution, if it be pure, but will form a white liniment if it contains castor oil; 6. if the balsam be triturated with a little of the common magnesia alba, it will form a clear solution, from which acids dissolve out the magnesia, and leave the oil transparent if it be pure, but opaque if it be adulterated. When turpentine is employed to falsify the balsam, the fraud is detected by the smell on heating the compound.

BARILLA. Imported in 1841, 2131 tons; in 1842, 2141. Retained for consumption, 2369 and 2139, respectively.

BEER. The Germans from time immemorial have been habitually beer drinkers, and have exercised much of their technical and scientific skill in the production of beer of many different kinds, some of which are little known to our nation, while one at least, called Bavarian, possesses excellent qualities, entitling it to the attention of all brewers and consumers of this beverage. The peculiarities in the manufacture of Bavarian beer have recently attracted the attention of the most eminent chemists in Germany, especially of Professor Liebig, and much new light has thereby been thrown upon this curious portion of vegetable chemistry, which I shall endeavour to reflect upon the present article.

The following is a list of the principal beers at present brewed in Germany.

1. Brown beer of Merseburg; of pure barley malt.
2. — — barley malt and beet-root sugar.
3. — barley malt, potatoes, and beet-root syrup.
4. — refined beet-root syrup alone.
5. Covent or thin beer.
6. Berlin white beer, or the Champagne of the north.
7. Broyhan, a famous Hanoverian beer.
8. Double beer of Grünthal.
9. Bavarian beer; 1. Summer beer; 2. Winter beer.
10. — Bock-beer.
11. Wheat *Lager*-beer (slowly fermented).
12. White bitter beer of Erlangen.

Considerable interest among men of science, in favour of the Bavarian beer process, has been excited ever since the appearance of Liebig's Organic Chemistry, first published about three years ago. In the introduction to this admirable work, he says, "The beers of England and France, and the most part of those of Germany, become gradually sour by contact of air. This defect does not belong to the beers of Bavaria, which may be preserved at pleasure in half-full casks, as well as full ones, without alteration in the air. This precious quality must be ascribed to a peculiar process employed for fermenting the wort, called in German *untergährung*, or fermentation from below; which has solved one of the finest theoretical problems.

"Wort is proportionally richer in soluble gluten than in sugar. * When it is set to ferment by the ordinary process, it evolves a large quantity of yeast, in the state of a thick froth, with bubbles of carbonic acid gas attached to it, whereby it is floated to the surface of the liquid. This phenomenon is easily explained. In the body of the wort along side of particles of sugar decomposing, there are particles of gluten being oxidized

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* It does not surely contain more gluten than it does sugar; at least no experiments, known to me, prove this proposition.

at the same time, and enveloping as it were the former particles, whence the carbonic acid of the sugar and the insoluble ferment from the gluten being simultaneously produced, should mutually adhere. When the metamorphosis of the sugar is completed, there remains still a large quantity of gluten dissolved in the fermented liquor, which gluten, in virtue of its tendency to appropriate oxygen, and to get decomposed, induces also the transformation of the alcohol into acetic acid (vinegar). But were all the matters susceptible of oxidizement as well as this vinegar ferment removed, the beer would thereby lose its faculty of becoming sour. These conditions are duly fulfilled in the process followed in Bavaria.

"In that country the malt-wort is set to ferment in open backs, with an extensive surface, and placed in cool cellars, having an atmospheric temperature not exceeding 8° or 10° centigrade (46½° or 50° F.). The operation lasts from 3 to 4 weeks; the carbonic acid is disengaged, not in large bubbles that burst on the surface of the liquid, but in very small vesicles, like those of a mineral water, or of a liquor saturated with carbonic acid, when the pressure is removed. The surface of the fermenting wort is always in contact with the oxygen of the atmosphere, as it is hardly covered with froth, and as all the yeast is deposited at the bottom of the back under the form of a very viscid sediment, called in German *unterhefe.*

"In order to form an exact idea of the difference between the two processes of fermentation, it must be borne in mind that the metamorphosis of gluten and of azotized bodies in general is accomplished successively in two principal periods, and that it is in the *first* that the gluten is transformed in the interior of the liquid into an insoluble ferment, and that it separates alongside of the carbonic acid proceeding from the sugar. This separation is the consequence of an absorption of oxygen. It is, however, hardly possible to decide if this oxygen comes from the sugar, from the water, or even from an intestine change of the gluten itself, or, in other words, whether the oxygen combines directly with the gluten, to give it a higher degree of oxidation, or whether it lays hold of its hydrogen to form water.

"This oxidation of the gluten, from whichever cause, and the transformation of the sugar into carbonic acid and alcohol, are two actions so correlated, that by an exclusion of the one, the other is immediately stopped."

The *superficial* ferment (*oberhefe* in German) which covers the surface of the fermenting works is gluten oxidized in a state of putrefaction; and the ferment of *deposit* is the gluten oxidized in a state of *érémacausie.*

The surface yeast, or barm, excites in liquids containing sugar and gluten the same alteration which itself is undergoing, whereby the sugar and the gluten suffer a rapid and tumultuous metamorphosis. We may form an exact idea of the different states of these two kinds of yeast by comparing the *superficial* to vegetable matters putrefying at the bottom of a marsh, and the *bottom* yeast to the rotting of wood in a state of *érémacausie*, that is, of slow combustion. The peculiar condition of the elements of the *sediment* ferment causes them to act upon the elements of the sugar in an extremely slow manner, and excites the change into alcohol and carbonic acid, without that of the dissolved gluten.

Sugar, which at ordinary temperatures has no tendency to combine with oxygen, enters in the above predicament into fermentation; but the action is rendered much slower by the low temperature, while the affinity of the dissolved gluten for the oxygen of the air is aided by the contact of the sediment. The superficial yeast may be removed without stopping the fermentation, but the under yeast cannot be removed without arresting all the phenomena of disoxidation of the second period. These would immediately cease; and if the temperature were now raised, they would be succeeded by the phenomena of the first period. The deposit does not excite the phenomena of tumultuous fermentation, for which reason it is totally unfit for panification (bread-baking), while the superficial yeast alone is suitable to this purpose.

If to wort at a temperature of from 46½° to 50° F. the top yeast be added, a quiet slow fermentation is produced, but one accompanied with a rising up of the mass, while yeast collects both at the surface and bottom of the backs. If this deposit be removed to make use of it in other operations, it acquires by little and little the characters of the *unterhefe*, and becomes incapable of exciting the phenomena of the first fermenting period, causing only, at 59° F., those of the second; namely, sedimentary fermentation. It must be carefully observed that the right *unterhefe* is not the precipitate which falls to the bottom of backs in the ordinary fermentation of beer, but is a matter entirely different. Peculiar pains must be taken to get it genuine, and in a proper condition at the commencement. Hence the brewers of Hessia and Prussia, who wished to make Bavarian beer, found it more to their interest to send for the article to Wurtzburg, or Bamberg, in Bavaria, than to prepare it themselves. When once the due primary fermentation has been established and well regulated in a brewery, abundance of the true *unterhefe* may be obtained for all future operations.

In a wort made to ferment at a low temperature with deposit only, the presence of the *unterhefe* is the first condition essential to the metamorphosis of the *saccharum*, but it is not competent to bring about the oxidation of the gluten dissolved in the wort, and its transformation into an insoluble state. This change must be accomplished at the cost of the atmospherical oxygen.

In the tendency of soluble gluten to absorb oxygen, and in the free access of the air, all the conditions necessary for its *érémacausis*, or slow combustion, are to be found. It is known that the presence of oxygen and soluble gluten are also the conditions of acetification (vinegar making), but they are not the only ones; for this process requires a temperature of a certain elevation for the alcohol to experience this slow combustion. Hence, by excluding that temperature, the combustion (oxidation) of alcohol is obstructed, while the gluten alone combines with the oxygen of the air. This property does not belong to alcohol at a low temperature, so that during the oxidation in this case of the gluten, the alcohol exists alongside of it, in the same condition as the gluten alongside of sulphurous acid in the *muted* wines. In wines not impregnated with the fumes of burning sulphur, the oxygen which would have combined at the same time with the gluten and the alcohol does not seize either of them in wines which have been subjected to *mutism*, but it unites itself to the sulphurous acid to convert it into the sulphuric. The action called *sedimentary* fermentation is therefore merely a simultaneous metamorphosis of putrefaction and slow combustion; the sugar and the *unterhefe* putrefy, and the soluble gluten gets oxidized, not at the expense of the oxygen of the water and the sugar, but of the oxygen of the air, and the gluten then falls in the insoluble state. The process of Appert for the preservation of provisions is founded upon the same principle as the Bavarian process of fermentation; in which all the putrescible matters are separated by the intervention of the air at a temperature too low for the alcohol to become oxidized. By removing them in this way, the tendency of the beer to grow sour, or to suffer a further change, is prevented. Appert's method consists in placing in presence of vegetables or meat which we wish to preserve the oxygen at a high temperature, so as to produce slow combustion, but without putrefaction or even fermentation. By removing the residuary oxygen after the combustion is finished, all the causes of an ulterior change are removed. In the sedimentary fermentation of beer, we remove the matter which *experiences* the combustion; whereas, on the contrary, in the method of Appert, we remove that which produces it.

It is uncertain whether the dissolved gluten, in being converted into insoluble yeast by the action of the oxygen, combines directly *with* the oxygen; that is to say, whether the yeast differs from the soluble gluten merely by having absorbed an additional quantity of oxygen. This question is in fact very difficult to solve by analysis. If the gluten be regarded as a hydrogenated combination, it is obvious that in the fermentation of wine-must, and malt-wort, the hydrogen will be carried off by the oxygen, and the action will then be the same as the transformation of alcohol into *aldehyde*. When the contact of the atmosphere is excluded, this oxygen cannot evidently be derived from the elements of the air, or from those of the water; for it cannot be supposed that oxygen will take hydrogen from the water, in order to re-compose water with the hydrogen of the gluten. The elements of the *saccharum* must therefore furnish this oxygen; or in the course of the formation of the yeast, a portion of the sugar will be decomposed; but this decomposition is not of the same kind as that which results from the immediate metamorphosis of the sugar into carbonic acid and alcohol; hence a certain portion of the sugar will afford neither alcohol nor carbonic acid, but it will yield less oxygenated products from its elements. These products occasion the great difference in the qualities of fermented liquors, and particularly in their alcoholic strength. In the ordinary fermentation of grape juice and worts, these liquids do not furnish a quantity of alcohol equivalent to the sugar which they contain, because a certain portion of the sugar serves for the oxidation of the gluten, and is not transformed like the rest. But whenever the liquor has arrived at the second period, the product in alcohol ought to be equivalent to the quantity of sugar present, as happens in all fermentations which are not accompanied with a formation, but a disappearance of the yeast. It is well ascertained that worts furnish in the Bavarian breweries 10 or 20 per cent. more alcohol than they do by the ordinary process of fermentation. It is also a well-established fact that in the manufacture of spirits from potatoes, where no yeast is produced, or merely a quantity corresponding to the proportion of barley malt added to the potato-wort, a quantity of alcohol may be produced, as also of carbonic acid, corresponding exactly to the quantity of carbon in the fecula employed. But, on the contrary, in the fermentation of beet-root juice, it is hardly possible to determine precisely, from the quantity of carbonic acid evolved, the quantity of sugar contained in the beets, for there is always less carbonic acid than the juice of the fresh root would furnish. In equal volumes, the beer made by the *unterhefe* process contains more alcohol, and is therefore more heady than that formed by the ordinary process.

The temperature at which fermentation is carried on has a very marked influence upon the quantity of alcohol produced. It is known that the juice of beets set to ferment between 86° and 95 Fahr. does not yield alcohol, and its sugar is replaced by a less oxygenated substance, *mannite*, and lactic acid, resulting from the mucilage. In proportion as the temperature is lowered the mannite fermentation diminishes. As to azotized juices, however, it is hardly possible to define the conditions under which the transformation of the sugar will take place, without being accompanied with another decomposition which modifies its products. The fermentation of beer by *deposit* demonstrates that by the simultaneous action of the oxygen of the air and a low temperature, the metamorphosis of sugar is effected in a complete manner; for the vessels in which the operation is carried on are so disposed that the oxygen of the air may act upon a surface great enough to transform all the gluten into insoluble yeast, and thus to present to the sugar a matter constantly undergoing decomposition. The oxidizement of the dissolved gluten goes on, but that of the alcohol requires a higher temperature; whence it cannot suffer eremacausis, that is, acetification, or conversion into vinegar.

At the beginning of the fermentation of must and wort, the quantity of matter undergoing change is obviously the largest. All the phenomena which accompany it, the disengagement of gas and the rise of temperature, are most active at this period, and in proportion as the decomposition advances, the external signs of it become less perceptible, without, however, disappearing completely before the transformation has reached its limit. The slow and continuous decomposition which succeeds to the rapid and violent disengagement of gases is denominated the *after* or *complementary* fermentation. For wine and beer it lasts till all the sugar has disappeared, so that the specific gravity of the liquors progressively diminishes during several months. This slow fermentation is in most cases a truly depositary fermentation; for by the progressive decomposition of the lees, the sugar still in solution gets completely transformed; but when the air is excluded, that decomposition does not occasion the complete separation of the azotized matters in an insoluble shape.

In several states of the German confederation, the favourable influence of a rational process of fermentation upon the quality of the beers has been fully recognised. In the Grand Duchy of Hesse considerable premiums were proposed for the brewing of beer according to the process pursued in Bavaria, which were decreed to those brewers who were able to prove that their product (neither strong nor highly hopped) had kept six months in the casks without becoming at all sour. When the first trials were being made several thousand barrels were spoiled, till eventually experience led to the discovery of the true practical conditions which theory had foreseen and prescribed.

Neither the richness in alcohol, nor in hops, nor both combined, can hinder ordinary beer from getting tart. In England, says Liebig, an immense capital is sacrificed to preserve the better sorts of ale and porter from souring, by leaving them for several years in enormous tuns quite full, and very well closed, while their tops are covered with sand. This treatment is identical with that applied to wines to make them deposit the wine-stone. A slight transpiration of air goes on in this case through the pores of the wood; but the quantity of azotized matter contained in the beer is so great, relatively to the proportion of oxygen admitted, that this element cannot act upon the alcohol. And yet the beer thus managed will not keep sweet more than two months in smaller casks to which air has access. The grand secret of the Munich brewers is to conduct the fermentation of the wort at too low a temperature to permit of the acetification of the alcohol, and to cause all the azotized matters to be completely separated by the intervention of the oxygen of the air, and not by the sacrifice of the sugar. It is only in March and October that the good store beer is begun to be made in Bavaria.

In our ordinary breweries, the copious disengagement of carbonic acid from the frothy top of the fermenting tuns and gyles prevents the contact of oxygen from the worts; so that, as the gluten cannot be oxidized by the air, it attracts oxygen from the sugar, and thus gives rise to several adventitious hydrogenated products, just as the fetid oil is generated in the rapid fermentation of spirit wash by the distillers. In this case no inconsiderable portion of the gluten remains undecomposed in the beer, which, by its extreme proneness to corruption, afterwards attracts oxygen greedily from the air, and, at temperatures above 52°, imparts this *contact action* to the alcohol, and, by a species of infection, changes it into vinegar. Indeed, in most of the rapid fermentations a portion of vinegar is formed, which itself serves as an acetous ferment to the rest of the alcohol: whereas the result of the *bottom* fermentation is a beer free from vinegar, and certainly hardly a trace of gluten; so that it does not possess the conditions requisite to intestine change or deterioration. This perfection is, however, in my opinion, rarely attained. In my several journeys into Germany I have met with much spurious or ill-made Bavarian beer. The best contains, when brought to England, a little acid, but no perceptible gluten on the addition of ammonia in excess. Most of our beers, ales, &c., deposit more or less gluten when thus treated.

The following Table exhibits the results of the chemical examination of the undermentioned kinds of beer: —

Name of the Beer.	Quantity in 100 parts by weight.				Analyst.
	Water.	Malt extr.	Alcohol.	Carb. acid.	
Augustine double-beer — Munich - -	88·36	8·0	3·6	0·14	Kaiser.
Salvator beer — do. - -	87·62	8·0	4·2	0·18	Do.
Bock-beer from the Royal brewery — do. -	88·64	7·2	4·0	0·16	Do.
Schenk (pot) beer, from a Bavarian country brewery; a kind of small beer -	92·94	4·0	2·9	0·16	Do.
Bock-beer of Brunswick, of the Bavarian kind -	88·50	6·50	5·0	- -	Balhorn.
Lager (store) beer, of Brunswick, of the Bavarian kind	91·0	5·4	3·50	- -	Otto.
Brunswick sweet small beer	84·70	14·0	1·30	- -	Do.
Brunswick mum - -	59·2	39·0	1·80	0·1	Kaiser.

Malting in Munich. — The barley is steeped till the acrospire, embryo, or seed-germ, seems to be quickened; a circumstance denoted by a swelling at the end of that ear which was attached to the foot-stalk, as also when, on pressing a pile between two fingers against the thumb nail, a slight projection of the embryo is perceptible. As long, however, as the seed-germ sticks too firm to the husk, it has not been steeped enough for exposure on the underground malt floor. Nor can deficient steeping be safely made up for afterwards by sprinkling the malt-couch with a watering-can, which is apt to render the malting irregular. The steep-water should be changed repeatedly, according to the degree of foulness and hardness of the barley; first, six hours after immersion, having previously stirred the whole mass several times; afterwards, in winter, every twenty-four hours, but in summer every twelve hours. It loses none of its substance in this way, whatever vulgar prejudice may think to the contrary. After letting off the last water from the stone cistern, the Bavarians leave the barley to drain in it during four or six hours. It is now taken out, and laid on the couch floor, in a square heap, eight or ten inches high, and it is turned over, morning and evening, with dexterity, so as to throw the middle portion upon the top and bottom of the new-made couch. When the acrospire has become as long as the grain itself, the malt is carried to the *withering* (*welkboden*) or drying floor, in the open air, where it is exposed (in dry weather) during from eight to fourteen days, being daily turned over three times with a winnowing shovel. It is next dried on a well-constructed cylinder or flue-heated malt-kiln, at a gentle clear heat, without being browned in the slightest degree, while it turns friable into a fine white meal. Smoked malt is entirely rejected by the best Bavarian brewers. Their malt is dried on a series of wove-wire horizontal shelves, placed over each other; up through whose interstices or perforations streams of air, heated to only 122° Fahr., rise, from the surfaces of rows of hot sheet-iron pipe-flues, arranged a little way below the shelves. Into these pipes the smoke and burned air of a little furnace on the ground are admitted. The whole is enclosed in a vaulted chamber, from whose top a large wooden pipe issues, for conveying away the steam from the drying malt. Each charge of malt may be completely dried on this kiln in the space of from eighteen to twenty-four hours, by a gentle uniform heat, which does not injure the diastase, or discolour the farina.*

The malt for store-beer should be kept three months at least before using it, and be freed by rubbing and sifting from the acrospires before being sent to the mill, where it should be crushed pretty fine. The barley employed is the best *distichon* or common kind, styled *hordeum vulgare.*

The hops are of the best and freshest growth of Bavaria, called the fine *spalter*, or *saatser Bohemian townhops*, and are twice as dear as the best ordinary hops of the rest of Germany. They are in such esteem as to be exported even into France.

The Bavarians are so much attached to the beer beverage, which they have enjoyed from their remotest ancestry, that they regard the use of distilled spirits, even in moderation, as so immoral a practice, as to disqualify dram-drinkers for decent society.

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* I have a set of designs of the Bavarian kiln, but I believe the above description will make its construction sufficiently intelligible.

Their government has taken great pains to improve this national beverage, by encouraging the growth of the best qualities of hops and barley. The vaults in which the beer is fermented, ripened, and kept are all underground, and mostly in stony excavations, called *felsenkeller* or rock-cellars. The beer is divided into two sorts, called *summer* and *winter*. The latter is light, and, being intended for immediate retail in tankards, is termed *schankbier*. The other, or the *lagerbier*, very sensibly increases in vinous strength in proportion as it decreases in sweetness, by the judicious management of the *nachgährung*, or fermentation in the casks. In several parts of Germany a keeping quality is communicated to beers by burning sulphur in the casks before filling them, or by the introduction of sulphite of lime. But the flavour thus imparted is disliked in Munich, Bayreuth, Regensburg, Nürnberg, Hof, and the other chief towns of Bavaria; instead of which a preservative virtue is sought for in an aromatic mineral or Tyrol *pitch*, with which the inside of the casks are carefully coated, and in which the ripe beer is kept and exported. In December and January, after the casks are charged with the summer or store-beer, the double doors of the cellars are closed, and lumps of ice are piled up against them, to prevent all access of warm air. The cellar is not opened till next August, in order to take out the beer for consumption. In these circumstances the beer becomes transparent like champagne wine; and, since but little carbonic acid gas has been disengaged, little or none of the additionally generated alcohol is lost by evaporation.

The winter or schank (pot) beer is brewed in the months of October, November, March, and April; but the summer or store-beer in December, January, and February, or the period of the coldest weather. For the former beer, the hopped worts are cooled down only to from 51° to 55°, but for the latter to from 41° to 42½° Fahr. The winter beer is also a little weaker than the summer beer, being intended to be sooner consumed; since four bushels * (Berlin measure) of fine, dry, sifted malt, of large heavy *hordeum vulgare distichon*, affords seven *eimers* of winter beer, but not more than from five and a half to six of summer beer.† At the second infusion of the worts, small beer is obtained to the amount of twenty quarts from the above quantity of malt. For the above quantity of winter beer, six pounds of middling hops are reckoned sufficient; but for the summer beer, from seven to eight pounds of the finest hops. The winter beer may be sent out to the publicans in barrels five days after the fermentation has been completed in the tuns, and, though not quite clear, it will become so in the course of six days: yet they generally do not serve it out in pots for two or three weeks. But the summer beer must be perfectly bright and still before it is racked off into casks for sale.

Statement of the Products of a Brewing of Bavarian Beer. — The quantity brewed is 41 Munich eimers (64 *maass*) = 85⅓ Berlin quarts; and 60 Berlin quarts = 1 eimer; or 24 Munich barrels (of 100 Berlin quarts each); 1 Munich eimer = 15 gallons Imperial. The beer contains from 50 to 60 parts, by weight, of dry saccharum in 1000 parts.

Expenditure.

	Thaler.	*Slbg.*
24 Berlin bushels of white kiln-dried barley, rather finely crushed, weighing from 12 to 13 cwts. - - -	24	0
36 pounds of new fine *spalter* (parted) hops at 46 thalers the cwt. -	16	17
½ pound of Carageen moss, for clarifying - - -	0	3
1 quart of yeast.		
1 quart of Tyrol pitch - - - - -	11	0
Mash — tax (in Bavaria and Prussia) upon 12 cwt. malt, at the rate of 20 *silbergroschen* = 2*s*., the cwt. - - -	8	0
Cost of crushing - - - - -	1	0
Fuel - - - - - -	4	0
Wages of labour, in the brewhouse and vault - -	6	0
Do. do. for cooper in pitching the casks - -	3	0
Sundry small expenses - - - -	2	10
Or 11*l.* 8*s.*	76	0
1 *thaler* = 30 *silbergroschen* = 3 shillings.		
Deduct for the grains of 12 cwt. of malt, at 10 *silbergroschen*, or 1*s.* per cwt. = 4 *thalers*, and for the value in yeast produced = 2 *thalers* more - - - - -	6	0
Total neat expenditure = 10*l.* 10*s.* - - -	70	0

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* An English quarter of grain is equal to 5 bushels (*scheffel*) and nearly one-third Prussian measure.

† 1 Eimer Prussian = 15¼ English Imperial gallons; one Munich *scheffel* is equal to four Berlin *scheffels*, 1 Lib. Munich = 1·235 *Eng. lbs. Avoird.*; 1 Lib. Berlin = 1·031 *lbs. Avoird.*

This cost for 42 eimers (1 eimer = 14¾ galls. Imp.) = 619½ gallons = 17·2 London porter barrels, amounts to 4½*d.* per gallon, or 12*s.* 2*d.* per barrel. By the above reckoning, a good profit accrues to the brewer, after allowing a liberal sum for the rent of premises, interest of capital, &c.

He has less profit from the summer beer. For a brewing of 33 eimers = 505 gallons Imp., containing from 60 to 65 pounds of saccharum in 1000 pounds of the beer, by Hermstaedt's saccharometer.

Expenditure.

	Thaler.	*Slbg.*
24 Berlin scheffels of white kiln-dried barley malt, weighing from 12 to 13 centners *	24	0
48 Berlin pounds of fresh Bavarian fine hops, at 46 thaler per centner	20	0
½ pound of Carageen moss	0	3
1 quart setting yeast (*unterhefe*).		
1 centner pitch	11	0
Malt tax on 12 centners	8	0
Crushing the malt	1	0
Fuel	4	0
Wages, 6 thalers; coopers' do., 3 thalers; and sundries, 3 th. 27 sq.	12	27
	81	0
Deduct for grains 4 thalers, and yeast 2 thalers	6	0
Neat cost	75	0

This cost of 11*l.* 5*s.* for 505 gallons amounts to fully 5⅓*d.* per gallon, and 16*s.* 6*d.* per barrel.

The cost at Munich is 2½ thalers the eimer, and 4 thalers the barrel. The eimer of the summer beer, or *lagerbier*, is sold for 4 thalers. The publicans there, as in London, are known to add more or less water to their beer before retailing it.

The yeast (*unterhefe*) is carefully freed by a scraper from the portions of light top yeast that may have fallen to the bottom; the true *unterhefe* is then carefully sliced off from the slimy sediment on the wood.

In Munich the malt is moistened slightly 12 or 16 hours before crushing it, with from 2 to 3 *maas*† of water for every bushel; the malt being well dried, and several months old. The mash-tun into which the malt is immediately conveyed is, in middle-sized breweries, a round oaken tub, about 4½ feet deep, 10 feet in diameter at bottom and 9 at top, outside measure, containing about 6000 Berlin quarts. Into this tun cold water is admitted late in the evening, to the amount of 25 quarts for each *scheffel*, or 600 quarts for the 24 *scheffels* of the ground malt, which are then shot in and stirred about and worked well about with the oars and rakes, till a uniform pasty is formed without lumps. It is left thus for three or four hours; 3000 quarts of water being put into the copper, and made to boil; and 1800 quarts are gradually run down into the mash-tun, and worked about in it, producing a mean temperature of 142·5° Fahr. After an hour's interval, during which the copper has been kept full, 1800 additional quarts of water are run into the tun, with suitable mashing. The copper being now emptied of water, the mash-mixture from the tun is transferred into it, and brought quickly to the boiling point, with careful stirring to prevent its setting on the bottom and getting burned, and it is kept at that temperature for half an hour. When the mash rises by the ebullition, it needs no more stirring. This process is called, in Bavaria, boiling the thick mash, *dickmaisch kochen.* The mash is next returned to the tun, and well worked about in it. A few barrels of a thin mash-wort are kept ready to be put into the copper the moment it is emptied of the thick mash. After a quarter of an hour's repose the portion of liquid filtered through the sieve part of the bottom of the tun into the wort-cistern is put into the copper, thrown back boiling hot into the mash in the tun, which is once more worked thoroughly.

The copper is next cleared out, filled up with water, which is made to boil for the after or small beer brewing. After two hours settling in the open tun, the worts are drawn off clear.

Into the copper, filled up one foot high with the wort, the hops are introduced, and the mixture is made to boil during a quarter of an hour. This is called *roasting the hops.* The rest of the wort is now put into the copper, and boiled along with the hops during at least an hour or an hour and a half. The mixture is then laded out through the hop-filter into the cooling cistern, where it stands three or four inches deep, and is exposed upon an extensive surface to natural or artificial currents of cold air, so as to

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* 1 Centner = 110 Prussian pounds = 113·44 lbs. Avoird.

† A Bavarian *maas* = 1¼ quarts English measure.

be quickly cooled. For every 20 barrels of lagerbier, there are allowed 10 of small beer; so that 30 barrels of wort are made in all.

For the winter or pot-beer the worts are brought down to about 59° Fahr. in the cooler, and the beer is to be transferred into the fermenting tuns at from 54·5° to 59° Fahr.; for the summer or *lagerbier*, the worts must be brought down in the cooler to from 43° to 45½°, and put into the fermenting tuns at to from 41° to 43° Fahr.

A few hours beforehand, while the wort is still at the temperature of 63½° Fahr., a quantity of *lobb* must be made, called *vorstellen* (*fore-setting*) in German, by mixing the proportion of *unterhefe* (yeast) intended for the whole brewing with a barrel or a barrel and a half of the worts, in a small tub called the *gähr-tiene*, stirring them well together, so that they may immediately run into fermentation. This *lobb* is in this state to be added to the worts. The *lobb* is known to be ready when it is covered with a white froth from one quarter to one half an inch thick; during which it must be well covered up. The large fermenting tun must in like manner be kept covered, even in the vault. The colder the worts, the more yeast must be used. For the above quantity, at

From 57° to 59° Fahr.,	6	*maas of unterhefe.*
53° to 55°	8	—
48° to 50°	10	—
41° to 33°	12	—

Some recommend that wort for this kind of fermentation (the *untergährung*) should be set with the yeast at from 48° to 57°; but the general practice at Munich is to set the summer *lager* beer at from 41° to 43° F.

By following the preceding directions, the wort in the tun should, in the course of from twelve to twenty-four hours, exhibit a white froth round the rim, and even a slight whiteness in the middle. After another twelve to twenty-four hours, the froth should appear in curls; and, in a third like period, these curls should be changed into a still higher frothy brownish mass. In from twenty-four to forty-eight hours more, the barm should have fallen down in portions through the beer, so as to allow it to be seen in certain points. In this case it may be turned over into the smaller ripening tuns in the course of other five or six days. But when the worts have been set to ferment at from 41° to 43° Fahr., they require from eight to nine days. The beer is transferred, after being freed from the top yeast by a skimmer, by means of the stopcock near the bottom of the large tun. It is either first run into an intermediate vessel, in order that the top and bottom portions may be well mixed, or into each of the *lager* casks, in a numbered series, like quantities of the top and bottom portions are introduced. In the ripening cellars the temperature cannot be too low. The best keeping beer can never be brewed unless the temperature of the worts at setting, and of course the fermenting vault, be as low as 50° F. In Bavaria, where this manufacture is carried on under government inspectors, a brewing period is prescribed by law, which is, for the under fermenting *lager* beer, from Michaelmas (29th September) to St. George (23d April). From the latter to the former period the ordinary top-barm beer alone is to be made. The ripening casks must not be quite full, and they are to be closed merely with a loose bung, in order to allow of the working over of the ferment. But should the fermentation appear too languid, after six or eight days, a little briskly fermenting *lager* beer may be introduced. The *store* lager beer tuns are not to be quite filled, so as to prevent all the yeasty particles from being discharged in the ripening fermentation; but the *pot* lager beer tuns must be made quite full, as this beverage is intended for speedy sale within a few weeks of its being made.

As soon as the summer-beer vaults are charged with their ripening casks, and with ice-cold air, they are closed air-tight with triple doors, having small intervals between, so that one may be entered and shut again, before the next is opened. These vaults are sometimes made in ranges radiating from a centre, and at others in rooms set off at right angles to a main gallery; so that in either case, when the external opening is well secured, with triple air-tight doors, it may be entered at any time, in order to inspect the interior, without the admission of warm air to the beer-barrels. The wooden bungs for loosely stopping them must be coated with the proper pitch, to prevent the possibility of their imparting any acetous ferment. In the *Beer Brewer** of A. F. Zimmermann, teacher of theoretical and practical brewing, who has devoted thirty-five years to this business, it is stated, that a ripened tun of lager or store-beer must be racked off all at once, for when it is left half full it becomes flat (*schaal*); and that the tun of pot *lager* beer must, if possible, be all drunk off in the same day it is tapped; because on the following day the beer gets an unpleasant taste, even when the bung has not been taken out, but only a small hole has been made, which is opened only at the time of drawing the beer, and is immediately closed again with a

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* *Der Eier-Brauer*, als Meister in seinem fache, &c., illustrated with many plates, Berlin, 1842.

spigot. He ascribes this change to the loss of the carbonic acid gas, with which the beer has got strongly impregnated during the latter period of its ripening, while being kept in tightly-bunged casks. The residuums in these casks are, however, bottled up in Bavaria, whereby the beer, after some time, recovers its brisk and pungent taste. But the beer-topers in Bavaria, who are professedly very numerous, indulge so delicate and fastidious a palate, that when assembled in their favourite pot-house, they wait impatiently for the tapping of a fresh cask, and cease for a while to tipple whenever it is half empty, puffing the time away with their pipes till another fresh tap be made. In the well-frequented beer-shops of Munich a common-sized cask of *lager* beer is thus drunk off in an hour. A reputation for superior brewing is there the readiest road to fortune.

Bock Beer of Bavaria.—This is a favourite double strong beverage, of the best *lager* description, which is so named from causing its consumers to prance and tumble about like a buck or a goat; — for the German word *bock* has both these meanings. It is merely a beer having a specific gravity one-third greater, and is therefore made with a third greater proportion of malt, but with the same proportion of hops, and flavoured with a few coriander seeds. It has a somewhat darker colour than the general *lager* beer, occasionally brownish, taste less bitter on account of the predominating malt, and somewhat aromatic. It is an eminently intoxicating beverage. It is brewed in December and January, and takes a long time to ferment and ripen; but still it contains too large a quantity of unchanged *saccharum* and *dextrine* for its hops, so that it tastes too luscious for habitual topers, and is drunk only from the beginning of May till the end of July, when the fashion and appetite for it are over for the year.

Statement of a Brewing of Bavarian Bock Beer.

For 41 Bavarian eimers of 64 maass each (about 15 gallons Imperial) per *eimer*, or 615 gallons, nearly 17 barrels English in all: —

Expenditure.

	Thaler.	*Slbg.*
32 Berlin scheffels of the best pale malt freed from its acrospires, weighing 17½ centners, at 1 thaler per centner	32	0
48 lbs. (Berlin) of the best Bavarian hops	20	0
½ lb. Carageen moss for clarifying	0	3
1 lb. Coriander seeds	0	1½
1 Quart setting yeast.		
1 Centner Tyrolese pitch	11	0
Malt-tax	11	20
Malt-crushing, fuel, wages, coopering, &c.	16	5½
Thalers of 3*s.* each	91	0
Deduct for the value of grains and yeast	7	0
Thalers of neat cost	84	0

This statement makes the eimer of the Bavarian bock-beer amount to about 2 thalers, or 6 shillings; being at the rate of nearly 5 pence per gallon; though without counting rent, interest of capital, or profit. It is, in fact, a malt or barley sweet wine or *liqueur*; but a very cheap one, as we see by this computation.

The chief difference in the process for making bock-beer lies in the mash-worts, and in the hops being boiled a shorter time, to preserve more of the aroma, and acquire less of the bitterness of the hop. The coriander seeds are coarsely bruised, and added along with the hops and Carageen moss, to the boiling mash-worts, about twenty or thirty minutes before they are laded or drawn off, into the mash-tun. Sometimes the hops are boiled apart in a little clear wort, as formerly described. The bock-beer is retailed in Munich at 3 silver groschen, about 3½*d.* the *seidel*, or pot, which is one English pint. The 25 gallon cask (*tonne*) is sold at 10 thalers, or 30 shillings. The publicans, therefore, have a very remunerating profit per pot, even supposing that they do not reduce the beer with water like our London craftsmen.

Zimmermann assumes the merit of having introduced Carageen moss as a clarifier into the beer manufacture. I do not know whether it may not have been used in this country for the same purpose, or in Ireland, where this *fucus* (*Chondra crispa*) grows abundantly. He says that 1 ounce of it is sufficient for 25 gallons of beer; and that it operates, not only in the act of boiling with the hops, but in that of cooling, as also in the squares and backs before the fermentation has begun. Whenever this change, however, takes place, the commixture throws up the gluten and moss to the surface of the liquid in a black scum, which is to be skimmed off, so that the proper yeast may not be soiled with it. It occasions the separation of much of the vegetable slime, or mucilage, called by the German brewers *pech* (pitch).

On the Clarifying or Clearing of Beers.—Clarifiers act either chemically,—by being soluble in the beer, and by forming an insoluble compound with the vegetable gluten, and other viscid vegetable extracts; gelatine and albumen, under one shape or other, have been most used; the former for beer, the latter, as white of egg, for wine,—or mechanically, by being diffused in fine particles through the turbid liquor, and, in their precipitation, carrying down with them the floating vegetable matters. To this class belong sand, bone-black (in some measure, but not entirely), and other such articles. The latter means are very imperfect, and can take down only such matters as exist already in an insoluble state; of the former class, milk, blood, glue, calf's-foot jelly, hartshorn shavings, and isinglass, have been chiefly recommended. Calves'-feet jelly is much used in many parts of Germany, where veal forms so common a kind of butcher-meat; but in summer it is apt to acquire a putrid taint, and to impart the same to the beer. In these islands, isinglass swollen and partly dissolved in vinegar, or sour beer, is almost the sole clarifier, called finings, employed. It is costly, when the best article is used; but an inferior kind of isinglass is imported for the brewers. The solvent or medium through or with which it is administered is eminently injudicious, as it never fails to infect the beer with an acetous ferment. In Germany their tart wine has been used hitherto for dissolving the isinglass; and this has also the same bad property. Mr. Zimmermann professes to have discovered an unexceptionable solvent in tartaric acid, one pound of which dissolved in 24 quarts of water is capable of dissolving two pounds of ordinary isinglass; forming finings which may be afterwards diluted with pure water at pleasure. Such isinglass imported from Petersburg into Berlin costs there only 3*s.* per lb. These finings are best added, as already mentioned, to the worts prior to fermentation, as soon as they are let in to the setting-back or tun, immediately after adding the yeast to it. They are best administered by mixing them in a small tub with thrice their volume of wort, raising the mixture into a froth with a whisk (*twig-besom*, in German), and then stirring it into the worts. The clarification becomes manifest in the course of a few hours, and when the fermentation is completed, the beer will be as brilliant as can be wished; the test of which with the German topers is when they can read a newspaper while a tall glass beaker of beer is placed between the paper and the candle. One quart of finings of the above strength will be generally found adequate to the clearing of 100 gallons of well-brewed lager-beer, though it will be surer to use double that proportion of finings. The Carageen moss, as finings, is to be cut in fine shreds, thrown into the boiling thin wort, when the flocks begin to separate, and before adding the hops; after which the boiling is continued for an hour and a half or two hours, as need be. The clarifying with this kind of finings takes place in the cooler, so that a limpid wort may be drawn off into the fermenting back.

Berlin White or Pale Beer (*Weiss-bier*).—This is the truly patriotic beverage of Prussia Proper, and he is not deemed a friend to his *Vaterland* who does not swig it. It is brewed from 1 part of barley malt and 5 parts of wheat malt, mingled, moistened, and coarsely crushed between rollers. This mixture is worked up first with water at 95° Fahr., in the proportion of 30 quarts per *scheffel* of the malt, to which pasty mixture 70 quarts of boiling water are forthwith added, and the whole is mashed in the tun. After it has been left here a little to settle, a portion of the thin liquor is drawn off by the tap, transferred to the copper, and then for each bushel of malt there is added to it a decoction of half a pound of *Altmark* hops separately prepared. This hopped wort, after half an hour's boiling, is turned back with the hops into the mash-tun, of which the temperature should now be 162½° Fahr., but not more. In half an hour the wort is to be drawn off from the grains, and pumped into the cooler. The grains are afterwards mashed with from 40 to 50 quarts of boiling water per *scheffel* of malt, and this infusion is drawn off and added to the former worts. The whole mixture is set at 66° Fahr., with a due proportion of top yeast or ordinary barm, and very moderately fermented. According to Zimmermann, a very competent judge, this his native beer is very apt to turn sour, and therefore it must be very speedily consumed. This proneness to acetification is the character of all wheat-malt beers. He recommends, what he himself has made for many years, a substitution of potato-starch sugar for this sort of malt, and as much tartaric acid as to give the degree of tartness peculiar to the pale Berlin beer, even in its best state. This acid moreover prevents the beer from running into the acetous fermentation.

Potato Beer.—The potatoes being well washed are to be rubbed down to a pulp by such a grating cylinder machine as is represented in *fig.* 5., where *a* is the hopper for receiving the roots (whether potato or beet, as in the French sugar factories); *b* is the crushing and grinding drum; *c*, the handle for turning the spur-wheel *d*, which drives the pinion *e*, and the fly-wheel *f*; *g*, *h*, is the frame. The dotted lines above *c*, are the

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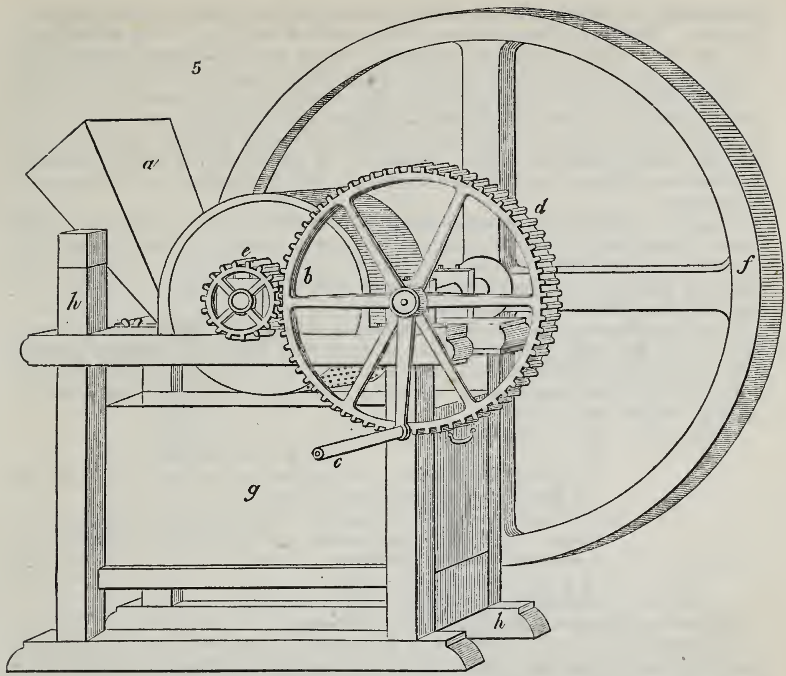
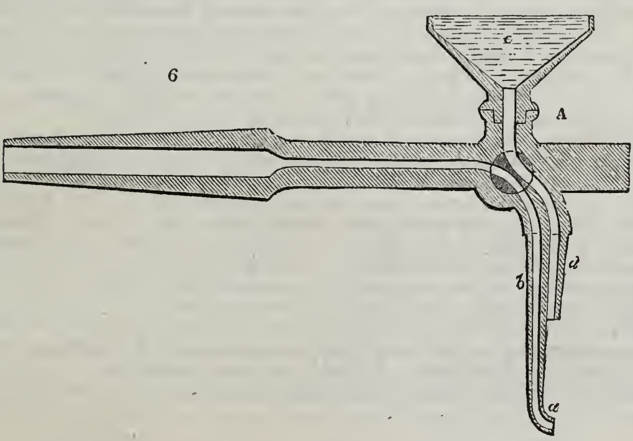


cullender through which the pulp passes. *Fig.* 6. is the stopcock used in Bavaria for bottling beer. For every scheffel of potatoes 80 quarts of water are to be put with them into the copper, and made to boil.

6



Crushed malt, to the amount of 12 scheffels, is to be well worked about in the mash-tun with 360 quarts, or 90 gallons (English), of cold water, to a thick pap, and then 840 additional quarts, or about 6 barrels (English), of cold water are to be successively introduced with constant stirring, and left to stand an hour at rest.

The potatoes having been meanwhile boiled to a fine starch paste, the whole malt-mash, thin and thick, is to be speedily laded into the copper, and the mixture in it is to be well stirred for an hour, taking care to keep the temperature at from 144° to 156° Fahr. all the time, in order that the *diastase* of the malt may convert the starch present in the two substances into sugar and dextrine. This transformation is made manifest by the white pasty liquid becoming transparent and thin. Whenever this happens the fire is to be raised, to make the mash boil, and to keep it at this heat for 10 minutes. The fire is then withdrawn, the contents of the copper are to be transferred into the mash, worked well there, and left to settle for half an hour; during which time the copper is to be washed out, and quickly charged once more with boiling water.

The clear wort is to be drawn off from the top of the tun, as usual, and boiled as soon as possible with the due proportion of hops; and the boiling water may be added in any desired quantity to the drained mash, for the second mashing. Wort made in this way is said to have no flavour whatever of the potato, and to clarify more easily than malt-wort, from its containing a smaller proportion of gluten relatively to that of saccharum.

A scheffel of good mealy potatoes affords from 26 to 27½ pounds of thick well-boiled syrup, of the density of 36° Baumé (*see* Areometer in the Dictionary); and 26 lbs. of such syrup are equivalent to a scheffel of malt in saccharine strength. Zimmermann thinks beer so brewed from potatoes quite equal, at least, if not superior, to pure malt beer, both in appearance and quality.

Porter and Brown Stout. — I offer the following statement of the process for brewing genuine London porter, believing it to be more near that really practised than any formula hitherto published.

For 180 barrels of brown stout, containing from 80 to 85 parts of malt extract in 1000 by weight: —

Components. — 530 bushels (English measure) of good barley malt.
10 do. of kiln-browned malt.
12 cwt. of *Essentia-bina, Caramel,* or sugar fused over a fire into a dark brown or black syrupy mass.
1500 lbs. of hops, or about 3 pounds to each bushel of malt.
10 quarts of *Calfini,* a preparation made with the oil distilled from the outer bark of the birch.
5 quarts of good porter yeast.
finings of isinglass dissolved in sour beer.

For the brewing process see Beer in the Dictionary.

The *essentia-bina* may be dissolved in hot worts in a separate copper, and mixed with the rest by running it into the cooler, immediately after the boiled wort is strained from the hops in the hop-back. The *Calfini* (a *hocus-pocus* term of the brewers) is prepared as follows: —

Put one ounce of birch-bark oil into a bottle with 4 quarts of spirits of wine 60 per cent. over proof; cork the mouth of the bottle, and place it in a slightly warm position till the oil be thoroughly combined with the alcohol, with the aid of occasional shaking. This solution being cooled is to be filtered through paper, and kept for use. The birch oil is an empyreumatic product made in large quantities in Russia and Poland, for the purpose of giving flavour and conservative properties to the Russia leather. It is sold for one shilling the quart. The dose of *Calfini* in porter is varied according to the taste of the brewers and consumers. See Appendix.

In concluding this supplementary article, I take occasion to refer my readers to the *Practical Treatise on Brewing,* by Mr. William Black, a gentleman experienced in the business, who has the merit of discovering the evil influence of galvanic combinations in the metallic parts of the fermenting backs and the beer tuns in our breweries. This little work contains much useful information. I have pleasure also in announcing that Messrs. Beamish and Crawford, the eminent porter brewers of Cork, have taken measures to establish the manufacture of genuine Bavarian beer on the best principles; having, with this view, caused their intelligent head brewer, Mr. Topp, to study the practical details of brewing in Munich. They have recently produced excellent brown stout, equal, if not superior, to any in London, by means of the Bavarian fermentation. It is nearly free from gluten, and will therefore prove light and wholesome to weak stomachs. It needs no finings to clarify it.

Professor Leo of Munich has given the following analysis of two kinds of Munich beer: —

	Bock-bier.	Heiliger Vater.
Specific gravity -	1·020	1·030
Alcohol - -	4·000	5·000
Extract - -	8·200	13·500
Carbonic acid -	0·085	0·077
Water - - -	87·393	81·923
	100·000	100·000

Carl states the alcohol in the Bavarian beer of Bamberg at only 2·840 in 100 Extract, 6·349.

The following analyses of other German beers are also by Leo : —

	Lichtenhain.	Upper Weimar.	Ilmenau.	Jena.	Double Jena.
Alcohol - -	3·168	2·567	3·096	3·018	2·080
Albumen - -	0·048	0·020	0·079	0·045	0·028
Extract - -	4·485	7·316	7·072	6·144	7·153
Water - -	92·299	90·097	89·753	90·793	90·739
	100·000	100·000	100·000	100·000	100·000

Under the term extract, in these analyses, is meant a mixture of starch, sugar, dextrine, lactic acid, various salts, certain extractive and aromatic parts of the hop, gluten, and fatty matter.

The following statement is from some of the published analyses of other beers : —

	Alcohol.
English ale - - - -	8·5 in 100
Burton - - - -	6·2
Scotch - - - -	5·8
Common London ale - - -	5·0
Brown stout - - - -	5·0
London porter - - -	4·0

To the above I add the following analyses of certain ales made lately by myself, as follows : —

1. After exposing a portion of the liquor in a wine glass till the bubbles of carbonic acid were disengaged, I took the specific gravity in a globe with a capillary bored stopper.

2. I then saturated 5000 grain measures of the ale with a test solution of pure carbonate of soda, to determine the quantity of acid present, after which I added an excess of the alkali to precipitate the gluten; which, however, being but small in amount, I did not separate by a filter, dry, and weigh.

3. I subjected the supersaturated liquid to distillation by the heat of 230° F. in a chlor-zinc bath till I drew off all its alcohol, of which I noted the quantity in water grain measures, and the specific gravity.

4. I evaporated to dryness 500 water grain measures slowly in a porcelain capsule, to determine the extract.

	Bavarian.	Do. Bock.	Allsop's.	Bass's.
Specific gravity -	1·004	1·013	1·010	1·006
Alcohol - -	4·00	4·50	6·00	7·00
Extract - -	4·50	6·40	5·00	4·80
Acetic acid - -	0·20	0·20	0·20	0·18
Water - - -	91·30	88·90	88·80	88·02
	100·00	100·00	100·00	100·00

The Bavarian beers had been recently imported from Germany in casks lined with pitch. The two samples of English ale are those made chiefly for the Indian market, but, being highly hopped, and comparatively clean, as the brewers say, have been recommended as a tonic beverage by the faculty. Hodgson's bitter beer was the original of this quality.

The above Bavarian beers afford no precipitate of gluten with carbonate of potash; the two English ales become mottled thereby, and yield a small portion of gluten, which had been held in solution by the acid, which is here estimated as the acetic. Common vinegar, excise strength, contains 5 per cent. of such acid as is stated in the above analysis, indicating from 3 to 4 per cent. of table vinegar in the above varieties of beer.

BICARBONATE OF POTASH AND OF SODA. These salts, so much used in medicine, may, according to M. Behrens, be very readily prepared by gradually adding acetic acid to a strong solution of their carbonates; that of soda being hot. The carbonic acid, at the moment of its disengagement, by the stronger affinity of the acetic for the alkalis, combines with a portion of them to form bicarbonates, which fall to the bottom of the vessel in which the mixture is made. The supernatant acetate being separated by decantation, the residuary bicarbonate is to be pressed in linen, washed with ice-cold water, and dried. This ingenious process may be practised by the chamber chemist, but will not afford the bicarbonates at so cheap a rate as the ordinary modes of manufacture.

BIRDLIME. All the parts of the misletoe contain a peculiar viscid gluey substance, which they yield by decoction, particularly of the bark and green portions; as also from the expressed juice of the bark or berries, when it is kneaded with the fingers under water. The birdlime is thus obtained in the form of a white opaque mass, sticking to the fingers. It may also be extracted from the berries of the misletoe by means of ether, repeatedly applied, digested with them. It dissolves at first a mixture of green wax and birdlime, but afterwards birdlime alone. By distilling off the ether, the birdlime remains colourless and pure. Birdlime may be considered as a kind of viscid resin which does not dry, and resembling in this respect an ointment of oil or lard and rosin melted together — the old *basilicon* of the surgeon. Alcohol, even boiling hot, dissolves hardly any birdlime; but merely its waxy impurities, which it deposits in flocks on cooling. It is soluble in the oils of rosemary and turpentine, as also in petroleum. Heated with the ley of caustic potash, it forms a compound soluble in alcohol. Nitric acid converts it into oxalic acid, and into a fat which solidifies.

Macaire has examined a substance which exudes from the receptacle and involucre of the *atractylis gummifera*, and describes it as the pure matter of birdlime, which he styles *viscine*. It is said to be composed in 100 parts of 75·6 carbon, 9·2 hydrogen, and 15·2 oxygen. Common birdlime may be regarded as a mixture of viscine, vegetable mucilage, and vinegar. The young shoots of the *ficus elastica* afford a milky juice, which is viscine, while the old branches afford a juice rich in caoutchouc.

BISCUITS. For the following account of the mechanical system of baking biscuits for the royal navy, I am indebted to the ingenious inventor, Thos. Grant, Esq. of Gosport.

Ships' biscuits are now made by machinery; and one of the reasons for this has been that the manual preparation of them was too slow and too costly during the last war. A landsman knows very little of the true value of a biscuit: with a seaman, biscuit is the only bread that he eats for months together. There are many reasons why common loaves of bread could not be used during a long voyage: because, containing a fermenting principle, they would soon become musty and unfit for food, if made previous to the voyage; while the preparation of them on board ship is subject to insuperable objections. Biscuits contain no leaven, and, when well baked throughout, they suffer little change during a long voyage.

The allowance of biscuit to each seaman on board a queen's ship is a pound per day (averaging six biscuits to the pound). The supply of a man-of-war for several months is, consequently, very large; and it often happened during the last war that the difficulty of making biscuits fast enough was so great, that at Portsmouth waggon loads were unpacked in the streets and conveyed on board ships.

We shall now describe the mode of making biscuits by hand; and afterwards speak of the improved method. The bakehouse at Gosport contained nine ovens, and to each was attached a gang of five men — the "turner," the "mate," the "driver," the "breakman," and the "idleman." The requisite proportions of flour and water were put into a large trough, and the "driver," with his naked arms, mixed the whole up together into the form of dough — a very laborious operation. The dough was then taken from the trough and put on a wooden platform called the break: on this platform worked a lever called the break-staff, five or six inches in diameter, and seven feet long; one end of this was loosely attached by a kind of staple to the wall, and the breakman, riding, or sitting, on the other end, worked this lever to and fro over the dough, by an uncouth jumping or shuffling movement. When the dough had become kneaded by this barbarous method into a thin sheet, it was removed to the moulding-board, and cut into slips by means of an enormous knife; these slips were then broken into pieces, each large enough for one biscuit, and then worked into a circular form by the hand. As each biscuit was shaped it was handed to a second workman, who stamped the king's mark, the number of the oven, &c., on the biscuit. The biscuit was then docked, that is, pierced with holes by an instrument adapted to the purpose. The finishing part of the process was one in which remarkable dexterity was displayed. A man stood before the open door of the oven, having in his hand the handle of a long shovel called a peel, the other end of which was lying flat in the oven. Another man took the biscuits as fast as they were formed and stamped, and jerked or threw them into the oven with such undeviating accuracy that they should always fall on the peel. The man with the peel then arranged the biscuits side by side over the whole floor of the oven. Nothing could exceed (in manual labour alone) the regularity with which this was all done. Seventy biscuits were thrown into the oven and regularly arranged in one minute; the attention of each man being vigorously directed to his own department; for a delay of a single second on the part of any one man would have disturbed the whole gang. The biscuits do not require many minutes' baking; and as the oven is kept open during the time that it is being filled, the biscuits first thrown in would be overbaked were not some precaution taken to prevent it. The moulder therefore made those which were to be first thrown into the oven larger than the subsequent ones, and diminished the size by a nice gradation.

The mode in which, since about the year 1831, ships' biscuits have been made by machinery invented by T. T. Grant, Esq., of the Royal Clarence Yard, is this: the meal or flour is conveyed into a hollow cylinder four or five feet long and about three feet in diameter, and the water, the quantity of which is regulated by a guage admitted to it; a shaft, armed with long knives, works rapidly round in the cylinder, with such astonishing effect that, in the short space of three minutes, 340 pounds of dough are produced, infinitely better made than that mixed by the naked arms of a man. The dough is removed from the cylinder and placed under the breaking-rollers; these latter, which perform the office of kneading, are two in number, and weigh 15 cwt. each; they are rolled to and fro over the surface of the dough by means of machinery, and in five minutes the dough is perfectly kneaded. The sheet of dough, which is about two inches thick, is then cut into pieces half a yard square, which pass under a second set of rollers, by which each piece is extended to the size of six feet by three, and reduced to the proper thickness for biscuits. The sheet of dough is now to be cut up into biscuits, and no part of the operation is more beautiful than the mode by which this is accomplished. The dough is brought under a stamping or cutting-out press, similar in effect, but not in detail, to that by which circular pieces for coins are cut out of a sheet of metal. A series of sharp knives are so arranged that, by one movement, they cut out of a piece of dough a yard square about sixty hexagonal biscuits. The reason for a hexagonal (six-sided) shape is, that not a particle of waste is thereby occasioned, as the sides of the hexagonals accurately fit into those of the adjoining biscuits; whereas circular pieces cut out of a large surface always leave vacant spaces between. That a flat sheet can be divided into hexagonal pieces without any waste of material is obvious.

Each biscuit is stamped with the queen's mark, as well as punctured with holes by the same movement which cuts it out of the piece of dough. The hexagonal cutters do not sever the biscuits completely asunder; so that a whole sheet of them can be put into the oven at once on a large peel or shovel adapted for the purpose. About fifteen minutes are sufficient to bake them; they are then withdrawn and broken asunder by the hand.

The corn for the biscuits is purchased at the markets, and cleaned, ground, and dressed, at the government mills; in quality it is a mixture of fine flour and middlings, the bran and pollard being removed. The ovens for baking are formed of fire-brick and tile, with an area of about 160 feet. About 112 lbs. weight of biscuits are put into the ovens at once. This is called a suit, and is reduced to about 110 lbs. by the baking. From twelve to sixteen suits can be baked in each oven every day, or after the rate of 224 lbs. per hour. The men engaged are dressed in clean check shirts and white linen trowsers, apron, and cap; and every endeavour is made to observe the most scrupulous cleanliness.

We may now make a few remarks on the comparative merits of the hand and the machine processes. If the meal and the water with which the biscuits are made be not thoroughly mixed up, there will be some parts moister than others. Now, it was formerly found that the dough was not well mixed by the arms of the workman; the consequence of which was that the dry parts became burnt up, or else that the moist parts acquired a peculiar kind of hardness which the sailors called "flint:" these defects are now removed by the thorough mixing and kneading which the ingredients receive by the machine.

We have seen that 450 lbs. of dough may be mixed by the machine in four minutes, and kneaded in five or six minutes; we need hardly say how much quicker this is than men's hands could effect it. The biscuits are cut out and stamped sixty at a time, instead of singly: besides the time thus saved, the biscuits become more equally baked, by the oven being more speedily filled. The nine ovens at Gosport used to employ 45 men to produce about 1500 lbs. of biscuit per hour; 16 men and boys will now produce, by the same number of ovens, 2240 lbs. of biscuits (one ton) per hour.

The comparative expense is thus stated: — Under the old system, wages, and wear and tear of utensils, cost about 1*s.* 6*d.* per cwt. of biscuit: under the new system, the cost is 5*d.*

The bakehouses at Deptford, Gosport, and Plymouth, could produce 7000 or 8000 tons of biscuits annually, at a saving of 12,000*l.* per annum from the cost under the old system. The advantages of machine-made over hand-made biscuits, therefore, are many: quality, cleanliness, expedition, cheapness, and independence of government contractors.

Fig. 7. represents the biscuit machinery, as executed beautifully by Messrs. Rennie,

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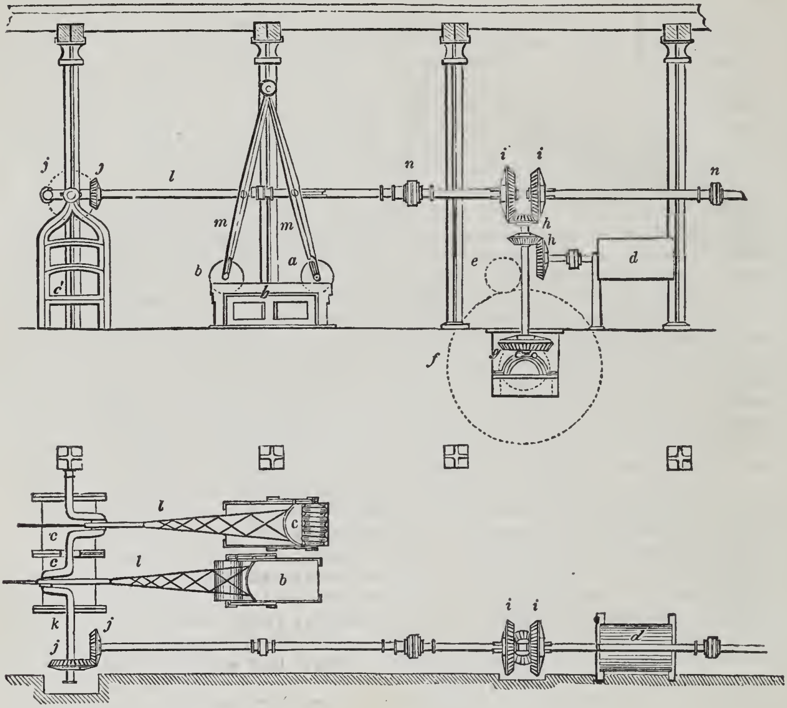

Engineers. *a* is the breaking roller, table and roller; *b*, the finishing roller, table and roller; *c*, *c*, docking machines for stamping out the biscuits; *d*, mixing machine for making the dough; *e*, spur pinion to engine shaft; *f*, spur-wheel; *g*, *g*, bevel mitre-wheels to give the upright motion; *h*, *h*, bevel-wheels for working the mixing machine; *i*, *i*, *i*, ditto for communicating motion to the rolling machines *j*, *j*; *k*, the crank shaft; *l*, *l*, connecting rods; *m*, *m*, pendulums for giving motion to rollers; *n*, *n*, clutches for connecting either half of the machinery to the other.

BITUMEN. It is a very remarkable fact, in the history of the useful arts, that asphalt, which was so generally employed as a solid and durable cement in the earliest constructions upon record, as in the walls of Babylon, should for so many thousand years have fallen well nigh into disuse among civilised nations. For there is certainly no class of mineral substance so well fitted as the bituminous, by their plasticity, fusibility, tenacity, adhesiveness to surfaces, impenetrability by water, and unchangeableness in the atmosphere, to enter into the composition of terraces, foot-pavements, roofs, and every kind of hydraulic work. Bitumen, combined with calcareous earth, forms a compact, semi-elastic solid, which is not liable to suffer injury by the greatest alternations of frost and thaw, which often disintegrate in a few years the hardest stone, nor can it be ground to dust and worn away by the attrition of the feet of men and animals, as sandstone, flags, and even blocks of granite are. An asphalt pavement, rightly tempered in tenacity, solidity, and elasticity, seems to be incapable of suffering abrasion in the most crowded thoroughfares; a fact exemplified of late in a few places in London, but much more extensively, and for a much longer time, in Paris.

The great Place de la Concorde (formerly Place Louis Quinze) is covered with a beautiful mosaic pavement of asphalte; many of the promenades on the Boulevards, formerly so filthy in wet weather, are now covered with a thin bed of bituminous mastich, free alike from dust and mud; the foot-paths of the Pont Royal and Pont Carousel, and the areas of the great public slaughter-houses, have been for several years paved in a similar manner with perfect success. It is much to be regretted that the Asphalt Companies of London made the ill-judged, and nearly abortive, attempt to pave the carriage-way near the east end of Oxford Street, and especially at a moist season, most unpropitious to the laying of bituminous mastich. Being formed of blocks not more than three or four inches thick, many of which contained much siliceous sand, such a pavement could not possibly resist the crash and vibration of many thousand heavy drays, waggons, and omnibuses daily rolling over it.* This failure can afford, however, no argument against rightly-constructed foot-pavements and terraces of asphalt. Numerous experiments and observations have led me to conclude that fossil bitumen possesses far more valuable properties, for making a durable mastich, than the solid pitch obtained by boiling wood or coal tar. The latter, when inspissated to a proper degree of hardness, becomes brittle, and may be readily crushed into powder; while the former, in like circumstances, retains sufficient tenacity to resist abrasion. Factitious tar and pitch being generated by the force of fire, seem to have a propensity to decompose by the joint agency of water and air, whereas mineral pitch has been known to remain for ages without alteration.

Bitumen alone is not so well adapted for making a substantial mastich as the native compound of bitumen and calcareous earth, which has been properly called asphaltic rock, of which the richest and most extensive mine is unquestionably that of the *Val-de-Travers,* in the canton of Neufchâtel. This interesting mineral deposit occurs in the Jurassic limestone formation, the equivalent of the English oolite. The mine is very accessible, and may be readily excavated by blasting with gunpowder. The stone is massive, of irregular fracture, of a liver-brown colour, and is interspersed with a few minute spangles of calcareous spar. Though it may be scratched with the nail, it is difficult to break by the hammer. When exposed to a very moderate heat it exhales a fragrant ambrosial smell, a property which at once distinguishes it from all compounds of factitious bitumen. Its specific gravity is 2·114, water being 1000, being nearly the density of bricks. It may be most conveniently analysed by digesting it in successive portions of hot oil of turpentine, whereby it affords 80 parts of a white pulverulent carbonate of lime, and 20 parts of bitumen in 100. The asphalt rock of Val-de-Travers seems therefore to be far richer than that of Pyrimont, which, according to the statement in the specification of Claridge's patent, of November, 1837, contains "carbonate of lime and bitumen in about the proportion of 90 parts of carbonate of lime to about 10 parts of bitumen."

The calcareous matter is so intimately combined and penetrated with the bitumen, as to resist the action not only of air and water for any length of time, but even of muriatic acid; a circumstance partly due to the total absence of moisture in the mineral, but chiefly to the vast incumbent pressure under which the two materials have been incorporated in the bowels of the earth. It would indeed be a difficult matter to combine, by artificial methods, calcareous earth thus intimately with bitumen, and for this reason the mastichs made in this way are found to be much more perishable. Many of the factitious asphalt cements contain a considerable quantity of siliceous sand, from which they derive the property of cracking and crumbling down when trodden upon. In fact, there seems to be so little attraction between siliceous matter and bitumen, that their parts separate from each other by a very small disruptive force.

Since the asphalt rock of Val de Travers is naturally rich enough in concrete bitumen, it may he converted into a plastic workable mastic of excellent quality for foot pavements and hydraulic works at very little expense, merely by the addition of a very small quantity of mineral or coal tar, amounting to not more than 6 or 8 per cent. The union between these materials may be effected in an iron caldron, by the application of a very moderate heat, as the asphalt bitumen readily coalesces with the tar into a tenacious solid.

The mode adopted for making the beautiful asphalt pavement at the Place de la Concorde in Paris was as follows: — The ground was made uniformly smooth, either in a horizontal plane or with a gentle slope to carry off the water; the curb-stones were then laid round the margin by the mason, about 4 inches above the level of the ground. This hollow space was filled to a depth of 3 inches with concrete, containing about a sixth part of hydraulic lime, well pressed upon its bed. The surface was next smoothed with a thin coat of mortar. When the whole mass had become perfectly dry, the mosaic pattern was set out on the surface, the moulds being formed of flat iron bars, rings, &c. about half an inch thick, into which the fluid mastic was poured by ladles from a cauldron, and spread evenly over.

The mastic was made in the following way: — The asphalt rock was first of all roasted in an oven, about 10 feet long and 3 broad, in order to render it friable.

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* See the conclusion of this article.

The bottom of the oven was sheet iron, heated below by a brisk fire. A volatile matter exhaled, probably of the nature of naptha, to the amount of one-fortieth the weight of asphalt; after roasting, the asphalt became so friable as to be easily reduced to powder, and passed through a sieve, having meshes about one-fourth of an inch square.

The bitumen destined to render the asphalt fusible and plastic, was melted in small quantities at a time, in an iron cauldron, and then the asphalt in powder was gradually stirred in to the amount of 12 or 13 times the weight of bitumen. When the mixture became fluid, nearly a bucketful of very small, clean gravel, previously heated apart, was stirred into it; and, as soon as the whole began to simmer with a treacley consistence, it was fit for use. It was transported in buckets, and poured into the moulds.

For the reasons above assigned, I consider this addition of rounded, polished, siliceous stones to be very injudicious. If any thing of the kind be wanted to give solidity to the pavement, it should be a granitic or hard calcareous sand, whose angular form will secure the cohesion of the mass. I conceive, also, that tar, in moderate quantity, should be used to give toughness to the asphaltic combination, and prevent its being pulverised and abraded by friction.

In the able report of the Bastenne and Gaujac Bitumen Company, drawn up by Messrs. Goldsmid and Russell, these gentlemen have made an interesting comparison between the properties of mineral tar and vegetable tar: the bitumen composed of the latter substance, including various modifications extracted from coal and gas, have, so far as they were able to ascertain, entirely failed. This bitumen, owing to the qualities and defects of vegetable tar, becomes soft at 115° of Farenheit's scale, and is brittle at the freezing point; while the bitumen, into which mineral tar enters, will sustain 170° of heat, without injury. In the course of the winter, 1837-38, when the cold was at 14½° below Zero, C., the bitumen of Bastenne and Gaujac, with which one side of the Pont Neuf at Paris is paved, was not at all impaired, and would, apparently, have resisted any degree of cold; while that in some parts of the Boulevard, which was composed of vegetable tar, cracked and opened in white fissures. The French Government, instructed by these experiments, has required, when any of the vegetable bitumens are laid, that the pavement should be an inch and a quarter thick; whereas, where the bitumen composed of mineral tar is used, a thickness of three-quarters of an inch is deemed sufficient. The pavement of the bonding warehouse at Bordeaux has been laid upwards of 15 years by the Bastenne Company, and is now in a condition as perfect as when first formed. The reservoirs constructed to contain the waters of the Seine at Batignolles, near Paris, have been mounted 6 years, and, notwithstanding the intense cold of the winter of 1837, which froze the whole of their contents into one solid mass, and the perpetual water pressure to which they are exposed, they have not betrayed the slightest imperfection in any point. The repairs done to the ancient fortifications at Bayonne, have answered so well, that the Government, 2 years ago, entered into a very large contract with the company for additional works, while the whole of the arches of the St. Germain and St. Cloud railways, and the pavements and floorings necessary for these works, are being laid with the Bastenne bitumen.

The mineral tar in the mines of Bastenne and Gaujac is easily separated from the earthy matter with which it is naturally mixed by the process of boiling, and is then transported in barrels to Paris or London, being laid down in the latter place to the company at 17*l.* per ton, in virtue of a monopoly of the article purchased by the company at a sum, it is said, of 8000*l.*

Mr. Harvey, the able superintendent of the Bastenne Company, was good enough to supply me with various samples of mineral tar, bitumen, and asphaltic rock for analysis. The tar of Bastenne is an exceedingly viscid mass, without any earthy impurity. It has the consistence of baker's dough at 60° of Fahrenheit; at 80° it yields to the slightest pressure of the finger; at 150 degrees it resembles a soft extract; and at 212 degrees it has the fluidity of molasses. It is admirably adapted to give plasticity to the calcareous asphalts.

A specimen of Egyptian asphalt which he brought me, gave, by analysis, the very same composition as the Val de Travers, namely, 80 per cent. of pure carbonate of lime, and 20 of bitumen. A specimen of mastich, prepared in France, was found to consist, in 100 parts, of 29 of bitumen, 52 of carbonate of lime, and 19 of siliceous sand. A portion of stone called the natural Bastenne rock, afforded me 80 parts of gritty siliceous matter and 20 of thick tar. The Trinidad bitumen contains a considerable portion of foreign earthy matter; one specimen having yielded me 25 per cent. of siliceous sand; a second, 28; a third, 20; and a fourth, 30: the remainder was pure pitch. One specimen of Egyptian bitumen, specific gravity 1·2, was found to be perfectly pure, for it dissolved in oil of turpentine without leaving any appreciable residuum.

Robinson's Parisian Bitumen Company use a mastich made with the pitch obtained from boiling coal tar mixed with chalk. One piece laid down by this company at Knightsbridge and another at Brighton, are said to have gone to pieces. The portion of pavement laid down by them in Oxford Street, next Charles Street, has been taken up. Claridge's Company have laid down their mastich under the archway of the Horse-Guards, and in the carriage entrance at the Ordnance Office; the latter has cracked at the junction with the old pavement of Yorkshire curb-stone. The foot-pavement laid down by Claridge's Company at Whitehall has stood well. The Bastenne Company has exhibited the best specimen of asphalt pavement in Oxford Street; they have laid down an excellent piece of foot-pavement near Northumberland House; a piece, 40 feet by 7, on Blackfriars' Bridge; they have made a substantial job in paving 830 superficial feet in front of the Guard-room at Woolwich, which, though much traversed by foot-passengers, and beat by the guard in grounding arms, remains sound; lastly, the floor of the stalls belonging to the cavalry barracks of the Blues at Knightsbridge, is probably the best example of asphaltic pavement laid down in this country, as it has received no injury from the beating of the horses' feet.

As the specific gravity of properly made mastich is nearly double that of water, a cubic foot of it will weigh from 125 to 130 lbs.; and a square foot, three quarters of an inch thick, will weigh very nearly eight pounds. A ton of it will therefore cover 280 square feet. The prices at which the Bastenne Bitumen Company sell their products is as follows: —

Pure Mineral tar, 24*l.* per ton, or 28*s.* per cwt.
Mastich 8*l.* 8*s.* per ton, or 10*s.* per cwt.

From	to	Side Pavement.		Roofs and Terraces.
50	100 feet,	1*s.* 3*d.* per foot.	-	1*s.* 6*d.* per foot.
100	250	1*s.* 1*d.* -	-	1*s.* 4*d.*
250	500	11*d.* -	-	1*s.* 1*d.*
500	750	10*d.* -	-	1*s.* 0*d.*
750	1000	9*d.* -	-	11*d.*
1000	2000	8*d.* -	-	10*d.*
2000	5000	7*d.* -	-	9*d.*

Where the work exceeds 5000 feet, contracts may be entered into.

For filling up joints of brickwork, &c., from 1*d.* to $1\frac{1}{4}$*d.* per foot, run according to quantity.

These prices are calculated for half an inch thickness, at which rate a ton will cover 420 square feet.

As the Val de Travers Company engage to lay down their rich asphaltic rock in London at 5*l.* per ton; and as a mineral tar equal to that of Seissel may probably be had in England at one fourth of the price of that foreign article, they may afford to lay their mastich three quarters of an inch thick per the thousand feet, including a substratum of concrete, at a rate of fivepence a square foot, instead of fifteenpence, being the rate charged under that condition by the Bastenne Company.

These charges are for London and its immediate vicinity.

Report of the experimental Pavements laid down in Oxford Street, from Charles Street to Tottenham Court Road, January, 1839.

1. Robinson's Parisian bitumen, laid in blocks 12 inches square and 5 inches deep; the substance is a compound of bitumen, lime, &c., and five granite stones are inserted in the top of each block; the work is laid in straight courses, the joints cemented with hot bitumen. The quantity of this is 97 square yards, the length is 20 feet, and the price, if adopted, 9*s.* per square yard.

2. Same as 1, but the courses laid diagonally. The quantity is 97 square yards, the length is 20 feet.

3. Granite paving, 9 inches deep, jointed with Claridge's asphalte, the work laid in straight courses. The cost to the parish has been 11*s.* 7*d.* per yard superficial for the stone and laying, &c., no charge being made by Claridge's Company for the asphalte. The quantity is 240 yards, the length 54 feet.

4. Granite paving, $4\frac{1}{2}$ inches deep, jointed with Claridge's asphalte, the work laid in diagonal courses. Cost to the parish 9*s.* 6*d.* per square yard. No charge made for the asphalte. The quantity is 88 square yards, the length 20 feet.

5. The Bastenne Bitumen Company. The blocks are 12 inches long, $6\frac{1}{4}$ wide, and $3\frac{3}{4}$ deep, with bevelled joints, close at bottom, and $\frac{1}{2}$ inch open at top; the joints cemented with hot bitumen; the substance is bituminous, with a very large proportion of granite imbedded in each block; the price, if adopted, 13*s.* 6*d.* per square yard; the length, in straight courses, 20 feet.

6. Same as 5, but the courses laid diagonally. The length 40 feet; the total quantity in 5 and 6 is 274 square yards.

7. Aberdeen granite paving, 9 inches deep; laid on a concrete bottom, formed of gravel and lime, the joints of the pavement run with hot lime grout, in straight courses. The length is 69 feet; cost, 16*s.* 5*d.* per square yard.

8. Same as 7, but the courses laid diagonally; length, 38 feet.

9. Aberdeen granite paving, 9 inches deep, in straight courses, without a concrete bottom; joints filled with fine gravel; cost, 12*s.* 5*d.* per yard; length, 24 feet.

10. The Scotch Asphaltum Company. The work is laid in blocks of divers length, 9 inches wide, and 6½ deep; the side joints are straight, the end joints are bevelled alternately. The work is laid in straight courses, and jointed in Roman cement; the substance is, apparently, a bituminous matter mixed with fine gravel. The length is 50 feet: the number of square yards, 210; the price, per yard, if adopted, 13*s.* 6*d.*

11. The wood paving. The blocks are sexagon on the plan, and (with the exception of a few courses that are only 8 inches), 12 inches deep. The work is laid endways of the grain; the blocks are mostly 8 inches diameter — a few courses are 7 inches. The material is Norway fir; there is no prepared bottom — the blocks are laid on the plain ground, a small layer of gravel being spread to bed them in. From the west end, 22 rows of courses of blocks are of wood in its natural state; 31 rows have been Kyanised; 9 rows at the eastern end have been dipped in Claridge's asphalte; 6 rows have been dipped in a solution prepared by the patentee; the remainder are of wood in the natural state. The length of this piece is 60 feet: the number of yards, 230; price per yard, if approved, 10*s.* 6*d.*

12. Val-de-Travers Company. Blocks in straight courses, 12 inches square, 5 inches deep, with square joints. The substance of the blocks is bituminous, with a very large proportion of granite imbedded in each block, the joints cemented with hot bitumen. The length is 25 feet; number of square yards 94; the work is performed gratuitously.

13. The same company. A layer of clean chippings and hot asphalt poured thereon. The face up with hot asphalt and broken stone imbedded therein. The length is 25 feet: number of yards, 94; the work is gratuitous.

14. Same as 9. The length 47 feet.

By order of the Committee,
H. Kensett, Chairman.

Statement of the Number of Carriages passing through Oxford Street at the undernamed Times and Places.

Date 1839.	Time.	Place.	Gents. 2-Wheel.	Gents 4-Wheel.	Omnibuses.	2 Wheel Hackney Carriages.	4-Wheel Hackney Carriages.	Stage Coaches.	Waggons, Drays, &c.	Light Carts and Sundries.	Total.
Jan. 16.	6 in the morning till 12 at night.	by the Pantheon.	347	935	890	621	752	91	372	1507	5515
18.	do.	by Stratford Place.	254	603	1213	401	728	89	472	993	4753
22.	do.	by Newman Street.	339	1241	1015	584	1288	85	958	1382	6992
26.	do.	by Stratford Place.	371	666	1337	542	762	92	881	1292	5943
26.	12 at night till 6 in the morning.	do.	—	4	1	82	139	2	38	58	324

BLACK DYE. The mordant much employed in some parts of Germany for this dye, with logwood, galls, sumach, &c., is *Iron-Alum*, so called on account of its having the crystalline form of alum, though it contains no alumina. It is prepared by dissolving 78 pounds of red oxide of iron in 117 pounds of sulphuric acid, diluting this compound with water, adding to the mixture 87 pounds of sulphate of potash, evaporating the solution to the crystallizing point. This potash-sulphate of iron has a fine amethyst colour when recently prepared; and though it gets coated in the air with a yellowish crust, it is none the worse on this account. As a mordant, a solution of this salt, in from 6 to 60 parts of water, serves to communicate and fix a great variety of uniform ground colours, from light grey to brown, blue, or jet black, with quercitron, galls, logwood, sumach, &c., separate or combined. The above solution may be usefully modified by adding to every 10 pounds of the *iron-alum*, dissolved in 8 gallons (80 pounds) of warm water, 10 pounds of acetate (sugar) of lead, and leaving the mixture, after careful stirring, to settle. Sulphate of lead falls, and the oxide of iron remains combined with the acetic acid and the potash. After passing through the above mordant, the cotton goods should be quickly dried.

BLACK PIGMENT. A fine lamp-black is obtained by the combustion of a thick torch of coal-gas, supplied with a quantity of air adequate to burn only its hydrogen. In this case, the whole of its carbon is deposited in the form of a very fine black powder of extreme lightness. This black is used in making the better qualities of printers' ink.

BLACKING FOR SHOES. (*Cirage des bottes*, Fr.; *Schuhschwärze.*) The following prescription for making liquid and paste blacking is given by William Bryant and Edward James, under the title of a patent, dated December, 1836. Their improvement consists in the introduction of caoutchouc, with the view, possibly, of making the blacking, waterproof: —

18 ounces of caoutchouc are to be dissolved in about 9 pounds of hot rape oil. To this solution 60 pounds of fine ivory black, and 45 pounds of molasses, are to be added, along with 1 pound of finely ground gum arabic, previously dissolved in 20 gallons of vinegar, of strength No. 24. These mixed ingredients are to be finely triturated in a paint mill till the mixture becomes perfectly smooth. To this varnish 12 pounds of sulphuric acid are to be now added in small successive quantities, with powerful stirring for half an hour. The blacking thus compounded is allowed to stand for 14 days, it being stirred half an hour daily; at the end of which time, 3 pounds of finely ground gum arabic are added; after which the stirring is repeated half an hour every day for 14 days longer, when the liquid blacking is ready for use.

In making the paste blacking, the patentees prescribe the above quantity of India rubber oil, ivory black, molasses, and gum arabic, the latter being dissolved in only 12 pounds of vinegar. These ingredients are to be well mixed, and then ground together in a mill till they form a perfectly smooth paste. To this paste 12 pounds of sulphuric acid are to be added in small quantities at a time, with powerful stirring, which is to be continued for half an hour after the last portion of the acid has been introduced. This paste will be found fit for use in about 7 days.

BLEACHING OF PAPER. The following are the proportions of liquid chloride of lime, at 10° of Gay Lussac's *Chlorometre*, employed for the different sorts of rags, consisting of 2 piles, or 200 pounds French.

Cotton.		litres.
No. 1.	Fine cotton rags	10
2.	Clean calicoes	12
3.	———	14
4.	White dirty calico, coarse cotton	16
5.	Coarse cotton	18
6.	Grey, No. 1.	20
	—— No. 2.	22
	Saxon grey	24
	——— No. 2.	26
	Pale white and half-white shades	28
	Saxon blues; pale pink, dark blue, velvet	32

It is considered to be much better to bleach the fine rags with liquid chloride of lime, and not with chlorine gas, because they are less injured by the former, and afford a paper of more nerve, less apt to break, and more easily sized. But the coarse or grey rags are much more economically bleached with the gaseous chlorine, without any risk of weakening the fibre too much. Bleaching by the gas is performed always upon the sorted rags, which have been boiled in an alkaline lye, and torn into the fibrous state. They are subjected to the press, in order to form them into damp cakes, which are broken in pieces and placed in large rectangular wooden cisterns. The chlorine gas is introduced by tubes in the lid of the cistern, which falls down by its superior gravity, acting always more strongly upon the rags at the bottom than those above.

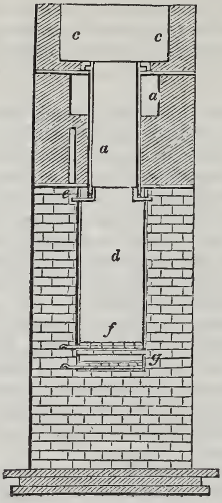
When the chlorine, disengaged from 150 kilogrammes (330 lbs.) of manganese and 500 kilos. of muriatic acid, is made to act upon 2,500 kilos. of the stuff (supposed dry), it will have completed its effect in the course of a few hours. The quantity of gaseous chlorine is equal to what is contained in the quantity of chloride of lime requisite to produce a like bleaching result. The bleached stuff should be forthwith carefully washed, to remove all the muriatic acid produced from the chlorine; for if any of this remain in the paper, it destroys lithographic stones, and weakens common ink.

BONE BLACK, or animal charcoal *restored.* A process for this purpose was made the subject of a patent by Messrs. Bancroft and Mac Innes of Liverpool, which consists in washing the granular charcoal, or digesting it when finely ground, with a weak solution of potash or soda, of specific gravity 1·06. The bone black which has been used in sugar refining may be thus restored, but it should be first cleared from all the soluble filth by means of water.

Mr. F. Parker's method, patented in June 1839, for effecting a like purpose, is, by a fresh calcination, as follows: —

Fig. 8. represents a front section of the furnace and retort; and *fig.* 9. is a transverse vertical section of the same. *a* is a retort, surrounded by the flues of the furnace *b* ; *c* is a hopper or chamber, to which a constant fresh supply of the black is furnished, as the preceding portion has been withdrawn, from the lower part of *a*. *d* is the cooling vessel, which is connected to the lower part of the retort *a* by a sand joint, *e*. The cooler *d* is made of thin sheet iron, and is large ; its bottom is closed with a slide plate, *f*. The black, after passing slowly through the retort *a* into the vessel *d*, gets so much cooled by the time it reaches *f*, that a portion of it may be safely withdrawn, so as to allow more to fall progressively down ; *g* is the charcoal-meter, with a slide door.

9



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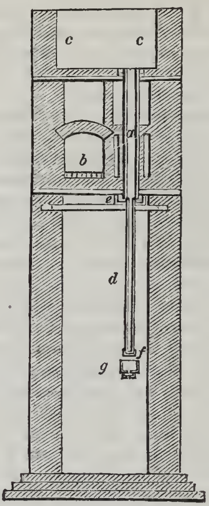

BOOKBINDING, *Mechanical* ; — An ingenious invention, for which Mr. Thomas Richards, of Liverpool, Bookbinder, obtained a patent in April, 1842. He employs, 1st, a mechanism to sew, weave, or bind a number of sheets together to form a book, instead of stitching them by hand; 2dly, a table which slides to and fro to feed or supply each sheet of paper separately into his machine; also needle bars, or holders, to present needles with the requisite threads, for stitching such sheets as they are supplied with in succession. He has, moreover, a series of holding fingers, or pincers, suitably provided with motions, to enable them to advance and clasp the needles, draw them through the sheets of paper, and return them into their respective holders, after threading or stitching the sheet; lastly, there are arms or levers for delivering each sheet regularly upon the top of the preceding sheets, in order to form a collection or book of such sheets, ready for boarding and finishing. A minute description of the whole apparatus, with plates, is given in *Newton's Journal*, C. S .xxiii. 157.

BORACIC ACID. Imported for consumption in 1839, 1,243,868 lbs.; in 1840, 524,205 lbs.

BORAX. Imported for home consumption in 1839, 498,079 lbs. ; in 1840, 319,126 lbs.

BRANDY. Imported for consumption in 1839, 167,756 galls. ; in 1840, 1,108,578 galls. : duty, 1*l.* 2*s.* 10*d.* per imperial proof gallon.

BRASS, YELLOW. The following table exhibits the composition of several varieties of this species of brass. No. 1. is a cast brass of uncertain origin ; 2. the brass of Jemappes ; 3. the sheet brass of Stolberg, near Aix-la-Chapelle ; 4 and 5. the brass for gilding, according to D'Arcet ; 6. the sheet brass of Romilly ; 7. English brass wire ; 8. Augsburg brass wire ; 9. brass wire of Neustadt-Eberswald, in the neighbourhood of Berlin.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Copper - -	61·6	64·6	64·8	63·70	64·45	70·1	70·29	71·89	70·16
Zinc - -	35·3	33·7	32·8	33·55	32·44	29·9	29·26	27·63	27·45
Lead - -	2·9	1·4	2·0	0·25	2·86	- -	0·28	- -	0·20
Tin - -	0·2	0·2	0·4	2·50	0·25	- -	0·17	0·85	0·79
	100·0	99·9	100·0	100·00	100·00	- -	100·00	100·37	98·60

The mean proportion of the metals in yellow brass is 30 zinc to 70 copper.

Tombak, or Red Brass, in the cast state, is an alloy of copper and zinc, containing not more than 20 per cent. of the latter constituent. The following varieties are distinguished: —1, 2, 3, tombak for making gilt articles; 4. French tombak for sword-handles, &c.; 4. tombak of the Okar, near Goslar, in the Hartz; 5. yellow tombak of Paris for gilt ornaments; 6. tombak for the same purpose from a factory in Hanover; 8. chrysochalk; 9. red tombak from Paris; 10. red tombak of Vienna.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Copper -	82·0	82	82·3	80	85	85·3	86	90·0	92	97·8
Zinc -	18·0	18	17·5	17	15	14·7	14	7·9	8	2·2
Lead -	1·5	3	- -	- -	- -	- -	- -	1·6		
Tin -	3·0	1	0·2	3	trace.					
	104·5	104	100·0	100	100	100·0	100	99·5	100	100·0

Pinchbeck is made of 2 parts copper and 1 yellow brass;
Prince's metal ... 3 ...... 1 *zinc*.

Mannheim gold (semilor), 28 copper, 12 yellow brass, 3 tin.

Cast white metal buttons are made of an alloy of 32 parts brass (yellow), 4 parts zinc, and 2 tin.

The specific gravity of brass is greater than the mean density of its constituents; varying from 7·82 to 8·73, according to the proportion of zinc to copper. Sheet brass varies from 8·52 to 8·62; brass wire from 8·49 to 8·73. Brass heated and quickly cooled becomes somewhat less dense. The specific gravity of sheet tombak (81·25 copper + 18·75 zinc) is 8·788; of tombak wire (87·5 copper + 12·5 zinc) has been found so great as 9·00.

BREAD. I believe it may be safely asserted that the art of baking bread, pastry, and confectionary, is carried in Paris to a pitch of refinement which it has never reached in London. I have never seen here any bread which, in flavour, colour, and texture, rivalled the French *pain de gruau*. In fact, our corn monopoly laws prevent us from getting the proper wheat for preparing, at a moderate price, the genuine *semoule* out of which that bread is baked. Hence, the plebeian *bourgeois* can daily grace his table with a more beautiful piece of bread than the most affluent English nobleman. The French process of baking has been recently described, with some minuteness, by their distinguished chemist, M. Dumas*, and it merits to be known in this country.

At each operation, the workman (*pétrisseur*) pours into the kneading trough the residuary leaven of a former kneading, adding the proportion of water which practice enjoins, and diffuses the leaven through it with his hands. He then introduces into the liquid mass the quantity of flour destined to form the sponge (*pâte*). This flour is let down from a chamber above, through a linen hose (*manche*), which may be shut by folding it up at the end.

The workman now introduces the rest of the flour by degrees, diffusing and mingling it, in a direction from the right to the left end of the trough. When he has thus treated the whole mass successively, he repeats the same manipulation from left to right. These operations require no little art for their dextrous performance; hence they have the proper name assigned respectively to each, of *frasage* and *contre-frasage*. The workman next subjects the dough to three different kinds of movement, in the kneading process. He malaxates it; that is, works it with his hands and fingers, in order to mix very exactly its component parts, while he adds the requisite quantity of flour. He divides it into six or seven lumps (*pâtons*), each of which he works successively in the same manner. Then he seizes portions of each, to draw them out, taking only as much as he can readily grasp in his hands. When he has thus kneaded the different lumps, he unites them into one mass, which he extends and folds repeatedly back upon itself. He then lifts up the whole at several times, and dashes it forcibly against the kneading trough, collecting it finally at its left end. The object of these operations is to effect an intimate mixture of the flour, the water, and the leaven. No dry powdery spots, called *marrons*, should be left in any part of the dough.

The kneader has now completed his work; and after leaving the dough for some time at rest, he turns it upside down. He lays the lumps, of a proper weight, upon a table, rolls them out, and dusts them with a little flour. He next turns over each lump, and puts it in its *panneton*, where he leaves it to swell. If the flour be of good

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* Traité de Chimie appliquée aux Arts, vi. p. 409.

quality, the dough be well made, and the temperature be suitable, the lumps will swell much and uniformly. If after the surface has risen, it falls to a considerable extent, the flour must be bad, or it must contain other substances, as potato starch, bean meal, &c.

Whenever the oven is hot enough, and the dough sufficiently fermented, it is subjected to the baking process. Ovens, as at present constructed, are not equably heated throughout, and are particularly liable to be chilled near the door, in consequence of its being occasionally opened and shut. To this cause M. Dumas ascribes many of the defects of ordinary bread; but he adds, that by adopting the patent invention of M. Mouchot these may be obviated. This is called the *improved bakery, boulangerie perfectionnée.*

Fig. 10. is a ground plan of the aerothermal bake-house, the granaries being in the upper stories, and not shown here. *b, b* are the ovens; *c*, the kneading machine; *d*, the place where the machinery is mounted for hoisting up the bread into the store room above; *e*, a space common to the two ovens, into which the hot air passes; *f*, the place of a wheel driven by dogs, for giving motion to the kneading machine.

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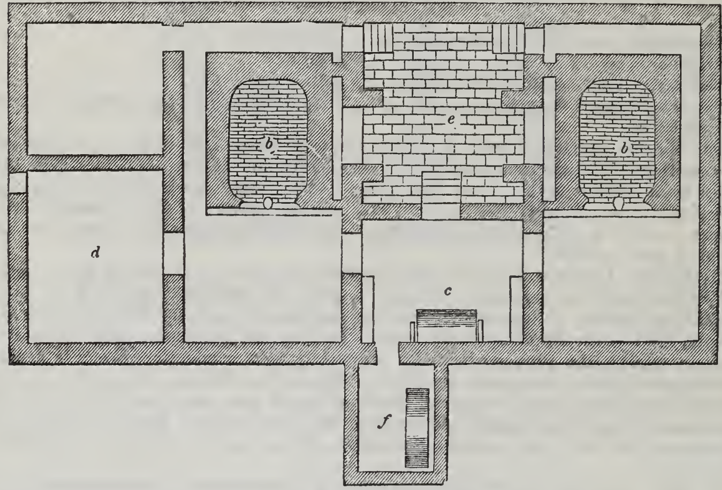

Fig. 11. is a longitudinal section of the oven; A, the grate where coke or even pit coals may be burned; B, B, void spaces which, becoming heated, serve for warming small pieces of dough in; *c, c* are flues for conducting the smoke, &c. from the fire-place; D, seen in *fig.* 12., is the chimney for carrying off the smoke transmitted by the flues; E, E, void spaces immediately over the flues, and beneath the sole, F, F, of the oven. By this arrangement the air, previously heated, which arrives from the void spaces B through the flues *c, c*, gets the benefit of the heat of the flame which circulates in these flues, and, after getting more heated in the spaces E, E, ascends through channels into the oven F, F, upon the sole of which the loaves to be baked are laid. The hot air is admitted into it through the passages *a, a*, being drawn from the reservoirs B, B, B, and also by the passage *d, d*, drawn from the reservoirs E, E. The sole is likewise heated by contact with the hot air contained in the space E, E, placed immediately below it. The hot air, loaded with moisture, issues by the passage *b, b*, and returns directly into the reservoir B, B. G, G, an enclosed space directly over the oven, to obstruct the dissipation of its heat; *g*, vault of the fire-place. *Fig.* 12., a transverse section through the middle of the oven. *Fig.* 13., the kneading machine, a longitudinal section passing through its axis; P, P, the contour of the machine, made of wood, and divided into three compartments for the reception of the dough. The wooden bars *o, o* are so placed in the interior of the compartments, as to divide the dough whenever the cylinder is made to revolve. One portion, D, of the cylinder may be opened and laid over upon the other by means of a hinge joint, when the dough and flour are introduced. A, B, C, the three compartments of the machine, two for making the dough, and one for preparing the sponge, called *levain*, or leaven, by the French. *a, a* is the pulley which receives its motion from the engine, and transmits it to the cylinder through the pinion *b*, and the spur-wheel *e*; *d*, *d*, the fly-wheel to regulate the motion; *g*, a brake to act upon the fly *d*, by means of a lever *h*; *i*, the pillar of the fly-wheel.

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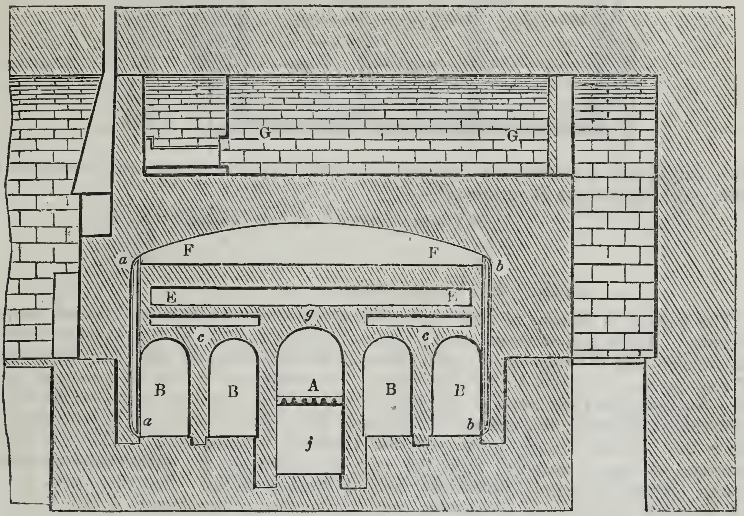
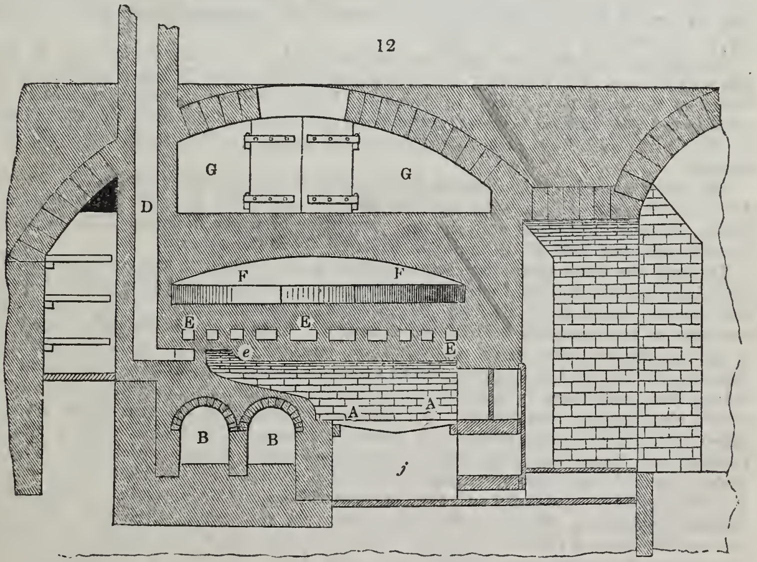


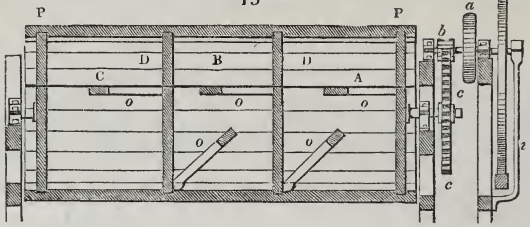
There is a ratchet wheel counter for numbering the turns of the kneading machine, but it cannot be shown in this view; *n*, cross bars of wood, which are easily removed when the cylinder is opened; they divide the dough.

12



Each of the three compartments of the *kneader* (*fig.* 13.) is furnished at pleasure with two bars fixed crosswise, but which may be easily removed, whenever the cylinder is opened. These bars constitute the sole agents for drawing out the dough.

13



In a continuous operation, the leaven is constantly prepared in the compartment A; with which view there is put into it —

	125	kilogrammes of ordinary leaven or yeast.
	67	flour.
	33	water.
In all	225	kilogrammes.

The person in charge of the mechanical kneader shuts down its lid, and sets it a-going. At the end of about seven minutes, he hears the bell of the counter sound, announcing that the number of revolutions has been sufficient to call for an inspection of the sponge, in regard to its consistence. The cylinder is therefore opened, and after verifying the right state of the leaven, and adding water to soften, or flour to stiffen it, he closes the lid, and sets the machine once more in motion. In ten minutes more the counter sounds again, and the kneading is completed. The 450 kilogrammes of leaven obtained from the two compartments are adequate to prepare dough enough to supply alternately each of the two ovens. For this purpose 75 kilogrammes of leaven are taken from each of the two compartments A and A′, and placed in the intermediate compartment B. The whole leaven is then 75 + 75=150 kilogrammes; to which are added 100 kilogs. of flour and 50 of water=150, so that the chest contains 300 kilogrammes. There is now replaced in each of the cavities A and A′ the primitive quantity, by adding 50 kilogrammes of flour and 25 of water = 75.

The cylinder is again set a-going; and, from the nature of the apparatus, it is obvious that the kneading takes place at once on the leavens A and A′, and on the paste B; which last is examined after 7 minutes, and completed in 10 more = 17, at the second sound of the counter-bell.

The kneader is opened, the paste on the sides and on the bars is gathered to the bottom by means of a scraper. The whole paste of the chest B being removed, 150 kilogs. of the leaven are taken, to which 150 kilogs. of flour and water are added to prepare the 300 kilogs. of paste destined for the supply of the oven No. 2. These 75 kilogs. of leaven from each compartment are replaced as before, and so on in succession.

The water used in this operation is raised to the proper temperature, viz. 25° or 30° C. (77° or 86° F.) in cold weather, and to about 68° F. in the hot season, by mixing common cold water with the due proportion of water maintained at the temperature of about 160° F., in the basin F placed above the ovens.

Through the water poured at each operation upon the flour in the compartment B, there is previously diffused from 200 to 250 grammes of fresh leaven, as obtained from the brewery, after being drained and pressed (*German yeast*). This quantity is sufficient to raise properly 300 kilogs. of dough. As soon as this dough is taken out of the kneader, as stated above, and while the machine goes on to work, the quantity requisite for each loaf is weighed, turned about on the table D, to give it its round or oblong form, and there is impressed upon it with the fore-arm, or roller, the cavity which characterises cleft loaves. All the lots of dough of the size of one kilog., called cleft loaves (*pains fendus*) are placed upon a cloth, a fold of which is raised between two loaves, the cloth being first spread upon a board; which thus charged with 10 or 15 loaves is transferred to the wooden shelves G G in front of the oven. The whole of them rise easily under the influence of the gentle temperature of this antechamber or *fournil*. Whenever the dough loaves are sufficiently raised here, they are put into the oven, a process called *enfournement* in France; which consists in setting each loaf on a wooden shovel dusted with coarse flour, and placing it thereby on the sole of the oven, close to its fellow, without touching it. This operation is made easy, in consequence of the introduction of a long jointed gas-pipe and burner into the interior of the oven, by the light of which all parts of it may be minutely examined. The oven is first kept moderately hot, by shutting the dampers; but whenever the thermometer attached to it indicates a temperature of from 300° to 290° C. (572° to 554° F.), the dampers or registers are opened, to restore the heat to its original degree, by allowing of the circulation of the hot air, which rises from the lower cavities around the fire-place into the interior of the oven. When the baking is completed the gas light, which had been withdrawn, is again introduced into the oven, and the bread is taken out; called the process of *défournement.* If the temperature have been maintained at about 300° C., the 300 kilogs. of dough divided into loaves of one kilog. ($2\frac{1}{5}$ lbs. avoirdupois) will be baked in 27 minutes. The charging having lasted 10 minutes, and the discharging as long, the baking of each batch will take up 47 minutes. But on account of accidental interruptions, an hour may be assigned for each charge of 260 loaves of 1 kilog. each; being at the rate of 6240 kilogs. (or 6·75 tons) of bread in 24 hours.

Although the outer parts of the loaves be exposed to the radiation of the walls, heated to 280° or 300° C., and undergo therefore that kind of caramelization (charring) which produces the colour, the taste, and the other special characters of the crust, yet the inner substance of the loaves, or the crumb, never attains to nearly so high a temperature; for a thermometer, whose bulb is inserted into the heart of a loaf, does not indicate more than 100° C. (212° F.).

The theory of *panification* (bread-baking) is easy of comprehension. The flour owes this valuable quality to the gluten, which it contains in greater abundance than any of the other *cerealia* (kinds of corn). This substance does not constitute, as had been heretofore imagined, the membranes of the tissue of the perisperm of the wheat; but is enclosed in cells of that tissue under the epidermic coats, even to the centre of the grain. In this respect the gluten lies in a situation analogous to that of the starch, and of most of the immediate principles of vegetables. The other immediate principles which play a part in *panification* are particularly the starch and the sugar; and they all operate as follows:

The diffusion of the flour through the water, *hydrates* the starch and dissolves the sugar, the albumen, and some other soluble matters. The kneading of the dough, by completing these reactions through a more intimate union, favours also the fermentation of the sugar, by bringing its particles into close contact with those of the leaven or yeast; and the drawing out and malaxating the dough softens and stratifies it, introducing at the same time oxygen to aid the fermentation. The dough, when distributed and formed into loaves, is kept some time in a gentle warmth, in the folds of the cloth, pans, &c., a circumstance propitious to the developement of their volume by fermentation. The dimensions of all the lumps of dough now gradually enlarge, from the disengagement of carbonic acid in the decomposition of the sugar; which gas is imprisoned by the glutinous paste. Were these phenomena to continue too long, the dough would become too vesicular; they must, therefore, be stopped at the proper point of sponginess, by placing the loaf lumps in the oven. Though this causes a sudden expansion of the enclosed gaseous globules, it puts an end to the fermentation, and to their growth; as also evaporates a portion of the water.

The fermentation of a small dose of sugar is, therefore, essential to true bread-baking; but the quantity actually fermented is so small as to be almost inappreciable. It seems probable that in well-made dough the whole carbonic acid that is generated remains in it; amounting to one-half the volume of the loaf itself at its baking temperature, or 212°. It thence results that less than one-hundredth part of the weight of the flour is all the sugar requisite to produce well-raised bread. What egregious folly was it, therefore, to mount the bakery in Chelsea, twelve years ago, at an expense of 20,000*l*., for the purpose of *catching the volatile spirits* in their escape from the loaves in the oven — or, as it was vulgarly termed, "taking the gin out of the bread!" whereas it was nothing but taking the cash out of the pockets of the pseudo-chemical visionaries who swarm in this metropolis.

The richness or nutritive powers of sound flour and also of bread are proportional to the quantity of gluten they contain. It is of great importance to determine this point, for both of these objects are of enormous value and consumption; and it may be accomplished most easily and exactly by digesting in a water-bath, at the temperature of 167° F., 1000 grains of bread (or flour) with 1000 grains of bruised barley-malt, in 5000 grains, or in a little more than half a pint, of water. When this mixture ceases to take a blue colour from iodine (that is, when all the starch is converted into soluble dextrine) the gluten left unchanged may be collected on a filter cloth, washed, dried at a heat of 212°, and weighed. The colour, texture, and taste of the gluten ought also to be examined, in forming a judgment of good flour, or bread.

Independently of the skill of the baker, bread varies in quality according to the quantity of water and gluten it contains. A patent of German or French origin was obtained here a few years ago, for manufacturing loaf-bread by using thin boiled flour-paste instead of water for setting the sponge, that is, for the preliminary dough fermentation. By this artifice, 104 loaves of 4 lbs. each could be made out of a sack of flour, instead of 94, as in ordinary baking; because the boiled paste gave a water-keeping faculty to the bread in that proportion. But this *hydrated* bread was apt to spoil in warm weather, and became an unprofitable speculation to all concerned.

Bread and flour are often adulterated in France with potato starch, but almost never, I believe, in this country. This sophistication is easily detected by the microscope, on account of the peculiar ovoid shape and the large size of the particles of the potato fecula. Horse-bean flour gives to wheaten bread a pinkish tint. In spoiled flour (such as is too often used, partially at least, by our inferior bakers) the gluten sometimes disappears altogether, and is replaced by ammoniacal salts.* In this case quicklime separates ammonia from the flour without heat; in flour slightly damaged, or ground from damaged wheat, the gluten present is deprived of its elasticity, and is softer than in the natural state. On this account the gluten test of M. Boland is valuable. It consists in putting some gluten into the bottom of a copper tube, and heating that tube in an oven, or in oil at a temperature of 284° F. The length to which the cylinder of gluten expands is proportional to and indicates its quality.

It appears that a French sack of flour, which weighs 159 kilogrammes, affords from 102 to 106 loaves of 2 kilogrammes each: and therefore,

159 : 52·0 :: 280 : 91·6; that is, if 159 kilogs. or lbs. afford 52 loaves of 4 kilogs. or lbs., 280 lbs., a sack English, should afford 91·6 loaves of 4 lbs. each; but our bakers usually make out 94 loaves, which are rated at 4 pounds, though they seldom weigh so much. The loaves of a baker in my neighbourhood, who supplied my family with bread for some time, were found on trial to be from 6 to 8 oz. deficient in weight; when challenged for this fraud, he had the effrontery to palliate it by alleging that all his neighbour bakers did the same. It must be borne in mind that a Paris loaf of 2 lbs. or 2 kilogs. contains more dry farina than a London loaf of like weight; for it contains, from its form and texture, more crust. The crumb is to the crust in the Paris long loaves, as 25 to 75, or 1 to 3: in our quartern loaves it is as 18 or 20 to 100.

M. Dumas gives the following Table: —

Weight of a Sack of Flour.	Number of Loaves.	Weight of the Bread.	Increase of Weight of flour.	Ratio of dry flour = 1, to Bread.
159 Kilogs.	102	202 Kilogs.	1·283	1 : 1·60
159 do.	104	208 do.	1·300	
159 do.	106	212 do.	1·333	

Thus it would appear that the mean yield would correspond to 130 kilogs. of bread for 100 of the flour employed; and admitting that common flour contains 0·17 of water, the product would be equivalent to 150 of bread for 100 of flour absolutely dry. The whole loaf contains 66 per cent. of dry substance, and the crumb only 44.

BRICKS. Mr. F. W. Simms, C. E., communicated to the Institution of Civil Engineers, in April and May, 1843, an account of the process of brick-making for the Dover railway. The plan adopted is called slop-moulding, because the mould is dipped into water before receiving the clay, instead of being sanded as in making sand-stock bricks. The workman throws the proper lump of clay with some force into the mould, presses it down with his hands to fill the cavities, and then strikes off the surplus clay with a stick. An attendant boy, who has previously placed another mould in a water trough by the side of the moulding table, takes the mould just filled, and carries it to the floor, where he carefully drops the brick from the mould on its flat side, and leaves it to dry; by the time he has returned to the moulding table, and deposited the empty mould in the water trough, the brickmaker will have filled the other mould, for the boy to convey to the floor, where they are allowed to dry, and are then stacked in readiness for being burned in clamps or kilns. The average product is shown in the following table: —

Force employed.	Area of land.		Duration of season.	Produce per week.	Produce per season.
	Roods.	Perches.	Weeks.	Bricks.	Bricks.
1 moulder 1 temperer 1 wheeler 1 carrier boy 1 picker boy	2	14½	22	16,100	354,200

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* Dumas, Chimie Appliquée, vi. 425.

It appears that while the produce in sand-stock bricks is to that of slop-bricks in the same time as 30 to 16, the amount of labour is as 7 to 4; while the quantity of land, and the cost of labour per thousand, is nearly the same in both processes. The quantity of coal consumed in the kiln was at the rate of 10 cwt. 8lbs. per thousand bricks. The cost of the bricks was *2l.* 1*s.* 6*d.* per thousand. The slop-made bricks are fully 1 pound heavier than the sand-stock. Mr. Bennett stated to the meeting, that at his brick-field at Cowley, the average number of sand-stock bricks moulded was 32,000; but that frequently so many as 37,000, or even 50,000, were formed. The total amount in the shrinkage of his bricks was $\frac{13}{16}$ of an inch upon 10 inches in length; but this differed with the different clays. Mr. Simms objected to the use of machinery in brick-making, because it caused economy only in the moulding, which constituted no more than about one-eighth of the total expense.

The principal varieties of bricks are called *malm*, *paviors*, *stocks*, *grizzles*, *places*, and *shuffs*. For the first and best kind, the clay was washed and selected with care; stocks were good enough for ordinary building purposes; the rest are inferior. The difference in price between malms, paviors, and stocks, was 15*s.* or 20*s.* per 1000; between stocks and places, 10*s.* The average weight of a sand-stock brick is fully 5 pounds, that of a slop is 1 pound more.

I believe that the siliceous sand on the surface of the sand-stocks is useful in favouring adhesion of mortar, by the production of a silicate of lime. To smooth aluminous bricks, mortar sometimes forms no stony adhesion.

Mr. Prosser, of Birmingham, makes bricks by pressure. The clay is first ground upon a slip kiln, as if for making pottery, then ground to a fine powder, and in that dry state it is subjected to the heavy pressure of about 250 tons, in strong metal moulds, by which means it is reduced to about one-third of its original thickness. The clay seems to have retained sufficient moisture to give it cohesion, and the tiles are perfectly sharp at the edges. They being then baked within seggars by the heat of a kiln, seldom crack in the baking. The bricks thus formed are denser than usual, and weigh 6¾ lbs., with a specific gravity of 2·5.

Fig. 14. represents Mr. Hunt's brick-making machine. The principal working parts consist of 2 cylinders, each covered by an endless web, and so placed as to form the front and back of a hopper, the two sides being iron plates, placed so that when the hopper is filled with tempered clay from the pug-mill, the lower part of the hopper, and consequently the mass of clay within it, has exactly the dimensions of a brick. Beneath the hopper an endless chain traverses simultaneously with the movement of the cylinders. The pallet-boards are laid at given intervals upon the chain, and being thus placed under the hopper, while the clay is brought down with a slight pressure, a frame with a wire stretched across it, is projected through the mass of clay, cutting off exactly the thickness of the brick, which is removed at the same moment by the forward movement of the endless chain. This operation is repeated each time that a pallet-board comes under the hopper.

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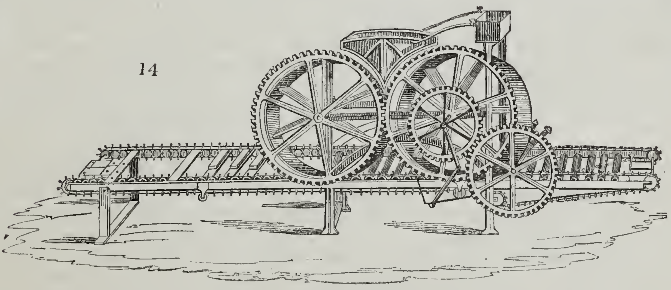
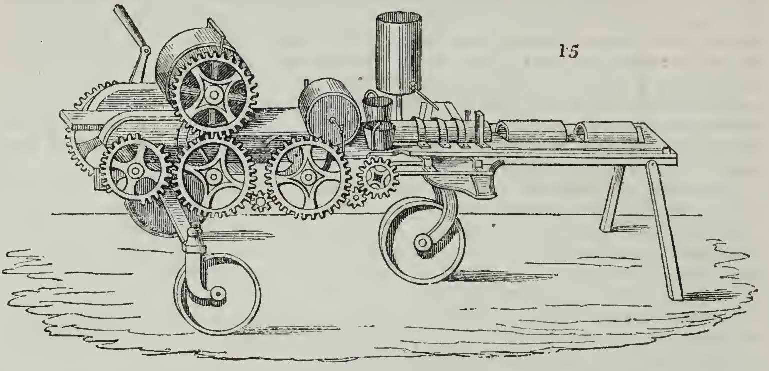


The chief object of this machine, which is worked by hand, is to produce good square compact bricks of uniform quality, using only a slight pressure. It has been found to be very difficult to dry bricks made by machinery, where a considerable pressure has been employed, because, before the evaporation from the centre of the clay is completed, the surfaces have become hard and peel off. The present machine is in operation in several parts of England, producing usually about 1200 bricks per hour, while each machine requires only 2 men and 3 boys to tend it, and to take off the bricks. The clot-moulders are dispensed with, and the workmen are common labourers, so that professed brick-makers at higher wages are not needed.

Fig. 15. shows Mr. Hunt's machine for making tiles, and it is on the same principle. It consists of two iron cylinders, round which webs or bands of cloth revolve, whereby the clay is pressed into a slab of uniform thickness, without adhering to the cylinders. It is then carried over a covered wheel, curved on the rim, which gives the tile the semi-cylindrical or other required form; after which the tiles are polished and finished by passing through three iron moulds of a horse-shoe form, as shown in the centre of the cut, while they are at the same time moistened from a water cylinder placed above them. The tiles are next cut off to such lengths as are wanted, and carried away by an endless web, whence they are transferred by boys to the drying shelves.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Flat tiles, for sole pieces to draining tiles, are formed in nearly the same manner, being divided into two portions while passing through the moulds; the quantity of clay used for one draining tile being as much as for two soles.

The method of making bricks in the vicinity of London differed from that of almost all other places, because the material there employed is not pure clay, but a loam of a slightly cohesive nature, which will not admit of its being used in the natural state and burned in close kilns with coal; but with an admixture of ashes it becomes sufficiently tenacious to be formed into bricks, by inducing a slight semi-fusion. But the coal-ashes are also of advantage in the process of burning, because they enable the fire to spread gradually from the lower tiers, through the whole mass in the kiln or clamp, and thus obviate the effect of an intense partial heat, where distinct coal fires are trusted to alone, whereby the bricks nearest it get vitrified and glazed.

The brick kilns and clamps round London, and other large cities, which are fired with the breeze-rubbish collected from dust holes, that contain the refuse of kitchens, &c. emit, in consequence, most unpleasant effluvia; but brick-kilns fired with clean coke or coals, give out no gases of a more noxious nature than common household fires. The consideration of this subject was closely pressed upon my attention on being consulted concerning an injunction issued by the Chancellor against a brick clamp in the Isle of Wight, fired with clean coke cinders from the steam-engine furnace at Portsmouth Dock Yard. The bricks being of the description called sand-stock, were of course made in moulds very slightly dusted with sand, to make them fall freely out. The sand was brought from Portsmouth Harbour, and on being subjected to a degree of heat, more intense certainly than it could suffer in the clamp, was discovered by two chemical witnesses to give out traces of hydrochloric acid. Not content with this trivial indication, the said chemists, in their evidence before the courts of law, paraded a train of goblin gases, as the probable products of the pre-adjudicated clamp.

As it is well known to the chemist that common salt strongly ignited in contact with moist sand will emit hydrochloric acid, there was nothing remarkable in the above observation, but I ascertained that the sand with which the moulds were strewed would give out no hydrochloric acid, at a heat equal at least to what the bricks were exposed to in a clamp 10 or 12 feet high, and fired at its bottom only with a layer of cinders 3 or 4 inches thick. But I further demonstrated that the entire substance of the brick with its scanty film of sand, on being exposed to ignition in a suitable apparatus, gave out — not hydrochloric or any other corrosive acid, but ammonia gas. Hence, the allegations that the clamp sent forth a host of acid gases to blight the neighbouring trees, were shown to be utterly groundless; on the contrary, the ammonia evolved from the heated clay would act beneficially upon vegetation, while it was too small in quantity to annoy any human being. A few yards to leeward of a similar clamp, in full activity, I could perceive no offensive odour. All ferruginous clay, when exposed to the atmosphere, absorbs ammonia from it, and of course emits it again on being gently ignited. It is a reproach to science when, as in the above case, it lends itself to judicial prejudice and oppression.

BRONZING (*of Objects in Imitation of Metallic Bronze.*) Plaster of Paris, paper, wood, and pasteboard, may be made to resemble pretty closely the appearance of articles of real bronze, modern or antique. The simplest way of giving a brilliant aspect of this kind is with a varnish made of the waste gold leaf of the beater, ground up on a porphyry slab with honey or gum-water. A coat of drying linseed-oil should be first applied, and then the metallic powder is put on with a linen dossil. Mosaic gold ground up with six parts of bone-ashes has been used in the same way. When it is to be put on paper, it should be ground up alone with white of eggs or spirit varnish, applied with a brush, and burnished when dry. When a plate of iron is plunged into a hot solution of sulphate of copper, it throws down fine scales of copper, which being repeatedly washed with water, and ground along with six times its weight of bone-ashes, forms a tolerable bronzing.

Powdered and sifted tin may be mixed with a clear solution of isinglass, applied with a brush, and burnished or not, according as a bright or dead surface is desired. Gypsum casts are commonly bronzed by rubbing brilliant black-lead, *graphite*, upon them with a cloth or brush. Real bronze long exposed to the air gets covered with a thin film of carbonate of copper, called by virtuosi antique *ærugo* (*patine antique*, Fr.) This may be imitated in a certain degree by several applications skilfully made. The new bronze being turned or filed into a bright surface, and rubbed over with dilute aquafortis by a linen rag or brush, will become at first greyish, and afterwards take a greenish blue tint; or we may pass repeatedly over the surface a liquor composed of 1 part of sal ammoniac, 3 parts of carbonate of potash, and 6 of sea salt, dissolved in 12 parts of boiling water, to which 8 parts of nitrate of copper are to be added; the tint thereby produced is at first unequal and crude, but it becomes more uniform and softer by time. A fine *green-blue* bronze may be obtained with very strong water of ammonia alone, rubbing it at intervals several times upon the metal

The base of most of the secret compositions for giving the antique appearance is vinegar with sal ammoniac. Skilful workmen use a solution of 2 ounces of that salt in an English quart of French vinegar. Another compound which gives good results is made with an ounce of sal ammoniac, and a quarter of an ounce of salt of sorrel (binoxalate of potash), dissolved in vinegar. One eminent Parisian sculptor makes use of a mixture of half an ounce of sal ammoniac, half an ounce of common salt, an ounce of spirits of hartshorn, and an English quart of vinegar. A good result will also be obtained by adding half an ounce of sal ammoniac, instead of the spirits of hartshorn. The piece of metal being well cleaned, is to be rubbed with one of these solutions, and then dried by friction with a fresh brush. If the hue be found too pale at the end of two or three days, the operation may be repeated. It is found to be more advantageous to operate in the sunshine than in the shade.

BUDE LIGHT. See Gas Light.

BUTTER is the fatty matter of milk, usually of that of the cow. Milk is composed of butter, caseine, sugar of milk, several salts, and water. The butter exists in the form of very small globules of nearly uniform size, quite transparent, and strongly refractive of light. Milk left in repose throws up the lighter particles of butter to the surface as cream. It was imagined that the butter was separated in the process of churning, in consequence of the milk becoming sour; but this is not the case, for milk rendered alkaline by bi-carbonate of potash affords its butter fully more readily than acidulous milk. The best temperature for churning milk or cream is 53° F.; that of 60° is too high; and under 50 it is too low. By the churning action the heat rises from 3 to 4 degrees F. All the particles of butter are never separated by churning; many remain diffused through the butter-milk, and are easily discoverable by the microscope. These are more numerous in proportion to the bulk of the liquid; and hence it is more economical to churn cream than the whole milk which affords it. It is computed that a cow which gives 1800 quarts (old English) of milk per annum, eats in that time 8000 lbs. of hay, and produces 140 lbs. of butter.* Analysis shows that this weight of hay contains 168 pounds of fat. The finest flavoured butter is obtained from milk churned not long after it is drawn; but the largest proportion is derived from the cream thrown up by milk after standing 24 hours, in a temperature of about 50° F. The butter-milk, which contains the very fermentable substance, caseine, should be well separated from the butter by washing with cold water, and by beating with the hands, or preferably, without water, for the sake of fine flavour, by the action of a press.

The French purify their butter by melting it in pots, plunged into water heated to 200° or 212°; and sometimes they mix a pure brine with the melting butter, whereby they favour the subsidence of the coagulated caseine and other impurities. The supernatant clear butter should be drawn or poured off, and rapidly cooled, to prevent the crystallization of its stearine and separation of its oleine, which injure its flavour and appearance.

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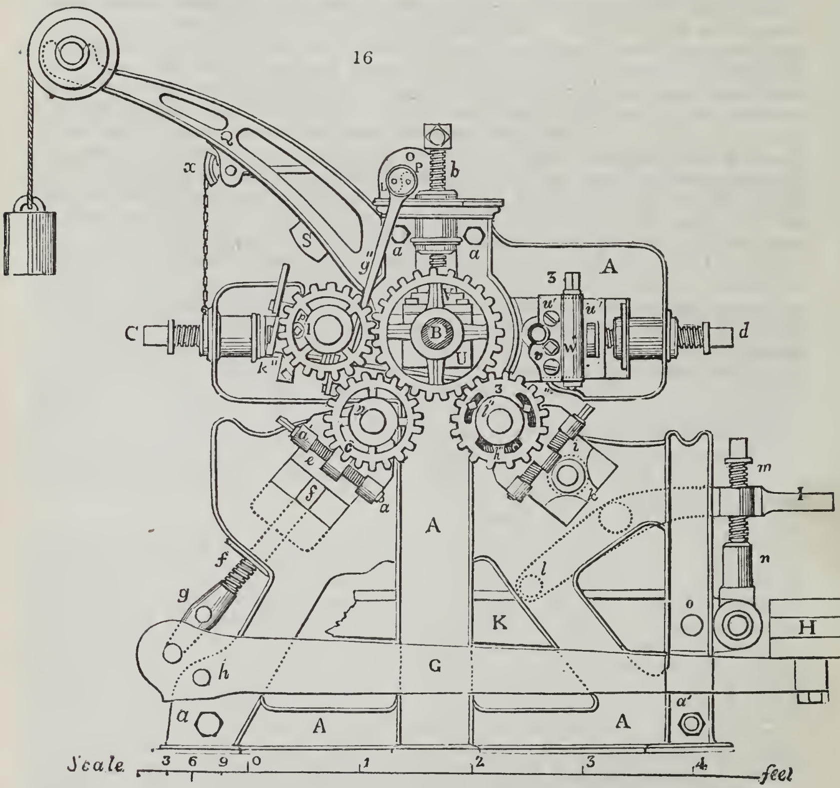
* Two pounds and a quarter of hay correspond to one quart of good milk; and a cow which eats 16,500 lbs. of hay will produce 300 lbs. of butter per annum.

C.

CALCIUM. The atomic weight of this element being an important point, both as to pure chemistry and the chemical arts, has been the subject of innumerable researches. Very lately Berzelius, in the *Annalen der Chemie und Pharmacie*, XLVI. p. 241, has collated the most recent results of the analysis of other philosophers with his own; and while Dumas, Marchand, and Erdmann estimate the weight at 20, that of hydrogen = 1, or 250 oxygen = 100, he finds it ought to be, as compared with the latter, 251,9; and to the former, 20,152.

CALICO PRINTING (4-*colour machine*). Of this beautiful and effective mechanism an accurate section is exhibited at p. 220. of the Dictionary. The outside working gear is shown in *fig.* 16., where A, A is a part of the two strong iron frames or cheeks in which the various rollers are mounted. They are bound together by the rods and bolts *a*, *a*, *a*. B is the large iron pressure cylinder, which rests with its gudgeons in bearings or bushes, which can be shifted up and down in slots of the side cheeks A, A. These bushes are suspended from powerful screws, *b*, which turn in brass nuts, made fast to the top of the frame A, as is plainly shown in the *figure.* These screws serve to counteract the strong pressure applied beneath that cylinder by the engraved cylinders D, E.

16



C, D, E, F, are four printing cylinders, named in the order of their operation. They consist of strong tubes of copper or gun metal, forcibly thrust by a screw press upon the iron mandrels, round which as shafts they revolve. The first and last cylinders, C and F, are mounted in brass bearings, which may be shifted in horizontal slots of the frame A. The pressure roller B, against whose surface they bear with a very little obliquity downwards, may be nicely adjusted to that pressure by its elevating and depressing screws. By this means C and F can be adjusted to B with geometrical precision, and made to press it in truly opposite directions.

The bearings of the cylinders D and E are lodged also in slots of the frame A, which point obliquely upwards towards the centre of B. The pressure of these two print cylinders, C and F, is produced by two screws, *c* and *d*, which work in brass nuts made fast to the frame, and very visible in the figure. The framework in which these bearings and screws are placed has a curvilinear form, in order to permit the cylinders to be readily removed and replaced, and also to introduce a certain degree of elasticity. Hence the pressure applied to the cylinders C and F partakes of the nature of a spring, a circumstance essential to their working smoothly, notwithstanding the occasional inequalities in the thickness of the felt web and the calico.

The pressure upon the other two print cylinders, D and E, is produced by weights acting with levers against the bearings. The bearings of D are, at each of their ends, acted upon by cylindrical rods, which slide in long tubular bosses of the frame, and press with their nuts *g*, at their under end upon the smaller arms of two strong levers G, which lie on each side of the machine, and whose fulcrum is at *h* (in the lower corner at the left hand). The longer arms of these levers, G, are loaded with weights, H, whereby they are made to press up against the bearings of the roller D, with any desired degree of force, by screwing up the nut *g*, and hanging on the requisite weights.

The manner in which the cylinder E is pressed up against B is by a similar construction to that just described. With each of its bearings there is connected, by the link *k*, a curved lever, I, whose fulcrum or centre of motion is at *o*. By turning, therefore, the screw *m*, the weight L, laid upon the end of the longer arm of the lever K (of which there is one on each side of the machine), may be made to act or not at pleasure upon the bearings of the cylinder E. The operation of this exquisite machine is minutely described in the Dictionary, pp. 220, 221.

A patent was obtained in August 1839, by Mr. J. C. Miller of Manchester, for certain improvements in printing calicoes, consisting of a modified mechanism, by which the same effect can be produced as by block printing.

Figs. 17, 18, 19, are several views of this machine, calculated to print two pieces, or two different patterns (on the same block) of calico, side by side, or four pieces, the carriage printing both ways, the intended device consisting of four colours to be printed from blocks.

17

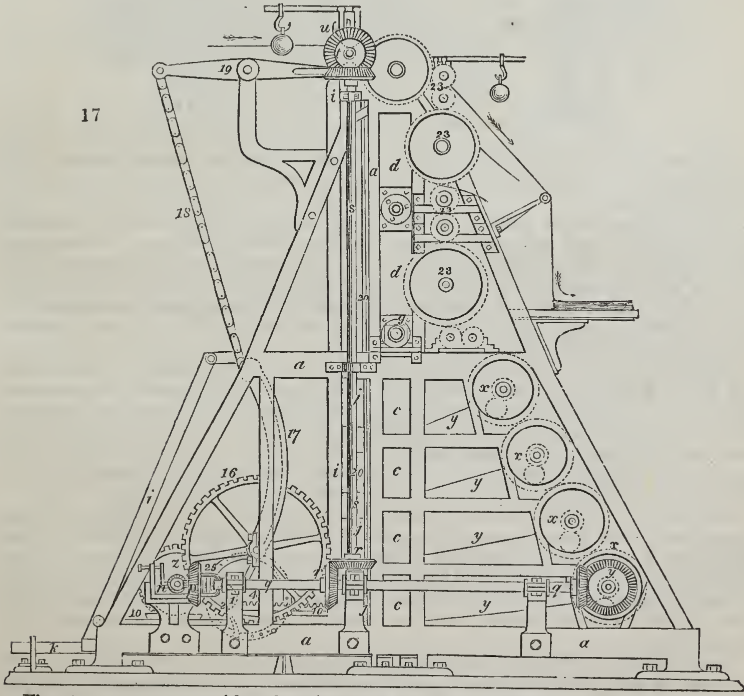
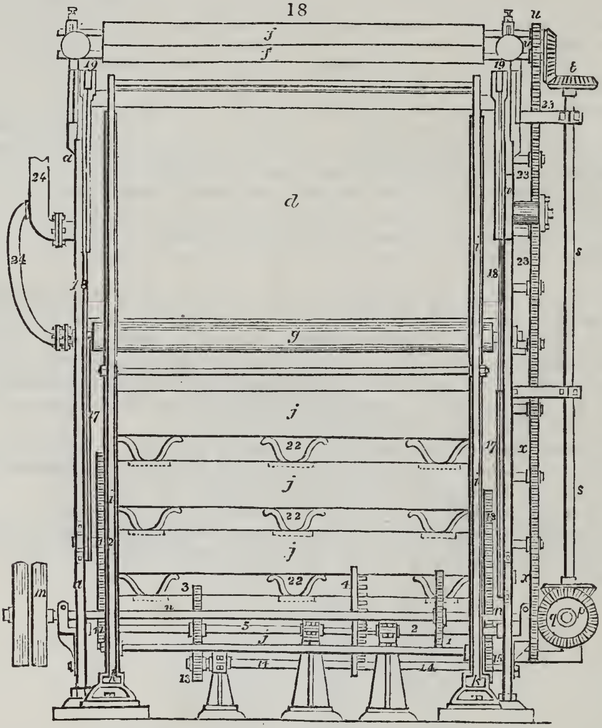


Fig. 17. represents a side elevation, *fig.* 18. a front view, and *fig.* 19. a transverse section, taken nearly through the middle of the machine.

The side or main framing is shown at *a*, *a*, supporting the colour boxes *b*, *b*, *b*, with their *doctors;* the furnishing tables or beds, *c*, *c*, *c* (substitutes for the sieves in ordinary block printing); the printing table, *d*, *d;* and the feeding, drying, and colouring rollers, *f*, *f*, *g*, *g*, *h*, *h*.

18



The machine is also provided with a carriage, *i*, *i*, for the printing blocks, *j*, *j*, *j*. This carriage, *i*, *i*, travels in and out at suitable intervals, upon rails, *k*, *k*, attached to the main framing.

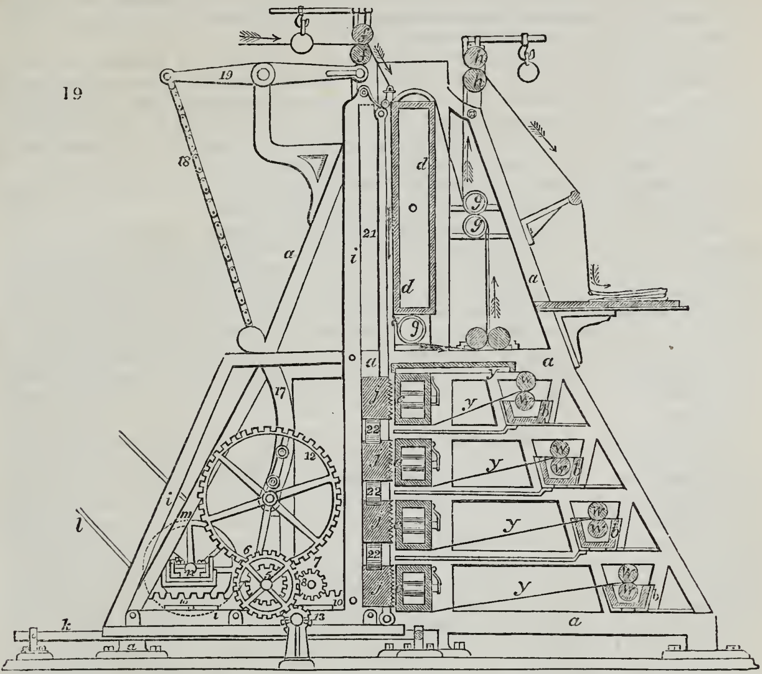
The operation of the machine is effected by passing a driving strap, *l*, round the driving pulley *m*, fixed at the extremity of the main driving shaft, *n*, *n*. At the other end of this shaft, the bevil pinion, *o*, is keyed, gearing at suitable intervals with the bevil wheel *p*, which is mounted upon the end of the cross shaft *q;* at about the middle of this shaft, the mitre wheels *r*, *r*, driving the upright shaft *s*, *s*, and mitre wheels, *t*, *t*, above, actuate, by means of the spur pinions *u*, *u*, the feeding rollers *f*, *f*, and thus draw the pieces of goods into the machine.

Simultaneously with the progress of the cloth, the mitre wheels *v*, *v*, at the other end of the cross shaft *q*, drive the furnishing rollers *w*, *w*, *w*, by means of the spur gearing *x*, *x*, *x*. The furnishing rollers, revolving in their respective colour-boxes, spread or apply the colours upon the travelling endless blankets, *y*, *y*, *y*, which pass round the top roller, and the furnishing tables or beds, *c*, *c*, *c*, in order to supply the colours to the surfaces of the printing blocks, *j*, *j*, *j*. Either beds or the backs of the printing blocks may be made slightly elastic, to insure the perfect taking up of the colours.

Supposing the carriage, *i*, *i*, to be run out upon its railways, at the farthest point from the beds *c*, *c*, it is drawn inwards towards the furnishing beds *c*, *c*, by means of the spur-wheel *x*, upon the driving-shaft *n*, taking into a small pinion, 1 (shown by dots in *fig.* 17.), upon the shaft, 2. On the end of this shaft is also keyed the mangle pinion, 3, gearing in the mangle wheel, 4, which is keyed upon the end of the shaft, 5. This shaft drives the spur-wheel, 6, in gear with the pinion, 7, made fast to the shaft, *s* (see *fig.* 19.).

Upon either end of the shaft, 5, is a rack pinion, 9, taking into the horizontal rack 10, made fast to the carriage-frame, *i*, *i;* and thus the blocks, *j*, *j*, are presented to the furnishing blankets *y*, *y*, *y*, and take a supply of colour ready for printing. The travelling-carriage and blocks now retire, by the agency of the mangle-wheel and pinion, 3 and 4, the pinion being fixed upon the end of the shaft, 2, and the wheel upon the other shaft in a line with the shaft, 2. At this time another operation of the machine takes place.

19



Upon the reverse end of the shaft, 5, is a pinion, 11, gearing with the spur-wheel, 12; and by means of the spur gearing, 6 and 13, and counter-shaft, 14, the pinion, 15, drives the spur-wheel, 16, which corresponds to the wheel, 12, on the other side of the machine. To one of these spur-wheels are attached by bolts two quadrant levers, 17, 17; and as these wheels revolve by means of the gearing just described, the levers, 17, 17, draw down the chains, 18, 18, actuate the levers, 19 and 20, and thus elevate the whole series of printing blocks in the parallel grooves, 21, 21; at the same time pressing or closing them into one mass or block by expanding the springs 22, 22; and at the nest of the carriage caused at a proper interval by the agency of the mangle-wheel, the blocks are made to impress the patterns upon the surface of the goods at once, in four or more different colours, and in one, two, or more widths of cloth at one operation.

The cloth is now drawn forward for the space of the exact width of one of the blocks, or sketch of the design, by means of the spur-wheels and pinions, 23, 23, and passed around heated cylinders, *g*, *g*, if necessary, and between the delivering rollers out of the machine. These operations are to be repeated by the continuous rotation of the main driving-shaft, until the printing is completed; the colours making a single advance upon the pattern at every presentation of the blocks, until the whole number of blocks has been presented to the same space or portion of the goods successively.

The steam pipes, 24, are to be in connection with the printing table and drying cylinders, in order to supply a degree of heat during the operation, which may be regulated at pleasure.

To give suitable intervals of rest and motion to the various parts of the driving-gear, an ordinary clutched box, 25 (shown in *fig.* 19.), and regulated by suitable stops fixed to the travelling carriage, is used for throwing the wheel, *p*, in and out of gear with the pinion, *o*; this is to prevent clots of colour from being dragged upon the blocks or cloth. — *Newton's Journal*, xxi. C. S. p. 242.

CALOMEL. A patent was obtained in September, 1841, by Anthony Todd Thomson, M.D., for an improved method of manufacturing calomel and corrosive sublimate, as follows: —

This invention consists in combining chlorine in the state of gas with the vapour of mercury or quicksilver, in order to produce calomel and corrosive sublimate.

The apparatus employed consists of a glass, earthenware, or other suitable vessel, mounted in brick-work, and communicating at one end with a large air-tight chamber, and at the other end, by means of a bent tube, with an alembic, such as is generally used for generating chlorine gas. The alembic is charged with a mixture of common salt, binoxide of manganese and sulphuric acid, or of binoxide of manganese and muriatic acid, in order to produce chlorine gas.

The mode of operating with this apparatus is as follows:—A quantity of mercury or quicksilver is placed in the glass vessel, and the temperature of the same is raised to between 350° and 660° Fahr., by means of an open fire beneath. The chlorine gas, as it is generated, passes from the alembic through the bent tube into the glass vessel, and there combining with the vapour of the mercury, forms either corrosive sublimate or calomel, according to the quantity of chlorine gas employed.

The product is found at the bottom of the air-tight chamber, and may be removed from the same through a door, when the operation is finished.

According to the patent of Mr. Josiah Jewel, the vapour of calomel was to be transmitted into a vessel containing water, in order to condense it at once into an impalpable powder. But this process was beset with many difficulties. The vapour of the calomel was afterwards introduced into a large receiver, into which steam was simultaneously admitted; but this plan has also been found to be precarious in the execution. The best way is to sublime the calomel into a very large chamber from an iron pot, in the same way as the flowers of sulphur are formed. The great body of cool air serves to cause the precipitation of the calomel in a finely comminuted state. It is afterwards washed with water, till it is no longer coloured by sulphuretted hydrogen.

CALOTYPE is the name given by Mr. Fox Talbot to the art invented by him, of making pictures on paper or other such surfaces by the agency of light. It is merely an improved kind of *photography*. The process is as follows:—Dissolve 100 grains of crystallised nitrate of silver in 6 ounces of distilled water, and brush over the paper (Whatman's sized post answers well) with a soft brush on one side only, with this solution, and mark the side. When nearly dry, dip it into a solution of iodide of potassium (for only a few minutes), containing 500 grains of that salt dissolved in a pint of water. As soon as the paper is completely imbued with this solution, it should be immediately washed in distilled water, drained, and hung up to dry. This paper is to be kept for subsequent use in a portfolio, and carefully secluded from light.

Next dissolve 100 grains of silver-nitrate in 2 ounces of distilled water, and add to the solution one sixth of its volume of strong acetic acid. Keep this solution in the dark. Make a saturated solution of gallic acid in distilled water. When it is required to make a calotype picture, the two liquids last described are to be mixed in equal quantities, but only so much as is needed for the operation. With this gallo-nitrate of silver, a sheet of the silver iodide paper is to be washed over upon its marked side with a soft brush, an operation to be performed by candle-light. After half a minute, the paper being dipped in water, and dried lightly by pressure between folds of blotting paper, becomes so exceedingly sensitive to light, as to take a pictorial impression in the camera in a space varying from one second to five minutes, according to the brightness of illumination. The camera should be mounted with a meniscus lens, in an adjustible tube, so as to throw the image of the object to be calotyped upon a vertical plate of roughened glass, in the posterior side or wall of the wooden box. Whenever the focus is correctly adjusted, the glass is withdrawn, and replaced by sliding in a groove a frame with the prepared sheet of paper fixed flat upon it, the prepared side towards the lens, but screened from light by a card or thin board. The screen being now removed, the light acts upon the paper, and produces a picture. A camera made entirely of metal, in a conical form, and mounted on a stand like a telescope, which has been invented for calotype purposes, by Dr. Petzval and M. Voigtlander, of Vienna, is recommended in preference to all others, by Mr. Talbot, especially for taking portraits.

The paper, after exposure for the due time in the camera, is to be again covered from the light, taken out, and subjected to another process; for as yet it has no pictorial appearance. To bring out this effect, it must be washed with the gallo-nitrate of silver, and then be gently warmed. In a few seconds the portions of the paper upon which the light has acted will begin to darken, and eventually grow quite black, while the rest of the paper retains its original hue. Even though the pictorial impression be very faint, it may be brought out by a second application of the same solution. The operator should watch the gradual development of the tints; and when it is sufficient, he should fix them by dipping the paper in water, drying it slightly with blotting paper, then washing it over with a solution of bromide of potassium, containing 100 grains of that salt, dissolved in 8 or 10 ounces of water. Strong brine will also answer, but not so well. Similar calotype pictures may be made by using the bright light emitted from lime ignited by the oxy-hydrogen flame; as is practised in making the Daguerrotype portraits at night.

In all the photographic pictures the lights and shades of the object are reversed; but they may be made conformable to nature by rendering the paper transparent with white wax scraped upon its back, melting this in by rubbing it with a hot smoothing-iron, after it is placed between two sheets of common paper, then laying it upon paper imbued with bromide of potassium, and exposing it to sunshine. Portraits are best taken by means of a lens, whose focal length is 3 or 4 times only greater than the diameter of the aperture.

CANDLES. Messrs. Hempel and Blundell have given a very minute account of the process for making palm-oil, stearic and margaric acids, in the specification of their patent for this mode of manufacturing candles: —

1. Their first process is called *crystallisation*, which consists in pouring the melted palm-oil into iron pans, and allowing it to cool slowly, whereby, at about 75° F., the elaine separates from the crystalline stearine and margarine.

2. The concreted oil is subjected to the action of an hydraulic press, in order to separate the elaine from the solid fats.

3. This process is called *oxidation*. To 104 lbs. of the stearine and margarine, melted in an iron pan, about 12 lbs. of slaked and sifted quicklime are added, with diligent stirring, during which the temperature is to be slowly raised to 240° F., and so maintained for about 3 hours, till a perfect chemical combination takes place. This is shown by the mass becoming thin, transparent, and assuming a glassy appearance when it cools. The fire being now withdrawn, cold water is added very gradually at first, with brisk stirring till the whole mass falls into a state of powdery granulation, when it is passed through a wire sieve to break down any lumps that may remain.

4. *Separation of the stearic and margaric acids* from the lime. For this purpose, as much muriate of lime (chlorcalcium) is taken as will, with its equivalent quantity of sulphuric acid (8 lbs. of dry chlorcalcium require 7 lbs. of the strongest sulphuric acid), produce as much muriatic acid as will dissolve the lime combined with the fat acids; and therefore that quantity of muriate of lime dissolved in water must be treated with as much sulphuric acid as will saturate its lime and throw it down in the state of sulphate of lime. Add the supernatant solution of muriatic acid in such proportion to the stearate and margarate of lime as will rather more than saturate the lime. Three pounds of muriatic acid diluted with 9 lbs. of water are stated as enough for 1 lb. of lime. This mixture is to be let alone for 3 or 4 days, in order to insure the complete separation of the lime from the fat acids; and then the mixture is heated so as to melt and cause them to separate in a stratum on the top of the liquid. The resulting muriate of lime is drawn off into another tub, and decomposed by its dose of sulphuric acid, so as to liberate its muriatic acid for a fresh operation.

5. The fat acids, being well washed by agitation with hot water, are then set to cool and crystallise, in which state they are subjected to the action of the hydraulic press, at a temperature of 75° F., whereat the margaric acid runs off from the solid stearic acid.

6. *Bleaching.* The stearic acid is taken from the press, and exposed upon water in large shallow vessels placed in the open air, where it is kept at the melting temperature from 8 to 12 hours, stirring meanwhile, in order to promote the blanching action of the atmosphere. The margaric acid is bleached in a similar manner in separate vessels.

7. *Refining process.* The fat is warmed again, and poured in a liquid state into an agitating tub; where, for every 1000 lbs. of the stearic acid, about 2½ lbs. of common black oxide of manganese, and 40 lbs. of concentrated sulphuric acid, diluted with 200 lbs. of pure water, are to be used. This solution ("mixture"), while warm from the heat evolved in diluting the acid, is placed in a suitable vessel above the agitating tub. The stearic acid being at the melting point, in the vessel below, agitation is to be given with a revolving shaft, while the mixed manganese and acid are run slowly down into it, till the whole be well mixed, which generally requires about 2 hours. The mass is allowed to lie in this state for 48 hours; after which it may be boiled by steam for 2 or 3 hours, when it will be sufficiently refined. The sulphuric acid, which is at the bottom, is now run off, and the stearic acid which remains is well washed with pure water. It is then put into large conical vessels of stone-ware, inclosed in a box or jacket, kept warm by steam-heat, and lined with conical bags of suitable strong filtering paper, through which, being warm, it finds its way; and when the stearic acid has been thus filtered, it is run into blocks, when it will be found to be a beautiful stearic acid or palm-wax, and is ready to be made into candles in the usual way.

On the above process with manganese and diluted sulphuric acid, it may be observed, that no solution or chemical action takes place between them, and their joint use seems therefore most problematical. The patentees proceed to describe other processes of refining, in which sulphate of manganese, with common salt, phosphoric acid (highly concentrated), and oxalic acid, are used, and in my opinion either ignorantly or for the purpose of mystification; for, as prescribed, they can serve no possible purpose of purifying the stearine.

The chief solid constituent of palm-oil is margaric acid. This they direct to be melted with tallow, in the proportion of from 10 to 20 lbs. of the former to 100 lbs. of the latter. See *Newton's Journal, C. S.*, xi. 207.

I was told by M. Runge, at Berlin, that he was the inventor of the process for making white margaric acid from palm-oil, and that Hempel had got it somehow from him, but most imperfectly, as it would appear. Hempel died here in the midst of the above patent operations; but the specification is, no doubt, a specimen of his manufacture of Runge's margaric acid. He gave me a splendid pearly-looking sample.

CAOUTCHOUC. Hitherto the greater part of the caoutchouc has been imported into Europe from South America, and the best from Para; but of late years a considerable quantity has been brought from Java, Penang, Sincapore, and Assam. About three years ago, Mr. William Griffith published an interesting report upon the *Ficus elastica*, the caoutchouc tree of Assam, which he drew up at the request of Captain Jenkins, agent in that country to the Governor-General of India. This remarkable species of figtree is either solitary, or in twofold or threefold groups. It is larger and more umbrageous than any of the other trees in the extensive forest where it abounds, and may be distinguished from the other trees, at a distance of several miles, by the picturesque appearance produced by its dense, huge, and lofty crown. The main trunk of one was carefully measured, and was found to have a circumference of no less than 74 feet; while the girth of the main trunk along with the supports immediately round it, was 120 feet. The area covered by the expanded branches had a circumference of 610 feet. The height of the central tree was 100 feet.

It has been estimated, after an accurate survey, that there are 43,240 such noble trees within a length of 30 miles, and breadth of 8 miles of forest near Ferozepoor, in the district of Chardwar, in Assam.

Lieutenant Veitch has since discovered that the *Ficus elastica* is equally abundant in the district of Naudwar. Its geographical range in Assam seems to be between 25 deg. 10 min. and 27 deg. 20 min. of north latitude, and between 90 deg. 40 min. and 95 deg. 30 min. of east longitude. It occurs on the slopes of the hills, up to an elevation of probably 22,500 feet. This tree is of the banyan tribe, famed for "its pillared shade, where daughters grow about the mother tree," which has furnished the motto *tot rami, quot arbores*, to the Royal Asiatic Society. Species of this genus afford grateful shade, however, in the tropical regions of America, as well as Asia.

Many species of other trees yield a milky tenacious juice, of which birdlime has been frequently made; as *Artocarpus integrifolia*, and *Lakoocha*, *Ficus indica* and *religiosa*, also *F. Tsiela*, *Roxburghii*, *glomerata*, and *oppositifolia*. From some of these an inferior kind of caoutchouc has been obtained.

The juice of the Ficus elastica of Chardwar is better when drawn from the old than from the young trees, and richer in the cold season than in the hot. It is extracted by making incisions a foot apart, across the bark down to the wood, all round the trunk, and also the large branches, up to the very top of the tree; the quantity which exudes increasing with the height of the incision. The bleeding may be safely repeated once every fortnight. The fluid, as fresh drawn, is nearly of the consistence of cream, and pure white. Somewhat more than half a *maund* (42 lbs.) is reckoned to be the average produce of each bleeding of one tree; or 20,000 trees will yield about 12,000 maunds of juice; which is composed in 10 parts, of from 4 to 6 parts of water, and, of course, from 6 to 4 parts of caoutchouc. The bleeding should be confined to the cold months, so as not to interfere with, or obstruct the vigorous vegetation of the tree in the hot months.

Mr. Griffith says, that the richest juice is obtained from transverse incisions made into the wood of the larger reflex roots, which are half exposed above ground, and that it proceeds from the bark alone. Beneath the line of incision, the natives of Assam scoop out a hole in the earth, in which they place a leaf of the *Phrynium capitatum*, Lin., rudely folded up into the shape of a cup. He observes that the various species of *Tetranthera*, upon which the *Moonga* silkworm feeds, as also the castor oil plant, which is the chief food of the Eria silkworm, do not afford a milky caoutchouc juice. Hence it would appear that Dr. Royle's notion of caoutchouc forming a necessary ingredient in the food of silkworms, and being "in some way employed in giving tenacity to their silk," seems to be unfounded. If Botany discountenances this idea, Chemistry would seem to scout it altogether; for silk contains 11·33 per cent. of azote, and caoutchouc contains none at all; being simply a solid hydro-carburet, and, therefore, widely dissimilar in constitution to silk, which consists of oxygen 34·04, azote 11·33, carbon 50·69, and hydrogen 3·94 in 100 parts.

This hydro-carburet emulsion is of common occurrence in the ORDERS *Euphorbiacia* and *Tulicea*, which may be looked on as the main sources of caoutchouc. The American caoutchouc is said to be furnished by the *Siphonia elastica*, or the *Hevea guianensis* of Aublet, a tree which grows in Brazil, and also in Surinam.

Dr. Royle sent models of cylinders, of 1½ to 2½ inches in diameter, and 4 or 5 inches in length, to both the Asiatic and Agricultural Societies of Bengal, to serve as patterns for the natives to mould their caoutchouc by. Mr. Griffith says that this plan of forming the caoutchouc into tumblers or bottles, as recommended by the committee of the London Joint-stock Caoutchouc Company, is, in his opinion, the worst that can possibly be offered; being tedious, laborious, causing the caoutchouc to be blackened in the drying, and not obviating the viscidity of the juice when it is exposed to the sun. He recommends, as a far better mode of treating the juice, to work it up with the hands, to blanch it in water, and then subject it to pressure. I shall presently describe a still better method which has recently occurred to me, in experimenting upon the caoutchouc juice. This fluid, with certain precautions, chiefly exclusion from air and much warmth, may be kept in the state of a creamy emulsion for a very long time.

NEW EXPERIMENTAL RESEARCHES ON CAOUTCHOUC.

The specific gravity of the best compact *Para* caoutchouc, taken in dilute alcohol, is	0·941567
The specific gravity of the best Assam is	0·942972
” ” Sincapore	0·936650
” ” Penang	0·919178

Having been favoured by Mr. Sievier, formerly managing director of the Joint-stock Caoutchouc Company, and by Mr. Beale, engineer, with two different samples of caoutchouc juice, I have subjected each to chemical examination.

That of Mr. Sievier is greyish brown, that of Mr. Beale is of a milky grey colour; the deviation from whiteness in each case being due to the presence of aloetic matter, which accompanies the caoutchouc in the secretion by the tree. The former juice is of the consistence of thin cream, has a specific gravity of 1·04125, and yields, by exposure upon a porcelain capsule, in a thin layer, for a few days, or by boiling, for a few minutes, with a little water, 20 per cent of solid caoutchouc. The latter, though it has the consistence of pretty rich cream, has a specific gravity of only 1·0175. It yields no less than 37 per cent. of white, solid, and very elastic caoutchouc.

It is interesting to observe how readily and compactly the separate little cloths or threads of caoutchouc coalesce into one spongy mass in the progress of the ebullition, particularly if the emulsive mixture be stirred; but the addition of water is necessary to prevent the coagulated caoutchouc from sticking to the sides or bottom of the vessel and becoming burnt. In order to convert the spongy mass thus formed into good caoutchouc, nothing more is requisite than to expose it to moderate pressure between the folds of a towel. By this process the whole of the aloetic extract, and other vegetable matters, which concrete into the substance of the balls and junks of caoutchouc prepared in Assam and Java, and contaminate it, are entirely separated, and an article nearly white and inodorous is obtained. Some of the cakes of American caoutchouc exhale when cut the fœtor of rotten cheese; a smell which adheres to the threads made of it, after every process of purification.

In the interior of many of the balls which come from both the Brazils and East Indies, spots are frequently found of a viscid tarry-looking matter, which, when exposed to the air, act in some manner as a ferment, and decompose the whole mass into a soft substance, which is good for nothing. Were the plan of boiling the fresh juice along with its own bulk of water, or a little more, adopted, a much purer article would be obtained, and with incomparably less trouble and delay, than has been hitherto brought into the market.

I find that neither of the above two samples of caoutchouc juice affords any appearance of coagulum when mixed in any proportions with alcohol of 0·825 specific gravity; and, therefore, I infer that albumen is not a necessary constituent of the juice, as Mr. Faraday inferred from his experiments published in the 21st vol. of the Journal of the Royal Institution.

The odour of Mr. Sievier's sample is slightly acescent, that of Mr. Beale's, which is by far the richer and purer, has no disagreeable smell whatever. The taste of the latter is at first bland and very slight, but eventually very bitter, from the aloetic impression upon the tongue. The taste of the former is bitter, from the first, in consequence of the great excess of aloes which it contains. When the brown solution which remains in the capsule, after the caoutchouc has been separated in a spongy state by ebullition, from 100 grains of the richer juice is passed through a filter and evaporated, it leaves 4 grains of concrete aloes.

Both of these emulsive juices mix readily with water, alcohol, and pyroxilic spirit, though they do not become at all clearer; they will not mix with *caoutchoucine* (the distilled spirit of caoutchouc), or with petroleum-naphtha, but remain at the bottom of these liquids as distinct as mercury does from water. Soda caustic lye does not dissolve the juice; nitric acid (double aquafortis) converts it into a red curdy magma. The filtered aloetic liquid is not affected by the nitrates of baryta and silver; it affords with oxalate of ammonia minute traces of lime.

I. CAOUTCHOUC MANUFACTURE.

This department of operative industry has, within a few years, acquired an importance equal to that of some of the older arts, and promises, ere long, to rival even the ancient textile fabrics in the variety of its designs and applications. The manufacture of caoutchouc has, at present, three principal branches:— 1. The condensation of the crude lumps or shreds of caoutchouc, as imported from South America, India, &c., into compact homogeneous blocks, and the cutting of these blocks into cakes or sheets for the stationer, surgeon, shoemaker, &c. 2. The filature of either the Indian rubber bottles, or the artificial sheet caoutchouc, into tapes and threads of any requisite length and fineness, which, being clothed with silk, cotton, linen, or woollen yarns, form the basis of elastic tissues of every kind. 3. The conversion of the refuse cuttings and coarser qualities of caoutchouc into a viscid varnish, which, being applied between two surfaces of cloth, constitutes the well-known double fabrics, impervious to water and air.

I. The caoutchouc, as imported in skinny shreds, fibrous balls, twisted concretions, cheese-like cakes, and irregular masses, is, more or less, impure, and sometimes fraudulently interstratified with earthy matter. It is cleansed by being cut into small pieces, and washed in warm water. It is now dried on iron trays, heated with steam, while being carefully stirred about to separate any remaining dirt, and is then passed through, between a pair of iron rolls, under a stream of water, whereby it gets a second washing, and becomes at the same time equalized by the separate pieces being blended together. The shreds and cuttings thus laminated, if still foul or heterogeneous, are thrown back into a kind of hopper over the rolls, set one-sixteenth of an inch apart, and passed several times through between them. The above method of preparation is that practised by Messrs. Keene and Co., of Lambeth, in their excellent manufactory, under a patent granted in October, 1836, to Mr. Christopher Nickels, a partner in the firm.

In the great establishment of the Joint-Stock Caoutchouc Company, at Tottenham, originally under the direction of Mr. Sievier, a gentleman distinguished no less by his genius and taste as a sculptor, than by his constructive talents, the preparatory rinsing and lamination are superseded by a process of washing practised in Mr. Nickels's second operation, commonly called the *grinding*, or, as it should more properly be styled, the *kneading*. The mill employed for agglutinating or incorporating the separate fragments and shreds of caoutchouc into a homogeneous elastic ball, is a cylindrical box or drum of cast iron, 8 or 9 inches in diameter, set on its side, and traversed in the line of its horizontal axis (also 8 or 9 inches long) by a shaft of wrought iron, furnished with 3 rows of projecting bars, or kneading arms, placed at angles of 120 deg. to each other. These act by rotation against 5 chisel-shaped teeth, which stand obliquely up from the front part of the bottom of the drum. The drum itself consists of 2 semi-cylinders; the under of which is made fast to a strong iron framing, and the upper is hinged to the under one behind, but bolted to it before, so as to form a cover or lid, which may be opened or laid back at pleasure, in order to examine the caoutchouc from time to time, and take it out when fully kneaded In the centre of the lid a funnel is made fast, by which the cuttings and shreds of the Indian rubber are introduced, and a stream of water is made to trickle in, for washing away the foul matter often imbedded in it. The power required to turn the axis of one of these mills, as the drums or boxes are called, may be judged of from the fact, that if it be only 2 inches in diameter, it is readily twisted asunder, and requires to be 3 inches to withstand every strain produced by the fixed teeth holding the caoutchouc against the revolving arms. Five pounds constitute a charge of the material.

One of the most remarkable phenomena of the kneading operation, is the prodigious heat disengaged in the alternate condensation and expansion of the caoutchouc. Though the water be cold as it trickles in, it soon becomes boiling hot, and emits copious vapours. When no water is admitted, the temperature rises much higher, so that the elastic lump, though a bad conductor of heat, cannot be safely touched with the hand. As we shall presently find that caoutchouc suffers no considerable or permanent diminution of its volume by the greatest pressure which can be applied, we must ascribe the heat evolved in the kneading process to the violent intestine movements excited throughout all the particles of the elastic mass.

During the steaming, much muddy water runs off through apertures in the bottom of the drum. In the course of half an hour's trituration, the various pieces become agglutinated into a soft, elastic, ovoid ball, of a reddish brown colour. This ball is now transferred into another similar iron drum, where it is exposed to the pricking and kneading action of 3 sets of chisel points, 5 in each set, that project from the revolving shaft at angles of 120 deg. to each other, and which encounter the resistance occasioned by five stationary chisel teeth, standing obliquely upwards from the bottom of the drum. Here the caoutchouc is kneaded dry along with a little quicklime. It soon gets very hot; discharges in steam through the punctures, the water and air which it had imbibed in the preceding washing operation; becomes, in consequence, more compact; and, in about an hour, assumes the dark brown colour of stationers' rubber. During all this time frequent explosions take place, from the expansion and sudden extrication of the imprisoned air and steam.

From the second set of drums the ball is transferred into a third set, whose revolving shaft, being furnished both with flat pressing bars, and parallel sharp chisels, perpendicular to it, exercises the twofold operation of pricking and kneading the mass, so as to condense the caoutchouc into a homogeneous solid. Seven of these finished balls, weighing, as above stated, 5 pounds each, are then introduced into a much larger iron drum of similar construction, but of much greater strength, whose shaft is studded all round with a formidable array of blunt chisels. Here the separate balls become perfectly incorporated into one mass, free from honeycomb cells or pores, and therefore fit for being squeezed into a rectangular or cylindrical form in a suitable cast-iron mould, by the action of a screw-press. When condensed to the utmost in this box, the lid is secured in its place by screw bolts, and the mould is set aside for several days. It is a curious fact, that Mr. Sievier has tried to give this moulding force, by the hydraulic press, without effect, as the cake of caoutchouc, after being so condensed, resiles much more considerably than after the compressing action of the screw. The cake form generally preferred for the recomposed, ground, or milled caoutchouc, is a rectangular mass, about 18 inches long, 9 inches broad, and 5 inches thick.

This is sliced into cakes for the stationer, and into sheets for making tapes and threads of caoutchouc, by an ingenious self-acting machine, in which a straight steel blade, with its edge slanting downwards, is made to vibrate most rapidly to and fro in a horizontal plane; while the cake of caoutchouc, clamped or embraced at each side between two strong iron bars, is slowly advanced against the blade by screw-work, like that of the slide rest of a lathe. In cutting caoutchouc by knives of every form, it is essential that either the blade or the incision be constantly moistened with water; for otherwise the tool would immediately stick fast. As the above straight vibrating knife slants obliquely downwards, the sheet which it cuts off spontaneously turns up over the blade in proportion as it is detached from the bottom mass of the cake. The thicker slices are afterwards cut by hand, with a wetted knife, into small parallelopipeds for the stationer, the sections being guided rectangularly by saw lines in a wooden frame. The wholesale price of these is now reduced to 2*s.* per pound. Slices may be cut off to almost any desired degree of thinness, by means of an adjusting screw—a mechanism that acts against a board which supports the bottom of the cake, and raises it by any aliquot part of an inch, the cutting blade being caused to vibrate always in the same horizontal plane. These thin slices constitute what is called sheet caoutchouc, and they serve tolerably for making tubes for pneumatic apparatus, and sheaths of every kind; since, if their two edges be cut obliquely with clean scissors, they may be made to coalesce, by gentle pressure, so intimately, that the line of junction cannot be discovered either by the eye, or by inflation of a bag or tube thus formed.

The mode of recomposing the cuttings, shreds, and coarse lumps of caoutchouc into a homogeneous elastic cake, specified by Mr. Nickels, for his patent, sealed October 24, 1836, is not essentially different from that above described. The cylinders of his mill are more capacious, are open at the sides like a cage, and do not require the washing apparatus, as the caoutchouc has been cleansed by previous lamination and rinsing. He completes the kneading operation, in this open cylinder, within the space of about two hours, and afterwards squeezes the large ball so formed into the cheese form, in a mould subjected to the action of an hydraulic press. As he succeeds perfectly in making compact cakes in this way, his caoutchouc must differ somewhat in its physical constitution from that recomposed by Mr. Sievier's process. He uses a press of the power of 70 tons; such pressure, however, must not be applied suddenly, but progressively, at intervals of two or three minutes between each stroke; and when the pressing is complete, he suffers the caoutchouc to remain under pressure till it is cold, when he thrusts it out of the mould entirely, or, placing his mould in the slide-rest mechanism, he gradually raises the caoutchouc out of it, while the vibrating knife cuts it into slices in the manner already described. The elegant machine by which these sheets are now so easily and accurately sliced, was, I believe, originally contrived and constructed by Mr. Beale, engineer, Church-lane, Whitechapel.

II. FILATURE OF CAOUTCHOUC FOR MAKING ELASTIC FABRICS.

Messrs. Rattier and Guibal mounted in their factory at St. Denys, so long ago as the year 1826 or 1827, a machine for cutting a disk of caoutchouc into a continuous fillet spirally, from its circumference towards its centre. This flat disc was made by pressing the bottom part of a bottle of Indian rubber in an iron mould. I have described this machine under the article Elastic Bands, in the Dictionary. A machine on the same principle was made the subject of a patent by Mr. Joshua Proctor Westhead, of Manchester, in Feb. 16. 1836; and, being constructed with the well-known precision of Manchester workmanship, it has been found to act perfectly well in cutting a disc of caoutchouc, from the circumference towards the centre spirally, into one continuous length of tape. For the service of this machine, the bottom of a bottle of India rubber of good quality being selected, is cut off and flattened by heat and pressure into a nearly round cake of uniform thickness. This cake is made fast at its centre by a screw nut and washer to the end of a horizontal shaft, which may be made to revolve with any desired velocity by means of appropriate pulleys and bands, at the same time that the edge of the disc of caoutchouc is acted on by a circular knife of cast steel, made to revolve 3000 times per minute, in a plane at right angles to that of the disc, and to advance upon its axis progressively, so as to pare off a continuous uniform tape or fillet from the circumference of the cake. During this cutting operation, the knife and caoutchouc are kept constantly moist with a slender stream of water. A succession of threads of any desired fineness is afterwards cut out of this fillet, by drawing it in a moist state through a guide slit, against the sharp edge of a revolving steel disc. This operation is dexterously performed by the hands of young girls. MM. Rattier and Guibal employed, at the above-mentioned period, a mechanism consisting of a series of circular steel knives, fixed parallel to each other at minute distances, regulated by interposed washers upon a revolving shaft; which series of knives acted against another similar series, placed upon a parallel adjoining shaft, with the effect of cutting the tape throughout its length into eight or more threads at once. An improved modification of that apparatus is described and figured in the specification of Mr. Nickels's patent of October, 1836. He employs it for cutting into threads the tapes made from the recomposed caoutchouc.

The body of the bottle of India rubber, and in general any hollow cylinder of caoutchouc, is cut into tapes, by being first forced upon a mandril of soft wood of such dimensions as to keep it equally distended. This mandril is then secured to the shaft of a lathe, which has one end formed into a fine-threaded screw, that works in a fixed nut, so as to traverse from right to left by its rotation. A circular disc of steel, kept moist, revolves upon a shaft parallel to the preceding, at such a distance from it as to cut through the caoutchouc, so that, by the traverse movement of the mandril shaft, the hollow cylinder is cut spirally into a continuous fillet of a breadth equal to the thickness of the side of the cylinder. Mr. Nickels has described two methods of forming hollow cylinders of recomposed caoutchouc, for the purpose of being cut into fillets by such a machine.

It is probable that the threads formed from the best India rubber bottles, as imported from Para, are considerably stronger than those made from recomposed caoutchouc, and therefore much better adapted for making Mr. Sievier's patent elastic cordage. When, however, the kneading operation has been skilfully performed, I find that the threads of the *ground* caoutchouc, as it is incorrectly called by the workmen, answer well for every ordinary purpose of elastic fabrics, and are, of course, greatly more economical, from the much lower price of the material.

Threads of caoutchouc are readily pieced by paring the broken ends obliquely with scissors, and then pressing them together with clean fingers, taking care to admit no grease or moisture within the junction line. These threads must be deprived of their elasticity before they can be made subservient to any torsile or textile manufacture. Each thread is *inelasticated* individually in the act of reeling, by the tenter boy or girl pressing it between his moist thumb and finger, so as to stretch it to at least eight times its natural length, while it is drawn rapidly through between them by the rotation of the power-driven reel. This extension is accompanied with condensation of the caoutchouc, and with very considerable disengagement of heat, as pointed out in Nicholson's Journal upwards of 30 years ago, by Mr. Gough, the blind philosopher of Kendal. I attempted to stretch the thread, in the act of reeling, but found the sensation of heat too painful for my unseasoned fingers. The reels, after being completely filled with the thread, are laid aside for some days, more or fewer, according to the quality of the caoutchouc, the recomposed requiring a longer period than the bottle material. When thus rendered inelastic, it is wound off upon bobbins of various sizes, adapted to various sizes of braiding, or other machines, where it is to be clothed with cotton or other yarn.

In the process of making the ELASTIC TISSUES, the threads of caoutchouc being first of all deprived of their elasticity, are prepared for receiving a sheath upon the braiding machine. For this purpose they are stretched by hand, in the act of winding upon the reel, to 7 or 8 times their natural length, and left two or three weeks in that state of tension upon the reels. Thread thus *inelasticated* has a specific gravity of no less than 0·948732; but when it has its elasticity restored, and its length reduced to its pristine state, by rubbing between the warm palms of the hands, the specific gravity of the same piece of thread is reduced to 0·925939. This phenomenon is akin to that exhibited in the process of wire-drawing, where the iron or brass gets condensed, hard, and brittle, while it disengages much heat: which the caoutchouc thread also does in a degree intolerable to unpractised fingers, as above mentioned.

The thread of the Joint-Stock Caoutchouc Company is numbered from 1 to 8. No. 1. is the finest, and has about 5000 yards in a pound weight; No. 4. has 2000 in the pound weight; and No. 8. 700, being a very powerful thread. The finest is used for the finer elastic tissues, as for ladies' silver and gold elastic bracelets and bands. The ropes made by Mr. Sievier with the strongest of the above threads, clothed with hemp and worked in his gigantic braiding machine, possess, after they are re-elasticated by heat, an extraordinary strength and elasticity; and, from the nearly rectilinear direction of all the strands, can stand, it is said, double the strain of the best patent cordage of like diameter.

In treating of the manufacture of elastic fabrics, I nave great pleasure in adverting to the ribbon looms at Holloway, which display to great advantage the mechanical genius of the patentee, Mr. Sievier. Their productive powers may be inferred from the following statement: — 5000 yards of 1-inch braces are woven weekly in one 18 ribbon loom, whereby the female operative, who has nothing to do but watch its automatic movements, earns 10*s.* a-week; 3000 yards of 2-inch braces are woven upon a similar loom in the same time. But one of Mr. Sievier's most curious patent inventions, is that of producing, by the shrinking of the caoutchouc threads in the foundation or warp of the stuff, the appearance of raised figures, closely resembling coach lace, in the weft. Thus, by a simple physical operation, there is produced, at an expense of one penny, an effect which could not be effected by mechanical means for less than one shilling.

III. OF THE WATER-PROOF DOUBLE FABRICS.

The parings, the waste of the kneading operations above described, and the coarsest qualities of imported caoutchouc, such as the inelastic lumps from Para, are worked up into varnish, wherewith two surfaces of cloth are cemented, so as to form a compound fabric, impervious to air and water. The caoutchouc is dissolved either in petroleum (coal-tar) naphtha, or oil of turpentine, by being triturated with either of the solvents in a close cast-iron vessel, with a stirring apparatus, moved by mechanical power. The heat generated during the attrition of the caoutchouc, is sufficient to favour the solution, without the application of fuel in any way. These triturating cylinders have been called pug mills by the workmen, because they are furnished with obliquely pressing and revolving arms, but in other respects they differ in construction. They are 4 feet in diameter and depth, receive 13 cwt. at a time, have a vertical revolving shaft of wrought iron 4 inches in diameter, and make one turn in a second. Three days are required to complete the solution of one charge of the varnish materials. The proportion of the solvent oils varies with the object in view, being always much less in weight than the caoutchouc.

When the varnish is to be applied to very nice purposes, as bookbinding, &c., it must be rubbed into a homogeneous smooth paste, by putting it in a hopper, and letting it fall between a couple of parallel iron rolls, set almost in contact.

The wooden framework of the gallery in which the waterproof cloth is manufactured, should be at least 50 yards long, to give ample room for extending, airing, and drying the pieces; it should be 2 yards wide, and not less than 5 high. It is formed of upright standards of wood, bound with three or four horizontal rails at the sides and the ends. At the end of the gallery, where the varnish is applied, the web which is to be smeared must be wound upon a beam, resembling in size and situation the cloth beam of the weaver's loom. The piece is thence drawn up and stretched in a horizontal direction over a bar, like the breast beam of a loom, whence it is extended in a somewhat slanting direction downwards, and passed over the edge of a horizontal bar. Above this bar, and parallel to it, a steel-armed edge of wood is adjusted, so closely as to leave but a narrow slit for the passage of the varnish and the cloth. This horizontal slit may be widened or narrowed at pleasure by thumb screws, which lower or raise the movable upper board. The caoutchouc paste being plastered thickly with a long spatula of wood upon the down-sloped part of the web, which lies between the breast-beam and the above-described slit, the cloth is then drawn through the slit by means of cords in a horizontal direction along the lowest rails of the gallery, whereby it gets uniformly besmeared. As soon as the whole web, consisting of about 40 yards, is thus coated with the viscid varnish, it is extended horizontally upon rollers, in the upper part of the gallery, and left for a day or two to dry. A second and third coat are then applied in succession. Two such webs, or pieces, are next cemented face to face, by passing them, at the instant of their being brought into contact, through between a pair of wooden rollers, care being taken by the operator to prevent the formation of any creases, or twisting of the twofold web. The under one of the two pieces being intended for the lining, should be a couple of inches broader than the upper one, to insure the uniform covering of the latter, which is destined to form the outside of the garment. The double cloth is finally suspended in a well-ventilated stove room, till it becomes day, and nearly free from smell. The parings cut from the broader edges of the under piece, are reserved for cementing the seams of cloaks and other articles of dress. The tape-like shreds of the double cloth are in great request among gardeners, for nailing up the twigs of wall shrubs.

Mr. Walton, of Sowerby-bridge, has recently substituted sheet India rubber for leather, in the construction of fillet cards for the cotton and tow manufactures. The superior elasticity of this article is said to prove advantageous in several respects.

Mr. Charles Keene, proprietor of the extensive and well-organized India-rubber factory in Lambeth, obtained a patent in March 1840, for applying a coat of caoutchouc to the outer surface of flexible leather. The varnish of caoutchouc, made with oil of turpentine, has so much lampblack incorporated with it, as to bring it to the consistence of dough. The edge of the doe-skin, buck-skin, or wash-leather, being introduced between a pair of wetted iron rollers, as much of the India-rubber compound, softened by a gentle heat, and rolled into a proper length as will cover the leather, is laid in the hollow between the leather and the moist cylinders. By their rotation, the coating is evenly effected. When the surface has become dry, it may be embossed or gilt, and varnished over with a solution of shellac, with a little Venice turpentine, in alcohol. After two or three applications of this kind, the leather is passed through a pair of rollers, either smoooth or embossed. When made up articles, such as shoes or portmanteaus, &c., are to be covered, the India-rubber varnish is used in a thinner state. — *Newton's Journal*, xxiii. 357.

CARMINE. This valuable pigment is often adulterated with starch. Water of ammonia enables us to detect this fraud by dissolving the pure carmine, and leaving the starchy matter, as well as most other sophisticating substances. Such debased carmine is apt to spoil with damp.

CASSAVA, or *Tapioca*, is obtained principally from the *Jatropha Manioc*. Its extraction is remarkable for the large quantity of hydrocyanic acid which the juice of that plant contains. When distilled it affords, as a first product, a liquor which, in the dose of 30 drops, will cause the death of a man in the course of six minutes; and it is well known that this acid does not pre-exist in the plant, but that it is generated in it, after it is grated down into a pulp. It would be interesting to discover in what state the substance exists, from which it proceeds. After the grating of the root, and washing of the pulp, this is dried upon hot plates, to agglutinate it into the form of concretions, constituting the tapioca of commerce. But the starch of the washed root floated in water, is spontaneously deposited, and, when dried in the sun, forms *Cassava* flour, called *moussache* by the French.

CASTOR OIL. Imported for consumption in 1839, 710,344 lbs.; in 1840, 807,175 lbs.: duty, 1*s.* 3*d.* per cwt.

CEMENTS. See MORTAR, HYDRAULIC.

An excellent cement for resisting moisture is made by incorporating thoroughly eight parts of melted glue, of the consistence used by carpenters, with four parts of linseed oil, boiled into varnish with litharge. This cement hardens in about forty-eight hours, and renders the joints of wooden cisterns and casks air and water tight. A compound of glue with one fourth its weight of Venice turpentine, made as above, serves to cement glass, metal, and wood, to one another. Fresh-made cheese curd, and old skim-milk cheese, boiled in water to a slimy consistence, dissolved in a solution of bicarbonate of potash, are said to form a good cement for glass and porcelain. The gluten of wheat, well prepared, is also a good cement. White of eggs, with flour and water well mixed, and smeared over linen cloth, forms a ready lute for steam joints in small apparatus.

Whitelead ground upon a slab with linseed oil varnish, and kept out of contact of air, affords a cement capable of repairing fractured bodies of all kinds. It requires a few weeks to harden. When stone and iron are to be cemented together, a compound of equal parts of sulphur with pitch answers very well.

CHALYBEATE. Is the name given in medicine to preparations of iron. The most agreeable, and one of the most powerful, forms of such medicines, is the improved chalybeate water, for which Mr. Henry Bewley, apothecary in Dublin, obtained a patent in June, 1842. The following is his valuable recipe: — Eight ounces of crystallised citric acid being dissolved in about four times their weight of water heated to 170° F., are saturated with pure peroxide of iron, in the washed state, after being precipitated by ammonia from the ferric sulphate. The solution is sweetened, flavoured, and charged highly with carbonic acid gas, so as to make a very palatable potion, agreeable also to the stomach.

I find by analysis that 100 parts of Mr. Bewley's brilliant citrate of iron contain 28·5 of peroxide, 48·5 of citric acid, and 23 of water; and that a six-ounce phial of his chalybeate water contains of that citrate a quantity equivalent to nearly 8 grains of peroxide of iron.

Similar compounds are also specified to be made with other organic salts, as the tartrate or lactate of iron. — *Newton's Journal*, xxii. 470.

CHAMELEON MINERAL. As this compound — so long known in chemistry as a mere curiosity, on account of the surprising changes of colour which it spontaneously assumes — has of late been largely employed for whitening tallow, palm oil, and decolouring other organic matters, it merits description in this dictionary. It exists in two states; one of which is called by chemists the manganate of potash, and the other the oxymanganate; denoting that the first is a compound of manganic acid with potash, and that the second is a compound of oxymanganic acid with the same base. They are both prepared in nearly the same way; the former by calcining together, at a red heat in a covered crucible, a mixture of one part of the black peroxide of manganese with three parts of the hydrate of potash (the fused potash of the apothecary). The mass is of a green colour when cold. It is to be dissolved in cold water, and the solution allowed to settle, and become clear, but by no means filtered for fear of the decomposition to which it is very prone. When the decanted liquid is evaporated under the exhausted receiver of an air-pump, over a surface of sulphuric acid, it affords crystals of a beautiful green colour, which should be laid on a clean porous brick to drain and dry. They may be preserved in dry air, but should be kept in a well-corked bottle. They are decomposed by water, but dissolve in weak water of potash. On diluting this much, decomposition of the salt ensues, with all the chameleon changes of tint; red, blue, and violet. Sometimes a green solution of this salt becomes red on being heated, and preserves this colour even when cold, but resumes its green hue the moment it is shaken: it might, therefore, furnish the crafty votaries of St. Januarius with an admirable means of mystifying the worshippers at his shrine. The original calcined mass, in being dissolved, always deposits a considerable quantity of a brown powder, which is a compound of the acid and peroxide of manganese combined with water. Much of the potash remains unchanged, which may be recovered.

The oxymanganate of potash is made by fusing, with a strong heat, a mixture of equal parts of peroxide of manganese and hydrate of potash, or one part of peroxide and two parts of nitre. The mass is to be dissolved in water, and, if the solution be green, it should be reddened by the cautious addition of a few drops of nitric acid. The clarified liquor is to be evaporated to the point of crystallisation. Even the smallest crystals of this salt have such an intense red colour, that they appear black with a green metallic reflection. In the air they gradually assume a steel grey hue, without undergoing any essential change of nature. A very little of the salt reddens a large body of water. The least portion of any organic matter added to the solution of this salt reduces the oxymanganic acid to the state of peroxide, which precipitates combined with water; and the liquor becomes green or colourless, according to circumstances.

A more permanent oxymanganic salt may be made as follows: — Melt chlorate of potash over a spirit lamp, and throw into it a few pieces of hydrate of potash, which immediately dissolve, and form a limpid liquid. When peroxide of manganese in fine powder is gradually introduced into that melted mixture, it immediately dissolves, with the production of a rich green colour. After adding the manganese in excess, the whole is to be exposed to a gentle red heat, in order to decompose the residuary chlorate of potash. It is now a mixture of manganate of potash, chloride of potassium and peroxide of manganese. It forms with water a deep green-coloured solution; which when boiled assumes a fine red colour, in consequence of its becoming an oxymanganate, and it ought to be decanted off the sediment while hot. By cooling, and still more after further evaporation, the oxymanganate of potash separates in crystals possessed of great lustre; but towards the end colourless crystals of chloride of potassium.

Both the above salts are readily decomposed by organic bodies and other combustibles, whereby they have their acid converted into an oxide, with the disengagement of oxygen, and the destruction of many vegetable and animal colours. In this respect they resemble the nitrates and chlorates.

CHINA INK. (*Encre de Chine*, Fr.; *Chinesischer Tusch*, Germ.) The finest kind of this useful pigment is seldom met with in our markets. According to a description in a Japanese book, it is made from the condensed smoke or soot of burned camphor; and hence, when of the best quality, it has this odour. Most of the China ink is made from oil-lampblack occasionally disguised, as to smell, with musk, or with a little camphor black. The binding substance is gelatine, commonly made from parchment or ass's skin; but isinglass answers equally well. A good imitation may be made by dissolving isinglass in warm water, with the addition of a very little alkali (soda), to destroy its gelatinizing power; and incorporating with that solution, by levigation on a porphyry slab, as much of the finest lampblack as to produce a mass of the proper consistence. The minute quantity of alkali serves also to saponify the oil which usually adheres to lampblack; and thereby to make a pigment readily miscible with water.

CHLORATE OF POTASH. The following ingenious and easy way of making this valuable compound has been lately suggested by Professor Graham: — Mix equal atomic weights of carbonate of potash and hydrate of lime (70 of the former, if pure, and 37 of slaked lime in powder), diffuse them through cold water, and transmit chloride gas through the mixture. The gas is absorbed with great avidity, and the production of a boiling heat. When the saturation is complete, carbonate of lime remains, and a mixture of muriate and chlorate of potash, which latter salts are to be separated, as usual, by the difference of their solubility in water.

It has been remarked on the above process, that it effects no saving of potassa, and therefore is far inferior to the one long practised in several parts of Germany, especially at Giessen, and introduced into this country a good many years ago by Dr. Wagenmann, from Berlin. The chlorine is passed into a mixture of one equivalent of chloride of potassium (76), and 6 equivalents of hydrate of lime (222), previously stirred with water, to the consistence of a thin paste. Thus the calcium of the lime unites with the chlorine to form chloride of calcium, while the chloride of potassium is converted into chlorate of potassa, which salt is easily separated in crystals by its sparing solubility.

Chlorate of potash may also be made by saturating with chlorine a mixture of 74 parts of chloride of potassium (muriate of potash) and 168 parts of quicklime, brought to the consistence of a thin pap by the cautious addition of water. The mass being dissolved in warm water, and evaporated and cooled, yields crystals of chlorate of potash, while a mother water of chloride of calcium (muriate of lime), remains. The following process has likewise been prescribed: — Mix 10 parts of good chloride of lime with water into a pap, and evaporate to dryness, whereby it is converted into a mixture of chloride of calcium and chlorate of lime devoid of bleaching power: dissolve it in water, filter, concentrate the solution by evaporation, then add to it 1 part of chloride of potassium, and cool for crystallisation. The salt which may thereby be separated from the chloride of calcium will afford 0·83 of pure chlorate of potash. By this process of Professor Liebig five sixths of the potash are saved, but much oxygen is wasted in the evaporation to dryness of the chloride of lime, and, consequently, much chloric acid is lost towards the production of the salt. Vée mixes the chloride of lime pap, before heating it, with the chloride of potassium, boils the mixture smartly, whereby much oxygen is undoubtedly thrown off, and then sets the liquor aside to crystallise. L. Gmelin suggests that saturation of the liquor with chlorine before boiling might be advantageous. Gay Lussac has suggested to make this valuable salt by precipitating a solution of chloride of lime with carbonate (or sulphate) of potash, saturating the liquor after filtration with chlorine gas, evaporating, and crystallising.

Professor Juch's process is to pass chlorine gas into a mixture of 1 pound caustic lime and 1 pound carbonate of potash, with 8 pounds of water. The resulting chloride of potash readily separates in the filtered liquid by crystallization, from the very soluble chloride of calcium. By this method, potash is not wasted in the useless production of chloride of potassium.

CHOCOLATE. About eighteen months ago, samples of chocolate were sent to me for analysis, by order of the Lords of the Admiralty. It was made at the victualling-yard, Deptford, for the use of the Royal Navy, by the government chocolate-mills, where about 400 tons are annually prepared, to be distributed to the sailors and convicts at the rate of an ounce daily, and to be used at their breakfast. After taking the said chocolate for some time, men in several ships complained of its occasioning sickness, vomiting, purging, and more serious maladies, terminating in a few cases fatally. I examined it with great care, but could find no injurious ingredient in it, and no chemical alteration from the beans of the Guyaquil coco from which it was manufactured. But I observed that it consisted of gritty grains, from very imperfect trituration or milling; that these grains were quite immiscible with water, like so much fine gravel; that they contained many sharp spiculæ of the coco-bean husks, and that hence, when swallowed, they were calculated to form mechanically irritating lodgements in the villous coats of the stomach and bowels, whereby they could produce the morbid effects certified by several naval surgeons. It was, moreover, obvious that, from the insoluble condition of the chocolate, it could be of little use as an article of food, or as a demulcent substitute for milk, and that, in fact, three-fourths of it were, on this account, an ineffective article of diet; or were wasted.

Having reported these results and opinions to the Lords of the Admiralty, they were pleased, after a few weeks' consideration, to request me to go down to the victualling-yard at Deptford, and superintend the preparation of a quantity of chocolate in the best manner I could with the means there provided. I accordingly repaired thither on the 13th September, 1842, and experienced the utmost courtesy and co-operation from Sir John Hill, the Captain Superintendent, and his subordinate officers. The coco-beans had been heretofore milled, after a slight roasting upon the sole of an oat-kiln, along with their husks. As I was satisfied, from analysis, that the husks were no better food than sawdust, and that they might cause irritation by their minute spiculæ left after grinding between rotating millstones, I set about a plan for shelling them, but could find no piece of apparatus destined for the purpose. There was, however, a pea-shelling mill, which had been used only for one day some years before, and had stood ever since idle*, which, on being cleaned and having its millstones placed at a proper distance, was found to answer pretty well. The beans for experiment, to the amount of 6 cwt., had been previously roasted, under my care, at a well-regulated heat, with much stirring, in the oat-kiln; and, on being cold, were run through the shelling mill, which was put in communication with the fanners of the flour mill. By this arrangement, the coco-beans were tolerably shelled, and the kernels separated from their scaly husks. The weighings were accurately made.

6 cwt. of the Guyaquil coco - - -		672 lbs.
Lost in roasting - -	43	
shells - -	54	117
waste - -	20	
Remained for milling - -		555

On the 14th September I made a report to the Lords of the Admiralty upon the experiments of the 13th, of which the following is an outline. After describing the pains taken to regulate the roasting temperature, and to equalize the effect upon the beans by moving them occasionally by a rake, I stated that the oat-kiln was not well adapted to the purpose of roasting the coco, because it was impossible to turn the beans regularly and continuously during the process, so that they could not be equally roasted, and because it was an unwholesome operation for the workmen, who must go into a chamber filled with noxious gases and fumes, to use the rakes. When the door of the kiln was shut, to allow the burned air from the fire below to draw up through it, mischief might be done to the stratum of coco on the sole, and when the door was again opened, to permit a person to go in and stir, time and heat were wasted in replenishing the chamber with fresh air. I understand that a revolving-cylinder-roasting machine had been made by Messrs. Rennie for the chocolate process at Deptford; but, for reasons unknown to me, it had never been employed.

The diminution of weight by roasting and shelling may be estimated at about 17 per cent. A part of this loss is moisture, which should be completely expelled, to prevent its causing the chocolate to become mouldy at sea. But a part of the defalcation was also due to some of the coco remaining in the crevices of the pea-splitting mill and the fanners, which would not be observable if these were in constant employment. I think, therefore, that the roasted kernels may be estimated in general at 85 per cent. of the raw beans.

Fig. 20. represents the chocolate mills at the victualling-yard, Deptford, as mounted by the celebrated engineers, Messrs. Rennie. There are four double millstones, A, B, C, D, each three feet in diameter, of which the nether rests upon a bed of cast iron, like a drum-head, kept at the temperature of about 220° by the admission of steam to the case below. Over each mill there is a feeding-hopper 1, 2, 3, 4, in communication by the pipes 5, 6, 7, 8, with the general reservoir E, charged upon the floor above with coco through the funnel placed over it. The vertical shafts which turn these mills are marked F, G, H, L; they are moved by the train of bevil wheels above, which are driven by an arm from the main shaft of the steam engine. Each mill can, of course, be thrown in and out of geer at pleasure. At I, I, I, I, the discharge-spout is shown, which pours out the semi-fluid hot chocolate into shallow cylindrical tin pans,

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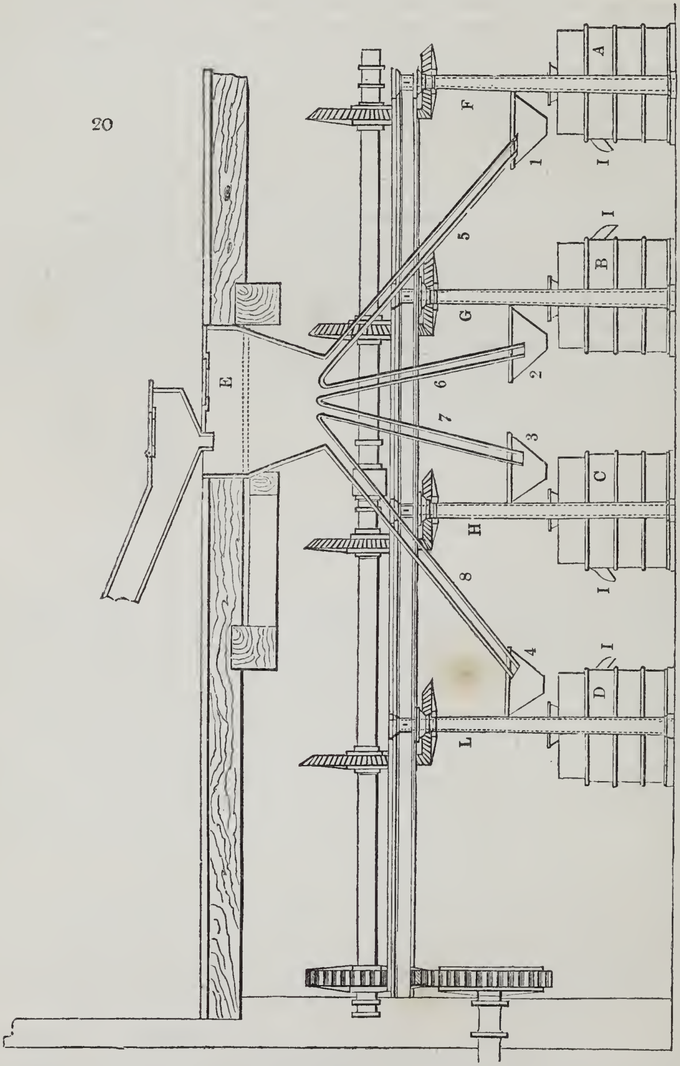
* It was found that peas in their skin kept better at sea than the split peas, and they were also preferred by the sailors in their natural state.

capable of containing about nine pounds of chocolate each. These four mills are capable of converting upwards of a ton of coco into good chocolate in a day, on the system of double trituration which I adopted, and two tons on the former rough plan. I found that the two stones of each mill had been placed so far asunder as would allow entire beans to pass through, as spurious chocolate, at one operation; but the chocolate thus discharged was in a very gritty state, whereas good chocolate in the liquefied state should be smooth and plastic between the fingers, and spread upon the tongue without leaving any granular particles in the mouth. To obtain such a result, I divided the milling into two steps; for the first, two pairs of the stones, A and C, were set as close together as for a paint mill (which they closely resemble), and the other two pairs, B and D, were left at their ordinary distance. The paste obtained from the first set was transferred, while nearly liquid, into the hoppers of the second pairs, from which it issued at the spouts as thin and smooth as honey from the comb. In subserviency to these experiments, I made an analysis of the Guyaquil coco, which I found to be composed as follows: —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Concrete fat or butter of coco, dissolved out by ether	37
Brown extractive, extractible by hot water, after the operation of ether	10
Ligneous matter, with some albumine	30
Shells	14
Water	6
Loss	3
	100

The solid fat of the coco should be most intimately combined by milling with the extractive, albumine, and ligneous matter, in order to render it capable of forming an emulsion with water; and, indeed, on account of the large proportion of concrete fat in the beans, some additional substance should be introduced to facilitate this emulsive union of the fat and water. Sugar, gum, and starch or flour are well adapted for this purpose.

Under this conviction, I employed in the first of these trials at Deptford, made with one half of the above roasted kernels = 277½ lbs., 5 per cent. of sugar, which was first mixed upon a board with shovels, and the mixture was then put progressively into the hoppers of the two mills B and D. The paste which ran out of their spouts, was immediately poured into the hoppers of A and C, from which it flowed smooth and very thin into the concreting pans. The sugar supplied to me was exceedingly moist, whereas it ought to be dry, like the bag sugar of the Mauritius. The other half of the coco kernels was milled alone once by the ordinary mills B and D. I subjected next day samples of these two varieties of chocolate to the following examination, and compared them with the sample of chocolate as usually made at Deptford, as also with a sample of chocolate sold by a respectable grocer in London. A like quantity of these four samples was treated with eight times its weight of boiling water, the diffusion well stirred, and then left to settle in a conical wineglass. Of the ordinary Deptford coco, four-fifths rapidly subsided in coarse grains, incapable of forming any thing like an emulsion with water, and therefore of little or no avail in making a breakfast beverage.

1. The single-milled chocolate made under my direction formed a smoother emulsion than the last, on account of the absence of the coco husks; but its particles were gritty, and subsided very soon.

2. The sugared double-milled chocolate, on the contrary, formed a milky-looking emulsion, which remained nearly uniform for some time, and then let fall a soft mucilaginous deposit, free from grittiness.

3. The shop chocolate formed a very indifferent emulsion, though it was well milled, because it contained evidently a large admixture of a coarse branny flour, as is too generally the case.

I have given small samples of the above No. 2. chocolate to various persons, and they have considered it superior to what is usually sold by our grocers. The presence of dry sugar in chocolate would also give it a conservative quality at sea, and prevent it from getting musty.

The Lords of the Admiralty, after seeing the above two samples of chocolate, and my report thereupon, were, about six weeks afterwards, pleased to request me to make at their victualling-yard further experiments in the preparation of chocolate; and they indicated two modes, one of milling twice with the husks, and another of milling twice without the husks; permitting me, at the same time, to mill a portion of the kernels with 10 per cent. of sugar, and a second portion of the kernels with 5 per cent. of sugar and 5 per cent. of the excellent flour used in making the biscuits for the royal navy. On the 24th October, 1842, I accordingly performed these experiments upon 12 cwt. of Guyaquil coco as carefully roasted as possible on the kiln.

The loss in drying and slightly roasting the 1344 lbs. of beans was 5 per cent.

1st experiment, 212 lbs. of roasted coco, milled twice with the husks, produced, of chocolate	209 lbs.
2d experiment, 191 lbs. ditto, milled twice without husks	189
3d experiment, 191 lbs. kernels, milled once along with 19 lbs. of sugar = 210 lbs.	212*
4th experiment, 573 lbs. of kernels, milled twice along with 68 lbs. of flour and 34 of sugar = 675	669

Sample cakes of these four varieties of chocolate were subsequently sent to me for examination and report. I found that the chocolate milled twice with the flour and

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* This small excess proceeded from a residue of the last experiment.

sugar formed a complete emulsion with hot water, bland and rich, like the best milk, but the other three were much inferior in this respect. Sugar alone, with proper milling, would serve to give the kernels of well roasted coco a perfect emulsive property. Instead of merely milling with rotatory stones, I would prefer, for the second or finishing operation, a levigating mill, in which rollers would be rolled either backwards and forwards, or, when slightly conical, in a circular direction, over a plane metallic, marble, or porphyry, slab, as is now, indeed, very generally practised by the trade. The coco-beans should be well selected, without musty taint, and possessed of a fine aroma, like the best of that imported from Trinidad. There is a great deal of very coarse coco and chocolate on sale in London and in the provincial towns of the United Kingdom.

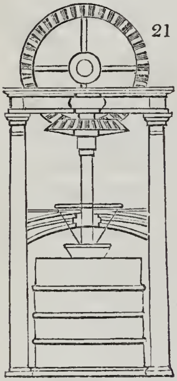

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Fig. 21. is an end view of one of the chocolate mills with its mitre-gearing. I consider the gritty chocolate hitherto made at Deptford as a very bad substitute for the chocolate which was made from coco by the sailors themselves with a pestle and mortar.

In 1840 the coco cleared for consumption in the United Kingdom was: —

		Rate of Duty.
British plantation - -	2,041,492 lbs.	2*d.* per lb.
Foreign - - -	186	6*d.*
Coco-nut husks and shells -	753,580	1*d.*
Chocolate and coco paste -	2,067	4*d.*

Of the coco-nut shells, 612,122 lbs. were consumed in Ireland! and less than 4000 lbs. of coco.

Of coco, 726,116 lbs. were consumed in Her Majesty's navy.

How scurvily are the people of Ireland treated by their own grocers! Upwards of 600,000 lbs. of worthless coco husks served out to them along with only 4000 lbs. of coco-beans!

CHROMIUM, OXIDE OF. Mix intimately 45 parts of gunpowder with 240 parts of perfectly dry chromate of potash, and 35 parts of hydrochlorate of ammonia (sal ammoniac), reduce to powder, and pass through a fine sieve; fill a conical glass or other mould with this powder, gently pressed, and invert so as to leave the powder on a porcelain slab of any kind. When set on fire at its apex with a lighted match, it will burn down to the bottom with brilliant corruscations. The black residuum, being elutriated with warm water, affords a fine bright green oxide of chromium.

CLOVES. Imported for home consumption in 1840, 85,769 cwts.

COAL. Under Pitcoal, the composition of several excellent coals, is stated, with their peculiar qualities, as analysed by me; such as the Llangennoek, Powell's Duffryn steam coal, the Blackley Hurst coal Lancashire, the Varley Rock vein coal, near Pontypool, &c.

COCHINEAL. Imported for consumption in 1839, 396,902 lbs.; in 1840, 325,744: duty, 1*s.* per cwt.

COFFEE. If tannin exist in roasted coffee, as maintained long ago by Chenevix, and generally admitted since, it must be very different from the tannin present in tea, catechu, kino, oak-bark, willow-bark, and other astringent vegetables; for I find that it is not, like them, precipitated by either gelatine, albumen, or sulphate of quinine. With regard to the action, upon the animal economy, of coffee, tea, and cocoa, which contain one common chemical principle called caffeine or theine, Liebig has lately advanced some ingenious views, and has, in particular, endeavoured to show that, to persons of sedentary habits in the present refined state of society, they afford eminently useful beverages, which contribute to the formation of the characteristic principle of *bile.* This important secreted fluid, deemed by Liebig to be subservient to the function of respiration, requires for its formation much azotised matter, and *that* in a state of combination analogous to what exists in caffeine. The quantity of this principle in tea and coffee being only from 2 to 5 per cent., might lead one to suppose that it could have little effect upon the system even of regular drinkers of their infusions; but if the bile contains only one tenth of solid matter, called choleic acid, which contains less than 4 per cent. of azote, then it may be shown that 3 grains of caffeine would impart to 500 grains of bile the azote which occurs in that crystalline precipitate of bile called *taurine,* which is thrown down from it by mineral acids.

One atom of caffeine, 9 atoms of oxygen, and 9 of water, being added together, produce the composition of 2 atoms of taurine. Now this is a very simple combination for the living organism to effect; one already paralleled in the generation of hippuric acid in urine, by the introduction of benzoic acid into the stomach; a physiological discovery made by my son, which is likely to lead to a more successful treatment of some of the most formidable diseases of man, particularly gout and gravel.

If the preceding views be established, they will justify the instinctive love of mankind for tea, coffee, and cocoa, in spite of the denunciations and vetos of *neuropathic*, *homœopathic*, and *hydropathic* doctors; sorry pathologists — *hoc genus omne*. See Tea.

Coffee imported for consumption in 1839, 26,789,945 lbs.; in 1840, 28,664,341. Net revenue in 1839, 779,115*l.*; in 1840, 921,551*l.*

COPAL and ANIME. Imported for consumption in 1839, 193,066 lbs.; in 1840, 181,388 lbs.: duty, 6*s.* per cwt., as upon gum arabic and tragacanth.

COPPER. Quantity of copper ore raised in Cornwall in the year 1838-1839, 159,214 tons; value of, 932,090*l.* 15*s.* 6*d.*

Quantity raised in the year 1839-1840, 147,049 tons; value of, 792,750*l.* 14*s.*

Quantity of metallic copper produced in the former year, 12,469 tons; standard 111*l.*: in the latter, 11,056; standard, 108*l.* 5*s.*

Produce per cent. 7¾ and 7½ respectively. Average price per ton, 5*l.* 17*s.* in the first; and 5*l.* 7*s.* 9*d.* in the second year.

Quantity of unwrought copper imported for home consumption in 1840, only 2½ cwts. *See* Metallic Statistics.

COPPER MEDALS AND MEDALLIONS may be readily made in the following way: — Let black oxide of copper, in a fine powder, be reduced to the metallic state, by exposing it to a stream of hydrogen, in a gun-barrel, heated barely to redness. The metallic powder thus obtained is to be sifted through crape, upon the surface of the mould, to the thickness of ¼ or ⅓ of an inch, and is then to be strongly pressed upon it, first by the hand, and lastly by percussion with a hammer. The impression thus formed is beautiful; but it acquires much more solidity by exposure to a red heat, out of contact with air. Such medals are said to have more tenacity than melted copper, and to be sharply defined.

M. Bœttger proposes the following improvement upon the above plan of Mr. Osann, He prepares the powder of copper easier and of better quality, by precipitating a boiling hot solution of sulphate of copper, with pieces of zinc, boiling the metallic powder thus obtained with dilute sulphuric acid for a little, to remove all traces of the zinc or oxide, washing it next with water, and drying it in a tubulated retort by the heat of a water bath, while a stream of hydrogen is passed over it. This cupreous precipitate possesses so energetic an affinity for oxygen, that it is difficult to prevent its passing into the state of orange oxide. If it be mixed with one half its atomic weight of precipitated sulphur, and the two be ground together, they combine very soon into sulphuret of copper with the evolution of light.

COPPER, *Purifying.* — Copper may be purified by melting 100 parts of it with 10 parts of copper scales (black oxide), along with 10 parts of ground bottle-glass or other flux. Mr. Lewis Thompson, who received a gold medal from the Society of Arts for this invention, says that after the copper has been kept in fusion for half an hour, it will be found at the bottom of the crucible perfectly pure; while the iron, lead, arsenic, &c., with which this metal is usually contaminated, will be oxidised by the scales, and will dissolve in the flux, or be volatilised. Thus he has obtained perfectly pure copper from brass, bell-metal, gun-metal, and several other alloys, containing from 4 up to 50 per cent. of iron, lead, antimony, bismuth, arsenic, &c. The scales of copper are cheap, being the product of every large manufactory where that metal is worked.

CORK. Unmanufactured, imported in 1840 for home consumption, 59,793 cwts.

CORTEX PERUVIANUS, or CINCHONA. Imported for home consumption in 1840, 43,705 lbs.

COTTON may be distinguished from linen in a cloth fabric by means of a good microscope; the former fibres being flat, riband-like, and more or less contorted or shrivelled, and the latter straight, round, and with cross knots at certain distances. These two fibrous matters may be also distinguished by the action at a boiling heat of a strong caustic lye, made by dissolving fused potash in its own weight of water. By digestion in this liquor, linen yarn becomes immediately yellow, while the cotton yarn remains white. The best way of operating is to immerse a square inch of the cloth to be tested for two minutes in the above boiling hot caustic lye, to lift it out on a glass rod, press it dry between folds of blotting-paper, and then to pull out a few of the warp and weft threads — when the linen ones will be found of a deep yellow tint, but the cotton, white or very pale yellow.

COTTON WOOL. Imported for home consumption in 1839, 352,000,277 lbs.; in 1840, 528,142,743 lbs.

CREOSOTE. Having been employed by a chemical manufacturer to examine his creosote, and compare it with others with a view to the improvement of his process, I found that the article, as made by eminent houses, differed considerably in its properties.

The specific gravities varied in the several specimens as follows:—1. a specimen given me by Messrs. Zimmer and Sell, at their factory in Sachsenhausen, by Frankfurt on the Maine, had a specific gravity of 1·0524; 2. a sample made in the north of England, sp. gr. 1·057, and its boiling point varied from 370° to 380° F. Mr. Morson's creosote, which is much esteemed, has a sp. gr. of 1·070, and boils first at 280°, but progressively rises in temperature up to 420°, when it remains stationary. The German creosote was distilled from the tar of the pyrolignous acid manufacture. Creosote, I believe, is often made from Stockholm tar. Berzelius gives the sp. gr. of creosote at 1·037, and its boiling point at 203° C.=397·4° F. I deemed it useless to subject to ultimate analysis products differing so considerably in their physical properties. They were all very soluble in potash lye.

CROSS-FLUCKANS or FLOOKANS. The name given by the Cornish miners to clay veins of more ancient formation.

CYANIDE OF POTASSIUM. This salt, so much used now in the electrotype processes, is prepared, according to Liebig's formula, by mixing 8 parts of pounded prussiate of potash, sharply dried, with 3 parts of pure carbonate of potash, fusing the mixture in an iron crucible, by a moderate red heat, and keeping it so, till the glass or iron rod with which the fluid mass should be occasionally stirred, comes out covered with a white crust. The crucible is then to be removed from the fire; and after the disengaged iron has fallen to the bottom, the supernatant fluid, still obscurely red hot, is to be poured off upon a clean surface of iron or platinum. After concretion and cooling, the white saline mass is to be pounded while hot, and then kept in a well-stopped bottle. It consists of about 5 parts of cyanide of potassium, and 1 of cyanate of potash. For most purposes, and the analysis of ores, the latter ingredient is no ways detrimental.

CYDER. The value of apples to produce this beverage of good quality is proportionate to the specific gravity of their juice. M. Couverchel has given the following table, illustrative of that proposition:—

Juice of the green renette, queen apple (*reinette verte*)	1084
English renette	1080
Red renette	1072
Musk renette	1069
Fouillet rayé	1064
Orange apple	1063
Renette of Caux	1060
Water	1000

Cyder apples may be distributed into three classes, the sweet, the bitter, and the sour. The second are the best; they afford a denser juice, richer in sugar, which clarifies well, and when fermented keeps a long time; the juice of sweet apples is difficult to clarify; but that of the sour ones makes bad cyder. Late apples are in general to be preferred. With regard to the proper soil for raising apple trees, the reader may consult with advantage an able essay upon "The Cultivation of Orchards and the making of Cyder and Perry," by Frederick Falkner, Esq., in the fourth volume of the Royal Agricultural Journal. He adverts judiciously to the necessity of the presence of alkaline and earthy bases, in the soils of all deciduous trees, and especially of such as produce acid fruits.

In November, 2340 kilogrammes of apples ($2\frac{1}{3}$ tons English, nearly) are supposed to afford 1000 litres ($220\frac{1}{2}$ gallons) of pure cyder; and 600 litres of a small cyder made with the marc mixed with water and pressed. But many persons mix all together, and thus manufacture 1600 litres out of the above weight of fruit. In France, the fermented liquor, as soon as it is clear, is often racked off into casks containing the fumes of burning sulphur, whereby it ceases to ferment, and preserves much of its sugar undecomposed. It is soon afterwards bottled. Average cyder should yield 6 per cent. of alcohol on distillation.

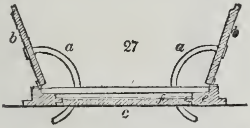
D.

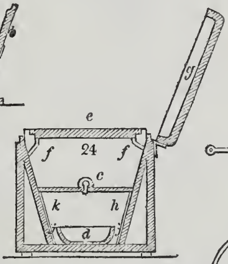
DAGUERROTYPE. This new and most ingenious invention, for producing pictures by the action of light, is due to M. Daguerre and M. Niepce, two Frenchmen. It was purchased from them by the French government for the benefit of the nation at large; but was made the subject of an exclusive patent in this country by M. Daguerre, as our government never purchases any scientific invention.

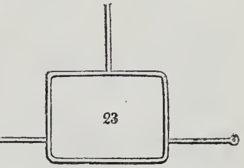
The fixation of the images, formed in the focus of the camera obscura, is made on very smooth surfaces of pure silver plated on copper. The process is divided into five operations. 1. The first consists in polishing and cleaning the silver surface, by friction with cotton fleece imbued with olive oil, upon the plate, previously dusted over with very finely-ground dry pumice-stone out of a muslin bag. The hand of the operator should be moved round in circles, of various dimensions. The plates should be laid upon a sheet of paper solidly supported. The pumice must be ground to an impalpable powder upon a porphyry slab with water, and then dried. The surface is next to be rubbed with a dossil of cotton, slightly moistened with nitric acid, diluted with sixteen parts of water, by applying the tuft to the mouth of the phial of acid, and inverting it for a moment. Two or three such dossils should be used in succession. The plate is lastly to be sprinkled with pumice powder or Venetian tripoli, and rubbed clean with cotton.

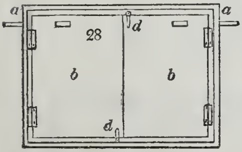
The next step is to heat the plate by placing it in a wire frame (*fig.* 23.), with the silver surface uppermost, over a spirit lamp, meanwhile moving it so as to act equally on every part of the plate. In about five minutes a whitish coating will indicate that this operation is completed. The plate must now be laid upon a flat metal or marble slab to cool it quickly. The white surface is to be brightened by rubbing it with cotton and pumice powder. It must be once more rubbed with the cotton imbued with acid, and afterwards dried by friction with cotton and pumice; avoiding to touch the plate with the fingers, or with the part of the cotton held in them, or to breathe upon the plate, since spots would thereby be produced. After cleaning with cotton alone, the plate is ready for the next operation.

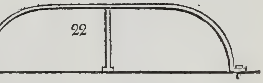
2. Here the following implements are required: 1. the box represented in *figs.* 24. and 25.; 2. the thin board or frame, *fig.* 26.; four small metallic bands of the same metals as the plates, also shown in *fig.* 26., a small handle and a box of small nails or tacks, and a phial of iodine.

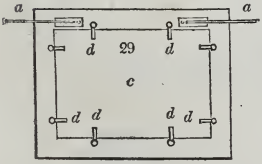


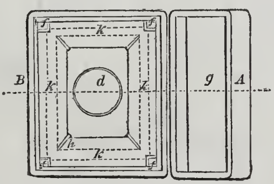


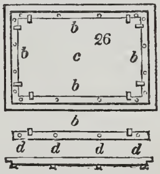








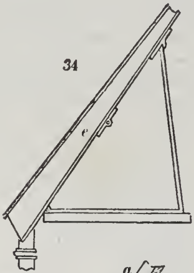


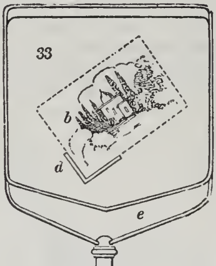


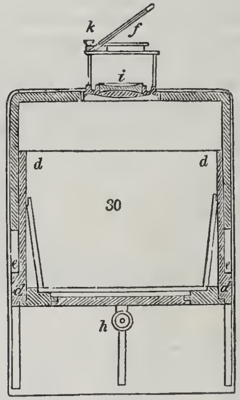
After fixing, by the metallic bands and the small nails, the plate upon the thin board, with the silver uppermost, several particles of iodine are then to be spread in the dish *d*, at the bottom of the box, *figs.* 24. and 25. The thin board with the plate is next placed, with the silver *beneath*, upon small supports at the four corners of the box, and its cover is applied. The plate must be left in this position till the surface of the silver acquires a fine golden hue, caused by the vapours of the iodine rising through the gauze cover of the dish, and condensing upon it; but it should not be allowed to assume a violet tint. The room should be darkened, and no heat should be employed. When the box is in constant use it gets impregnated with iodine, and acts more uniformly and rapidly; but in general states of the atmospheric temperature this operation will be effected in about twenty minutes. If the purple colour be produced, the plate must be repolished, and the whole process repeated.

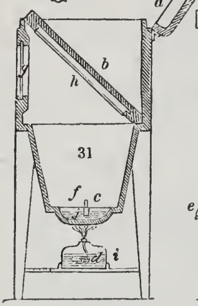
The plate with its golden hue is to be introduced with its board into the frame, *figs.* 27, 28, 29., which is adapted to the camera obscura. During this transfer the light must not be suffered to strike upon the surface of the plate; on which account, the camera obscura may be lighted briefly with a small wax taper.

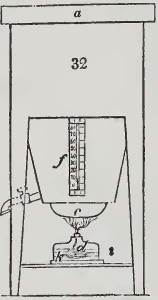
3. The plate is now submitted to the third operation, that of the camera obscura, *figs.* 30. and 22.; and with the least possible delay. The action of this machine is obviously quicker the brighter the light which acts upon it; and more correct, according as the focus is previously accurately adjusted to the place of the plate, by moving backwards and forwards a roughened pane of glass, till the focal point be found; and the plate is to be inserted precisely there, see *figs.* 27, 28, 29. This apparatus exactly replaces the ground glass. While the prepared plate is being fastened, the camera must be closed. The darkening shutters, *b b*, of the apparatus are opened by means of the two semicircles *a*, *a*. The plate is now in a proper position to receive and retain the impression of the image of the objects presented the moment that the camera is opened. Experience alone can teach the proper length of time for submitting the plate to the concentrated rays of light; because that time varies with the climate, the seasons, and the time of day. More time should not be allowed to pass than what is necessary for fixing a distinct impression, because the parts meant to be clear would be apt to become clouded.

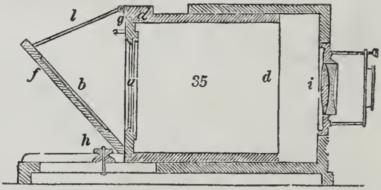


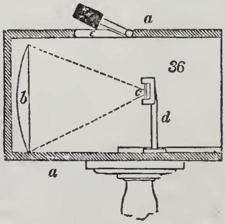












4. The fourth is the operation with quicksilver, which must follow as soon as possible the completion of the third. Here a phial of quicksilver, a spirit lamp (the apparatus represented in *figs.* 31. and 32.), and a glass funnel with a long neck, are required. The funnel is used for pouring the mercury into the cup *c*, placed in the bottom of the apparatus, so as to cover the bulb of the thermometer *f.* No day-light must now be admitted, but that of a small taper only should be used by the operator in conducting the process. The board with the plate is to be withdrawn from the camera, and inserted into the grooves of the blackened board, *b*, *fig.* 31. This black board is laid back into the box at an angle of 45 degrees with the horizon; the prepared metal surface *h* being placed undermost, so that it may be viewed through the side glass, *g*; and the cover, *a*, of the box must be put down gently to prevent any par-

ticles of mercury from being thrown about by the agitation of the air. The whole being thus prepared, the spirit-lamp is lighted, and placed under the cup containing the mercury, and left there until the thermometer indicates a temperature of 140° Fahr., when the lamp is to be removed. The heat should in no case be permitted to exceed 167° F.

The impression of the image of nature is now actually made upon the plate; but it is as yet invisible; and it is only after a lapse of several minutes that faint tracings of the objects begin to be seen through the peep-glass by the momentary gleam of a taper. The plate should be left in the box till the thermometer has cooled to 113° F., when it is to be taken out.

After each operation, the interior of the apparatus, and the black board or frame, should be carefully wiped, in order to remove every particle of mercury.

The picture may now be inspected in a feeble light, to see how far the process has succeeded. The plate, freed from the metallic bands, is to be placed in a box, provided with a cover and grooves, to exclude the light, till it is made to undergo the fifth and last operation, which may be done after any convenient interval of time without detriment, provided the plate be kept in the dark. The following articles are now required: — 1. strong brine, or a weak solution of hyposulphite of soda; 2. the apparatus represented in *figs.* 33. and 34.; 3. two troughs of tin-plate; 4. a jug of distilled water. The object of this process is to fix the photogenic picture. One of the troughs is to be filled with brine to the depth of an inch, and the other with pure water, both liquids being heated somewhat under the boiling pitch. The solution of hyposulphite of soda is preferable, and does not need to be warm. The plate is to be first immersed in the pure water for a moment, and transferred immediately to the saline solution, and moved to and fro in it to equalise the action of the liquor. Whenever the yellow tint of the iodine is removed, the plate is to be lifted out by the edges, and dipped straightway in the water-trough. The apparatus of *figs.* 33. and 34. is then brought into use, with a vessel filled with distilled water, hot, but not boiling. The plate, when lifted out of the water-trough, is to be placed immediately on the inclined plane *e*; and without allowing it time to dry, is to be floated over with the hot distilled water from the top, so as to carry off all the saline matter. As the quicksilver which traces the images will not bear touching, the silvered plate should be secured by a cover of glass, made tight at the edges by pasting paper round them.

In *fig.* 25., which is a plan view of the iodine-box apparatus, *c* is an interior cover; *d* is the iodine-dish; *e* is the thin board to which the silvered plate is fixed, as shown at *fig.* 24.; *g* is the cover of the box; *h h* are small rods, at the four corners of the inclined lining, *k*, of the box, to support the lid *c*; *j* is a gauze of wire cloth cover, to diffuse the iodine vapour; *k* is the wooden lining, sloping like a hopper; *d d*, in *fig.* 27., are buttons to fasten the board on the doors; *e* shows the thickness of the frame; *f* is the silvered plate. In *fig.* 35., *a* is the ground glass of the camera; *b* is a mirror inclined about 45° to the horizon, by means of the rod *l*. The image of the object is easily brought into focus by moving forward or backward the sliding-box *d*, in laying hold of it with both hands by the projections *a*, *fig.* 28. When the focus is adjusted, the thumb-screw, *h*, fixes the whole. The mirror is kept closed by two hooks at *f*, which take into small eyes at *g*. The frame and ground glass plate are withdrawn and replaced by the frame carrying the prepared plate, as represented in *fig.* 22., with the shading doors, *b*, open in the camera. These doors and the sliding-box *d* are lined with black velvet. The object glass is achromatic and periscopic, the concave being outside in the camera; its diameter is about 3½ inches, and focus about 13 inches. A diaphragm is placed before the object glass, at 3½ inches from it, and its aperture may be closed by a plate moving in a pivot. This camera reverses the objects from left to right; but this may be obviated by placing a plane mirror on the outside beyond the aperture of the diaphragm, as at *f*, *fig* 30., where it is fixed by means of a screw, *k*. Loss of light is thereby occasioned.

Fig. 31. is an upright section, and *fig.* 32. a front elevation of the mercurial apparatus. *a* the cover; *b* the black board, with grooves to receive the board *h*; *c* the cup of quicksilver; *d*, the spirit-lamp; *e*, a small cock, through which the quicksilver may be run off, if the apparatus be laid to one side; *f*, the thermometer; *g*, a glass window; *h*, the board bearing the metallic plate; *l*, a stand for the spirit lamp, which is held by the ring *k*, so that its flame may strike the bottom of the cup. The whole of the inside of the apparatus should be blackened and varnished.

Fig. 33. is a front view of the washing apparatus made of tin plate, varnished. The plates, to be washed, are laid on the angular ledge, *d*. *e* is a ledge to conduct the water to the receptacle *c*. *Fig.* 34. is a side view of the washing apparatus. The patent was enrolled in February, 1840. (See *Newton's Journal*, C. S. xvi. 1.)

Mr. Richard Beard having purchased from M. Daguerre a license to practise his invention above described, received from a foreigner a communication of certain improvements for which he obtained a patent in June, 1840. The first of these is the substitution of a concave reflecting mirror for the lens in the camera obscura. *Fig.* 36. represents in section a slight wooden box, *a a*, open at the front, opposite to the person sitting for the portrait. In the back part of the box a concave mirror, *b*, is placed, to reflect the rays coming from the person. A small frame, *c*, is fixed to an adjustable pedestal, *d*, which slides in grooves in the bottom of the box, for the purpose of being set at the focal point of the mirror. In this frame, *c*, a polished surface is first to be placed for trial, to receive the image correctly, as observed by the operator, by looking through the opening, *e*, in the top of the box. The prepared silvered plate is now substituted in the exact place for the trial one. The luminous impression being made, the slide, *d*, is withdrawn, and the plate removed; carefully shut up in a box from the light.

The second object of this patent is making the prepared surface more uniform, by passing two plates, with their silvered faces in contact, several times between hardened rollers, annealing them at a low red heat after each passage.

His third object is to use a compound of bromine and iodine, instead of the latter alone, for coating the silver; which increases its sensibility to light, thereby shortening and improving the operation of taking likenesses. He also recommends to use a combination of iodine with nitric acid. Finally, Mr. Beard finds that by placing a screen of any desired colour behind the sitter, the appearance of his Daguerrotype portrait is improved. (*Newton's Journal*, xxiii. 112.)

M. A. J. F. Claudet, who had also purchased a license from M. Daguerre, obtained a patent in December, 1841, for certain improvements upon the original process. His first object is to give the front of the camera obscura such an aperture as to admit the largest object glass intended to be used; and of such he provides a series of different dimensions, each attached to its board, that may be fitted by a slide to the front of the camera.

One of the greatest difficulties in the Daguerrotype process was the impossibility of ascertaining the precise moment at which the light had produced, on the prepared plate, the effect requisite for the vapour of mercury to bring out the image. By applying that vapour to the plate while the silver surface is being acted upon by the light, the operator is enabled to see when his picture is complete. Another advantage of this joint operation is, that the effect of the mercury upon those parts of the plate which have been acted upon by the light, are more perfect when caused to take place immediately under the luminous influence. Hence, instead of using the distinct box with the cup of quicksilver, he places a cup containing that metal in the camera obscura, with its spirit-lamp, and exhales the vapours there. When the mercury has risen to the proper temperature, the aperture of the object-glass is thrown open, and the light, reflected from the object to be delineated, is allowed to operate.

He watches the effect through an opening in the side of the camera, where he views the prepared plate by the light of a lantern passing through a piece of red or orange-coloured glass in the (other) side of the camera. Whenever the light and mercury, by their simultaneous action, have produced a good image, the object-glass is covered, and the silver plate, with its picture, removed, in order to be washed, and finished. M. Claudet embellishes his Daguerrotype portraits by placing behind the sitter screens of painted scenery, which furnish pleasing back grounds. He specifies also various kinds of artificial illumination, to be used in the absence of solar light. (*Newton's Journal*, C. S. xx. 430.)

According to M. Barnard, Daguerre's iodized plate should be exposed for half a minute to the action of chlorine, mixed with a large proportion of common air; whereby it becomes so sensitive, that the pictorial impression is produced in the short space of time necessary for removing and replacing the screen of the camera. The mercury is afterwards employed; as also the hyposulphite wash. Daguerrotype pictures are coloured by dusting over them powders of proper hues, which are immediately washed by passing the plate through water. What remains of the colour after this ablution does not seem in the least to injure the appearance or alter the form of the image. It would seem that those parts of the picture which were at first black, retain, after being washed, a larger proportion of colouring matter than the lighter parts.

Several valuable improvements seem to have been made in Vienna upon the Daguerrotype process; and among others, the mode of using *chloriodine.*

The best form of box for applying the chloriodic vapour is square, with its bottom of plate glass, supported a little above the table by feet, a thumb-screw being one of them, in order to give a certain inclination to the glass plate for spreading the chloriodine over it uniformly. A sheet of white paper being laid beneath the box, enables the operator to see whether the liquid chloriodine is properly distributed. There is a groove round the top of the box, into which the ledge of the lid fits tight. A thermometer is placed in the box.

Voigtland's lenses consist of two achromatic object glasses placed apart; the first nearest the object, having an aperture of 18 lines; the second one of 19 lines; the solar focus of the two is $5\frac{1}{2}$ inches. A system of lenses of so short a focus with so large apertures affords from 11 to 12 times more illumination than Daguerre's original apparatus did. The finest portraits can be produced in the course of from 10 to 30 seconds with this arrangement. Such an apparatus, elegantly made in brass, costs only 120 gulden, or about 10 guineas.

Voigtland has recently made a camera with two object glasses, as above arranged, each having an aperture of 37 lines, and a combined focus of 12 inches. By means of this instrument, portraits $5\frac{1}{3}$ inches in size can be made. The landscapes produced in them are very beautiful. Its price is 144 gulden, about 12 guineas. Along with the above apparatus, a box with a bottom of amalgamated copper is used for applying the vapour of mercury.

By peculiar methods of polishing the silvered copper plate peculiar tones and tints may be given to the picture. The olive oil and pumice powder are indispensable for removing the scratches from the plate and to render its surface uniform. If a delicate blue tone be desired, the plate should be a second time polished with sulphuric ether and washed tripoli; and a third time with dilute nitric acid and Paris red, rubbing the plate lastly with a piece of washleather and crocus. But if a brownish black tone be wished for, a like series of operations is to be gone through, only instead of the ether and tripoli, spirit of ammonia and Vienna lime is to be used.

To give the plate the utmost sensibility to light, a film of iodine should be given in the first place. If with dry iodine, this should be strewed, then covered with cotton, and lastly with a sheet of paper, and the plate above the last, but not so as to touch it. This may be done also with a solution of 1 part of iodine in 6 of spirits of wine, put into a saucer, which is laid on the bottom of the box and covered with gauze. The plate is to be removed whenever it has acquired a faint brazen tint. By this means the plate receives the impressions of light so well as to produce good contrasts between the white and the dark places. The application of bromine afterwards causes a rapid reception of the image, and occasions the deep black shades of an object. The best form is *brome* water, made by dissolving the bromine in a little distilled water, and then adding more, when it is wanted, till the solution acquires a straw yellow colour. A delicate thermometer being put into the box, the solution is to be spread uniformly on its glass bottom, the plate being laid on above and covered up, while the time of exposure must be counted by seconds, with a clock or watch. If the temperature be

41° F. the time should be 258 seconds.
50° ——— 230 —
59° ——— 201 —
68° ——— 158 —
77° ——— 113 —

By attending to these instructions exact results may always be obtained.

A second mode of experimenting is with bromiodine; prepared by dissolving 1 part of bromine in an alcoholic solution of 5 parts of iodine; and diluting this mixture with water, till it acquires the colour of Bavarian beer. The action of this application upon the plate is so rapid as hardly to leave time for consideration. It must be watched every instant till the dark gold yellow tint appear; when it is ready for the camera.

The best time of day for Daguerrotype operations is from an hour after the sun rises till he comes within 45° of the meridian, and not again till he has passed the meridian by 45°. When the sitting is too long, the parts which should be pure white become of a dirty blue tint, and the dark parts become brown. The picture is burnt, so to speak.

Chloride of gold applied to the picture has the effect of fixing and enlivening the tints. A small grate being fixed by a clamp to the edge of a table, the plate is laid upon it with the image uppermost, and overspread evenly with solution of chloride of gold, by means of a fine broad camel hair brush, without letting any drop over the edge. A spirit lamp is now brought under the plate, and moved to and fro till a number of small steam bubbles appear upon the image. The spirit lamp must be immediately withdrawn. The remainder of the chloride solution must be poured back into the phial, to be used on another occasion. It is lastly to be washed and examined. This operation has been repeated three or four times with the happiest effect, of giving fixity and force to the picture. It may then be wiped with cotton without injury.

By dusting various pigment powders from small cotton wool dossils upon the picture, previously coated with an alcoholic solution of copal, and nearly dry, the appearance of a coloured miniature has been very successfully imitated. The varnish must be applied delicately with one stroke of a broad brush of badger hair.*

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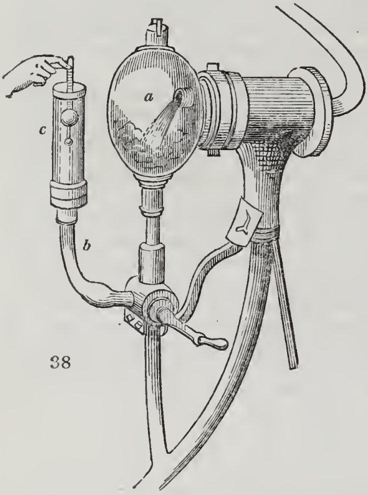
* See Praktische Anweisung zum Daguerrotypiren, Leipzig. &c. 1843.

DEXTRINE. This substance has exactly the same chemical composition as starch, consisting of 24 atoms of carbon, 20 of hydrogen, and 10 of oxygen (Dumas); but it is distinguished from starch by its solubility in cold water, like gum, and not being affected by iodine. British gum, as it is called, or roasted starch, is merely dextrine somewhat discoloured; a substance apparently used for the paste on the Queen's head post-office letter stamps. A process discovered by M. Payen, and patented in France by M. Henzé, for making dextrine, consists in moistening one ton of dry starch with water containing 4½ lbs. of strong nitric acid. The starch thus uniformly wetted, is made up into small bricks or loaves, and dried in a stove. It is then rubbed down into a coarse powder, and exposed in a stove-room to a stream of air heated to about 160° F. Being now triturated, sifted, and heated in a stove to about 228° F., it forms a perfect dextrine of a fair colour; because the acid acts as a substitute for the higher heat, used in making the British gum. Such an article makes a fine dressing for muslin and silk goods, and is much employed in French surgery, for making a stiff paste-support to the bandages of fractured limbs.

DISTILLATION. *Fig.* 38. represents one form of the worm-safe, which is a contrivance for permitting the distiller to observe and note at any period of the distillation the alcoholic strength or the specific gravity of his spirits, without access to the still or the means of purloining the product before it has paid duty. The nose-pipe of the worm tub terminates in, and is firmly cemented to the side of the glass globe, *a*, from whose bottom the discharge pipe descends vertically, but has a stop-cock upon it, and a branch small pipe *b*, turned up parallel to the former. This branch is surmounted with a glass cylinder, *c*, which, when the stop-cock is opened, gets filled with the spirits, and then receives a hydrometer to show the gravity of the fluid. The stop-cock mechanism is so contrived, that only one full of the small glass cylinder can be obtained at a time.



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The following is the gross produce of the Excise duties on British distilled spirits for the United Kingdom annually, from 1830 to 1840 inclusive: — 1831, 5,196,175*l.*; 1832, 5,163,373*l.*; 1833, 5,258,572*l.*; 1834, 5,287,032; 1835, 5,073,276*l.*; 1836, 5,485,883*l.*; 1837, 5,006,697*l.*; 1838, 5,451,792*l.*; 1839, 5,363,220*l.*; 1840, 5,208,040*l.* The net produce is very nearly the same. In 1838, 26,486,543 millions of gallons paid duty; in 1839, 25,190,843; and in 1840, 21,859,337. See Rum, Spirits, and Still.

E.

ELECTRO-METALLURGY. By this elegant art perfectly exact copies of any object can be made in copper, silver, gold, and some other metals, through the agency of voltaic electricity. The earliest application of this kind, seems to have been practised about ten years ago, by Mr. Bessemer, of Camden Town, London, who deposited a coating of copper on lead castings, so as to produce antique heads in relief, about 3 or 4 inches in size. He contented himself with forming a few such ornaments for his mantelpiece; and though he made no secret of his purpose, he published nothing upon the subject. A letter of the 22d of May, 1839, written by Mr. J. C. Jordan, which appeared in the *Mechanics' Mag.* for *June* 8, following, contains the first printed notice of the manipulation requisite for obtaining electro-metallic casts; and to this gentleman, therefore, the world is indebted for the first discovery of this new and important application of science to the uses of life. It appears that Mr. Jordan had made his experiments in the preceding summer, and having become otherwise busily occupied, did not think of publishing till he observed a vague statement in the Journals, that Professor Jacobi, of St. Petersburg, had done something of the same kind. Mr. Jordan's apparatus consisted of a glass tube closed at one extremity with a plug of plaster of Paris, and nearly filled with a solution of sulphate of copper. This tube, and its contents, were immersed in a solution of common salt. A plate of copper was plunged in the cupreous solution, and was connected by means of a wire and solder, with a zinc plate dipped in the brine. A slow electric action was thus established through the moist plaster, and copper was deposited on the metal in a thin plate, corresponding to the former in smoothness and polish; so that when he used an engraved metal matrix, he obtained an impression of it by this electric agency. "On detaching the precipitated metal," says he, "the most delicate and superficial markings, from the fine particles of powder used in polishing to the deeper touches of a needle or graver, exhibited their correspondent impressions in relief with great fidelity. It is, therefore, evident that this principle will admit of improvement, and that casts and moulds may be obtained from any form of copper. This rendered it probable that impressions might be obtained from those other metals having an electro-negative relation to the zinc plate of the battery. With this view a common printing type was substituted for the copper-plate, and treated in the same manner. This, also, was successful; the reduced copper coated that portion of the type immersed in the solution. This, when removed, was found to be a perfect matrix, and might be employed for the purpose of casting, where time is not an object." "Casts may probably be obtained from a plaster surface surrounding a plate of copper, &c."

On the 12th of September following the above publication, Mr. Thomas Spencer read a Paper "On Voltaic Electricity applied to the purpose of working in Metal," before the Polytechnic Society of Liverpool; which he had intended to present to the British Association at Birmingham in the preceding August, but not being well received there, he exhibited merely some electro-metallic casts which he had prepared. The Society published Mr. Spencer's Paper, and thereby served to give rapid diffusion to the practice of electro-metallurgy.

One of the most successful cultivators of this art has been Mr. C. V. Walker, Secretary to the London Electrical Society. He has published an ingenious little work in two parts, entitled *Electrotype Manipulation*, where he presents, in a lucid manner, the theory and practice of working in metals, by precipitating them from their solutions through the agency of voltaic electricity. His first part is devoted to the explanation of principles, to the preparation of moulds, to the description of the voltaic apparatus to be used, to bronzing, to coating busts with copper, to the multiplication of engraved plates, and to the deposition of other metals.

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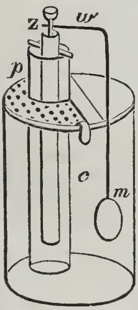
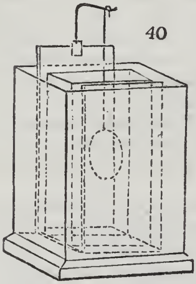


Fig. 39. represents a single cell voltaic apparatus for electro-metallurgy. *z* is a rod of amalgamated zinc, *m* is the mould on which the metal is to be deposited; *w*, is the wire joining them; *c*, is a strong solution of sulphate of copper in the large vessel; *p*, is a tube or cylinder of porous earthenware, standing in the other, and containing dilute sulphuric acid. The solution of blue vitriol is kept saturated, during the progress of its depositing copper, by piling crystals of the salt upon the shelf, shown by the dots under *p*. The mould to be coated should not be too small in reference to the surface of zinc under voltaic action. The time for the deposition to be effected depends upon the temperature; and is less the higher this is within certain limits; and at a freezing temperature it ceases almost entirely. When a mould of fusible metal is used, it should not be placed in the voltaic apparatus till every thing is arranged, otherwise oxide will be deposited upon it, and spoil the effect. When the circuit is completed the mould may be immersed, but not before. Wax moulds are rendered electric conductors, and thereby depositors as follows: — After breathing on the wax, rub its surface with a soft brush dipped in plumbago; breathing and rubbing alternately till the surface be uniformly covered. Attach a clean wire to the back of the mould, connecting it by plumbago with the blackened wax. Sealing-wax is coated in like manner. Casts of Paris plaster are first well imbued with melted wax or tallow, and then black-leaded. Objects in Paris plaster should be thoroughly penetrated with hot water, but not wet on the surface, before wax casts are made from them. Moulds are best taken from medals in stearine (stearic acid). For plating and gilding by electro-chemical agency, the following simple plan of apparatus is used. *Fig.* 40. is a rectangular porcelain vessel, which contains in its centre a porous cell for containing the solution of oxide of silver or gold, by means of cyanide of potassium; and this porous cell is surrounded at a little distance by a similarly formed vessel of zinc. The connection is formed between the zinc and the suspended object to be coated, either by a pinching screw, or by the pressure of its weight upon the wire. The dilute acid which excites the zinc should, in this case, be very weak, in reference to the strength of the cyanide solution, which should be recruited occasionally by the addition of oxide.

It has been found that with cyanide solutions of gold and silver in the electro-chemical apparatus, the nascent cyanogen at the positive pole or plate, in a decomposition cell, will act upon and dissolve gold and silver. Two or three of Daniell's cylindric cells, as shown at *a* in *fig.* 41., of a pint size, for acting upon solutions of gold or silver, will in general suffice. The decomposition cell *b* is made of glass or porcelain. The zinc may be amalgamated, and excited with brine; the copper cell contains, as usual, a solution of blue vitriol. To the end of the wire attached to the copper cylinder of the battery, a plate of silver or gold is affixed; and to the end of the wire attached to the zinc cylinder is affixed the mould, or surface, to be plated or gilt. The plates of silver or gold and zinc should be placed face to face as shown in the figure in the decomposition cell; which is filled by the cyanide solution. A certain degree of heat favours the processes of electro-gilding and plating. The surface is dead as first obtained, but it may be easily polished with leather and plate-powder, and burnished in whole or in parts with a steel or agate tool.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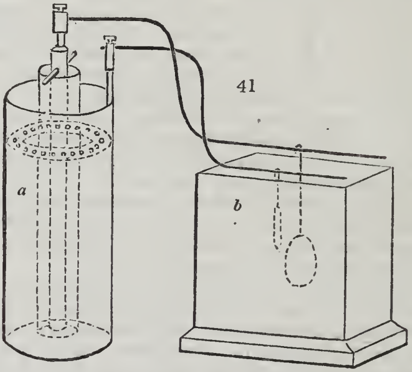
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In March, 1840, Messrs. Elkington obtained a patent for the use of *prussiate of potash*, as a solvent for the oxides of gold and silver in the electro-chemical apparatus for plating and gilding metals. They also "sometimes employ a solution of protoxide (purple of Cassius) in the muriates of potash, &c." The chemical misnomers, in their specification, are very remarkable, and do great discredit to the person employed to draw it up. Prussiate of potash is the ordinary commercial name of a salt very different from the cyanide of potassium,—the substance really meant by the patentees—and the purple of Cassius, is very different from protoxide of gold.

In plating or gilding great care must be bestowed in making the articles clean, bright, and perfectly free from the least film of grease. For this purpose, they should be boiled in a solution of caustic alkali, then scoured with sand and water, next dipped into a dilute acid, and finally rinsed with water. A solution of the nitrate or cyanide of mercury may also be used with advantage for cleaning surfaces. The following metals have been deposited by electro-chemistry:—

Gold, platinum, silver, copper, zinc, nickel, antimony, bismuth, cobalt, palladium, cadmium, lead, and tin; of these, the first five are the most important and valuable. The gilding solution may be prepared by placing slips or sheets of gold in a solution of cyanide of potassium, and attaching to the negative pole of a voltaic battery, a small plate of gold, but to the positive pole a much larger one; whereby the latter combines with the cyanogen, under the influence of positive electricity, and forms a solution. Or, oxide of gold, precipitated from the chloride by magnesia, may be dissolved in the solution of the cyanide.

For making copper medals, &c., a plate of amalgamated zinc is to be put into a vessel of unglazed earthenware, or of any other porous substance, filled with dilute sulphuric acid; which vessel is set into a trough of glass, glazed pottery, or pitched wood, containing blue vitriol in the state of solution, as well as in the state of crystals upon a perforated shelf, near the surface of the liquid.

The moulds to be covered with copper are to be attached by a copper wire to the zinc plate. The surface of zinc excited by the acid should be equal to that of the moulds; with which view a piece of zinc, equivalent in size to the mould, should be suspended in front of it.

For depositing copper upon iron, Messrs. Elkington use a solution of ferrocyanide of copper in cyanide of potassium in the decomposition trough, instead of sulphate of copper, neutralized from time to time with a little caustic alkali, as in the common practice of making medals, &c., of copper. I should imagine that the black oxide of copper dissolved in solution of cyanide of potassium would answer better; as the iron in the ferrocyanide might be rather injurious. The iron to be coppered being previously well cleaned from rust, &c., with the aid of a dilute acid, is to be plunged into the cyanide solution heated to 120° Fahrenheit, and connected by a wire with the negative pole of a voltaic battery, as formerly described. In from five to ten minutes, the iron will be completely coated. It is then to be scoured with sand, and plunged into solution of sulphate of copper; whereby it will show black spots wherever there are any defective places. In this case, it is to be cleaned and replaced under the cyanide solution, in the decomposition cell for a minute or two. Zinc may be deposited from a solution of its sulphate by a like arrangement.

Metallic cloth may be made as follows: — On a plate of copper attach quite smoothly a stout linen, cotton, or woollen cloth, and connect the plate, with the negative pole of a voltaic battery; then immerse it in a solution of copper or other metal, connecting a piece of the same metal as that in the solution with the positive pole; decomposition takes place, and the separated metallic particles in their progress towards the metal plate or negative pole, insinuate themselves into the pores of the tissue, and form a complete sheet of flexible metal. Lace is metallised by coating it with plumbago, and then subjecting it to the electro-metallurgic process.

The gilding solution should be used in the electric process at a temperature of 130° F. The more intense the electric power, the denser and harder is the metallic coat deposited.

Metallic silver may be combined with cyanogen by subjecting it to the joint action of a solution of cyanide of potassium and positive electricity. Or cyanide of silver may be precipitated from the nitrate by a little cyanide of potassium, and afterwards dissolved by means of an excess of cyanide of potassium. The *quantity* of electric power or surface-size of the battery should in all cases be proportioned to the surface of the articles to be plated or gilt, and the electric intensity or number of sets of jars proportioned to the density of the solution. Plating is accomplished in from 4 to 6 hours. The articles should be weighed before and after this operation, to ascertain how much silver they have taken on.

Messrs. Elkington make their moulds with wax, combined with a little phosphorus, which reduces upon their surfaces a thin film of gold or silver, from solutions of these metals, which films are better than the blackleaded surfaces for receiving the copper deposit. They also recommend to add a little alkali to the solution of sulphate of copper, intended to afford a deposit of metal. The single cell, first described above, is best adapted for this purpose.

M. Ruolz employs for gilding, a solution of sulphuret of gold in sulphuret of potassium, which he prepares by precipitating a solution of gold in *aqua regia*, by sulphuretted hydrogen, and re-dissolving the precipitate with sulphuret of potassium. By the use of this solution of gold, he obtains a very beautiful and solid gilding, and at less expense than with cyanide of potassium. Every metal which is a negative electrode to gold may be gilded.

Platinizing is effected best by means of a solution of the potash-chloride of platinum in caustic potash. 1 milligramme (0·015 grain) covers completely a surface of 50 square centimetres (2 inches square); the film of platinum is only one hundredth of a milligramme thick.

M. Bœttger has shown that we may easily tin copper and brass in the moist way by dissolving peroxide of tin (putty) in hydrate of potash (caustic potash ley), putting at the bottom of the vessel holding that solution some turnings of tin, setting the piece of copper or brass upon the turnings, and making the liquor boil. An electric current is produced by the contact of the dissimilar metals; and as the tin is withdrawn by the copper or brass from the solution, it is restored to it by the turnings. Zinking may be done in the same way; by putting pieces of zinc into a concentrated solution of chlorine, by setting the piece of metal to be zinked in contact with these pieces, and applying heat to the vessel containing the whole.

For certain new methods of constructing and arranging voltaic batteries for electro-metallurgic operations, a patent was obtained by Dr. Leeson in June 1842.

Fig. 42. is a longitudinal section of the battery, and *fig.* 43. a plan view of the frame to which the metal plates are attached. *a* is a rectangular wooden trough, containing a wooden frame *b*, formed with vertical grooves in its sides, to receive a series of porous cells *c*, *c*, *c*. The plates of the battery are suspended in the fluid or fluids by brass forks *d*, *d*, fastened to a wooden frame *e*, *e*, which rests upon the trough *a*, and is connected to the other frame *b*, by two pins *f*, when they are required to be raised together out of the trough *a*, *a*.

The battery may be charged as usual with one or two fluids; one of them in the latter case being contained in the porous cells *c*, *c*, *c*; and plates of copper and zinc, or any other suitable metals, may be employed.

The second improvement consists in cleaning copper and zinc plates after they have been used in a battery, by the employment of a voltaic battery; and also in amalgamating or coating with mercury the surfaces of zinc plates, by the same means to render them suitable for being used in the construction of the voltaic apparatus.

The third improvement consists in exciting electricity by a combination of nitric, sulphuric, or muriatic acid, with any of the following substances; viz. impure ammoniacal or lime liquor of the gas works, solutions of alkaline and earthy sulphurets, the alkalies and their carbonates, or lastly the acidulous sulphate of iron generated from iron pyrites.

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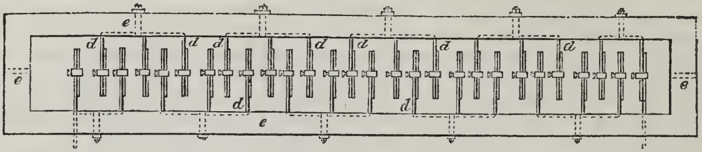

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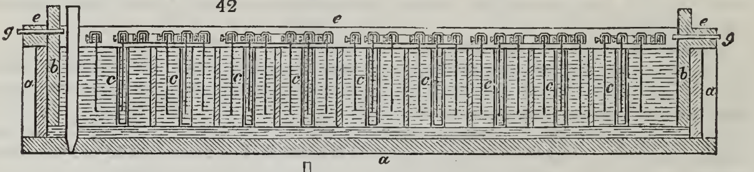
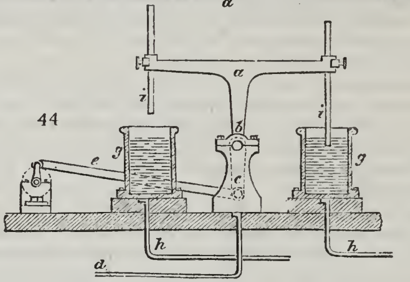




Another of Dr. Leeson's manifold improvements is for depositing metallic alloys, consists in the employment of one battery, with the "alternating cathode," represented in *fig*. 44. It is composed of a beam, *a*, mounted on the shaft, *b*, which turns in bearings carried by standards, *c*; the beam communicates with the anode of the battery by the wire, *d*, and a vibrating motion is given to it by the rod, *e*, from the shaft, *f*, which is driven by an electro-magnetic engine, or any other suitable prime mover. *g*, *g* are two vessels containing mercury, connected by wires, *h*, *h*, with the cathode plates of the two metals composing the alloy (but if the alloy is to consist of more than two metals, then more vessels, *g*, will be required, one for each cathode plate); these plates are immersed in a solution composed of similar salts of the different metals to be deposited, together with the anode, or surface to be deposited upon, which is connected by a wire with the cathode of the battery. A communication is established between the two cathode plates, or supply metals, and the anode of the battery, by means of the rods, *i*, *i*, which are caused, by the vibration of the beam, *a*, to dip alternately into either the one or the other of the vessels, *g*; and thus each metal will be deposited on the article to be coated, during the time that the connection is established between it and the battery, by the immersion of its rod into the vessel of mercury. The relative proportions of the two metals is adjusted by lengthening or shortening the rods, *i*, *i*, as shown in the figure, so that they may be immersed for a longer or shorter period in the mercury.

Where the electrical current enters the electrolyte, is the *anode;* where it leaves it, is the *cathode.*

The patentee describes ten other improvements, which seem to be ingenious. See *Newton's Journal*, xxii. 292.

ELEMENTS, CHEMICAL The catalogue given in the Dictionary has been augmented by four new bodies; *Lanthanium, Didymium*, from Cerium; *Erbium* and *Terbium*, from Yttria.

ELVAN. The name given by the Cornish miners to porphyry, as also to the heterogeneous rocky masses which occur in the granite or in the clay slate, deranging the direction of their metallic veins, or even the mineral strata: but elvan generally indicates a felspar porphyry.

EMBOSSING OF LEATHER. Beautiful ornaments in basso-relievo for decorating the exteriors or interiors of buildings, medallions, picture-frames, cabinet work, &c., have been recently made by the pressure of metallic blocks and dies, for which invention a patent was obtained in June, 1839, by M. Claude Schroth. The dies are made of type metal, or of the fusible alloy with bismuth, called d'Arcet's. The leather is beaten soft in water, then wrung, pressed, rolled, and fulled as it were, by working it with the hands till it becomes thicker and quite supple. In this state it is laid on the mould, and forced into all its cavities by means of a wooden, bone, or copper tool. In other cases, the embossing is performed by the force of a press. The leather, when it has become dry, is easily taken off the mould, however deeply it may be inserted into its crevices, by virtue of its elasticity. A full detail of all the processes is given in *Newton's Journal*, vol. xxii. p. 122.

ENAMELLING *of Cast Iron and other Hollow Ware for Saucepans, &c.* In December, 1799, a patent was obtained for this process by Dr. Samuel Sandy Hickling. His specification is subdivided into two parts: —

1. The coating or lining of iron vessels, &c. by fusion with a vitrifiable mixture, composed of 6 parts of calcined flints, 2 parts of *composition* or Cornish stone, 9 parts of litharge, 6 parts of borax, 1 part of argillaceous earth, 1 part of nitre, 6 parts of calx of tin, and 1 part of purified potash. Or, 2dly,

8 parts of calcined flints, 8 red lead, 6 borax, 5 calx of tin, and 1 of nitre. Or, 3dly,

12 of potter's composition, 8 borax, 10 white lead, 2 nitre, 1 white marble calcined, 1 argillaceous earth, 2 purified potash, and 5 of calx of tin. Or, 4thly,

4 parts calcined flint, 1 potter's composition, 2 nitre, 8 borax, 1 white marble calcined, $\frac{1}{2}$ argillaceous earth, and 2 calx of tin.

Whichever of the above compositions is taken, must be finely powdered, mixed, fused; the vitreous mass is to be ground when cold, sifted, and levigated with water. It is then made into a pap with water or gum water. This pap is smeared or brushed over the interior of the vessel, dried, and fused with a proper heat in a muffle.

Calcined bones are also proposed as an ingredient of the flux.

The fusibility of the vitreous compounds is to vary according to the heat to be applied to the vessel, by using various proportions of the siliceous and fluxing materials. Colours may be given, and also gilding.

The second part or process in his specification describes certain alloys of iron and nickel, which he casts into vessels, and lines or coats them with copper precipitated from its saline solutions. It also describes a mode of giving the precipitated copper a brassy surface by acting upon it with an amalgam of zinc with the aid of heat.

A factory of such enamelled hollow wares was carried on for some time, but it was given up for want of due encouragement.

A patent was granted to Thomas and Charles Clarke on the 25th of May, 1839, for a method of enamelling or coating the internal surfaces of iron pots and saucepans, in such a way as shall prevent the enamel from cracking or splitting off from the effects of fire. This specification prescribes the vessel to be first cleaned by exposing it to the action of dilute sulphuric acid (sensibly sour to the taste) for three or four hours, then boiling the vessel in pure water for a short time, and next applying the composition. This consists of 100 lbs. of calcined ground flints; 50 lbs. of borax calcined, and finely ground with the above. That mixture is to be fused and gradually cooled.

40 lbs. weight of the above product is to be taken with 5 lbs. weight of potter's clay; to be ground together in water until the mixture forms a pasty consistenced mass, which will leave or form a coat on the inner surface of the vessel about one-sixth of an inch thick. When this coat is set, by placing the vessel in a warm room, the second composition is to be applied. This consists of 125 lbs. of white glass (without lead), 25 lbs. of borax, 20 lbs. of soda (crystals), all pulverized together and vitrified by fusion, then ground, cooled in water, and dried. To 45 lbs. of that mixture, 1 lb. of soda is to be added, the whole mixed together in hot water, and when dry pounded; then sifted finely and evenly over the internal surface of the vessel previously covered with the first coating or composition, whilst this is still moist. This is the glazing. The vessel thus prepared is to be put into a stove, and dried at the temperature of 212° F. It is then heated in a kiln or muffle like that used for glazing china. The kiln being brought to its full heat, the vessel is placed first at its mouth to heat it gradually, and then put into the interior for fusion of the glaze. In practice it has been found advantageous also to dust the glaze powder over the fused glaze, and apply a second fluxing heat in the oven. The enamel, by this double application, becomes much smoother and sounder.

Messrs. Kenrick of West Bromwich having produced in their factory and sent into the market some excellent specimens of enamelled saucepans of cast iron, were sued by Messrs. Clarke for an invasion of their patent rights; but after a long litigation in Chancery the patentees were nonsuited in the Court of Exchequer. The previous process of cleansing with dilute sulphuric acid appeared by the evidence on the trial to have been given up by the patentees, and it was also shown by their own principal scientific witness that a good enamelled iron saucepan could be made by Hickling's specification. In fact, the formulæ by which a good enamel may be compounded are almost innumerable; so that a patent for such a purpose seems to be untenable, or at least most easily evaded. I have exposed the finely enamelled saucepans of Messrs. Kenrick to very severe trials, having fused even chloride of calcium in them, and have found them to stand the fire very perfectly without chipping or cracking. I consider such a manufacture to be one of the greatest improvements recently introduced into domestic economy; such vessels being remarkably clean, salubrious, and adapted to the most delicate culinary operations of boiling, stewing, making of jellies, preserves, &c. They are also admirably fitted for preparing pharmaceutical decoctions, and ordinary extracts.

The enamel of the said saucepans is quite free from lead, in consequence of the glass which enters into its composition being quite free from that metal. In several of the saucepans which were at first sent into the market by Messrs. Clarke, their enamel was found on analysis by several chemists to contain a notable proportion of oxide of lead. In consequence of the quantity of borax and soda in the glaze, this oxide was so readily acted upon by acids that sugar of lead was formed by digesting vinegar in them with a gentle heat. The presence of this noxious metal formed, in my opinion, a legitimate ground for contesting the patent, being in direct violation of the terms of the specification. Messrs. Kenrick's wares have been always free from this deleterious metal. Messrs. Clarke, I understand, have for some time been careful to reject from their enamel-composition all glass which contains lead; and they now manufacture also wholesome enamelled ware. Thus the public have profited in a most important point by the aforesaid litigation.

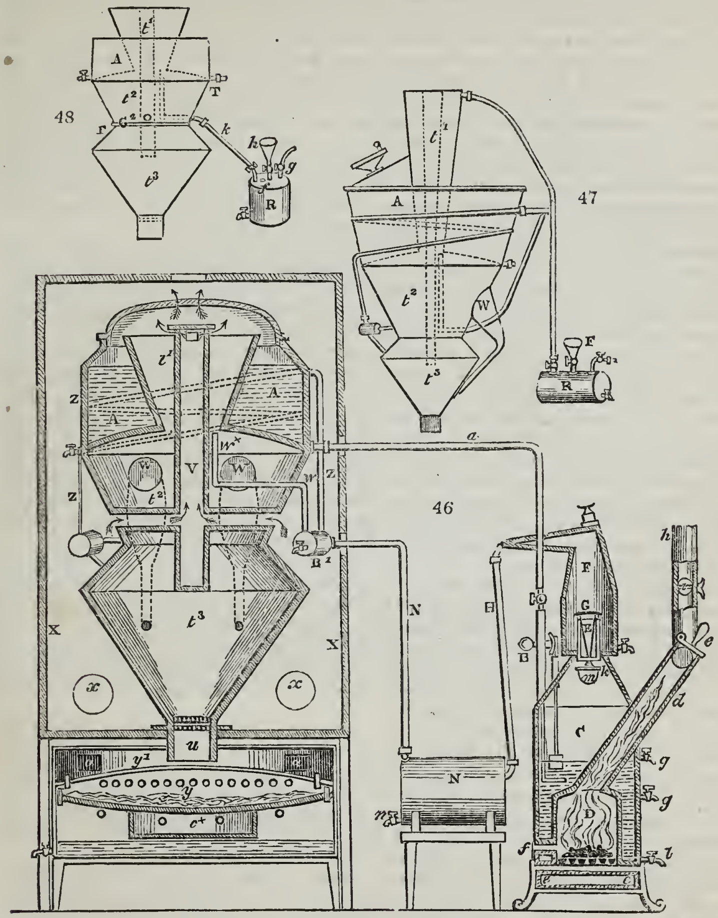
Enamelled iron saucepans had been many years ago imported from Germany, and sold in London. I had occasion to analyse their enamel, and found to my surprise that it contains abundance of litharge or oxide of lead. The Prussian government has issued an edict prohibiting the use of lead in the enamelling of saucepans, which are so extensively manufactured in Peiz, Gleiwitz, &c. Probably the German ware sent to England was fabricated for exportation, with an enamel made to flux easily by a dose of litharge. The composition of the said enamel is nearly the same with that which I found upon some of the earlier saucepans of Messrs. Clarke. Had their patent been sustained, the important legal question would have arisen, whether it gave the patentees the power of preventing dealers from continuing to sell what they had been habitually doing for a great many years.

A suitable oven or muffle for lining or coating metals with enamel may have the following dimensions: —

The outside, 8 feet square, with 14-inch walls; the interior muffle, 4 feet square at bottom, rising 6 inches at the sides, and then arched over; the crown may be 18 inches high from the floor; the muffle should be built of fire-brick, 2½ inches thick. Another arch is turned over the first one, which second arch is 7 inches wider at the bottom, and 4 inches higher at the top. A 9-inch wall under the bottom of the muffle at its centre divides the fire-places into two, of 16 inches width each, and 3 feet 3 inches long. The flame of the fire plays between the two arches and up through a 3-inch flue in front, and issues from the top of the arch through three holes, about 4 inches square. These open into a flue, 10 × 9 inches, which runs into the chimney.

The materials for the enamel body (ground flint, potter's clay, and borax) are first mixed together and then put into a reverberatory furnace, 6 feet 6 inches long, by 3 feet 4 wide, and 12 inches high. The flame from an 18-inch fireplace passes over the hearth. The materials are spread over the floor of the oven, about 6 inches thick, and ignited or fritted for four or five hours, until they begin to heave and work like yeast, when another coating is put on the top, also 6 inches thick, and fired again, and so on the whole day. If it be fired too much, it becomes hard and too refractory to work in the muffles. The glaze is worked in an oven similar to the above. It may be composed of about one half borax and one half of Cornish stone in a yellowish powder procured from the potteries. This is fritted for 10 hours, and then fused into a glass which is ground up for the glaze.

EVAPORATION. For the following scheme of generating, purifying, and condensing steam, Mr. Charles Clark, merchant, London, obtained a patent in January, 1843. His apparatus for converting sea-water, &c., economically into good fresh water, is represented in *figs.* 46, 47, 48. A is the supply cistern, which communicates with a pipe *a*, with a self-regulating eduction apparatus B. C is a strong wrought iron cylinder, fitted at bottom into a flanged ring-place, c, and covered with a conical



top; it is about two thirds filled with the water, to be operated upon. D is a cylindrical furnace concentric with the water cylinder C; *d* is an upwards air and water-tight tube, which serves both as a feed-pipe, through which the fuel is supplied to the furnace, and as a passage for the escape of the smoke, and other gaseous products of combustion; *e* is a hinged trap-door through which the fuel is passed into the tube *d*; *h* is a chimney into which the pipe *d* terminates; and *i*, a damper, by which the degree of activity given to the furnace can be regulated at pleasure; *f* is an open air-pipe, which leads from the outside, through the boiler into the furnace, a little way above the fire-bars, and assists in securing a good draught through the furnace into the chimney. To the water cylinder C there are attached gauge-cocks, *g g*, for ascertaining from time to time the height of the water; *l* is a cock or tap for drawing off the brine, and other residual matters which collect at the bottom of the boiler; *m* is a screw-cap and hole, through which access may be had to the interior of the water cylinder C, when it needs to be cleaned; E is a short pipe fitted into the conical top of the water cylinder C, which conveys the steam generated in it, into the steam-head or receiver F; G is a concave plate, resting upon the top of the pipe E, a little larger than that pipe, and kept steady by a weight, *k*, of one or more pounds, suspended from it by wires. This plate prevents, in a great measure, the escape water escaping into the steam-head (an accident commonly called *priming* in steam engines; because, till the steam has acquired a pressure exceeding that of the counterweight *k*, it cannot raise the weight G, so as to escape freely into the steam-head F, since any particle of water must, during the rising of the cap G, strike against it, and drop back, either into the water cylinder C, through the pipe E, or into the space round that pipe at the bottom of the steam-head F; whence it may be withdrawn by the cock shown in the drawing. H is a pipe which conveys the steam from the steam-head F to the rectifier R. This consists simply of a cylinder (about one third the size of the cylinder C) laid horizontally, in the lower part of which a body of water speedily collects, and serves to retain any particle of undecomposed matter, which may come over with the steam, as it continues to flow in from the boiler; whereby only its purer portions may pass off from the rectifier R, by the pipe N. n is a cock or tap, at the botom of the cylinder R for drawing off its water occasionally; R^1 is a second steam-rectifier, like R, into which the steam passes from the pipe N, and is thereby still further purified; but when the proportion of saline matter is small, R' may be dispensed with, and for very foul water, two or three more such rectifiers may be added.

The condenser for liquefying the purified steam, and *aerating* the resulting water, is shown at t^1, t^2, t^3. It is composed of conical upright compartments communicating with each other; the chamber t^1 is surrounded by the water in the cistern A (slightly heated by the steam in that chamber), while the chambers t^2 and t^3 are exposed freely to the air. The lowest of these, t^3, terminates at bottom in a tube, u, containing at the mouth of the cone two or three plates of perforated zinc, for admission of the atmosphere. An upright steam-tight tube of zinc, at about the middle of the lowest chamber, t^3, and is continued to the top of the uppermost chamber, t^1, having two lateral branches. This tube is closed at its lower end, but open at top, and at the ends of the two branches, to give a draught of cool air into the tube, and a rapid flow of heated air from the top of the tube. W, W are pipes which pass externally from about the middle of the chamber t^2, to near the bottom of the chamber t^3. At their tops they are of large dimensions, as represented, but diminish gradually to small pipes at bottom. Of these pipes, there should be as many as can be conveniently applied, in order that the process of condensation may be effectually promoted.

From the second rectifier, R^1, the steam is conveyed by a pipe, w, of gradually increasing dimensions, to near the top of the middle chamber, t, whence it diffuses itself through the three chambers, where it gets condensed. The hottest steam passes into t^1, and is there most powerfully condensed. The main body of the water produced therefrom, either drops directly into the bottom of the chamber t^3, or runs down the inclined sides of the chambers t^1, t^2, t^3, thence through the outer pipes W, W, and out at the bottom of the tube, getting partially aerated in its progress, by means of the air ascending constantly through the tube u.

Z, Z, is an auxiliar steam-pipe from the rectifier R^1, passing twice or thrice close round the water supplying the cistern, A, and terminating in a cylinder which communicates by pipes with the chambers, t^2 and t^3; whereby all the water thus condensed may fall through the perforated zinc plates, into the general discharge tube, u. X is an outer casing of wood or metal, leaving a small space round the condenser, with draught-holes, x, x, for the admission of air. The refrigerator is made of protected metal "(tinned copper?)" and divided into three compartments, y^1, y^2, y^3.

In the top of y^1, the end of the discharged tube u is inserted; and at a little distance from this tube there are air apertures, a, a, furnished with shutters in the inside, slanting from the top downwards, to prevent as much as possible the escape outwards of any vapour which may occasionally be carried down with the water from the condenser. The middle compartment, y^2, is perforated, convex at top, and concave at bottom; so that the water that drops from the tube u, in the convex top of y^2, falls off laterally through small pipes into the chamber y^2, while its concave bottom turns the water into a central filtering-box, c, that projects a little into y^3, set to receive it. For aerating this water, the bottom of y^2 is covered about an inch deep with small pebbles. y^3, which is the reservoir of the purified cool water, is perforated with small holes. c^1, c^1, are small pipes for promoting a continual upwards flow of cold air. y^3 is furnished with a tap to draw off its water, as required.

For re-distilling or rectifying spirituous liquids, the apparatus, *fig.* 47. is employed; in which the supply cistern A is much larger, and close at top; the upper condensing chambers, t^1, t^2, are also larger, but the lowest, t^3, is narrowed. The second rectifier of *fig.* 46. is removed. The feints collect in the bottom of the rectifier R, to be drawn off by a cock; while the rectified spirit passes off at top into the condenser. The refrigerator has only two compartments, and no pebbles. F is a funnel into which the spirits may be returned for re-distillation.

For extracting the soluble matter of vegetable infusions, the apparatus, shown in *fig.* 48., is used. The rectifier is vertical, has a screw-capped hand-hole, *f*, for admitting the vegetables. g is a steam pipe; and h is a funnel for returning portions of the liquid extract. R is connected by a pipe, k, with the condenser, T, made in two portions, fitted water-tight together, but separable for the purpose of cleansing. The steam which passes from the boiler into the rectifier R disengages the soluble portion of the vegetable substances, and, if they be volatile, carries them off to the condenser; if not, it combines and falls with them to the bottom of the vessel, whence this portion of the extract is drawn off by the cock, and a fresh charge may be introduced. The steam is shut off from the rectifier R by a cock on the pipe *g*. When the steam is afterwards admitted to assist the process of maceration, the supply of it is regulated by the stop-cocks in the pipes *g* and *k*. — *Newton's Journal*, xxiii. p. 247. C. S.

EXTRACTS. These preparations of vegetables for medicinal use are made either by evaporating the infusions of the dried plant in water, or in alcohol, or the expressed juice of the fresh plant; and this evaporation may be effected by a naked fire, a sand bath, an air bath, a steam heat, or a liquid *balneum* of any nature, all of which may be carried on either in the open air, or *in vacuo.* Of late years, since the vacuum-pan has been so successfully employed in concentrating syrups in sugar-houses, the same system has been adopted for making pharmaceutical extracts. An elegant apparatus of this kind, invented by Mr. Barry, of Plough Court, was made the subject of a patent about 25 years ago. The use of the air-pump for evaporating such chemical substances as are readily injured by heat, has been very common since Professor Leslie's discovery of the efficacy of the combined influence of rarified air, and an absorbing surface of sulphuric acid, in evaporating water at low temperatures. It has been supposed that the virtues of narcotic plants in particular might be better obtained and preserved, by evaporation in vacuo than otherwise, as the decomposing agency of heat and atmospheric oxygen would be thereby excluded. There is no doubt that extracts thus made from the expressed juices of fresh vegetables, possess, for some time at least, the green aspect and odour of the plants in far greater perfection than those usually made in the air, with the aid of artificial heat. Dr. Meurer, in the *Archiv. der Pharmacie* for April 1843, has endeavoured to show that the colour and odour are of no value in determining the value of extracts of narcotics, that the albumen left unchanged in the extracts made in vacuo, tends to cause their spontaneous decomposition, and that the extracts made with the aid of alcohol, as is the practice in Germany, are more efficacious at first, and much less apt to be injured by keeping. M. Baldenius has, in the same number of the *Archiv*, detailed experiments to prove that the juices of recent plants mixed with alcohol, in the homœopathic fashion, are very liable to spontaneous decomposition. To the above expressed juice, the Germans add the alcoholic tincture of the residuary vegetable matter, and evaporating both together, with filtration, prepare very powerful extracts.

F.

FATS. The following statement is given on the authority of Braconnot: —

	Oleine.	Stearine.
Fresh butter in summer - -	60	40
——— in winter - -	37	63
Hog's Lard - - - -	62	38
Ox Marrow - - - -	24	76
Goose Fat - - - -	68	32
Duck Fat - - - -	72	28
Ox Tallow - - - -	25	75
Mutton Suet - - - -	26	74

M. Dumas says that butter contains no stearine. The purification and decoloration of fats has been the object of many patents. Under CANDLE, Hempel's process for refining palm-oil and extracting its *margarine* is described.

About 30 years ago, palm-oil was deprived of colour to a certain degree by mixing with the melted oil, previously freed from its impurities by filtration, some dilute nitric acid, wooden vessels being used, and the oil being in a melted state. This process was both expensive and imperfect. More lately whitening has been prescribed by means of chromic acid, which, in the act of decomposition into chromic oxide, gives out oxygen, and thereby destroys vegetable colours. One pound of bichromate of potash in solution is to be mixed with two pounds of strong sulphuric acid, diluted beforehand with about two gallons of water; and this mixture is to be incorporated by diligent stirring with 2 cwt. of the filtered palm-oil, at a temperature of about 100° F., contained in a wooden vessel. The palm-oil is afterwards to be washed in warm lime-water, to which some solution of chloride of lime may be advantageously added. By this process, well managed, a fat may be obtained from palm oil fit for making white soap. Tallow may be also blanched to a considerable degree by a like operation.

Instead of sulphuric acid, the muriatic may be used to convert the chromic acid into chromic oxide in the above process, and thereby to liberate the blanching oxygen. The resulting solution of green muriate of chrome being freed from some adhering oil, is to be mixed with so much milk of lime as just to neutralise the excess of acid that may be present. The clear green muriate is then to be decomposed in a separate vessel, by the addition of well-slaked and sifted lime, in some excess. The green mixture of lime and chrome-oxide is now to be dried, and gently ignited, whereby it is converted into yellow chromate of lime, with some unsaturated lime. This compound being decomposed by dilute sulphuric acid, affords chromic acid, to be applied again in the decolouring of palm-oil, on the principles above explained.

Mr. Prynne obtained a patent in March, 1840, for purifying tallow for the candlemaker, by heating it along with a solution of carbonate of potash or soda for 8 hours, letting the whole cool, removing the tallow to another vessel, heating it by means of steam up to 206° F., along with dry carbonate of potash (pearlash): letting this mixture cool very slowly; and finally removing the tallow to a vessel inclosed in steam, so as to expel any subsidiary moisture. — *Newton's Journal*, xxi. 258.

A patent for a like purpose was obtained in June, 1842, by Mr. H. H. Watson. He avails himself of the blanching power of oxygen, as evolved from manganate of potash (chameleon mineral), in the act of its decomposition by acids, while in contact with the melted fat. He prescribes a leaden vessel (a well-joined wooden tub will also serve) for operating upon the melted tallow, with one twentieth of its weight of the manganate, dissolved in water, and acidulated to the taste. The whole are to be well mixed, and gradually heated from 150° up to 212° F., and maintained at that temperature for an hour. On account of the tendency of the dissolved manganate to spontaneous decomposition, it should be added to the dilute acid, mixed with the fat previously melted at the lowest temperature consistent with its fluidity.

Palm-oil may be well blanched in the course of 12 hours by heat alone; if it be exposed in a layer of one or two inches to the air and sunshine, upon the surface of water kept up at nearly the boiling point by a coil of steam-pipes laid in the bottom of a square cistern of lead or wood, well jointed.

Tallow imported for home consumption in 1839, 1,148,192 cwt.; in 1840, 1,131.513. Duty, 3*s.* 2*d.* per cwt.

FELTED CLOTH. This woollen fabric, made without spinning and weaving, was made the subject of a patent by Mr. T. R. Williams in February, 1840. A copious description of the process is given in *Newton's Journal*, xxii. 1.

Varnished or Japanned Felt is made by imbuing the stuff of coarse hat-bodies with drying oil, prepared by boiling 50 lbs. of linseed oil with white lead, litharge, and umber, of each one pound. The felt is to be dried in a stove, and then polished by pumice-stone. Five or six coats of oil are required. The surface is at last varnished. When the object is intended to be stiff, like visors, the fabric is to be impregnated first of all with flour-paste, then stove-dried, cut into the desired shape, next imbued with the drying-oil, and pumiced repeatedly; lastly placed, to the number of 20, in a hot iron mould, and exposed to strong pressure. Japanned hats, made in this way, are sold in France at 1*s.* 3*d.* a piece; and they will stand several years' wear.

FERMENTATION. This term has been of late extended to several chemical operations, besides those formerly included under it. The phenomena which it exhibits under these different phases, and the changes which it effects among the various subjects of its operation, are no less striking and mysterious in their principle than important in their applications to the arts of life. Fermentations are now arranged into twelve classes — 1. the alcoholic; 2. the glucosic or saccharine; 3. the viscous or mucous; 4. the lactic; 5. the acetic; 6. the gallic; 7. the pectic; 8. the benzoilic; 9. the sinapic; 10. the ammoniacal; 11. the putrid; and 12. the fatty.

Fermentation, in the most general sense, may be defined to be a spontaneous reaction, a chemical metamorphosis, excited in a mass of organic matter, by the mere presence of another substance, which neither abstracts from nor gives to the matter which it decomposes any thing whatever. This process requires the following conditions: — 1. A temperature from 45° to 90° F.; 2. Water; 3. The contact of air; 4. The presence of a neutral organic azotised matter, in very small quantity, and of a crystallisable non-azotised substance, in considerable quantity. The former is the ferment, the latter undergoes fermentation. In ordinary chemical actions we perceive one body unite to another to form a new compound; or one body turn another out of a combination, and take its place, in virtue of a superior affinity. These effects are foreseen and explained by the intervention of that molecular force which governs all chemical operations, that attractive power which unites the particles of dissimilar bodies. Thus, also, in the ordinary phenomena of decomposition, we perceive the agency of heat at one time, at another of light, or of electricity; forces of which, though we are not acquainted with the essence, yet we know the exact effect under determinate circumstances. But fermentation, on the contrary, can be explained neither by the known laws of chemical affinity nor by the intervention of the powers of light, electricity, or heat. Fermentation reduces complex organic substances to simpler compounds, thereby reducing them nearer to the constitution of mineral nature. It is an operation analogous, in some respects, to that effected by animals upon their vegetable food.

With a good microscope, any person may convince himself that ferment or yeast is an organised matter, formed entirely of globules, or of corpuscles slightly ovoid, from the three to the four-thousandth part of an inch in diameter. Sometimes their surface seems to have a little tail, which has been regarded as a bud or germ attached to the mother cell. Whenever the fermentation begins, the yeast does not remain an instant idle. These small round bodies become agitated in all directions, and if the substance undergoing fermentation is mixed with an azotized matter, as in beer worts, the corpuscles become larger, the small tails get developed, and on acquiring a certain size they separate from the parent globule, to live by themselves, and give birth to new corpuscles.* In the fermentation of beer from malt, this series of multiplications produces a quantity of yeast seven times greater than what was added at the commencement. Were the above ingenious speculations demonstrated with certainty, we should be led to admit, in all these phenomena, actions truly vital, and a reproduction like that of buds in the vegetable kingdom. The existence of a vital force seems to be rendered probable by the fact, that in incomplete fermentation, such as that of fine syrup with too little yeast, the ferment loses its properties and powers. If, however, we add to the solution of pure sugar an albuminous substance, a caseous or fleshy matter, the development of yeast becomes manifest, and an additional quantity of it is found at the end of the operation. Thus with nourishment, ferment engenders ferment. It is for this reason that a little fermenting must, added to a body of fresh grape-juice, excites fermentation in the whole mass. These effects are not confined to alcoholic fermentation. The smallest portions of sour milk, of sour dough, or sour juice of beet-root, of putrefied flesh or blood, occasion like alterations in fresh milk, dough, juice of beetroots, flesh, and blood. But further, and which is a very curious circumstance, if we put into a liquid containing any fermenting substance, another in a sound state, the latter would suffer decomposition under the influence of the former. If we place urea in presence of beer-yeast, it experiences no change; while, if we add it to sugar-water in a fermenting state, the urea is converted into carbonate of ammonia. We thus possess two modes of decomposition, the one direct, the other indirect.

Although yeast has all the appearances of an organised substance, it is merely by analogy that its multiplication by growth is assumed, for this is a phenomenon very difficult of experimental demonstration. When blood, cerebral substance, gall, pus, and such like substances, in a putrid state, are laid upon fresh wounds in animals, vomiting, debility, and death soon supervene. The scratches from bones in putrid bodies have been often the causes of disease and death to anatomists. The poison in bad sausages is of the same class of ferments. In Wurtemberg, where sausages are prepared from very miscellaneous matters, as blood, livers, brains, and offal of many other kinds, with bread, meal, salt, and spices, fatal results from eating them are not uncommon. Death in these cases is preceded by the gradual wasting of the muscular fibre, and of all the like constituents of the human body; so that the patient becomes emaciated, dries into a complete mummy, and soon expires. The cadaver is stiff as if frozen, and is not subject to putrefaction. During the progress of the *sausage* disease, the saliva becomes viscid, and emits an offensive smell. No peculiar poison can be detected by analysis in the sausages; but they are rendered wholesome food for animals by the action of alcohol, or by that of boiling water, which destroy the noxious *fomes* without acquiring it themselves; and thus decompose the putrefactive ferment of the sausages. When this, however, passes unchanged through the stomach into the circulating system, it imparts its peculiar action to the constituents of the blood, operating upon it as yeast does upon wort. Poisons of a like kind are produced by the body itself in some diseases. In plague, small-pox, measles, &c., substances of a peculiar fermentative nature are generated from the blood, which are capable of inducing in the blood of a healthy person a decomposition like that of which themselves are the subjects. The morbid virus reproduces itself, and multiplies indefinitely, just as the particles of yeast do in the fermentation of beer. The temperature of boiling water, and alcohol applied to matters imbued with such poisonous secretions, render their poison inert. Many

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* M. Turpin, M. Cagniard Latour, M. Quêvenne, and Professor Mitscherlich.

acids, chlorine, iodine, bromine, empyreumatic oils, smoke, creosote, strong decoction of coffee, have the same salutary effect. All these agents are known to counteract fermentation, putrefaction, and that dry wasting of organic matter called *eremacausis*, or *slow combustion*. It is most deserving of remark, that the poisons chemically neutral or alkaline, such as those of small-pox in man, and of *typhus ruminantium* in cows, lose their baneful power when subjected to the action of the stomach; whereas that of bad sausages, which is acid, resists the modifying power of the digestive organs.

Alcoholic fermentation has been copiously discussed in the *Dictionary*. I may here add that ammonia, being a product of that change in solution of pure sugar, proves the presence of azote in the yeast; and that sulphuretted hydrogen, being made manifest in the disengaged gaseous products, by their blackening paper imbued with acetate of lead, proves the presence of sulphur. The acid liquor accompanying yeast may be washed away, without impairing materially its fermenting power, while the acid so removed has of itself no such virtue.

Yeast, freed from all soluble matters by water, alcohol, and ether, contains, independently of ashes; carbon, 50·6; hydrogen, 7·3; azote, 15; oxygen, sulphur, and phosphorus, 27·1, in 100 parts. Viewed atomically, yeast bears a close analogy to albumen. Like albuminous matter, yeast takes a violet tint with muriatic acid, and it may be replaced as ferment by gluten. Caseum (the curd of milk) and flesh operate the same effect. All these fermentative powers have the same globular appearance in the microscope with yeast. When the activity of yeast has been destroyed by heat, &c. it can be restored by the positive energy of the voltaic battery, which causes its combination with oxygen. The best proportion of sugar and water, for exhibiting the phenomena of fermentation, is 1 of the former to 3 or 4 of the latter, and 5 parts of sugar to 1 of fresh yeast may be added; though in the course of fermentation, 100 parts of sugar do not consume 2 parts of yeast, estimated in the dry state. The quickest fermenting temperature is from 68° to 86°. A very little oil of turpentine or creosote, or of the mineral acids, prevents or stops fermentation completely; oxalic and prussic acids have the same effect, as also corrosive sublimate and verdigris. It has been known from time immemorial in Burgundy, that a little red precipitate of mercury, when added to the must-tun, stopped the fermentation. All alkalies counteract fermentation, but when they are saturated it re-commences. The first person who described the microscopic globules of yeast with precision was Désmazières, who arranged them among the mycodermes (*fungus-skinned*), under the name of *mycoderma cerevisiæ*. They have not the flattened form of the globules of blood, but are rather egg-shaped. One small black point may be seen on their surface, which, after some days, is associated with 3, 4, or 5 others. Their average diameter is from $\frac{1}{5000}$ to $\frac{1}{4000}$ of an inch. Sometimes more minute globules cluster round one of ordinary size, and whirl about with it, when the liquor in which the globules float is agitated.

Fresh yeast loses, by drying, 68 parts in the 100, and becomes solid, horny-looking, and semitransparent, breaking readily into gray or reddish fragments. With water, it resumes immediately its pristine appearance. When fresh yeast is triturated with its own weight of white sugar, it forms a liquid possessing the fluidity of oil of almonds, and a yellow colour. The globules continue unchanged, except perhaps becoming somewhat smaller. Yeast in the dry state retains its fermentative virtue for a long time.

Saccharine Fermentation is that by which starch and dextrine are converted into sugar, as shown remarkably in the action of diastase upon these bodies. If we mix 2 parts of starch paste with 1 part of dry gluten, and keep the mixture at a temperature of from 122° to 140° F., we obtain a good deal of sugar and dextrine. Some lactic acid is also formed. Flour paste, long kept, spontaneously produces sugar by a like reaction. *See* FERMENTATION in the Dictionary.

Lactic Fermentation. — Almost all azotised organic matters, after being modified by the contact of air, become capable of giving rise to this fermentation. Oxygen does not come into play, except as the means of transforming the animal substances into a ferment. Diastase and caseum are well adapted to exhibit this change. The body that is to furnish the lactic acid may be any one of the neutral vegetable matters, possessing a like composition with lactic acid, such as cane sugar, grape or potato sugar, dextrine, and sugar of milk. All the agents which stop the alcoholic, stop also the lactic fermentation; while diastase and caseum are its two best exciters. For producing abundance of lactic acid, we have merely to moisten malt, to expose it to the air for a few days, then to triturate it with a quantity of water, and leave the emulsion for some days more in the air, at a temperature between 67° and 86° F. We then saturate the liquor with chalk, after having filtered it, and thereby obtain the lactate of lime, which may be crystallised in alcohol, to deprive it of the dextrine and earthy phospahtes; and then decomposed by sulphuric acid.

Lactic Acid, formed from curd (caseum), exhibits more remarkable phenomena. Thus when milk is left alone for some time it becomes sour, and coagulates. The coagulum is formed of caseum and butter; while the whey of it contains sugar of milk and some salts. The coagulation of the caseum has been occasioned by the lactic acid, which was generated in consequence of an action which the caseum itself exercised upon the sugar of milk. Thus with the concourse of air, the caseum becomes a ferment, and excites the conversion of the sugar of milk into lactic acid. The lactic acid in its turn coagulates the caseum, which in the consolidation of its particles attracts the butter The caseum then ceases to act upon the sugar of milk, and consequently produces no more lactic acid.

But now, if the lactic acid already formed be saturated, the caseum will re-dissolve, and the phenomena will re-commence in the same order. This is easily done by adding a due dose of bicarbonate of soda to the soured milk. In the course of 30 hours, a fresh portion of lactic acid will be generated, and will have coagulated the milk again. We may also add some sugar of milk to the liquid, and to a certain extent convert it into lactic acid. Milk boiled, and kept from contact of air, will not coagulate, and remains fresh for many months. Animal membranes, modified by exposure to moist air for some time, form a true ferment for the lactic fermentation, and acidify solutions of sugar, dextrine, and gum, but the membranes must not be putrescent. Cane-sugar, starch-sugar, and sugar of milk, by assuming or losing a little water, acquire the constitution of lactic acid.

Viscous or Mucous Fermentation. — Every one is acquainted with this spontaneous modification of white wine and ale, which gives them a stringy or oily aspect, and is called in French *graisse*, or fat of wines, and in English the ropiness of beer. The viscous fermentation may be excited by boiling yeast with water, and dissolving sugar in the decoction, after it has been filtered. The syrup should have a specific gravity from 1·040 to 1·055, and be kept in a warm place. It soon assumes the consistence and aspect of a thick mucilage, like linseed tea, with the disengagement of a little carbonic acid and hydrogen, in the proportion of 2 or 3 of the former gas to 1 of the latter. A ferment of globular texture like that of yeast is formed, which is capable of producing viscous fermentation in any saccharine solution to which it is added, provided the temperature be suitable. The viscid matter being evaporated to dryness forms transparent plates, of a sub-nauseous taste, and soluble in water, but less easily than gum arabic. Its mucilage is, however, thicker than that of gum, and yields with nitric acid, oxalic acid, but no mucic acid. Four parts of sugar, treated as above described, furnish 2·84 of unchanged sugar, and 1·27 of the mucilage; from which it appears that water becomes fixed in the transformation. Muriatic, sulphuric, sulphurous acids, and alum, prevent the production of the viscous fermentation, by precipitating its ferment. It is probably the soluble portion of gluten which is the cause of this species of fermentation. It has been found, accordingly, that tannin, which precipitates the said glutinous ferment, completely stops the viscous fermentation, or *graisse*, of wines. It is owing to the tannin which the red wines derive from the grape stalks, with which they are long in contact during fermentation, that they are preserved from this malady of the white wines. The gluten of must is of two kinds, the one soluble in virtue of the alcohol and tartaric acid, and producing the viscous, the other insoluble, and producing the alcoholic fermentation. The art of the wine maker consists in precipitating the injurious ferment, without impeding the action of the beneficial one; an art of considerable delicacy with regard to sparkling wines.

Acid Fermentation has been fully discussed under acetic acid. It requires the presence of ready formed alcohol and air. The lactic fermentation, on the contrary, may take place with starchy or saccharine substances, without the intervention of alcohol or constant exposure to the atmosphere; and when once begun, it can go on without air. Acetification has a striking analogy with nitrification, as is shown by the necessity of a high temperature, and the utility of porous bodies for exposing the liquid on a great surface to the air.

Benzoic Fermentation is that which transforms the azotised neutral crystalline matter, existing in bitter almonds, which has no action upon the animal economy, into new and remarkable products, amongst others the hydrure of benzöile and hydrocyanic (prussic) acid, which together constitute the liquid, called oil, or essence, of bitter almonds, a compound possessed of volatility and poisonous qualities. The attentive study of this fermentation has revealed a great fact in vegetable physiology, the spontaneous production, by means of certain artifices, of certain volatile oils, not pre-existing in the plants, yet capable of being generated in the products of their decomposition. The volatile oil of bitter almonds constitutes in this respect a starting point, from which have proceeded the oil of mustard, the oil of spiræa, and which will likely lead to other discoveries of the same kind. See Almond and Amygdaline.

Sinapic Fermentation is that by which the oil of mustard is formed, and which takes place by the contact of water, under certain conditions, of too refined and scientific a nature for this practical work.

Pectic Fermentation. — Pectic acid may be obtained from the expressed juice of carrots, and it seems to be formed in the process of extraction by the reaction of albumine in the carrots upon a substance called pectine ; a transformation analogous therefore with that which takes place in the formation of the essence of bitter almonds.

Gallic Fermentation. — Gallic acid does not exist ready formed in nut-galls, but is generated from their tannin when they are ground, made pasty with water, and exposed to the air. This conversion may be counteracted by the red oxide of mercury, alcohol, sulphuric, muriatic, and nitric acids, bromine, essence of turpentine, creosote, oxalic, acetic, and prussic acids. The tannin disappears in the sequel of the above metamorphosis.

Fatty Fermentation. — All fats are transformed by the action of an alkaline or other base into certain acids, the stearic, margaric, the oleic, ethalic, &c. When these acids are once formed, they cannot by any means, hitherto known, be reconverted into the primitive fat. By the fixation of water in the acid and the base (called *glycerine*), a change is effected which cannot be undone, because the glyceric base is incapable by itself to displace the water, once combined in the hydrated fat acid. The circumstances necessary to the fatty fermentation, are like those of other fermentations ; namely, the co-operation of an albuminoid matter, along with water, and a temperature of from 60° to 86° F. ; under these conditions, the matter becomes warm, and assumes speedily the character of rancidity ; acid is generated, and the carbonate of soda can then form salts, while the fatty acid is liberated ; a circumstance impossible when the fat was acted upon in the neutral state. This altered fat, treated with water, gives up to it *glyceric alcohol.*

Digestive Fermentation. — Digestion of food may be considered in its essential features as a peculiar fermentative process. The gastric juice is a genuine ferment. Tiedmann, Gmelin, and Prout have shown that the gastric juice contains muriatic acid; and Eberli has made interesting experiments on the digestion of food out of the body, with water containing a few drops of the same acid. He observed that when this liquid contained none of the mucous secretion of the stomach, it did not dissolve the aliments put into it; but with a little of that mucus it acquired that property in an eminent degree. Even the mucus of the bladder had a like effect. Schwann and Vogel have produced this digestive principle in a pure state, called by them *pepsine*, as obtained most abundantly from the stomachs of swine. The glandular part of that viscus being separated from the serous, is cut into small pieces, and washed with cold distilled water. After digestion for 24 hours, that water is poured off, and fresh water is poured on. This operation is repeated for several days, till a putrid odour begins to be felt. The watery infusion thus obtained is precipitated by acetate of lead. This white flaky precipitate contains the *pepsine*, accompanied with much albumen. It is then washed, mixed with water, and subjected to a stream of sulphuretted hydrogen. The whole being now thrown on a filter, the coagulated albumen remains on the paper, along with the sulphuret of lead, while the pepsine liquor passes, associated with some acetic acid. If to this liquor a very small quantity of muriatic acid be added, it becomes capable of carrying on artificial digestion. Dry pepsine may be obtained by evaporating the above filtered liquor on a water bath, to a syrupy consistence, then adding to it absolute alcohol, which causes a bulky whitish precipitate. This dried in the air constitutes *pepsine.* It contains a minute quantity of acetic acid, which may be removed completely, by heating it some hours on the water bath. The white powder then obtained is soluble in water, and betrays the presence of no acid whatever. According to Vogel, this substance is composed of, carbon, 57·72 ; hydrogen, 5·67 ; azote, 21·09 ; oxygen, &c. 15·52 = 100. Vogel has proved the analogy between the action of pepsine and diastase by the following experiment :

He dissolved two grains of pepsine in very weak muriatic acid, and put into this liquor heated to 81° F., small bits of boiled beef. In the course of a few hours the pieces became transparent on their edges, and not long after they were completely dissolved. He now added fresh morsels in succession, till those last put in remained unchanged. He found by analysis, that 1·98 grains of the pepsine were left, showing how minute a portion of this ferment was necessary to establish and effect digestion. In fact, we may infer that pepsine, like yeast, serves to accomplish digestion without any waste of its own substance whatever, or probably with its multiplication.

Rennet, with which milk is coagulated in making cheese, is somewhat of the same nature as pepsine. It has been called *chymosine.* But the simplest digesting liquor is the following :

If 10,000 parts of water by weight be mixed with 6 parts of ordinary muriatic acid and a little rennet, a liquor is obtained capable of dissolving hard boiled white of egg, beef, gluten, &c. into a transparent jelly in a few hours.

Ammoniacal Fermentation. — Under this title may be described the conversion of urea into carbonate of ammonia under the influence of water, a ferment, and a favourable temperature. Urea is composed in atoms ; reckoned

	Carbon	hydrogen	azote	oxygen
In volumes,	4;	8;	4;	2;
which by fixing	—	4;	—	2;
give	4;	12;	4;	4:

which is 4 vol. of carbonic acid, and 8 of ammonia; equivalent to ordinary carbonate of ammonia. The fermentation of urea plays an important part in the reciprocal offices of vegetable and animal existence. By its conversion into carbonate of ammonia, urea becomes a food fit for plants; and by the intervention of the mucous ferment which urine contains, that conversion is effected. Thus the urea constitutes a neutral and innocuous substance while it remains in the bladder, but is changed into a volatile, alkaline, and acrid substance when it is acted upon by the air. Yeast added to pure urea mixed with water, exercises no action on it in the course of several days; but when added to urine, it soon causes decomposition, with the formation of carbonate of ammonia, and disengagement of carbonic acid. The deposit on chamberpots ill-cleaned acts as a very powerful ferment on urine, causing the complete decomposition of fresh urine in one fifth of the time that would otherwise be requisite.

Nitrous Fermentation, as exhibited in the formation of nitric acid from the atmosphere, and consequent production of nitrates in certain soils, has been with much probability traced to the action of ammonia on oxygen, as the intermedium or ferment.

Caseous and putrid Fermentations. — Curd *is converted into cheese, when after being coagulated by rennet*, it is left to itself under certain conditions; and this constitutes the true distinctive character of caseum. In the production of cheese there is evidently the intervention of a peculiar ferment which is gradually formed, and the decomposition of the curd into new products.

For animal and vegetable matters to run into putrefaction, they must be in contact with air and water, at a certain temperature; viz. between the freezing and boiling points of water. The contact of a putrid substance acts as a ferment to fresh animal and vegetable matters. The reagents which counteract fermentation in general stop also putrefaction. In this process, myriads of microscopic animalcules make their appearance, and contribute to the destruction of the substances.

A dispute having taken place between some distillers in Ireland and officers of Excise, concerning the formation of alcohol in the vats or tuns by spontaneous fermentation, without the presence of yeast, the Commissioners of Excise thought fit to cause a series of experiments to be made upon the subject, and they were placed under my general superintendence. An experiment was made on the 6th of October, with the following mixture of corn: —

	lbs.	oz.
2 Bushels of Barley, weighing - - - -	100	5
½ Bushel of Malt, - - - - -	21	7
½ Bushel of Oats, - - - - -	20	12
Total, 3 Bushels, weighing - - -	142	8

The bruised corn was wetted with 26 gallons of water at the temperature of 160° F., and, after proper stirring, had 8 gallons more of water added to it at the average temperature of 194°. The mash was again well stirred, and at the end of 45 minutes the whole was covered up, having at that time a temperature of 138° F. Three hours afterwards, 16 gallons of wash only were drawn off; being considerably less than should have been obtained, had the apparatus been constructed somewhat differently, as shall be presently pointed out. The gravity of that wash was 1·060, or, in the language of the distiller, 60°. After a delay of two hours more, twenty additional gallons of water at the temperature of 200° were introduced, when the mash was well stirred, and then covered up for two hours, at which period 23 gallons of fine worts of specific gravity 1·042 were drawn off. An hour afterwards 12 gallons of water at 200° were added to the residual grains, and in an hour and a half 11 gallons of wort of the density 1·033 were obtained. Next morning the several worts were collected in a new mash tun. They consisted of 48 gallons at the temperature 80°, and of a specific gravity 2·0465 when reduced to 60°. Being set at 80°, fermentation soon commenced; in two days the specific gravity had fallen to 1·0317, in three days to 1·018, in four days to 1·013, and in five days to 1·012, the temperature having at last fallen to 78° F. The total attenuation was therefore 34½°, indicating the production of 3·31 gallons of proof spirit, while the produce by distillation in low wines was 3·22; and by rectification in spirits and feints it was 3·05. The next experiment was commenced on the 12th of October, upon a similar mixture of corn to the preceding. 48 gallons of worts of 1·043 specific gravity were set at 82° in the tun, which next day was attenuated to 1·0418, in two days to 1·0202, in three days to 1·0125, and in five days to 1·0105, constituting in the whole an attenuation of 32½°, which indicates the production of 3·12 gallons of proof spirits; while the produce of the first distillation was 2·93 in low wines, and that of the second in feints and spirits was 2·66. In these experiments the wash, when fermenting most actively, seemed to simmer and boil on the surface, with the emission of a hissing noise, and the copious evolution of carbonic acid gas. They prove beyond all doubt that much alcohol may be generated in grain worts without the addition of yeast, and that, also, at an early period; but the fermentation is never so active as with yeast, nor does it continue so long, or proceed to nearly the same degree of attenuation. I was never satisfied with the construction of the mash tun used in these experiments, and had accordingly suggested another form, by which the mash mixture could be maintained at the proper temperature during the mashing period. It is known to chemists that the diastase of malt is the true saccharifying ferment which converts the fecula, or starch of barley and other corn, into sugar; but it acts beneficially only between the temperatures of 145° and 168° F. When the temperature falls below the former number, saccharification languishes; and when it rises much above the latter, it is entirely checked. The new mash tun was made of sheet zinc, somewhat wider at bottom than top; it was placed in a wooden tun, so much larger as to leave an interstitial space between the two of a couple of inches at the sides and bottom. Through this space a current of water at 160° was made to circulate slowly during the mashing period. Three bushels of malt, weighing 125 lbs. 3 oz., were wetted with 30 gallons of water at 167°, and the mixture being well agitated, the mash was left covered up at a temperature of 140° during three hours, when 19 gallons of fine worts were drawn off at the specific gravity of 1·0902 or 90·2°. Twenty gallons more water at 167° were then added to the residuum, which afforded after two hours 28 gallons of wort at the gravity 1·036; 12 gallons of water at 167° were now poured on, which yielded after other two hours 15 gallons at the gravity 1·0185. Forty gallons of fine worts at 1·058 gravity and 68° temperature were collected in the evening of the same day, and let into the tun with 5 per cent. of yeast. The attenuation amounted in six days to 54°. The third wort of this brewing, amounting to 15 gallons, being very feeble, was mixed with 7 gallons of the first and second worts, put into a copper, and concentrated by boiling to 11 gallons, which had a gravity of 1·058 at 60° F. They were separately fermented with 5 per cent. of yeast, and suffered an attenuation of 48½°. The produce of spirit from both indicated by the attenuation was 5·36 gallons; the produce in low wines was actually 5·52, and that in spirits and feints was 5·33, being a perfect accordance with the Excise tables.

The next experiments were made with a view of determining at what elevation of temperature the activity or efficiency of yeast would be paralysed, and how far the attenuation of worts could be pushed within six hours, which is the time limited by law for worts to be collected into the tun, from the time of beginning to run from the coolers. When worts of the gravity 1·0898 were set at 96° Fahr., with 5 per cent. of yeast, they attenuated 26·9° in 6 hours; worts of 1·0535 gravity set at 110° with 5 per cent. of yeast, attenuated 16° in about 5 hours; but when worts of 1·0533 were set, as above, at 120°, they neither fermented then, nor when allowed to cool; showing that the activity of the yeast was destroyed. When fresh yeast was now added to the last portion of worts, the attenuation became 5·8° in 2 hours, and 28·4° in 3 days; showing that the saccharine matter of the worts still retained its fermentative faculty. Malt worts, being brewed as above specified, were set in the tun, one portion at a temperature of 70°, with a gravity of 1·0939, and 5 per cent of yeast, which attenuated 66° in 3 days; other two portions of the same gravity were set at 120° with about 10 per cent. of yeast, which underwent no fermentative change or attenuation in 6 hours, all the yeast having fallen to the bottom of the tuns. When these two samples of worts were allowed, however, to cool to from 74° to 72°, fermentation commenced, and produced in two days an attenuation of about 79°. It would appear, from these last two experiments, that yeast to the amount of 5 per cent. is so powerfully affected by strong worts heated to 120° as to have its fermentative energy destroyed; but that when yeast is added to the amount of 10 per cent., the 5 parts of excess are not permanently decomposed, but have their activity merely suspended till the saccharine liquid falls to a temperature compatible with fermentation. Yeast, according to my observations, when viewed in a good acromatic microscope, consists altogether of translucent spherical and spheroidal particles, each of about the 6000th part of an inch in diameter. When the beer in which they float is washed away with a little water, they are seen to be colourless; their yellowish tint, when they are examined directly from the fermenting square or round of a porter brewery, being due to the infusion of the brown malt. The yeast of a square newly set seems to consist of particles smaller than those of older yeast, but the difference of size is not considerable. The researches of Schulze, Cagniard de la Tour, and Schwann, appear to show, that the vinous fermentation, and the putrefaction of animal matters—processes which have been hitherto considered as belonging entirely to the domain of chemical affinity — are essentially the results of an organic development of living beings. This position seems to be established by the following experiments: — 1. A matrass or flask containing a few bits of flesh, being filled up to one-third of its capacity with water, was closed with a cork, into which two slender glass tubes were cemented air-tight. Both of these tubes were passed externally through a metallic bath, kept constantly melted, at a temperature approaching to that of boiling mercury. The end of one of the tubes, on emerging from the bath, was placed in communication with a gasometer. The contents of the matrass were now made to boil briskly, so that the air contained in it and the glass tubes was expelled. The matrass being then allowed to cool, a current of atmospherical air was made constantly to pass through it from the gasometer, while the metallic bath was kept constantly hot enough to decompose the living particles in the air. In these experiments, which were many times repeated, no infusoria or fungi appeared, no putrefaction took place, the flesh underwent no change, and the liquor remained as clear as it was immediately after being boiled. As it was found very troublesome to maintain the metallic bath at the melting pitch, the following modification of the apparatus was adopted in the subsequent researches. A flask of three ounces capacity, being one-fourth filled with water and flesh, was closed with a tight cork, secured in its place by wire. Two glass tubes were passed through the cork; the one of them was bent down, and dipped at its end into a small capsule containing quicksilver, covered with a layer of oil; the other was bent on leaving the cork, first into a horizontal direction, and downwards for an inch and a half, afterwards into a pair of spiral turns, then upwards, lastly horizontal, whence it was drawn out to a point. The pores of the cork having been filled with caoutchouc varnish, the contents of the flask were boiled till steam issued copiously through both of the glass tubes, and the quicksilver and oil became as hot as boiling water. In order that no living particles could be generated in the water condensed beneath the oil, a few fragments of corrosive sublimate were laid upon the quicksilver. During the boiling, the flame of a spirit lamp was drawn up over the spiral part of the second glass tube, by means of a glass chimney placed over it, so as to soften the glass, while the further part of the tube was heated by another spirit lamp, to prevent its getting cracked by the condensation of the steam. After the ebullition had been kept up a quarter of an hour, the flask was allowed to cool, and get filled with air through the hot spiral of the second tube. When the contents were quite cold, the end of this tube was hermetically sealed, the part of it between the point and the spiral was heated strongly with the flames, and the lamps were then withdrawn. The matrass contained now nothing but boiled flesh and gently ignited air. The air was renewed occasionally through the second tube, its spiral part being first strongly heated, its point then broken off, and connected with a gasometer, which caused the air to pass onwards slowly, and escape at the end of the first tube immersed in the quicksilver. The end of the second tube was again hermetically closed, while the part interjacent between it and the spiral was exposed to the spirit flame. By means of these precautions, decoctions of flesh were preserved, during a period of six weeks, in a temperature of from 14° to 20° R. (63½° to 77° F.), without any appearance of putrefaction, infusoria, or mouldiness: on opening the vessel, however, the contents fermented in a few days, as if they had been boiled in the ordinary manner. In conducting such researches, the greatest pains must be taken to render the cork and junctions of the glass tubes perfectly air-tight. The following more convenient modification of the experiment, but one equally successful and demonstrative, was arranged by F. Schulze. The glass tubes connected with the flask were furnished each with a bulb at a little distance from the cork; into one of which globes caustic alkaline lye being put, and into the other strong sulphuric acid, air was slowly sucked through the extremity of the one tube, while it entered at the other, so as to renew the atmosphere over the decoction of flesh in the flask. In another set of experiments, four flasks being filled with a solution of cane-sugar containing some beer-yeast, were corked and plunged in boiling water till they acquired its temperature. They were then taken out, inverted in a mercurial bath, uncorked, and allowed to cool in that position. From one-third to one-fourth of their volume of atmospherical air was now introduced into each of the flasks; into two of them through slender glass tubes kept red hot at a certain point, into the other two through glass tubes not heated. By analysis it was found that the air thus heated contained only 19·4 per cent. of oxygen, instead of 20·8; but, to compensate for this deficiency, a little more air was admitted into the two flasks connected with the heated tubes than into the two others. The flasks were now corked and placed in an inverted position, in a temperature of from 10° to 14° R. (54½° to 63½° F.). After a period of from four to six weeks, it was found that fermentation had taken place in both of the flasks which contained the non-ignited air — for, in loosening the corks, some of the contents were projected with force — but, in the other two flasks, there was no appearance of fermentation, either then, or in double the time. As the extract of nux vomica is known to be a poison to *infusoria* (animalcules), but not to vegetating mould, while arsenic is a poison to both, by these tests it was proved that the living particles instrumental to fermentation belonged to the order of plants of the Confervoid family. Beer yeast, according to Schwann, consists entirely of microscopic fungi, in the shape of small oval grains of a yellowish white colour, arranged in rows oblique to each other. Fresh grape must contains none of them; but after being exposed to the air at 20° R., for 36 hours, similar grains become visible in the microscope, and may be observed to grow larger in the course of an hour, or even in half that time. A few hours after these plants are first perceived, gas begins to be disengaged. They multiply greatly in the course of fermentation, and at its conclusion subside to the bottom of the beer in the shape of a yellow white powder.

FERRIC ACID. This new compound having been prescribed as a source of supplying oxygen to persons confined in diving-bells and in mines, by M. Payerne, in a patent recently granted to him, merits notice in a practical work. M. Fremy is the discoverer of this new acid, which he obtains in the state of ferrate of potash, by projecting 10 parts of dry nitre in powder upon 5 parts of iron filings, ignited in a crucible; when a reddish mass, containing much ferrate of potash, is formed. The preparation succeeds best when a large crucible, capable of holding about a pint of water, is heated so strongly that the bottom and a couple of inches above it, appear faintly, but distinctly red, in which state the heat is just adequate to effect due deflagration without decomposition. An intimate mixture of about 200 grains of *dried* nitre with about one half its weight of the finest iron filings, is to be thrown at once upon the side of the crucible. The mixture will soon swell and deflagrate. The crucible being taken from the fire, and the ignited mass being cooled, is to be taken out with an iron spoon, pounded, immediately put into a bottle, and secluded from the air, in which it would speedily attract moisture, and be decomposed. It is resolved by the action of water, especially with heat, into oxygen gas, peroxide, and nitrate of iron.

Mr. J. D. Smith prepares the ferrate of potash by exposing to a full red heat a mixture of finely powdered peroxide of iron with four times its weight of dry nitre. It has an amethyst hue, but so deep as to appear black, except at the edges. Oxygen is rapidly evolved by the action of the sulphuric or nitric acid upon its solution. He considers the atom of iron to exist in this compound, associated with 3 atoms of oxygen, or double the proportion of that in the red oxide. Hence 52 grains of pure ferric acid should give off 12 grains of oxygen, equal to about 35 cubic inches; but how much of the ferrate of potash may be requisite to produce a like quantity of oxygen, cannot be stated, from the uncertainty of the operation by which it is produced.

FERRIC-CYANIDE OF POTASSIUM, or *Red Prussiate of Potash.* This beautiful and useful salt, discovered by L. Gmelin, is prepared by passing chlorine gas through a weak solution of the prussiate of potash (ferro-cyanide of potassium) till it ceases to affect solution of red sulphate of iron, taking care to agitate the liquid all the while, and not to add an excess of chlorine. On looking through the weak solution to the flame of a candle, one may see the period of change from the greenish to the red hue, which indicates the completion of the process. The liquor being filtered and evaporated in a dish with upright sides, will eventually afford crystalline needles, possessed of an almost metallic lustre, and a yellow colour, inclining to red. These being dissolved and re-crystallised, will become extremely beautiful. This salt is composed of 33·68 parts of potassium, 16·48 of iron, and 47·84 of cyanogen. It is therefore a dry salt. It dissolves in 38 parts of cold water, and as it forms then the most delicate test of the protoxide of iron, is very useful in *Chlorometry.* — See Appendix.

The solution of this salt affords the following coloured precipitates with the solutions of the respective metals: —

Titanium - - -	Brownish yellow.
Uranium - - -	Reddish brown.
Manganese - - -	Brownish grey.
Cobalt - - -	Deep reddish brown.
Nickel - - -	Yellowish brown.
Copper - - -	Dirty yellowish brown.
Silver - - -	Orange yellow.
Mercury - - -	Yellow, with both the protoxide and peroxide salts.
Tin - - -	White.
Zinc - - -	Orange Yellow.
Bismuth - - -	Yellowish brown.
Lead - - -	No precip.
Iron protoxide - -	Blue.
—— peroxide - -	No precip.

The ferric-cyanide of potassium has been introduced into dyeing and calico-printing.

In case an excess of chlorine has been used in preparing the above salt, Posselt recommends to add to its solution, when near the crystallising point, a few drops of potash ley, in order to decompose a green substance that is present, which takes place with the precipitation of a little peroxide of iron.

FIRE-ARMS. *Barrel-welding by Machinery.* — The barrels of musquets, birding-guns, &c, or what are called *plain*, to distinguish them from those denominated *stub* or twisted barrels, have of late years been formed by means of rolls, a process in which the welding is first effected on a short slab of thick iron, and then the barrel is brought down to its destined length, and form, by repeatedly passing it between a pair of rolls, that have been previously grooved to the exact shape of the barrel intended to be made.

This method has entirely superseded the skelp-welding by hand described in the *Dic. of Man.* p. 471., and is conducted as follows: —

The iron being thoroughly refined, and reduced into flat bars by the process described at length at p. 705., is cut by the shears into slabs or lengths of 10 to 12 inches, and 10 to 10½ lbs. weight, or less, according to the description of gun-barrel that is intended to be made. These slabs are then heated, and bent in their whole length, by means of conveniently grooved bending rolls, until they assume the form of rough tubes, of the kind of section shewn by A., *fig.* 49. They are then placed on the hearth of the reverberatory furnace (*Dict.* p. 701.), and brought to a full welding heat, and as soon as the edges of a tube come to a semi-fluid state, it is taken out and passed between rolls having grooves somewhat smaller in diameter than the exterior of the tube, by which means the tube is perfectly welded from end to end; and if care be taken in the management of the heat, and the juncture be kept clear of dirt and cinders, the iron will be found perfectly homogeneous in every part, and there will be no appearance whatever of the seam where the edges came together. These tubes are repeatedly heated, and passed between the barrel rolls, which are of sufficient diameter to admit of gradually decreasing grooves, the whole length of the intended barrel being indented on their surfaces.

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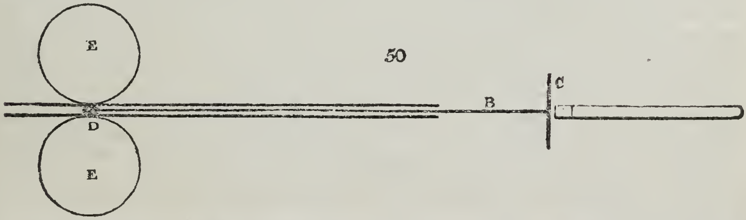
To preserve the tubular form, and ensure regularity in the size of the bore during the welding process, they are taken out of the furnace, by thrusting into them a tool called a mandril B., which consists of a long rod of iron, having a short steel treblett on its end, of the diameter that the bore of the barrel is meant to be. This rod is so adjusted by means of a strong iron plate C. near its handle, which is of wood, and long, that when passed with the heated tube on it between two transverse holding bars, the short steel treblett D. shall be found exactly between the point of impact of the barrel-rolls, E E.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The adhesion of the hot iron to the surface of the rolls is strong enough to draw the tube off the mandril, which thus keeps the bore open from end to end, and by repeating the process through the whole series of grooves in the rolls, the barrel is gradually elongated, and brought down to the exact form required: any superfluous length at the muzzle is then cut off. The breach end is then adjusted by the hammer — a tripple-seat welded on by hand if it be intended for a percussion lock, and then the barrel is ready to go forward to the mill to be bored, turned, and finished.

Gun barrels formed by this mechanical method are found to stand proof better than those worked by hand, because the heat is more equalised; and any imperfections in the original mass of iron are more dispersed over the whole extent of the tube.

Mr. Wells Ingram, of Bradford Street, Birmingham, has lately perfected a very complete lathe for turning the exterior of gun barrels of all descriptions, a process which is fast superseding the use of the grindstone, for equalising the barrels of all kinds of fire-arms.

I am indebted for this article to Mr. Lovell, Director of the Royal Arms Manufactory. See Musquet.

FLAX and TOW, or *Codilla of Hemp and Flax*, imported for home consumption in 1839, 1,216,811 cwt.; in 1840, 1,256,322; 1*d.* per cwt.

FLOOKAN. The name given by the Cornish miners to a vein of clay-stone, often nearly vertical.

FLOOR CLOTH MANUFACTURE has become of late years a very large branch of trade. The cloth is a strong somewhat open canvas, woven of flax with a little hemp, and from 6 to 8 yards wide, being manufactured in appropriate looms chiefly at Dundee. A piece of this canvas from 60 to 100 feet in length, is secured tight in an upright open frame of oaken bars, in which position it receives the foundation coats of paint, 2 or 3 in number, first on the back side, and then on the front; but it previously is brushed over with glue-size, and rubbed smooth with pumice stones. The foundation paint made with linseed oil and ochre, or any cheap colouring matter, is too thick to be applied by the brush, and is therefore spread evenly by a long narrow trowel, held in the right hand, from a patch of it laid on just before with a brush in the left hand of the workman. Each foundation coat of the front surface is smoothed by pumice whenever it is hard enough to bear the operation. When both sides are dry, the painted cloth is detached from the frame, coiled round a roller, in this state transferred to the proper printing room, where it is spread flat on a table, and variously figured and coloured devices are given to it by wooden blocks, exactly as in the block printing of calicoes, and in the wood-printing of books. The blocks of the floor cloth manufacture are formed of two layers of white deal and one of pear-tree timber, placed with their grain crossing one another alternately. There is of course a block for each colour in the pattern, and in each block those parts are cut away that correspond to the impressions given by the others; a practice now well understood in the printing of two or more colours by the press. The faces of the blocks are so indented with fine lines, that they do not take up the paint in a heavy daub from the flat cushion on which it is spread with a brush, but in minute dots, so as to lay on the paint (somewhat thicker than that of the house painter) in a congeries of little dots or teeth, with minute interstices between. Applied in this way, the various pigments lie more evenly, are more sightly, and dry much sooner than if the prominent part of the block which takes up the colour were a smooth surface. The best kinds of floor cloth require from two to three months for their production.

FODDER, a weight of 21 cwt., by which lead is sold in the north of England.

FUEL. On the measurement of heat, and the qualities of different kinds of coal, I made an elaborate series of experiments, a few years ago, of which the following is an outline.

The first and most celebrated, though probably not the most accurate apparatus for measuring the quantity of heat transferable from a hotter to a colder body, was the Calorimeter of Lavoisier and Laplace. It consisted of three concentric cylinders of tin plate, placed at certain distances asunder; the two outer interstitial spaces being filled with ice, while the innermost cylinder received the hot body, the subject of experiment. The quantity of water discharged from the middle space by the melting of the ice in it, served to measure the quantity of heat given out by the body in the central cylinder. A simpler and better instrument on this principle would be a hollow cylinder of ice of proper thickness, into whose interior the hot body would be introduced, and which would indicate by the quantity of water found melted within it the quantity of heat absorbed by the ice. In this case, the errors occasioned by the retention of water among the fragments of ice packed into the cylindric cell of the tin calorimeter, would be avoided. One pound of water at 172° F., introduced into the hollow cylinder above described, will melt exactly one pound of ice; and one pound of oil heated to 172° will melt half a pound.

The method of refrigeration, contrived at first by Meyer, has been in modern times brought to great perfection by Dulong and Petit. It rests on the principle, that two surfaces of like size, and of equal radiating force, lose in like times the same quantity of heat when they are at the same temperature. Suppose for example, that a vessel of polished silver, of small size, and very thin in the metal, is successively filled with different pulverized substances, and that it is allowed to cool from the same elevation of temperature; the quantities of heat lost in the first instant of cooling will be always equal to each other; and if for one of the substances, the velocity of cooling is double of that for another, we may conclude that its capacity for heat is one half, when its weight is the same; since by losing the same quantity of heat, it sinks in temperature double the number of degrees.

The method of mixtures. — In this method, two bodies are always employed; a hot body which becomes cool, and a cold body, which becomes hot, in such manner that all the caloric which goes out of the former is expended in heating the latter. Suppose for example, that we pour a pound of quicksilver at 212° F., into a pound of water at 32°; the quicksilver will cool and the water will heat, till the mixture by stirring acquires a common temperature. If this temperature was 122°, the water and mercury would have equal capacities, since the same quantity of heat would produce in an equal mass of these two substances equal changes of temperature, viz., an elevation of 90° in the water and a depression of 90° in the mercury. But in reality, the mixture is found to have a temperature of only 37½°, showing that while the mercury loses 174½° the water gains only 5½°; two numbers in the ratio of about 32 to 1; whence it is concluded, that the capacity of mercury is $\frac{1}{32}$ of that of water. Corrections must be made for the influence of the vessel and for the heat dissipated during the time of the experiment.

The following calorimeter, founded upon the same principle as that of Count Rumford, but with certain improvements, may be considered as an equally correct instrument for measuring heat, with any of the preceding, but one of much more general application, since it can determine the quantity of heat disengaged in combustion, as well as the latent heat of steam and other vapours.

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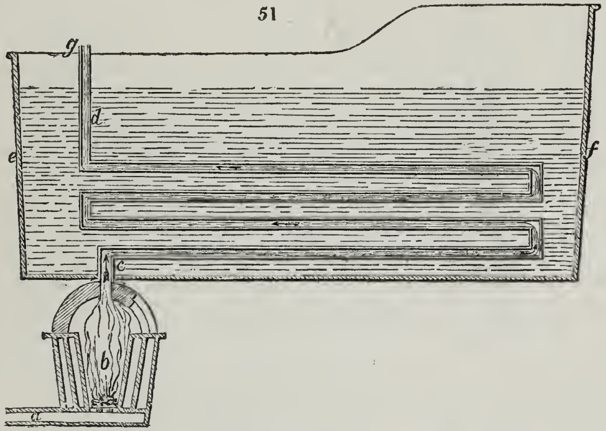

(Scale about ⅓ inch to the foot.)

It consists of a large copper bath, *e*, *f*, (*fig*. 51.) capable of holding 100 gallons of water. It is traversed four times, backwards and forwards, in four different levels, by a zig-zag horizontal flue, or flat pipe *d*, *c*, nine inches broad and one deep, ending below in a round pipe at *c*, which passes through the bottom of the copper bath *e*, *f*, and receives there into it the top of a small black lead furnace *b*. The innermost crucible contains the fuel. It is surrounded at the distance of one inch by a second crucible, which is enclosed at the same time by the sides of the outermost furnace; the strata of stagnant air between the crucibles serving to prevent the heat from being dissipated into the atmosphere round the body of the furnace. A pipe *a*, from a pair of cylinder double bellows, enters the ash-pit of the furnace at one side, and supplies a steady but gentle blast, to carry on the combustion, kindled at first by half an ounce of red-hot charcoal. So completely is the heat which is disengaged by the burning fuel absorbed by the water in the bath, that the air discharged at the top orifice *g*, has usually the same temperature as the atmosphere.

The vessel is made of copper, weighing two pounds per square foot; it is 5½ feet long, 1½ wide, 2 deep, with a bottom 5½ feet long, and 1¾ broad, upon an average. Including the zig-zag tin plate flue, and a rim of wrought iron, it weighs altogether 85 pounds. Since the specific heat of copper is to that of water as 94 to 1000; the specific heat of the vessel is equal to that of 8 pounds of water, for which, therefore, the exact correction is made by leaving 8 pounds of water out of the 600, or 1000 pounds used in each experiment.

In the experiments made with former calorimeters of this kind, the combustion was maintained by the current or draft of a chimney, open at bottom, which carried off at the top orifice of the flue a variable quantity of heat, very difficult to estimate.

When the object is to determine the latent heat of steam and other vapours, they may be introduced through a tube into the top orifice *g*, the latent heat being deduced from the elevation of temperature in the water of the bath, and the volume of vapour expended from the quantity of liquid discharged into a measure glass from the bottom outlet *c*. In this case, the furnace is of course removed.

The heating power of the fuel is measured by the number of degrees of temperature which the combustion of one pound of it, raises 600 or 1000 pounds of water in the bath,—the copper substance of the vessel being taken into account. One pound of dry wood charcoal by its combustion causes 6000 pounds of water to become 20° hotter. For the sake of brevity, we shall call this calorific energy 12,000 unities. In like circumstances, one pound of Llangennoek coal will yield by combustion 11,500 unities of caloric. One pound of charcoal after exposure to the air gives out in burning only 10,500 unities; but when previously deprived of the moisture which it so greedily imbibes from the atmosphere, it affords the above quantity. One pound of Lambton's Wall's-end coals, affords 8500 unities; and one of anthracite 11,000.

It must be borne in mind that a coal which gives off much unburnt carburetted hydrogen gas, does not afford so much heat, since in the production of the gas a great deal of heat is carried off in the latent state. I have no doubt, that by this distillatory process, from one-third to one-fourth of the total calorific effect of many coals is dissipated in the air. But by means of such a furnace as the patent Argand invention of Mr. C. W. Williams, the whole heat produceable by the hydrogen as well as the carbon is obtained; and it should be borne in mind that a pound of hydrogen in burning generates as much heat as three pounds of carbon.

M. Berthier proposes to determine the proportion of carbon in coals and other kinds of fuel, by igniting in a crucible a mixture of the carbonaceous matter with litharge, both finely comminuted, and observing the quantity of lead which is reduced. For every 34 parts of lead, he estimates 1 part of carbon, apparently on the principle, that when carbon is ignited in contact with abundance of litharge, it is converted into carbonic acid. Each atom of the carbon is therefore supposed to seize two atoms of oxygen, for which it must decompose two atoms of litharge, and revive two atoms of lead. Calling the atom of carbon 6, and that of lead 104, we shall have the following ratio : — $6 : \overline{104 \times 2} :: 1 : 34.66$, being Berthier's proportion, very nearly.

On subjecting this theory to the touchstone of experiment, I have found it to be entirely fallacious. Having mixed very intimately 10 grains of recently calcined charcoal with 1000 grains of litharge, both in fine powder, I placed the mixture in a crucible which was so carefully covered, as to be protected from all fuliginous fumes, and exposed it to distinct ignition. No less than 603 grains of lead were obtained; whereas by Berthier's rule, only 340 or 346.6 were possible. On igniting a mixture of 10 grains of pulverized anthracite from Merthyr Tydfil, with 500 grains of pure litharge (previously fused and pulverized), I obtained 380 grains of metallic lead. In a second similar experiment with the same anthracite and litharge, I obtained 450 grains of lead; and in a third only 350 grains. It is therefore obvious that this method of Berthier is altogether nugatory for ascertaining the quantity of carbon in coals, and is worse than useless for judging of the calorific qualities of different kinds of fuel.

In my researches upon coals, I have also made it one of my principal objects to determine the quantity of sulphur which they may contain; a point which has been hitherto very little investigated in this country at least, but which is of great consequence, not only in reference to their domestic combustion, but to their employment by manufacturers of iron and gas. That good iron cannot be produced with a sulphureous coal, however well coked, has been proved in France by a very costly experience. The presence of a notable proportion of sulphur in a gas coal is most injurious to the gaseous products, because so much sulphuretted hydrogen is generated as to require an operose process of washing or purification, which impoverishes the gas, and impairs its illuminating powers by the abstraction of its olefiant gas, or bicarburetted hydrogen. In proof of this proposition, I have only to state the fact, that I found in a specimen of coal gas as delivered from the retorts of one of the metropolitan companies, no less than 18 per cent. of olefiant gas, while in the same gas, after being passed through the purifiers, there remained only 11 per cent. of that richly-illuminating gas. By using a gas-coal, nearly free from sulphur, such as No. 4. in the subjoined list, I think it probable that 10 per cent. of more light may be realized than with the common more sulphureous coal. This is an important circumstance which the directors of gas-works have hitherto neglected to investigate with analytical precision, though it is one upon which their success and profits mainly depend.

How little attention indeed has been bestowed upon the sulphureous impregnation of pit-coal may be inferred from the fact that one of our professional chemists of note, in a public report, upon a great commercial enterprize, stated that a certain coal analyzed by him was free from sulphur, which coal I found by infallible chemical evidence to contain no less than 7 per cent. of sulphur, being about the double of what is contained in English coals of average quality. The proportion of sulphur may in general be inferred from the appearance and quantity of the ashes. If these be of a red or ochrey colour, and amount to above 10 per cent., we may be sure that the coal is eminently sulphureous. The coal above referred to afforded from 15 to 16 per cent. of ferruginous ashes I believe that sulphur exists in coal generally, though not always in the state of pyrites, either in manifest particles, or invisibly disseminated through their substance.

The readiest method of determining rigidly the quantity of sulphur in any compound, is to mix a given weight of it with a proper weight of carbonate of potassa, nitre, and common salt, each chemically pure, and to ignite the mixture in a platinum crucible. A whitish mass is obtained, in which all the sulphur has been converted into sulphate of potassa. By determining with nitrate of baryta the amount of sulphuric acid produced, that of the sulphur becomes known. By means of this process applied to different samples of coals, I obtained the following results: —

Gas Coals.	Sulphur in 100 parts.	Gas Coals.	Sulphur in 100 parts.
No. 1	3.00	No. 5	2.50
2	3.90	6	5.20
3	2.42	7	3.40
4	3.80	8	3.50

Coals for puddling cast iron, to be converted into steel,		Sulphur in 100 parts.
No. 1, hard foliated or splent coal, specific gravity	1.258	0.80
2, ditto	1.290	0.96
3, ditto	1.273	3.10
4, cubical and rather soft	1.267	0.80

The last coal being rich in bitumen, would prove an excellent one for the production of a pure coal gas. See Pitcoal.

FUEL, ECONOMY OF. In the report of the Transactions of the Institution of Civil Engineers for February, 1838, the results of exact comparisons between the performance of different steam-engines exhibit this economy in a remarkable manner. It is there shown that a condensing engine of the most perfect construction, and in perfect condition, of the common low pressure crank-kind, not working expansively, performs a duty of not more than 20 or 21 millions of lbs. raised one foot high, by 90 or 94 lbs. of coal; or ten lbs. of coal per horse power per hour.

The following table exhibits the relative value of different engines in lbs. of coal per horse power per hour: —

Cornish Pumping Engine	1·57
Bolton and Watt's Single Engine	4·82
Cornish Double Engine	3·25
Bolton and Watt's Double Engine	10·5

The greatest duty performed by the measured bushel of 84 lbs. was 86½ millions of lbs. There was raised by the Huel Towan engine in Cornwall 1085 tons (of water) one foot high for one farthing. Hence the weight of a man (1½ cwt.) would be raised ten miles for one penny!

In order to raise steam with economy, the surface of water in the boiler, exposed to the fire, ought not to be less than 10 square feet per horse power; but the usual allowance in Lancashire is only 7½; and by Messrs. Boulton and Watt, 5 square feet.

The values of the mean of the Cornish, Warwick, London, Lancashire, and locomotive experiments, as reported by Mr. Josiah Parkes, were respectively 21, 18, 13½, and 10 cubic feet of water evaporated by 112 lbs. of coals, from water heated to 212° F.

FUEL, GRANT'S PATENT. This fuel is composed of coal-dust and coal-tar pitch; these materials are mixed together, under the influence of heat, in the following proportions: — 20 lbs. of pitch to 1 cwt. of coal-dust, by appropriate machinery; consisting of crushing-rollers for breaking the coal in the first instance sufficiently small, so that it may pass through a screen the meshes of which do not exceed a quarter of an inch asunder; 2dly, of mixing-pans or cylinders, heated to the temperature of 220°, either by steam or heated air; and, 3dly, of moulding machines, by which the fuel is compressed, under a pressure equal to five tons, into the size of a common brick; the fuel bricks are then whitewashed, which prevents their sticking together, either in the coal bunkers or in hot climates. The advantages of Grant's fuel over even the best coal may be stated to consist, first, in its superior efficacy in generating steam, which may be thus stated — 200 tons of this fuel will perform the same work as 300 tons of coal, such as are generally used; secondly, it occupies less space; that is to say, 500 tons of it may be stowed in an area which will contain only 400 tons of coal; thirdly, it is used with much greater ease by the stokers or firemen than coal, and it creates little or no dirt or dust, considerations of some importance when the delicate machinery of a steam-engine is considered; fourthly, it produces a very small proportion of clinkers, and thus it is far less liable to choke and destroy the furnace bars and boilers than coal; fifthly, the ignition is so complete that comparatively little smoke, and only a small quantity of ashes, are produced by it; sixthly, from the mixture of the patent fuel, and the manner of its manufacture, it is not liable to enter into spontaneous ignition.

G.

GALVANO-PLASTIC is the German name of *Electro-Metallurgy.*

GARANCINE, an extract of madder by means of sulphuric acid, prepared in France.

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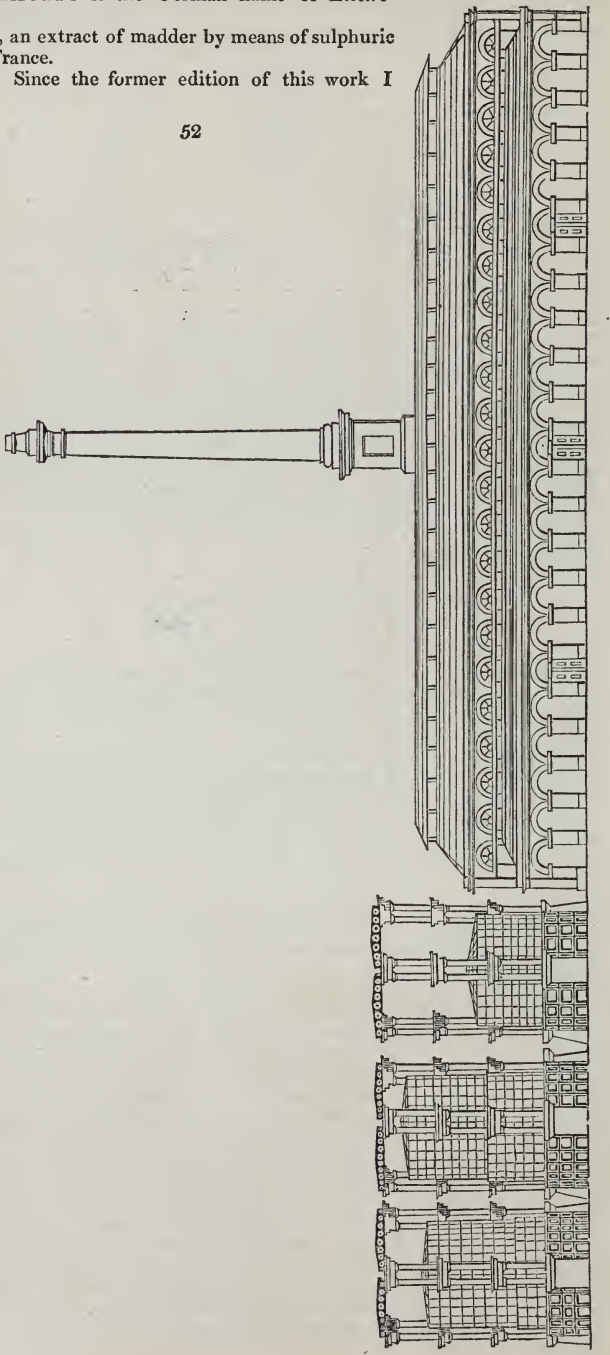

GAS-LIGHT. Since the former edition of this work I have received from Mr. Hedley, an engineer of great eminence and experience, plans and drawings of gas works and of apparatus of the most approved and modern construction, and on the very largest scale as to extent of business or manufacture; also plans and drawings of a gas work on a smaller scale, with its corresponding apparatus. In the first, or large work, purification by wet lime, before described, is used; in the latter, by dry lime.

The large work referred to is calculated for and is arranged to contain 400 retorts, 12 wet-lime purifiers, & 2 washers; 12 large double or telescopic gasholders, capable of storing 1,000,000 cubic feet of gas; and coal stores capable of holding 10,000 tons of coal.

The smaller work is calculated for and will contain 40 retorts, 2 dry-lime purifiers, and a wash vessel; 2 gasholders capable of storing 50,000 cubic feet of gas; and coal stores sufficient for 1000 tons of coal.

Fig. 52. is the side elevation (front view) of a gas work capable of containing 400 retorts, and all their dependencies.

Fig. 53. is the plan of the retort house, coal stores, tanks, gas-holders, &c., on the largest scale and most approved form, viz., A, the retort house, 300 feet long, 56 feet wide; B, retort beds; C, chimney stack; D, flues; E, hydraulic mains; F, coal stores, each 300 feet long, 30 feet wide; G, condensers; H, engine houses; J, wash

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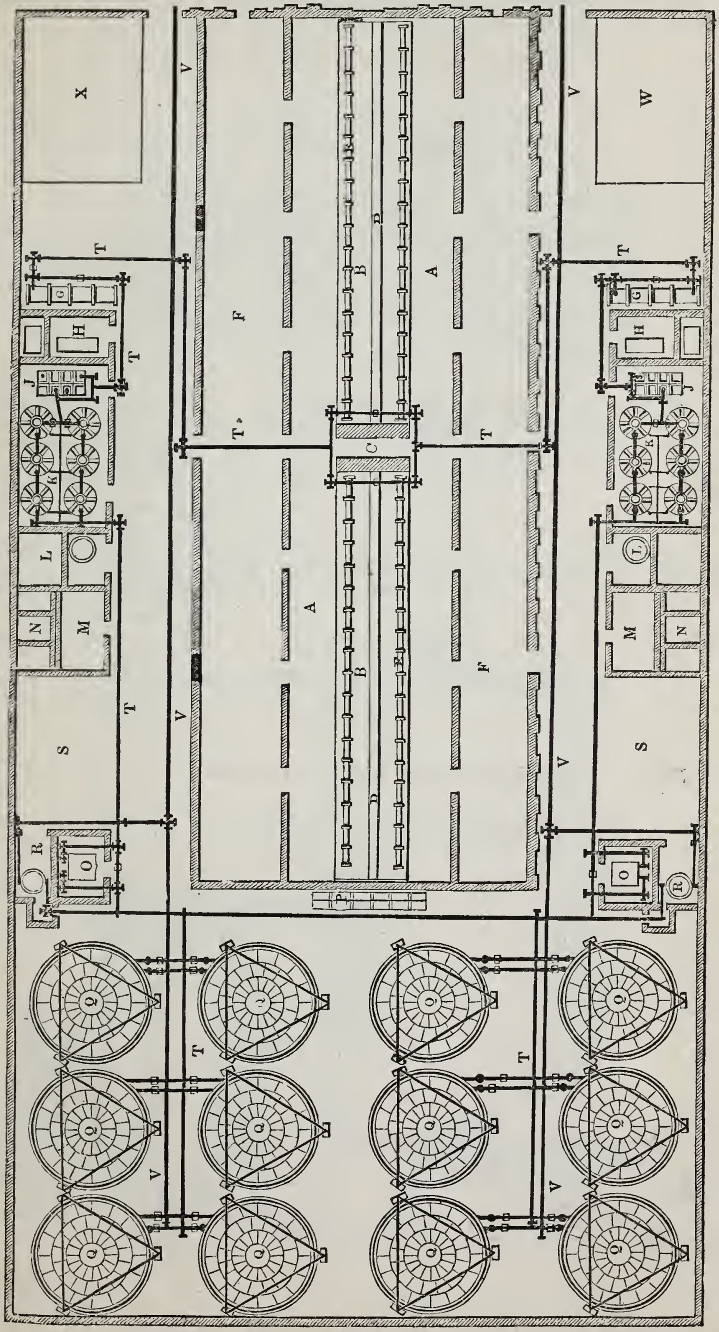

vessels; K, purifiers and connections; L, lime store and mixing tub; M, smiths' and fitters' shop; N, refuse lime pits; O, meter houses; P, tar tank; Q, tanks, gas-holders, bridges, columns, valves, and connections; R, governors; S, coke stores; T, inlet pipes; V, outlet pipes; W, house and offices; X, stores.

Fig. 54. Transverse section and elevation of a bed of 5 D retorts: A, transverse section; B, elevation.

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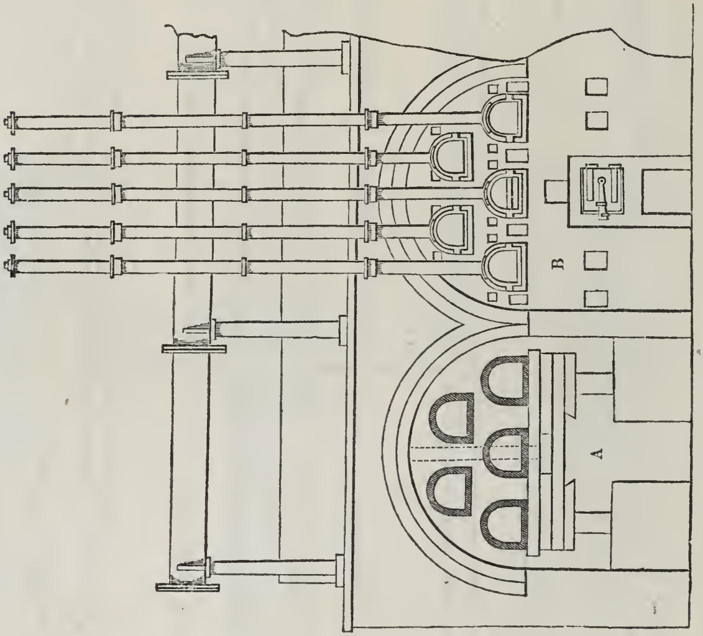

Fig. 55. Longitudinal section of a bed of 5 D retorts.

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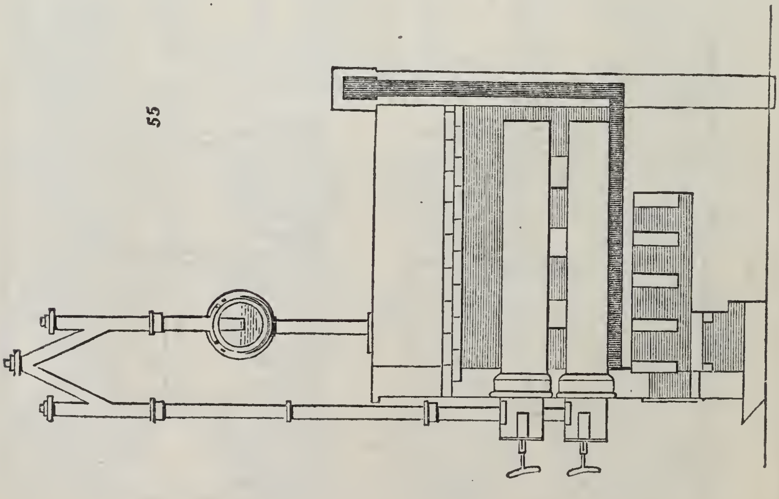

Fig. 56. Elevation of an upright air condenser, consisting of 5 chambers, with a series of 10-inch pipes.

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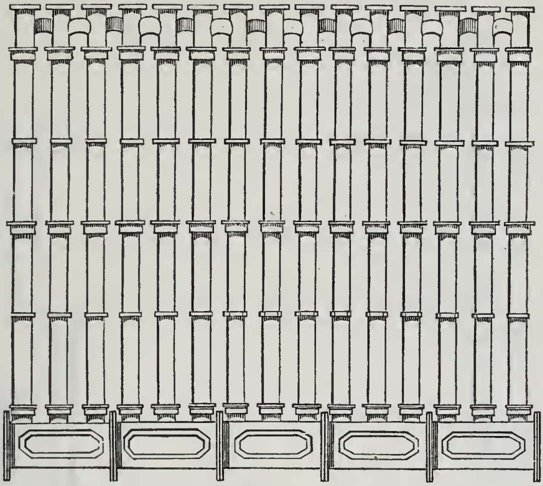

Fig. 57. Elevation of a double or telescopic gas-holder, of a modern and approved form, with part of tank.

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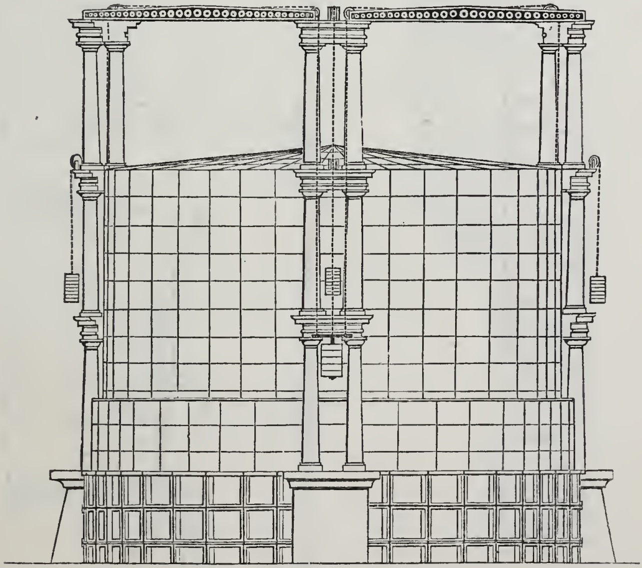

Fig. 58. End elevation and plan of air condenser; A, end elevation; B, plan.

Fig. 59. Set of 3 wet-lime purifiers and wash-vessels in elevation and section, with feed-heads, agitators, valves, and connections, raised for the lime liquor to run from one purifier to the next below it, and ultimately into the refuse lime-pits, viz. A, section of wash vessel; B, section of purifier; C, elevation of purifier.

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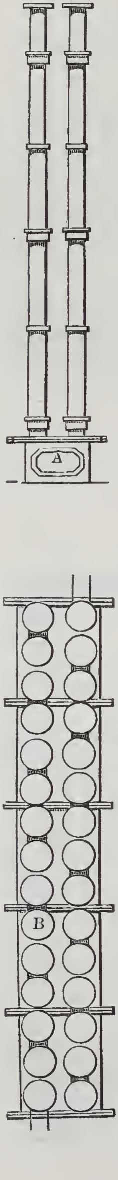

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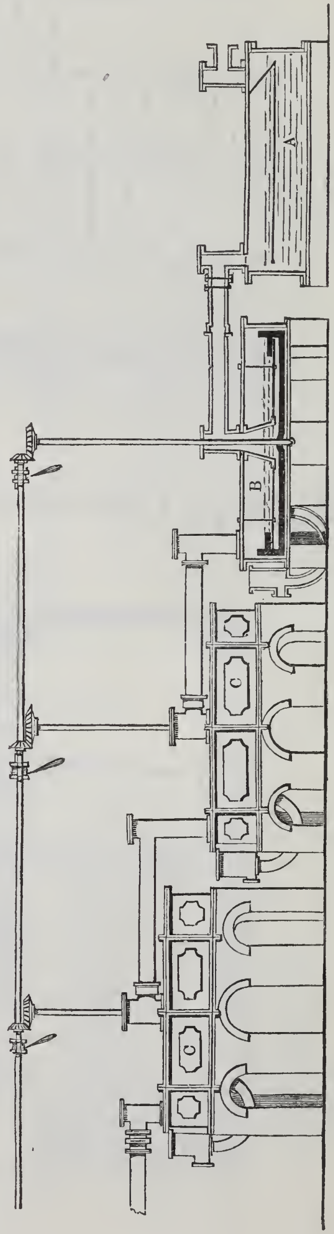

Fig. 60. Front elevation of gas works on a smaller scale, where dry lime is used.

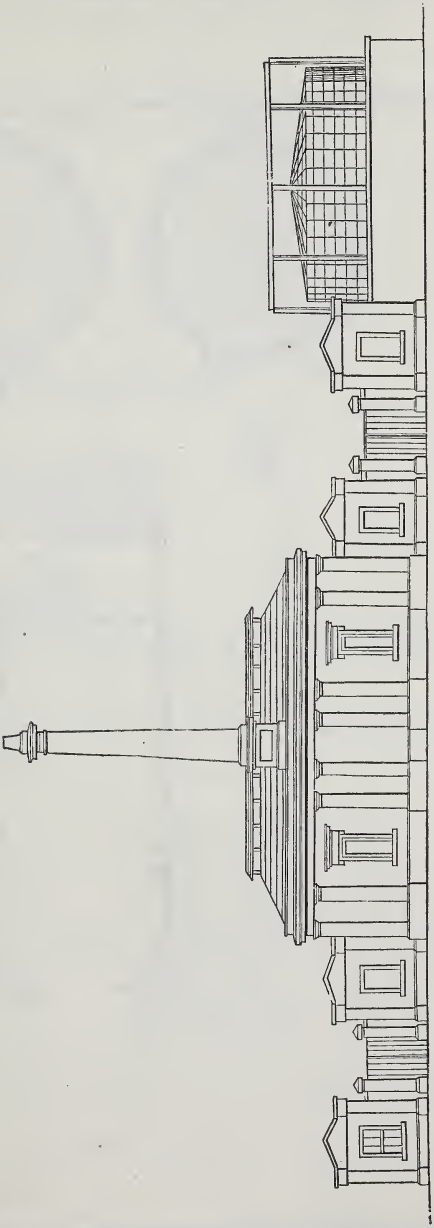

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Fig. 61. Plan of gas works, consisting of, viz.: A, retort house; B, retort beds; C, chimney stack; D, flue; E, hydraulic main; F, coal store: G, lime store; H, washer and purifiers; J, store; K, tar-tank; L, horizontal condenser laid on the ground; M, inlet pipe; N, outlet pipe; O, tanks and gas-holders; P, meter and governor; Q, smiths' shop; R, office; S, coke store.

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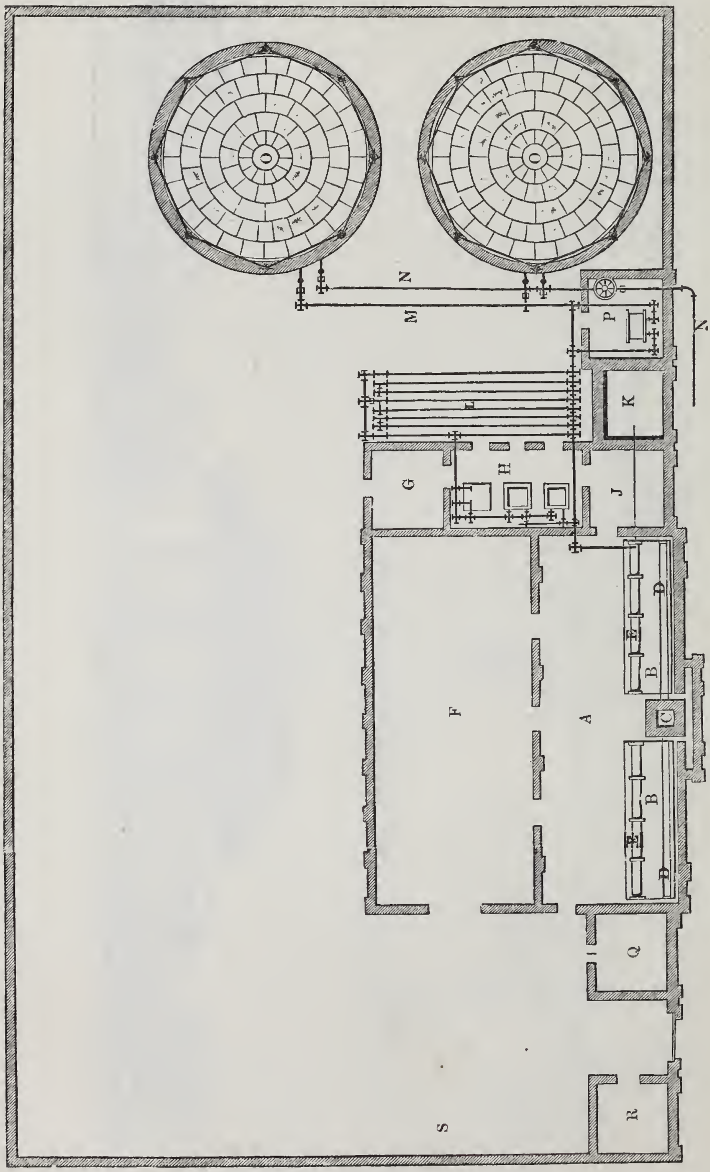
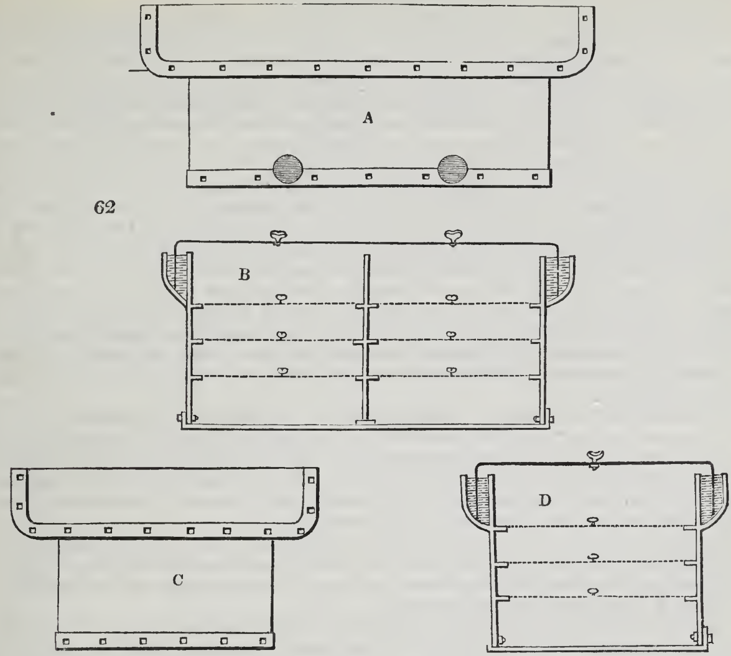


Fig. 62. Elevations and sections of dry-lime purifiers; A, longitudinal elevation; B, ditto section; C, transverse elevation; D, ditto section.



I am well convinced that a distribution and arrangement of gas-works, combining effectiveness, economy, convenience, and elegance, at all equal to the preceding, have never before met the public eye, in this or any other country.

Trials of, and Experiments on, various Kinds of Coal as regards the Production of Gas from each, and its Quality or Illuminating Power; by Joseph Hedley, Esq., Consulting Gas Engineer, London.

Note. — In all the experiments the gas was passed through a governor, on a pressure of 5-10ths of an inch.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Name and Description of Coal.	Through an Aperture or Tube without a Burner, 2-10ths of an Inch, turned full on. — Height of Flame.	Gas consumed per Hour by ditto.	Single Jet Hole, 28th of an Inch Diameter, turned full on. — Height of Flame.	Gas consumed per Hour by ditto.	Single Jet Flame, restricted to 4 Inches High, consumed per Hour.	Equal in Illuminating Power to	Argand with 20 Holes; outer Diameter 9-10ths of an Inch; inner ditto 6·4 of an Inch; Holes 40th of an Inch Diameter; Distances apart, 1-10th of an Inch; full Illuminating Power equal to 12 Candles; consumed per Hour.	Argand with 30 Holes; outer Diameter 1¼ Inch; inner ditto 7-8th of an Inch; Holes 40th of an Inch Diameter; Distances apart, 1-10th of an Inch; full Illuminating Power equal to 25 Candles; Consumption per Hour.	Specific Gravity.	Total Production of Gas from 20 lbs. of Coal, and Duration of Charge.		At End of 1st Half-hour.	2d Half-hour.	3d ditto.	4th ditto.	5th ditto.	6th ditto.
	Inches.	Cubic Feet.	Inches.	Cubic Feet.	Cubic Feet.	Candles.	Cubic Feet.	Cubic Feet.	Parts of 1·000.	Cubic Feet.	Hours.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.
Lismahago, or Glasgow Cannel - -	21 to 22	12	7½	12·1	7·2	2·77	2·3	3·9	·737	101	2½	39	27	22	11	2	
Newcastle Coal	18	16	6	16·2	11·1	1·75	5·	7·5	·475	104	3	30	20	18	15	15	6
Welsh Cannel -	22	11	9	12·1	7·1	3·	2·	3·	·737	102	2	50	30	20	2		
Pelaw, Newcastle Coal -	18	16	5½	16·1	11·1	1·75	5·	7·5	·444	102	3	29	20	17	16	14	6
Pelton, ditto -	18	16	5¾	16·2	11·2	1·73	5·	7·5	·437	102	3	28	20	19	16	14	6
Bickerstaff, Liverpool ditto -	19	14	6½	16·2	11·1	2·04	4·6	6·5	·475	102	3	30	24	18	16	10	4
Wigan Cannel -	22	12	8½	13·1	7·2	3·	2·	3·	·606	100	2½	38	30	18	10	4	
Blenkinsopp, Carlisle Coal -	27	16	6½	15·1	11·1	1·87	4·6	7·	·521	100	3	28	24	18	18	10	2
Neath Coal -	18	16	7	19·1	12·1	1·75	5·22	7·5	·468	100	3	26	21	20	14	12	7

Note. — The candle here used was a composition candle, with plaited wick, requiring no snuffing, giving at least one-third more light than mould tallow candles.

Attention to the preceding tabular statement of experiments is important, as exhibiting several very important facts, particularly interesting at this moment to the science of gas-lighting, *and now for the first time made public.*

It will not fail to be observed by these experiments that all the coals, produced nearly equal *quantities* of gas, notwithstanding the variable characters and qualities of the coal. The greatest quantity produced being at the rate of 11·648 cubic feet per ton of 20 cwt., the smallest 11·200 cubic feet. All these experiments were performed with the greatest care, and under *precisely similar circumstances* as to pressure, manufacture, &c. &c. The *time* in which the *quantity* of gas is produced from the several coals varies considerably, and deserves notice, as it most materially affects the economy of production — *that coal being the most valuable*, all other things being alike, which yields or gives out its gas in the *shortest time;* and particular attention is claimed to this fact. For the more ready reference to the table the columns are numbered. No. 11. exhibits this difference, and it will also be seen by this column that the *time* varies as the *quality* of the coal, the best coal yielding its gas in *two* hours, and the worst in *three* hours.

Another most important, material, and interesting fact is established by these experiments — that the *flow of gas* is *as its density*— demonstrated by the variation in the heights of the flames, as shown in column No. 1. being 18 inches in the inferior gases to 22 inches in the superior; whilst the quantity of gas required to supply these flames is in the inverse ratio of their heights, the *longer* flame requiring but *twelve* cubic feet to maintain it, when the *shorter* flame, from the inferior gas, required *sixteen* cubic feet. See column No. 2.

Remarkable as this difference in the heights of the flames and the consumption is, it is not so great as the difference caused by the quality or illuminating power of the several gases, shown by columns Nos. 5 and 6.; where it will be seen that the consumption of the best gas per hour was only $\frac{7}{10}$ths of a cubic foot, and its light was equal to 3 candles, whilst that of the worst gas was $\frac{12}{10}$ths of a cubic foot, and its light equal only to 1·75 candles, or nearly, the best to the worst, as 1 to 3.

The next column, No. 7., exhibits similar results as to the superior value or illuminating power of one gas over another. In this case an *argand burner* was used. The best gas required only *two* feet to be equal to *twelve* candles, whilst the inferior required *five* feet to be equal to the same.

And in column No. 8., in which another and superior *argand burner* was used, the best gas required only *three* feet to be equal to *twenty-five* mould candles, whilst the inferior required *seven and a half* feet: from this it results that the $7\frac{1}{2}$ cubic feet of inferior gas, to be equal to the 3 feet of good gas, should have given light equal to *sixty-two and a half* candles, whereas they only gave light equal to *twenty-five* candles; *so great is the difference in the* QUALITIES *of gas for producing light.*

Whilst on the subject of the illuminating power and the value of one gas over another, it will not fail to be observed, by the table, that another great difference also exists, caused by the use of particular burners; as, for example, the best gas in column No. 5., where the single jet was used, required *seven tenths* of a cubic foot to be equal to *three* candles, whilst the same gas in column No. 7., where a 20-hole argand burner was used, required only *two* feet to be equal to *twelve* candles; and in column No. 8., where a 30-hole argand burner was used, only *three* feet were required to be equal to *twenty-five* candles; demonstrating the fact that a great and extraordinary improvement in the quantity of illuminating power is effected by the simple increase or enlargement of the burner, affording, where great light in one position is required, a most extraordinary economy in the use of gas, shown in fact practically by the recent introduction of the celebrated "Bude" light, patented by Mr. Goldsworthy Gurney.

Tabular Statement, deduced from the foregoing Experiments, showing the Cost of Candles to produce as much Light as 9,000 Cubic Feet of Gas would afford, being the Product of One Ton of Coal. (The candles are moulds, 6 to the pound, 9 inches long, and each candle is calculated to burn $9\frac{1}{2}$ hours. Cost of candles $7\frac{1}{2}$*d.* per pound, or 7*s.* 6*d.* per dozen pounds.)

Candles would cost, to be equivalent to	Where a Single Jet Burner is used.	Where a 20-hole Argand Burner is used.	Where a 30-hole Argand Burner is used.	Where a Bude Burner is used, according to Statement of Company.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Common coal gas - -	10 18 6	15 15 8	21 18 0	59 2 7
Good do. - -	25 18 4	39 9 6	54 16 7	148 0 9

Table, also deduced from the foregoing, showing the Cost of Gas at the several Prices undermentioned, and equivalent to 100 lbs. of Mould Candles, costing *3l. 2s. 6d.*

Description of Gas.	If burnt in a Single Jet Gas equal to 100 lbs. of Mould Candles	Gas would cost at per thousand Cubic Feet.			If burnt in a 20-hole Argand Burner, Gas equal to 100 lbs. of Candles.	Gas would cost at per thousand Cubic Feet.			If burnt in a 30-hole Argand Burner, Gas equal to 100 lbs. of Candles.	Gas would cost at per thousand Cubic Feet.		
	Cub. feet.	5*s.*	7*s.*	9*s.*	Cub. feet.	5*s.*	7*s.*	9*s.*	Cub. feet.	5*s.*	7*s.*	9*s.*
		s. d.	*s. d.*	*s. d.*		*s. d.*	*s. d.*	*s. d.*		*s. d.*	*s. d.*	*s. d.*
Common	2,687	13 5	18 9	24 2	1,781	8 10	12 5	16 0	1,282	6 5	8 11	11 6
Good -	1,072	5 4	7 5	9 7	712	3 6	4 11	6 4	513	2 7	3 7	4 7

In the brief description of the meter given in the Dictionary, I omitted to state, that this most ingenious scientific contrivance for measuring aeriform or gaseous fluids as they flow through pipes is the invention of Samuel Clegg, Esq., Civil Engineer, of London, Manchester, Liverpool, Birmingham, Chester, Bristol, &c. &c., in all which places he has erected gas-works. To this gentleman's genius and skill the public are mainly indebted for many valuable improvements in the application of gas from coal to purposes of illumination.

Brought up in the great engineering establishment of Messrs. Boulton and Watt, at Soho, near Birmingham, he became connected with Mr. Wm. Murdoch, who most undoubtedly was the author and originator of gas-lighting, as the evidence given before a Committee of the House of Commons in the year 1809 abundantly verified. He demonstrated that the light produced from gas was superior in economy to all other modes of artificial illumination; and by that evidence, though so long back as 1809, it will be seen that all the information of the present day was even then known to him, clearly pointed out, and illustrated by his experiments, which strangely contrasted with the statements put forward by the parties then attempting to introduce this mode of lighting into the metropolis. All the ephemeral plans of those parties have, however, long since disappeared, or nearly all. One, unfortunately, remains, and that a most unlucky one — the unprofitable manufacture of coke in gas-making — an article worthless in the scale of value, which should never have been sought for. Messrs. Watt and Murdoch predicted that when the parties became incorporated by Parliament, they would resort to *their* apparatus, notwithstanding their repudiation of it at the time, alleging their own schemes to be so much superior; and they verified this prediction a very few years afterwards by engaging the services of Mr. Clegg, to extricate them from their manifold and egregious errors. He began by introducing the very apparatus of Messrs. Murdoch and Watt, so inconsiderately condemned by them.

Mr. Clegg put up the *first* gas-holder ever erected in London.

To Mr. Clegg is due also the introduction of lime for the purification of the gas, without which gas-lighting would to this day have afforded little comfort and economy. The hydraulic main, for separating the gas *making* from the gas *made*, valves, lutes, and many other admirable contrivances, are peculiarly due to Mr Clegg. But the crowning performance of all his inventions, was that for measuring out the gas to the several parties requiring it exactly according to their demands. The manufacture of gas having by this time been so far mechanically perfected as to be brought to our doors, it became at once apparent that some contrivance should be found by the use of which every person might consume as much or as little gas as he pleased, paying only for what he really used, thus making science subservient to fair dealing.

Mr. Clegg took out a patent for the gas-meter about the year 1814; but great as its merits were, he soon found that serious difficulties remained to be overcome, in inducing parties to support and encourage its use, even where their interests should have prompted them to adopt it. Mr. Clegg had, however, fortunately associated with him, towards the completion of the apparatus, Mr. Samuel Crosley; and by their joint labours it acquired its present precision.

The value of the meter is *primarily* to the gas companies, *next* to the public. By its use, the gas companies are enabled to supply gas to all places where light is required, at a rate proportioned to its just value. The public thereby see the economy afforded by gas over candles, oil, or other material; but they gain also in another most important way — by the use of the meter, gas companies, being duly paid, are enabled to *reduce* the *price of gas*, and *yet realise equal profits*, thus bringing it within the reach of a much larger class of the community; and it is a well established fact that in towns where gas is sold by meter, gas companies can and do sell at nearly one half the price they otherwise could do.

Reduction of price increases demand; increased demand increases profits; increased profits again enable prices to be reduced; and again, reduced prices increase the demand, thus benefiting reciprocally companies and consumers.

Notwithstanding, however, all these advantages, there are not wanting persons who have set up an outcry against the use of the meter, by impugning its accuracy, and accusing the gas companies with fraud in charging by it. It would be idle to follow these parties in their baseless allegations. An action for pirating it was brought and tried in the Court of King's Bench, in which not only the novelty of the machine was fully established, but its accuracy and usefulness proved by the ablest mathematicians, mechanicians, and chemists of the day; and a verdict in its favour obtained. Subsequently very large damages have been given for the infringement — in one case as much as 5000*l.*, and in another, in the Court of Chancery, a decree was made referring it to the Master, to take an account of the profits made by the use of the meter; this is not yet finally settled, the Master's report finding 6000*l.* to be due; but this is excepted to by the parties infringing: the Chancellor, however, allowed the exceptions to be argued, only on payment by the infringers of 4000*l.* into court to meet the patentee's law costs. These exceptions have no reference whatever to the question of the accuracy of the meter, but are simply as to whether the advantages of the meter were as great as allowed by the Master.

The patent for the meter expired about the year 1828; since that period numerous competitors have commenced making the machine.

Mr. Clegg has recently obtained a patent for a *dry* gas-meter, of which the following are its advantages and construction, as described by the very meritorious inventor: —

1. Working without water.
2. Working without membranes or valves.
3. Working without requiring the least pressure.
4. Working without interference with the perfect steadiness of the lights.
5. Registering more accurately than any other meter.
6. Occupying only one-tenth of the space of the common meters.
7. Being subject to little or no wear and tear.
8. And being cheaper.

Prices. — For plain meters, —

	£	*s.*	*d.*
Three-light meter	1	12	0
Six-light do.	2	4	0
Twelve-light do.	3	3	0

The highest numbers will be still cheaper in proportion.

Ornamental meters, appearing like handsome time-pieces, for halls, living-rooms, committee-rooms, offices, counting-houses, &c., are charged extra, at *ten shillings each* and upwards, according to pattern.

Description of Clegg's patent dry Gas-meter.

The two *figs.* 63, 64. are half the full size of the apparatus, and the letters of reference are the same in both.

B, B, *fig.* 63., represents a cylindrical vessel, about three inches and three quarters diameter, and four inches deep, being the dimensions of a meter capable of measuring gas for three burners, called a three-light meter. In this vessel are two glass cylinders F, F, connected together by the bent tube *d.* The cylinders being perfectly exhausted of air, and half filled with alcohol, are made to vibrate on centres *e* and *e*, and are balanced by the weight *f.*

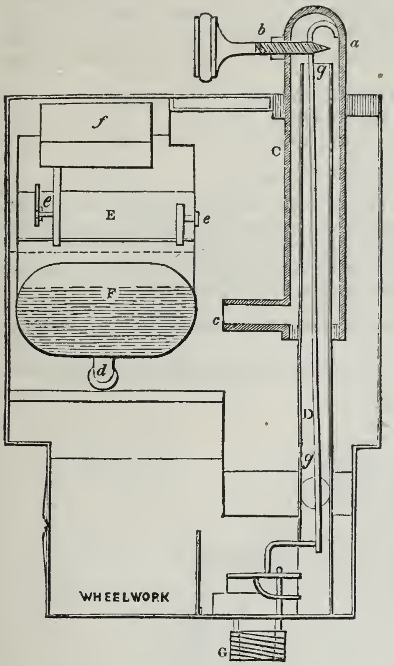
This instrument accurately indicates the excess of heat to which either cylinder may be exposed, upon the principle of Leslie's differential thermometer.

C is a hollow brass box, called the heater, about four inches long, and half an inch broad, projecting out of the meter about one inch. At *a* issues a small jet of gas, which, when inflamed, gives motion to the cylinders.

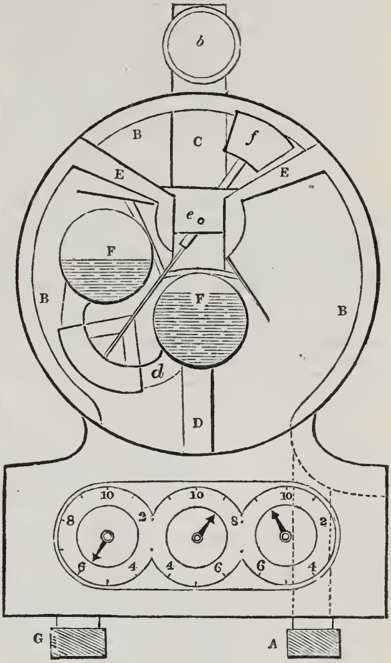
The gas enters the meter by the pipe A, and circulates throughout the double case B: having passed round the case B, a portion of it enters the top of the box C, by the pipe D, and passes out again at the bottom by the tube *c*, into the meter; the rest of the gas enters the body of the meter through holes in the curved faces of the hoods EE, and, after blowing on the glass cylinders, passes to the burners by the outlet pipe.

To put the meter in action, let the jet *a* be lighted about an hour before the burners are wanted. In most cases this jet will be lighted all day as a useful flame. The hole *a* is so situated on the box C, that whatever be the size of the jet, a fixed temperature is given to the box, that temperature depending on the quantity of flame in contact with the box, and not at all on the length of the jet. The jet being lighted, and the box C thereby heated, the gas which passes through it is raised to the same temperature, and, flowing out at the tube *c*, impinges on the glass cylinder which happens for the time to be the lowest; the heated gas soon raises a vapour in the lower cylinder, the expansion of which drives the liquid into the upper one, until it becomes heavier than the counterpoise *f*, when the cylinders swing on their centre, the higher one descends, and comes in the line of the current of hot gas, and the lower one ascends; the same motion continues as long as the jet *a* burns. The same effect on the cylinder is maintained, however the outward temperature may change, by the cold gas, which, issuing from the curved side of the hood EE, impinges on the upper cylinder, and hastens the condensation of the vapour which it contains.

64



63



The cold gas and the heater vary in temperature with the room, and thus counteract each other.

The lighting of the jet *a* is essential to the action of the meters; in order to insure this, the supply of gas to the burners is made to depend on it in the following manner. The pipe G, by which the gas leaves the meter, is covered by a slide valve, which is opened and shut by the action of the pyrometer *g*; the pyrometer is in communication with and receives heat from the jet, and opens the valve when hot, closing it again when cold.

The speed at which the cylinders vibrate is an index of the quantity of heat communicated to them, and is in exact proportion to the quantity of gas blowing on them through the pipe *c* and curved side of the hoods EE.

The gas passed through the heater is a fixed proportion of the whole gas passing the meter; therefore the number of vibrations of the cylinders is in proportion to the gas consumed.

A train of wheel-work, with dials similar to that used in the common meter, registers the vibrations.

Simplicity, accuracy, and compactness, are the most remarkable features of this instrument, and the absence of all corrosive agents will insure its durability.

Directions for fixing and using Clegg's patent dry Gas-meters.

Choose a situation for fixing the meter, where the small jet of flame will be of the greatest use, such as an office-desk or counter, taking care to screw the same firm and level on its base. When the jet at the top of the meter is required to be kept constantly burning as a useful flame, press in the brass knob at the front of the meter, and before lighting the burners pull it out; when the small flame is not required, let it be lighted about an hour before you want the burners lighted. Adjust the size of the small flame at pleasure by the screw *b*.

On the back of each meter is marked the number of lights it will supply.

The inlet and outlet pipes are marked at the bottom of the meter.

The quantity of gas consumed is recorded by the index in the usual way.

For testing Clegg's patent dry Gas-meters.

Pass the gas through two meters at least, and take the mean. Vary the number of lights at pleasure, not exceeding the number marked on the meter, and when one or two hundred cubic feet of gas have been consumed, compare the indices.

These meters are not for measuring small fractional parts; but taking the average for any periodical consumption, are more accurate than any other meter.

Mr. Thomas Edge, of Great Peter Street, Westminster, has contrived the following meter, of which drawings are annexed.

Fig. 65. is a front view of a three-light meter, the front plate being removed, and some of the parts shown in section 65.

65

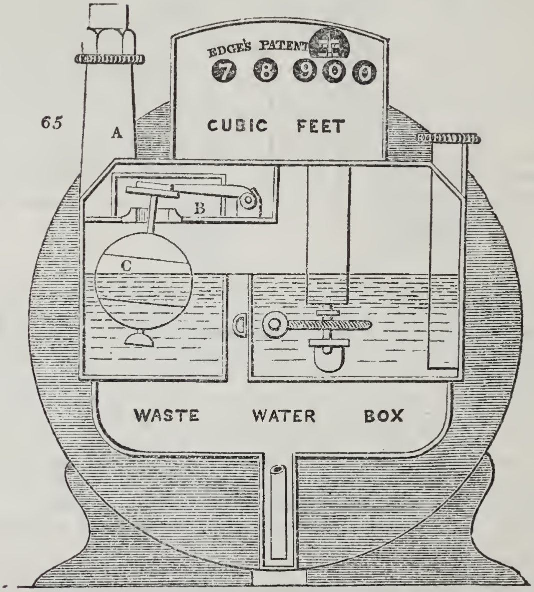
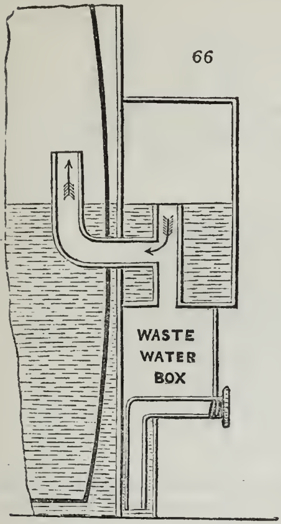


Fig. 66. is a transverse section of the same.

The gas enters at A into the small chamber B, in the bottom of which is a lever valve (part of Mr. Edge's patent improvements), moving upon its axis and attached by the rod to a metal float C, which in the present drawing is buoyant. The object of this arrangement is to intercept the passage of the gas into the meter, unless a sufficient quantity of water is in it, that being necessary to its proper action; the gas then passes through the inverted syphon or tunnel into the convex cover, whence it passes into the chambers of the drum.

Another of Mr. Edge's improvements consists in the cutting down of this syphon pipe or tunnel to the proper water level, and connecting the bottom of it to a waste water-box, into which any surplus water must fall. The importance of this precaution will be seen on investigating the drum, as an excessive height of the water will materially interfere with the measurement, the quantity of gas delivered per revolution being considerably less. This, in connection with the lever valve and float, confines the variation of the water levels within such narrow limits, that the measurement may be considered perfectly just on all occasions.



The last patent by Mr. Edge is for an improved Index, which is composed of a series of moving dials, with 10 figures upon each, one figure only appearing of each series at a time.

This contrivance is very ingenious, and will no doubt be applied to other machines, where indexes (*indices*) of quantity are required.

Recurring to Mr. Clegg, he is also the inventor of an instrument of great value — appropriately called a "Governor." Its purpose is to render equal the height of flame of the several burners in any house or establishment, and to keep them so, notwithstanding any, and whatever alteration may be made in the pressure at the works or elsewhere. This instrument is perfected, and successfully applied, though it is not so generally in use as it ought to be. By the use of this instrument a light once set at the height desired will maintain that height uniformly, and without the least variation the whole evening; and continue to do so till altered.

Without this instrument, it is necessary to pay attention to the burning of gas lights, as their heights are frequently affected by the most trifling circumstance, such, for example, as their extinction at the hour of closing the shops, which makes a sensible difference in the neighbourhood.

All these works have prodigiously increased in the quantity of gas made and supplied. Since the account in the former edition of this work, large additional manufactories have been erected by new companies, and great additions made by the old ones. There are now in the metropolis *alone* 15 public gas companies, having amongst them 23 gas establishments. The quantity of gas manufactured by these 23 gas works, and supplied to the public was during the past year three thousand one hundred millions of cubic feet of gas; and the coal used to produce this quantity of gas was at the least 400,000 tons!

Baked clay retorts are very generally used in Scotland, and found to be most economical as regards wear and tear; in London, however, they are mostly of cast iron.

The pressure upon the retorts is caused principally by the use of *wet lime*, used in London, because the process is less expensive and less cumbersome than dry lime. Wet lime cannot be used with clay retorts, owing to this excess of pressure.

Merit is due, for enlarging the capacities of double gas holders, to the late Mr. Joshua Horton, of West Bromwich, near Birmingham: and to Mr. Stephen Hutchison, engineer, of the New London Gas Works, Vauxhall, where they were first successfully introduced, and manufactured by Mr. Horton. They have now come very generally into use throughout the kingdom, and are manufactured by all gasholder makers.

Separate gasholders are advisable and advantageous, but they are not generally used, except in Glasgow, Manchester, Birmingham, Sheffield, and a few other places.

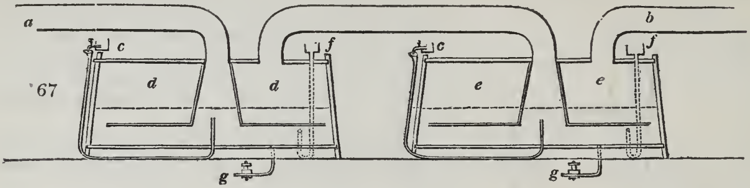
The annexed drawing represents Mr. Croll's vessels for the purification of gas from ammonia, which is effected by means of dilute sulphuric acid applied between the condensers and the ordinary lime purifiers. The vessels are made of either wood or iron, and lined with lead; have a washplate similar to the wet lime purifiers. The radiating bottom formed of wooden bars, as shown in the drawing, is for the purpose of supporting the washplate and distributing the gas.

Fig. 67. *a*, is the inlet pipe; *b*, the outlet pipe; *c*, *c*, the tube with funnel for introducing the sulphuric acid; *d*, the first purifying vat; *e*, the second do., both lined with lead, and which are filled up to the dotted line with the dilute acid; *f*, *f*, the water supply-pipe; *g*, *g*, the discharging cocks.

Fig. 68. represents a ground-plan of the vats, each 10 feet in diameter; A, the bottom of the middle; B, the inlet of the gas; C, the outlet of do.

In commencing the process, these vessels are charged with water and sulphuric acid, in the proportion of 7 pounds, or thereabouts, of the latter, to 100 gallons of the former. As the acid is neutralized by the ammonia contained in the gas passing through the vessels, the above proportion, as near as may be, is kept up by a continuous dropping or running of acid, regulated according to the quantity of ammonia contained in the gas, from a reservoir placed on the top of the saturator. This mode of supplying the acid is continued until the specific gravity of the solution arrives at 1170, or close to the

67



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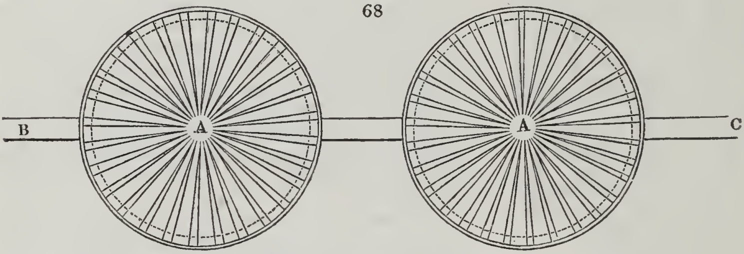


point of crystallization, after which the supply of acid is discontinued, and the liquor retained in the vessel until neutral, when it is drawn off and evaporated, and yields a pure sulphate of ammonia.

This process has been introduced at several of the provincial gas works, the three stations of the Chartered, the Imperial, Phœnix, &c. &c. Mr. Croll is also now in treaty with several other companies for its introduction.

The produce — sulphate of ammonia — from the process, by the gas companies using it, now amounts to several tons per week — and it may be here mentioned, as one of the advantages of science, that the ammonia so produced before the adoption of this process passed along with the gas to the consumer, destroying rapidly the main pipes, fittings, and metres, through which it was transmitted, as well as deteriorating the illuminating power of the gas, and producing a choky effect when consumed in close apartments. It is now employed as a manure, and found to be superior in its effects as a fertilizer, as well as comparatively cheaper than any of the other artificial manures; so that whether Mr. C.'s invention be looked upon as effecting improvements in the manufacture of gas, hitherto unknown, or as producing a valuable manure, the results are alike of the utmost importance.

(When Mr. Croll's process is employed before the lime purifiers, dry lime can be used without creating the nuisance hitherto complained of, and a much less quantity is required for this purification.)

Mr. Croll has recently patented another invention, connected also with the manufacture of gas, which consists in the combination of clay and iron retorts, so that the heat of the furnace first acts on the clay retorts and then passes to those of iron.

The annexed drawing is a transverse section: —

A is the fire-place.

B B are piers of fire bricks, placed at intervals to form nostrils or flues, and the fire tile resting upon them in conjunction with the front and back wall, form the bed or support of the clay retort 1, and the clay retort 2, is also supported by the front and back brick work, and a lump, or fire brick, E, placed midway on the crown of the retort 1.

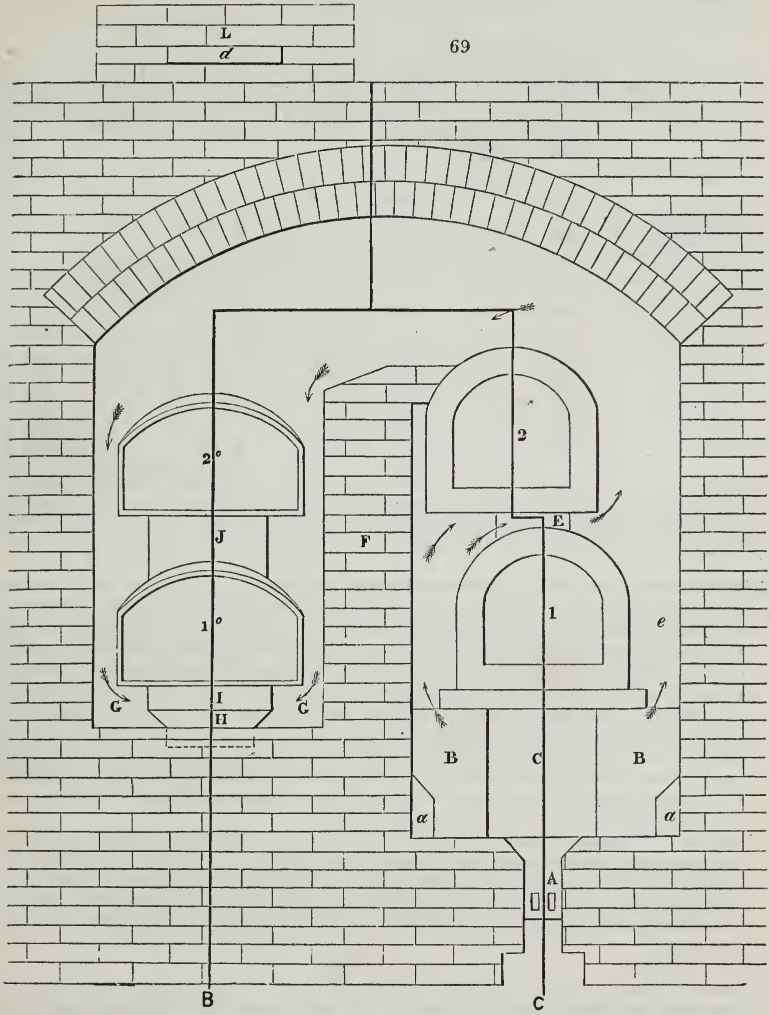
F is a wall which separates the clay retorts 1 and 2, and the iron retorts 1° and 2°; a space being left between the top of the said wall F, and the under surface of the arch, to allow the fire or heated air to pass freely from the clay to the iron retorts.

G G is the bed, and H H is the flue under the iron retort 1°. The retort 2°, is supported by the front wall and pieces or lumps.

J, placed at the back and crown of the retort 1°, in connection with the horizontal flue. H is a vertical flue, forming a passage from thence into the shaft or chimney.

The heat passes from the furnace or fireplace A, through the spaces or nostrils formed by the piers B B, and around the clay retorts 1 and 2, over the wall F, descends between and around the iron retorts and along the flue H, and escapes by the vertical flue into the chimney. The advantages of this mode of setting retorts are the small quantity of brickwork necessary for the erections, the increased durability of the retorts, and the economy in fuel. From adopting this mode of setting a brick lump, it has been found that 12 tons of coke will carbonise 100 tons of coal.

69



L is the chimney stalk, and *d* is a damper or register plate for regulating the chimney draught.

Before dismissing Mr. Croll's patent improvements, it is proper to state, that the sulphuric acid used for condensing the ammonia should be free from iron, otherwise the sulphuretted hydrogen of the coal gas is apt to give rise to sulphuret of that metal which will blacken the sulphate of ammonia and reduce its value in the market. An occurrence of this kind was recently brought professionally before me for investigation. The sulphuric acid had been made from pyrites.

Copy of a paper laid before a Committee of the House of Commons, showing not only the relative values of the Gases produced at the under-mentioned places, but showing in like manner the relative economy of Gas, as produced at the different places, over candles. By Joseph Hedley, Esq.

Names of the Places where Experiments were made.	Illuminating power of a single Jet of Gas-flame four inches high, taken by a comparison of Shadows.	The Jet of Gas burnt, four inches high, consumed per hour and was equal to the Candles in the last column.	Gas required to be equal to 100 lbs. of mould Candles, 6 to the lb., 9 inches long each.*	Selling price of Gas per meter per 1000 cubic feet.	Cost of Gas equal in illuminating power to 100 lbs. of candles.†	Average discount allowed off the charge for Gas.	Net cost of Gas equal to 100 lbs. of Candles.	Specific gravity of the Gas.
	Equal to Candles.	*Cubic Feet.*	*Cubic Feet.*	*s. d.*	*L. s. d.*	*Per Cent.*	*L. s. d.*	
Birmingham ; Birmingham and Staffordshire ; two Companies	2·572	1·22	2704	10 0	1 7 0	9	1 4 7	·541
Stockport - -	3·254	·85	1489	10 0	0 14 11	12½	0 13 0	·534
Manchester - -	3·060	·825	1536	8 0	0 12 3	11¼	0 10 10	
Liverpool Old Company‡ -	2·369	1·1	2646	10 0	1 6 5	6¼	1 4 9	·4
Liverpool New Gas Company	4·408	·9	1164	10 0	0 11 8	6¼	0 9 10	·580
Bradford - -	2·190	1·2	3123	9 0	1 8 1	12½	1 4 6	·420
Leeds - - -	2·970	·855	1644	8 0	0 13 2	6¼	0 12 4	·530
Sheffield - -	2·434	1·04	2440	8 0	0 19 6	6¼	0 18 3	·466
Leicester - -	2·435	1·1	2575	7 6	0 19 3	15	0 16 5	·528
Nottingham - -	1·645	1·3	4200	9 0	1 17 9	15	1 11 3	·424
Derby - - -	1·937	1·2	3521	10 0	1 15 4	15	1 10 0	·448
Preston - - -	2·136	1·15	3069	10 0	1 10 8	15	1 6 2	·419
London - -	2·083	1·13	3092	10 0	1 10 11	none allowed.	1 10 11	·412

* 100 lbs. of candles are estimated to burn 5700 hours. † The candles cost 3*l.* 2*s.* 6*d.*

‡ The Liverpool Old Company have since resorted to the use of Cannel coal, and consequently very nearly assimilate to the Liverpool New Company in illuminating power.

Memorandum. — It will not fail to be observed that in deducing the comparative value between candles and gas by these experiments, the single jet (and in every instance, of course, it was the same), has been the medium. This, however, though decidedly the most correct way of making the comparative estimate of the illuminating power of the several gases, is highly disadvantageous in the economical comparison, inasmuch as gas burnt in a properly regulated argand burner, with its proper sized glass, air aperture, and sufficient number of holes, gives an advantage in favour of gas consumed in an argand, over a jet burner, of from 30 to 40 per cent. At the same time it must not be overlooked that in many situations where great light is not required, it will be found far more economical to adopt the use of single jets, which by means of swing brackets and light elegant shades, become splendid substitutes for candles, in banking establishments, offices, libraries, &c. &c.

Note. — In Glasgow, Edinburgh, Dundee, Perth, and the Scotch towns, generally, the Parrot or Scotch Cannel coal is used; in illuminating power and specific gravity the gas produced is equal to that from the best description of Cannel coal in England. The price per 1000 cubic feet ranges about 9*s.*, with from 5 to 30 per cent. off for discounts, leaving the nett price about 9*s.* to be equal in the above table to 100 lbs. of candles.

Epitome of Experiments made in Gas produced from different qualities of Coal, and consumed in different kinds of Burners, tried at the Sheffield Gas Light Company's Works, and laid before a Committee of the House of Commons. By Joseph Hedley, Esq.

Date 1835.	Description of Burner.	Species of Coal.	Specific Gravity of Gas.	Distance of Candle from Shadow.	Gas consumed per Hour.	Height of Gas-flame.	Equal to Mould Tallow Candles, 6 to the pound, 9 inches long each.	Gas equal to 100 lbs. of Mould Candles.	Cost of Gas at 8s. per 1000 cubic feet.	Cost of 100 lbs. of Mould Candles at 7*s.* 6*d.* per dozen lbs.
May.				*Inches.*	*Cubic Feet.*	*Inches.*	*Candles.*	*Cubic Feet.*	*L. s. d.*	*L. s. d.*
8	Single Jet	Deep Pit	·410	75	1·	4	2·36	2415	0 19 3½	3 2 6
9	Ditto	Mortormley	·450	74	·95	4	2·434	2224	0 17 9½	
9	Ditto	Cannel	·660	61¼	·7	4	3·54	1127	0 9 0	
8	Argand 14 holes	Deep Pit	·410	34	3·3	3½	11·53	1631	0 13 0½	
9	Ditto	Mortormley	·450	33	3·1	3½	12·24	1443	0 11 6½	
9	Ditto	Cannel	·660	29	2·6	3½	15·85	935	0 7 5¾	

Copy of Experiments made at the Alliance Gas Company's Works in Dublin, during the past year 1837. By Joseph Hedley, Esq.

Results of experiments on the qualities of various coals for the production of gas; its value in illuminating power; produce of coke, and quality; and other particulars important in gas-making: —

1*st Experiment, Saturday, May* 27*th*, 1837. — Deane coal (Cumberland), 2 cwt. of 112 lbs. each (or 224 lbs.) produced 970 cubic feet of gas; 4 bushels of coke of middling quality; specific gravity of the gas, 475. Consumed in a single-jet burner, flame 4 inches high, $1\frac{4}{10}$ cubic feet per hour; distance from shadow 76 inches or 2·3 mould candles. Average quantity of gas made from the charge (6 hours) 4·33 cubic feet per lb., or 9700 cubic feet per ton of 20 cwt. Increase of coke over coal in measure, not quite 30 per cent. Loss in weight between coal, coke, and breize 56 lbs., converted into gas, tar, ammonia, &c.

2*nd Experiment, May* 28*th.* — Carlisle coal (Blenkinsopp). 224 lbs. produced 1010 cubic feet of gas, 4 bushels of coke of good quality though small; increase of coke over coal in measure not quite 30 per cent. Loss in weight, same as foregoing experiment. Average quantity of gas made from the charge (6 hours) 4·5 cubic feet per lb. or 10,080 per ton.

Illuminating Power of the Gas.

	Consumed per hour, single jet.	Distance from candle.	Equal to candles.	Specific gravity.
	Feet.	*Inches.*		
At the end of the 1st hour -	$1\frac{1}{10}$	70	2·72	·475
Ditto ditto with 20-hole argand burner - -	5	25	21·33	·475
When charge nearly off -	$1\frac{4}{10}$	85	1·84	·442
When charge quite off, with 20-hole argand burner -	9	100	not 1	·266

3*rd Experiment, May* 29*th.* — Carlisle coal (Blenkinsopp). 112 lbs. produced 556 cubic feet of gas. Other products, loss of weight, &c., same proportion as foregoing experiment. Average quantity of gas made from the charge (6 hours) 4·96 cubic feet per lb., or 11,120 per ton.

In this experiment the quantity of gas generated every hour was ascertained; the illuminating power, the specific gravity, and the quantity of gas consumed by the single jet with a flame 4 inches high, was tried at the end of each hour, with the respective gases generated at each hour; and the following is a table of results.

RESULTS.

Hour.	Gas produced.	Consumed per hour per single jet, 4 inches high.	Specific gravity.	Distance of candle from shadow.	Illuminating power equal to mould candles.
	Cubic Feet.	*Cubic Feet.*		*Inches.*	
1st.	150	$11\frac{1}{2}$-10ths. or 1·15	·534	70	2·72
2nd.	120	11	·495	75	2·36
3rd.	95	12	·344	75	2·36
4th	95	15	·311	80	2·08
5th.	80	17	·270	85	1·81
6th.	16	29	·200	100	not one
Total	556				

Average of the above gas, 6-hour charge.

$92\frac{2}{3}$	16-10ths. nearly	·359	81	2·03

Average of the above gas at 4-hour charge.

115	$12\frac{1}{3}$-10ths.	·421	75	2·36

Production of gas in 6 hours 556 feet, or at the rate of 11,120 cubic feet per ton.
Ditto in 4 hours 460 feet, or at the rate of 9,200 ditto.

The relative value of these productions of gas is as follows, viz. : —

11,120 at 16-10ths per hour nearly, (or 1·5916 accurately) and equal to 22·03 candles; the 11,120 feet would be equal to and last as long as 1597 candles, or 266⅙ lbs. of candles.

9200 at 12⅓-10ths. per hour, (or 1·2375 accurately) and equal to 2·36 candles; the 9200 feet would be equal to 1949 candles, or 324⅚ lbs. candles.

Now 266⅙ lbs. of mould candles, at 7*s.* 6*d.* per dozen lbs., will cost 8*l.* 6*s.* 4½*d.*, whilst
324⅝ lbs. of do. do. at 7*s.* 6*d.* per do. do. 10*l.* 3*s.*

Showing the value of 4-hour charges over 6-hour charges; and of 9200 cubic feet over 11,120 cubic feet.

Note. — 9500 cubic feet of Wigan cannel coal gas are equal in illuminating power to 859 1-6th lbs. of candles, which at 7*s.* 6*d.* per dozen lbs. will cost 25*l.* 10*s.* 5⅓*d.* It is also found that any burner with superior gas, will consume only about half the quantity it would do with common gas.

4*th Experiment, May* 30*th.* — Cannel and Cardiff coal mixed ½ and ½, together 112 lbs., produced 460 feet of gas, 2 bushels of coke of good quality; increase of coke over coal in measure about 30 per cent.; loss in weight 41 lbs.; coke weighed 71 lbs., no breize. Average quantity of gas made from the charge, (4 hours) 4·1 cubic feet per lb., or 9·200, per ton.

Illuminating Power. — At end of first hour,

	Candles.		Cubic Feet.
Distance of candle from shadow - -	73 or 2·49	Consumed per hour, single jet, 4 inches high -	12-10ths.
At end of 2nd hour, do.	70 or 2·72	Do. do. do.	11½-10ths.
At end of 3d hour.	This gas very indifferent.		
Average of the three -	70 or 2·72	Do. do. do.	11½-10ths

Specific gravity 3·44; 5 feet per hour, with a 20-hole argand burner, equal to 14·66 candles.

5*th Experiment, May* 31*st.* — Carlisle coal, 112 lbs. produced 410 feet of gas; other products, same as in former experiments with this coal, but heat very low.

Illuminating Power and Produce of Gas.

410 feet	1st hour	120 cubic feet.
	2nd	100
	3d	90
	4th	100

Average of this gas: specific gravity, 540; distance of candle from shadow, 55 inches, or 4·4 candles consumed per single jet, 9-10ths of a cubic foot per hour. 20-hole argand burner, 4 feet per hour, equal to 21·33 candles.

It is possible, from the superior quality of this gas, that a little of the cannel gas made for a particular purpose may have got intermixed with it in the experimental gasholder and apparatus.

Various other experiments were tried on different qualities of coal, and mixtures of ditto, too tedious to insert here, though extremely valuable, and all tending to show the superior value of gas produced at short over long charges; and also showing the importance and value of coal producing gas of the highest illuminating power; among which the cannel coal produced in Lancashire, Yorkshire, and some other counties of England and Wales, and the Parrot or splent coal of Scotland, stand pre-eminent.

Note. — In all the foregoing experiments the same single-jet burner was used; its flame in all instances exactly 4 inches high.
The coal when drawn from the retort was slaked with water, and after allowing some short time for drying, was weighed.

A Table of the Number of Hours Gas is burnt in each Month, Quarter, and Year.

Time of Burning.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apl.	May.	June	Mid. quar.	Mic. quar.	Xms. quar.	Lady day quar.	Totl. of Year	
o'clock.																		
From Dusk to 6	—	—	2	31	62	80	65	33	4	—	—	—	—	2	173	102	277	For Sundays off deduct one seventh.
— 7	—	14	22	62	92	111	96	61	31	4	—	—	4	36	265	188	493	
— 8	—	40	52	93	122	142	127	89	62	28	4	—	32	92	357	278	759	
— 9	13	71	82	124	152	173	158	117	93	58	29	8	95	166	449	368	1078	
— 10	44	102	112	155	182	204	189	145	124	88	60	38	186	258	541	458	1443	
— 11	75	133	142	186	212	235	220	173	155	118	91	68	277	350	633	548	1808	
— 12	106	164	172	217	242	266	251	201	186	148	122	98	368	442	725	638	2173	
All night -	217	307	345	421	473	527	512	411	382	295	242	195	732	869	1421	1305	4327	
Morning from 4	—	16	48	80	110	137	137	98	71	28	2	—	30	64	327	306	727	
— 5	—	—	18	49	80	106	106	70	40	3	—	—	3	18	235	216	472	
— 6	—	—	—	18	50	75	75	42	9	—	—	—	—	—	143	126	269	
— 7	—	—	—	—	20	44	44	14	—	—	—	—	—	—	64	58	122	

A Table showing the Rate per Thousand Cubic Feet received for any Burner consuming from ½ a Cubic Foot to 10 Cubic Feet per Hour, at any given Price per Annum, and to the times below stated. By Joseph Hedley, Esq.

Time of Burning per Annum.	No. of hours.*	Single Jets.			2 Jets.			3 Jets.			Small Argand.			Large Argand.			Fancy and extravagant Burners.		
		Cub. ft. ½	Cub. ft. ¾	Cub. ft. 1	Cub. ft. 1¼	Cub. ft. 1½	Cub. ft. 1¾	Cub. ft. 2	Cub. ft. 2½	Cub. ft. 3	Cub. ft. 3½	Cub ft. 4	Cub. ft. 4½	Cub. ft. 5	Cub. ft. 6	Cub. ft. 7	Cub. ft. 8	Cub. ft. 9	Cub. ft. 10
From Dusk to 8 o'clock	781	2·56	1·706	1·28	1·026	·853	·731	·64	·5132	·4268	·3658	·3201	·2846	·2561	·2134	·1829	·16	·1423	·128
ditto and Sundays	902	2·216	1·478	1·108	·887	·739	·633	·554	·4434	·3695	·3168	·2771	·2464	·2217	·1848	·1584	·1383	·1232	·1108
ditto and from 6 o'clock mornings	1050	1·904	1·27	·952	·762	·635	·544	·476	·381	·3174	·272	·2381	·2116	·1905	·1587	136	·119	·1058	·0952
ditto and Sundays and from ditto	1172	1·706	1·138	·853	·682	·569	·487	·426	·3412	·2844	·2438	·2133	·1896	·1706	·1422	·1219	·1067	·0948	·0853
9 o'clock	1054	1·896	1·264	·948	·759	·632	·542	·474	·3794	·3162	·271	·2371	·2108	·1897	·1581	·1355	·1185	·1054	·0948
ditto and Sundays	1221	1·638	1·092	·819	·675	·546	·463	·409	·3376	·273	·234	·2047	·182	·1638	·1365	·117	·1024	·091	·0819
ditto and from 6 o'clock mornings	1323	1·510	1·006	·755	·604	·503	·431	·378	·3022	·2519	·2158	·1889	·1678	·1511	·1259	·1079	·0945	·0839	·0755
ditto and Sundays and from ditto	1490	1·342	·894	·671	·536	·447	·383	·335	·2684	·2236	·1918	·1675	·1492	·1312	·1118	·0959	·0839	·0746	·0671
10 o'clock	1367	1·462	·974	·731	·585	·487	·418	·366	·2926	·2438	·209	·1829	·1626	·1463	·1219	·1045	·0914	.0813	·0731
ditto and Sundays	1586	1·26	·84	·63	·504	·42	·36	·315	·2522	·2101	·1802	·1576	·14	·1261	·1051	·0901	·0789	·07	·0630
ditto and from 6 o'clock mornings	1636	1·222	·814	·611	·489	·407	·349	·305	·2444	·2037	·1746	·1528	·1358	·1222	·1019	·0873	·0764	·0679	·0611
ditto and Sundays and from ditto	1855	1·078	·718	·539	·431	·359	·308	·269	·2156	·1796	·154	·1347	·1198	·1078	·0898	·077	·0674	·0599	·0539
11 o'clock	1680	1·19	·794	·595	·476	·397	·34	·297	·238	·1984	·17	·1488	·133	·119	·0992	·085	·0744	·0665	·0595
ditto and Sundays	1951	1·024	·682	·512	·409	·341	·293	·256	·2048	·1707	·1466	·1281	·1138	·1024	·0854	·0733	·064	·0569	·0512
ditto and from 6 o'clock mornings	1949	1·026	·684	·513	·41	·342	·294	·256	·2052	·171	·1466	·1282	·114	·1026	·0855	·0733	·0641	·057	·0513
ditto and Sundays and from ditto	2220	·9	·6	·45	·36	·3	·257	·225	·1802	·1501	·1286	·1126	·1	·0981	·0751	·0643	·0563	·05	·045
12 o'clock	1993	1·	·668	·502	·4	·334	·287	·251	·2006	·1672	·1434	·1254	·1114	·1003	·0836	·0717	·0627	·0557	·0502
ditto and Sundays	2316	·862	·574	·432	·345	·287	·247	·215	·1726	·1439	·1236	·1079	·0958	·0863	·0719	·0618	·0539	·0479	·0432
ditto and from 6 o'clock mornings	2262	·884	·59	·442	·353	·295	·255	·221	·1768	·1476	·1274	·1105	·0982	·0884	·0737	·0637	·0552	·0491	·0442
ditto and Sundays and from ditto	2585	·772	·514	·387	·309	·257	·221	·193	·1546	·1289	·1104	·0967	·0858	·0773	·0645	·0552	·0483	·0429	·0387
1 o'clock	2306	·866	·578	·434	·347	·289	·247	·217	·1734	·1445	·1238	·1080	·0962	·0867	·0723	·0619	·0542	·0481	·0434
ditto and Sundays	2681	·746	·498	·373	·298	·249	·213	·186	·1492	·1243	·1066	·0932	·0828	·0746	·0621	·0533	·0466	·0414	·0373
ditto and from 6 o'clock mornings	2575	·776	·518	·388	·31	·259	·222	·194	·1552	·1294	·111	·0971	·0862	·0776	·0647	·0555	·0485	·0431	·0388
ditto and Sundays and from ditto	2950	·678	·452	·339	·271	·226	·193	·169	·1356	·113	·0968	·0847	·0754	·0678	·0565	·0484	0424	·0377	·0339
All night	4327	·462	·308	·231	·185	·154	·132	·115	·6924	·077	·066	·0578	·0515	·0462	·0385	·033	·0289	·0257	·0231

To use the Table.— Select the hour to which it is agreed the gas is to burn,—9, 10, 11 o'clock, Sundays, &c., as the case may be, and the description of the burner.—Multiply the decimal number opposite to it by the amount in shillings agreed to be paid per annum, and the product will be the sum received per m. cubic feet for the gas.

Example.— Suppose a small argand which should burn 3½ feet per hour, is agreed for till 9 o'clock at 2*l*. per annum. Look along the line at 9 o'clock till you arrive at the column of 3½ feet per hour, and you find the number, 271. Multiply this number by 40*s*. and the result gives 10*s*. 10*d*. per m. cubic feet. But suppose instead of keeping to 9 o'clock the party burns till 1 o'clock, Sundays and mornings, and by enlarging the holes or height of flame consumes 8 cubic feet of gas per hour; then you have the number, ·0424, which multiplied by 40*s*., still the price paid, gives 1*s*. 8*d*. per m. cubic feet only, and so on for any greater or lesser variation of the agreement

* The "number of hours" includes ¼ of an hour allowed for shutting shops, and 1 hour's extra burning on Saturday nights.

Copy of a Paper submitted to a Committee of the House of Commons in the Session of 1837, of England; and procured by actual Survey and

Name of the Place where Gas Works are situated.	Price of Gas per Meter, and Discounts allowed.	Price of Coal, and Description; delivered per Ton.	Average Quantity of Gas made per Ton of Coals.	Coke made from a Ton of Coal.	Selling Price of Coke.	Material usual to heat Retorts.	Quantity used per Ton of Coal.	No. of Public or Street Lamps supplied.	Description. — Size or Sort.	Price paid per Annum for Ditto.	Who lights, cleans, puts out, and repairs.
			Cu.ft.							*L. s. d.*	
Birmingham Gas Company.	10*s.* per 1000 cub. feet. Discounts. 10*l.* to 30*l.* 2½ 30*l.* to 50*l.* 5 50*l.* to 75*l.* 7½ 75*l.* to 100*l.* 10 per an. per cent. 100*l.* & upwards 15	Lump coal from West Bromwich pits risen much of late. 1837, 11*s.* 10*d.*	6,500	32 bushels.	2*s.* 1*d.* per quarter delivered, or about 3*d.* per bushel.	Slack.	About 5 cwt. of slack, at 6*s.* per ton, 25 per cent.	490	Batswings 460 30	1 10 0 2 0 0	Company, and provides posts, services, &c.
Birmingham and Staffordshire.	10*s.* per 1000 cub. feet. Discounts as above.	From West Bromwich pits, 1837, 9*s.* 3*d.*	6,500	24 bush. but larger measure than Birmingham	2*s.* 10*d.* per sack of 8 bushels.	Slack and Tar.	5 cwt. of slack, at 4*s.* 25 per cent.	1,500	Batswings.	average 1 18 0	Ditto.
Macclesfield	10*s.* per 1000 cub. feet. Discounts. 50*l.* 75*l.* 5 75*l.* 100*l.* 7½ 100*l.* 125*l.* 10 125*l.* 150*l.* 12½ 150*l.* 175*l.* 15 175*l.* 200*l.* 17½ Above and not exceeding per cent. 200*l.* & upwards 20	Common, 8*s.* average 1834.	6,720	12 cwt.	10*s.* per ton.	Coke.	No account kept.	220	Ditto.	2 10 0	Company.
Stockport -	10*s.* per 1000 cub. feet. Discounts same as Macclesfield. Macclesfield discounts taken from Stockport card.	Coal 10*s.* 6*d.* cannel 19*s.* 6*d.* about half and half used. Average 15*s.* 1834.	7,800	7 cwt.	6*s.* 8*d.* per ton.	Coal, coke, and tar.	Ditto.	230	Ditto.	2 10 0 1834. 2 0 0 1837.	Comrs. provide lamps and posts. Company's service light, repair, clean, and extinguish.
Manchester -	10*s.* per m. cub. ft. 1834. 9*s.* and 8*s.* — 1837. Discounts 50*l.* 100*l.* 2½ 100*l.* 150*l.* 5 150*l.* 200*l.* 7½ 200*l.* 225*l.* 10 225*l.* 250*l.* 12½ 250*l.* 300*l.* 15 300*l.* 400*l.* 17½ and under per cent. 400*l.* & upwards 20	15*s.* 2*d.* average. Oldham Water gate - Wigan - cannel. Mixed, 1834.	9,500	14 cwt.	Ditto.	Coke.	4, 2-3ds cwt.	2,375	Single jets and flat flames. about half and half.	1 2 0 2 0 0	Commissioners of police.
Liverpool Old Company, 1834.	10*s.* per 1000 cub. feet. Discounts. 10*l.* & under 30*l.* 2½ 30*l.* to 100*l.* 5 100*l.* to 200*l.* 7½ per ct. 300*l.* & upwards 10	7*s.* 3*d.* per ton of 112 lbs. per cwt. Ormskirk or Wigan slack.	8,200	11¾ cwt.	8*s.* 4*d.* per ton of 112 lb. per cwt.	Slack. 7*s.* 3*d.* per ton.	6½ cwt.	1,700 30	Batswings, 1 jet, 2 — 3 — 4 —	4 10 0 2 5 0 2 13 0 3 2 9 3 13 11	Company light, clean, put out, and repair.
Ditto ditto -	In 1835 this Company resorted to the use of cannel coal similar to the Liverpool New Gas and Coke Company, producing nearly										
Liverpool New Gas and Coke, 1835.	10*s.* per 1000 cub. feet. Discounts same as Liverpool Old Company.	18*s.* all cannel Wigan.	9,500	13 cwt.	7*s.* 6*d.* per ton.	Coke and slack.	5½ cwt.	Only a few.	Argands.	4 0 0	Commissioners.
Bradford, 1834.	9*s.* per 1000 cub. feet to large consumers. Discounts 20*l.* to 30*l.* 5 30*l.* to 40*l.* 7½ 40*l.* to 60*l.* 10 60*l.* to 80*l.* 12½ 80*l.* to 100*l.* 15 per cent. 100*l.* & upwards 20. Small consumers, 10*s.* per 1000 cub. feet, and 5 per cent. off from 10*l.* to. 20*l.*	8*s.* 6*d.* per ton. 3 sorts used average. Slack 5*s.* 6*d.* Low Moor 8*s.* 10*d.* Catherine slack 8*s.*	8,000	13 cwt.	12*s.* per ton.	Coke.	8½ cwt.	220	Batswings.	2 12 6	Company light, repair, &c.
Leeds, 1834 -	8*s.* per 1000 cubic feet. Discounts. 2½ 5 7½ 10 per cent. on half-yearly payments 15*l.* 30*l.* 50*l.* 100*l.*	8*s.* per ton average. 2-3ds common 7*s.* 1-3d cannel, 10*s.*	6,500	12 cwt.	7*s.* 6*d.* per ton.	Ditto.	5¼ cwt.	517	Ditto.	2 12 6	Commissioners, except extinguishing, for which Company pay 3*s.* 10*d.* per lamp.
Sheffield, 1835.	8*s.* per 1000 cubic feet. Discounts same as Leeds.	7*s.* 9*d.* per ton average. 3 sorts used, 1, 2-10ths cannel, at 16*s.* 8, 2-10ths deep pit, 7*s.* 1-10th silk stone, 10*s.*	8,000	10 cwt. of saleable coke.	10*s.* per ton.	Ditto.	3½ cwt.	600	Ditto.	2 10 0	Company provide lamps, clean, repair, put out, &c.
Leicester, 1837.	7*s.* 6*d.* per 1000 cub. ft. Discounts on half-yearly rental not exceeding 10*l.*, 5 per cent. 10*l.* 20*l.* 7½ 20*l.* 30*l.* 10 30*l.* 40*l.* 12½ 40*l.* 50*l.* 15 50*l.* 60*l* 20 Above and not exceeding per cent. 60*l.* & upwards 25	13*s.* 6*d.* average. Derbyshire soft coal.	7,500	4 quarters	10*s.* 8*d.* or 2*s.* 8*d.* per qr.	Coke, tar, &c.	About 1-3d of coke.	414	Ditto.	2 18 6	Company light, put out, and clean.
Derby, 1834.	10*s.* per 1000 cub. feet. Discounts. 5 to 35 per cent.	Same coal used as at Leicester.	7,000	Ditto.	Ditto.	Coke.	Ditto.	219	Ditto.	2 2 0 2 7 0	Commissioners light, put out, &c.
Nottingham, 1834.	9*s.* per 1000 cubic feet. Discounts as above.	Ditto.	7,000	Ditto.	Ditto.	Ditto.	Ditto.	300	Ditto.	3 3 0	Commissioners light, clean, repair, &c.
London, 1834.	10*s.* per 1000 cub. feet. No discounts.	17*s.* average. Newcastle.	8,500	36 bush.	12*s.* per chaldron	Ditto.	13 bush.	26,280	Ditto.	4 0 0	Company light, clean, put out, but not repair.
Ditto, 1837 -	Ditto.	Ditto.	8,500	Ditto.	Ditto.	Ditto.	Ditto.	30,400	Ditto.	4 0 0	Ditto.

being a Synopsis of the Proceedings of the under-mentioned principal Gas-Light Establishments
Experiments between the years 1834 and 1837. By Joseph Hedley, Esq.

No. of Hours, or Time burnt in the Year.	Gas consumed in each Lamp per Hour.	Rate per 1000 Cubic Feet received for Ditto.	Amount deducted for cleaning, lighting, extinguishing, providing Lamp Posts, &c.	Per Centage of Loss of Gas made.	Greatest Quantity of Gas delivered in One Night.	Duration of Charges.	Method of Purification.	Number of Gas Holders.	Specific Gravity of the Gas.	Distance of Candle from Shadow.	Gas equal to Candles. Gas burnt in a single Jet Four Inches high.	Gas consumed per Hour with a Four-Inch Flame.	Gas Flame reduced to Candle burnt per Hour	Height of Gas Flame equal to Light from Candle.
		s. d.	*s. d.*		*Cubic Feet.*					*Inch.*	*Candles*	*Cu.ft.*	*Cu.ft.*	*Inch.*
226 nights, or 2938 hours, 9 months, omitting 5 nights for moons.	5 feet per hour.	30 10 40 18	18 0	Receives nett about 6*s.* 8*d.* per 1000 cubic feet.	48 millions in the year.	6 hours.	Dry lime.	4, and 2 in the town, and large new gas station.	·453	72	1,929	1·22	·8	2½
234 nights, or 3042 hours.	Ditto.	1 3½	18 0	Receives nett about 5*s.* 6*d.* per 1000 cubic feet.	85 millions in the year.	Ditto.	Ditto.	6, and 6 in the town 7 miles off.	·455	72	1,929	1·22	·8	2½
8 months, omitting 5 nights for moons.	4 feet per hour.	3 0	12 0	Could not say.	80,000. Total for year about 15 millions.	8 hours.	Ditto.	3 gas holders.	Not taken	70	204	Not taken	·8	2¾
8 months. 4 nights omitted for moons. 237 nights – 2800 hours.	Ditto.	2 6	12 6	Ditto.	65,000. Total for year about 12 millions.	Ditto.	Ditto.	4 gas holders.	·539	64	2,441	·85	·55	2⅝
3390 hours.	1 foot, 2 feet, per hour.	6 6 5 6	nothing	About 15 to 17½ per cent. receive about 7*s.* 4*d.* per 1000 cubic feet, public and private. Nearly all by meter.	500,000. Total for year 100 millions.	6 hours.	Wet lime.	10 gas holders, and 2 in the town.	·534	66	2,295	·825	·475	2¼
3600 hours.	5 feet per hour.	4 4	12 0	Could not learn in the absence of the manager	360,000. Total for year 72 millions.	8 hours, large retorts, holding 6 cwt. each.	Wet and dry lime, principally dry.	8 gas holders in all, 4 in the town, 1000 yards off the works.	·462	75	1,777	1·1	·75	2⅝
similar results, which see.														
3000 hours.	3½ feet per hour	5 6	nothing	Nearly all by meter.	Not sufficiently long at work.	4 hours.	Wet lime.	2 large gas holders.	·580	55	3,306	·9	·45	2
8 months, omitting 7 nights. 2600 hours to 4 o'clock in the morning.	5 feet per hour.	3 1	12 6	Receive 8*s.* per 1000 cubic feet, less 5½ per cent.	42,500. Total for year 8,619,000.	8 hours.	Dry lime.	4 gas holders.	·420	78	1,643	·12	·9	3
2330 hours.	4 feet per hour.	5 2	3 10	Receive for public and private 6*s.* 8*d.* per 1000 cubic feet. Public 5*s.*, private 7*s.*; meters used 5 to 1 for private rental.	176,000. Total for year 31 millions.	6 hours.	Ditto.	5 gas holders.	·530	67	2,228	·85	·51	2¼
2200 hours.	Ditto.	3 2½	18 0	Receive for public and private lights 5*s.* per 1000 cubic feet. Public 3*s.* 2½*d.*, private 5*s.* 9½*d.* Few meters used.	220,000. Total for year 40 millions.	Ditto.	Ditto.	4 gas holders, and 2 more erecting.	·466	74	1,826	1·04	·735	2
From August 14th to September 1st, omitting 3 nights for moons, 3000 hours.	5 feet per hour.	3 4¾	7 0	Not sufficiently long, at 7*s.* 6*d.*	Total for year 18 millions.	Ditto.	Ditto.	3 gas holders, and 1 erecting.	·528	74	1,826		·75	2¾
2173 hours, from August to May.	Ditto.	4 0 nearly	—	Lose about 17½ per cent.	Ditto.	Ditto	Wet lime.	4 gas holders.	·448	83	1,453	1·2	·925	3
All the year, 4327 hours.	Ditto.	3 0 nearly	—	Could not learn.	Ditto.	Ditto.	Ditto.	—	·424	90	1,234	1·3	1·175	3
4327 hours, all the year.	4 feet per hour.	4 0	12 0	Receive for public and private lights 7*s.* public, 4*s.* private, 8*s.*; few meters used.	Total for year 1000 millions. Longest night 4,910,000.	Ditto.	Ditto.	130 gas holders.	·412	80	1,562	1·13	·84	2¾
Ditto.	Ditto.	4 0	12 0	Ditto.	Total for year 1460 millions. Longest night 7,120,000.	Ditto.	Ditto.	176 gas holders.	·412	80	1,562	1·13	·84	2¾

Bude-light. — This brilliant mode of illumination has been so called from the name of the residence in Cornwall of Mr. Goldsworthy Gurney, who obtained a patent for it in the year 1838. In its first form it consisted of a common Argand oil flame or lamp of rather narrow circular bore, into the centre of whose wick a jet of oxygen gas was admitted through a tube inserted in the middle of the burner. This contrivance was not, however, new in this country, for a similar lamp, similarly supplied with oxygen gas was employed by the celebrated Dr. Thomas Young in his lectures at the Royal Institution of Great Britain for the purpose of illuminating a solar microscope, or gas microscope, about 40 years ago, and I had done the same thing in Glasgow in the year 1806 or 1807. When used as a light for lighthouses or for other continuous illumination, it has been found to be too expensive and difficult to manage. It was tried upon a good scale a few years ago both by the Trinity House in Tower Hill, and in one of their lighthouses on the coast, as well as by the House of Commons. The Masters of the Trinity did not find it to be essentially superior for the use of their lighthouses to their old and ordinary plan of illumination with a number of Argand lamps placed in the focus, or near the focus, of reflecting mirrors. It was, after several expensive trials by them, and in the House of Commons, abandoned by both.

In the course of numerous experiments in the Trinity House, Tower Hill, Mr. Gurney had occasion to examine the structure and see the performance of Mr. Fresnel's compound Argand lamps which are used in the French lighthouses, furnished with refracting lenses of peculiar forms which surround these lamps, and transmit their concentrated light in any desired horizontal direction along the surface of the sea. Two of Mr. Fresnel's lamps are placed in the lamp apartment of the Trinity House. Each consists of a series of 4, 5, or 6 concentric wicks in the same plane, supplied with oil from the fountain below by means of a pumping mechanism, as in the well-known Parisian lamps of Carcel and Gagneau. The effect of 4, 5, or 6 concentric flames thus placed in close proximity to each other, with suitable supply of air through the interior of the innermost tube and the interstices between the exterior ones, is, to increase the heat in a very remarkable degree, and by this augmentation of the heat to increase proportionably the light. For it has been long known that a piece of even incombustible matter, such as a lump of brick, intensely heated, sends forth a most brilliant irradiation of light. This fact was applied first to the purpose of illuminating objects by Professor Hare, of Philadelphia, fully 40 years ago. By directing the very feebly luminous flame of the compound jet of hydrogen and oxygen upon a bit of clay, such as one of Wedgwood's pyrometer pieces, a most vivid illumination was sent forth from it as soon as it became intensely heated. More lately, a piece of lime has been used instead of a bit of clay, as it is not so apt to change by the ignition, and affords, therefore, a more durable effect. It is used in our modern gas microscopes. Mr. Gurney suggested the use of lime for the above purpose in a work on chemistry which he published more than twenty years ago. It was afterwards adopted by Mr. Drummond, in order to make signal lights in the trigonometrical survey of the Board of Ordnance, and was therefrom called the Drummond light, though he had no share whatever in the merit of the invention.

The structure of the Fresnel lamp would naturally suggest to Mr. Gurney the idea of trying the effect of a similar construction of an Argand gas lamp. But prior to the execution of this scheme, he obtained a second patent in the year 1839, for increasing the illuminating power of coal gas by feeding its flame in a common Argand burner with a stream of oxygen. But here a serious difficulty occurred. The stream of oxygen, when admitted into the centre of such a flame, instead of augmenting its quantity of light, destroys it almost entirely. This result might have been predicted by a person well versant in the principles of gas illumination, as long ago expounded in Sir Humphrey Davy's admirable Researches on Flame. This philosopher demonstrated that the white light of gas-lamps, as also of oil lamps, was due to the vivid ignition of solid particles of carbon evolved by the igneous decomposition of the hydro-carburet, either in the state of gas or vapour; and that if, by any means, these particles were not deposited, but burned more or less completely in the moment or act of their evolution from the hydro-carburet, then the illumination would be more or less impaired. Mr. Gurney, on observing this result, sought to obviate the evil, by charging the coal gas, with the vapour of naphtha. Thus a larger supply of hydro-carburet, and of carbon of course, being obtained, the flame of the naphthalised gas, admitted with advantage the application of oxygen gas, for the increase of its light; on the principle of greater intensity of ignition, and consequently of light, being produced by the burning of carbon in oxygen than in common air, as had been long known to the chemical world. But an obstruction to the permanent employment of naphthalised gas was experienced by Mr. Gurney, from the deposition of liquid naphtha in the pipes of distribution. He was therefore induced to renounce this project. He then resorted to the use of coal gas, purified in a peculiar way, and burned in compound Argand lamps, consisting of two or more concentric metallic rings, perforated with rows of holes in their upper surfaces, having intervals between the rings for the admission of a proper quantity of air, the burner being enclosed in a glass chimney at the level of the flame, surmounted by a tall iron chimney. Between these two chimneys, a certain space is left for the admission of air, and to favour draught and ventilation. The intensity and whiteness of the cylinder of light produced by the combustion of coal gas in this lamp are truly admirable, and form such an improvement in illumination for streets, churches, public rooms, and private houses, as to merit the protection of a patent, and the encouragement of the public at large.

General Estimate of Sizes, Number of Concentrics, Consumption of Gas, and Comparative Light.

Size.	Number of Concentrics.	Bude Consumption per Hour.		Height of Flame.	Comparative Light.	Argand Consumption per Hour.
Inches.		Feet.	Inches.	Inches.	15-hole argands.	Cubic feet.
2½	2	10	6	3	5	30
3	2	16	4	3	8	48
3½	2	21	6	3	10	60
4	2	26	4	3	12	72
4½	2	33	7	3	15	90
5	3	40	0	3¼	18	108
5½	3	43	5	3½	20	120
6	3	56	4	4	24	144

GELATINE. The substance produced by boiling the skin of animals in water, which in its crude but solid state is called *glue*, and when a tremulous semi-liquid, *size.* The latter preparation is greatly used by the paper-makers, and was much improved by the following process, for which Mr. William Rattray obtained a patent in May, 1838. The parings and scrows of skins are steeped in water till they begin to putrefy; they are then washed repeatedly in fresh water with the aid of stampers, afterwards subjected, in wooden or leaden vessels, to the action of water strongly impregnated with sulphurous acid for from 12 to 24 hours; they are now drained, washed with stampers in cold water, and next washed with water of the temperature of 120° F., which is poured upon them and run off very soon to complete their purification. The scrows are finally converted into size, by digestion in water of 120° for 24 hours; and the solution is made perfectly fine by being strained through several thicknesses of woollen cloth. They must be exhausted of their gelatinous substance, by repeated digestions in the warm water. The claim is for the sulphurous acid, which, while it cleanses, acts as an antiseptic.—*Newton's Journal*, xiv. 173.

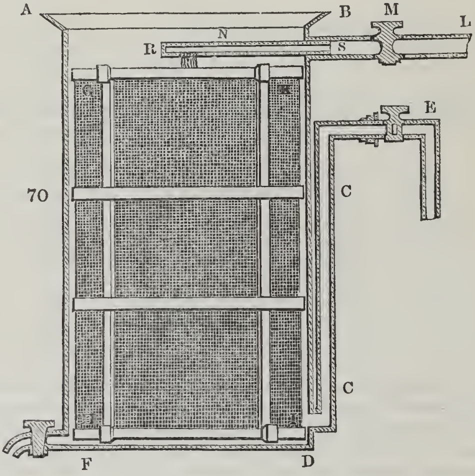
A fine gelatine for culinary uses, as a substitute for isinglass, is prepared by Mr. Nelson's patent, dated March, 1839. After washing the parings, &c., of skin, he scores their surfaces, and then digests them in a dilute caustic soda lye during ten days. They are next placed in an air-tight vat, lined with cement, kept at a temperature of 70° F.; then washed in a revolving cylinder apparatus with plenty of cold water, and afterwards exposed to the fumes of burning sulphur (sulphurous acid) in a wooden chamber. They are now squeezed to expel the moisture, and finally converted into soluble gelatine by water in earthen vessels, enclosed in steam cases. The fluid gelatine is purified by straining it at a temperature of 100° or 120° F. I have examined this patent gelatine, and found it to be remarkably good, and capable of forming a fine calf's foot jelly.

Very recently a very beautiful sparkling gelatine has been prepared under a patent granted to Messrs. J. and G. Cox, of Edinburgh. By their process the substance is rendered perfectly pure, while it possesses a gelatinizing force superior even to isinglass. It makes a splendid calves' feet jelly and a milk-white blanc-mange. The patentees also prepare a semi-solid gelatine, resembling jujubes, which readily dissolves in warm water, as also in the mouth, and may be employed to make an extemporaneous jelly.

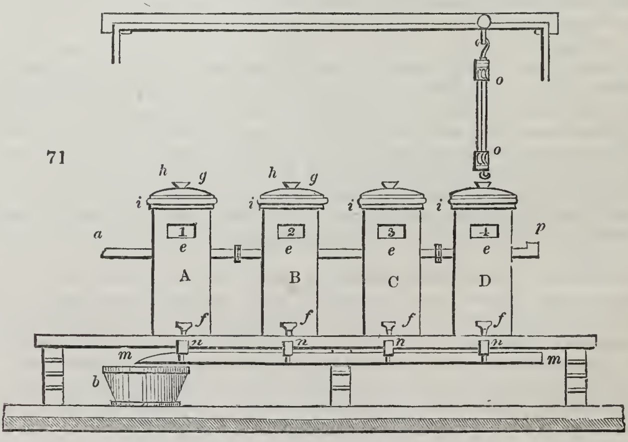
The gelatine of bones may be extracted best by the combined action of steam and a current of water trickling over their crushed fragments in a properly constructed apparatus. When the gelatine is to be used as an alimentary article, the bones ought to be quite fresh, well preserved in brine, or to be dried strongly by a stove. Bones are best crushed by passing them between grooved iron rolls. The cast-iron cylinders in which they are to be steamed, should be three times greater in length than in diameter. To obtain 1000 rations of gelatinous soup daily, a charge of four cylinders is required; each being 3½ feet long, by 14 inches wide, capable of holding 70 lbs. of bones. These will yield each hour about 20 gallons of a strong jelly, and will require nearly 1 gallon of water in the form of steam, and 5 gallons of water to be passed through them in the liquid state. The 5 quarts of jelly produced hourly by each cylinder, proceeds from the 1 quart of steam-water and 4 quarts of percolating water.

The boiler should furnish steam of about 223° Fahr., at a pressure of about 4 lbs. on the square inch.

70

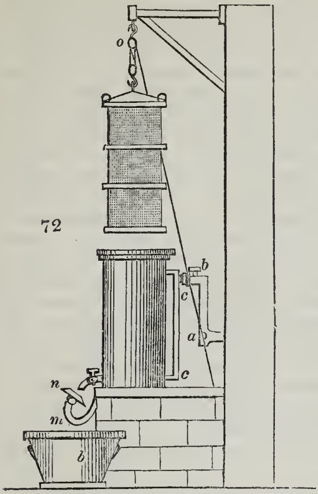


71



In *fig.* 70. A, B, C, D, represents a vertical section of the cylinder; G, H, I, K, a section of the basket or cage, as filled with the bruised bones, inclosed in the cylinder; E, C, C, the pipe which conducts the steam down to the bottom of the cylinder; L, S, a pipe for introducing water into the interior; M, a stopcock for regulating the quantity of water (according to the force of the steam pressure within the apparatus), which should be 3½ quarts per hour; N is a tube of tin plate fitting tightly into the part S of the pipe L; it is shut at R, and perforated below with a hole; it is inserted in its place, after the cage full of bones has been introduced. *Fig.* 71. is an elevation of the apparatus. A, B, C, D, represent the four cylinders raised about 20 inches above the floor, and fixed in their seats by screws; *h*, *h*, are the lids; *g*, *g*, tubulures or valves in the lids; *i*, ring junction of the lid; *p*, a thermometer; *f*, *f*, stop-cocks for drawing off the jelly; *n*, *n*, small gutters of tin-plate; *m*, the general gutter of discharge into the cistern *b*; *o*, a block and tackle for hoisting the cageful of bones in and out. *Fig.* 72. is an end view of the apparatus; *a*, the main steam-pipe; *a*, *b*, *c*, *c*, branches that conduct the steam to the bottom of the cylinder; *o*, the tackle for raising the cage; *s*, stopcock; *n*, small gutter; *m*, main conduit; *b*, cistern of reception.

72



When a strong and pure jelly is wished for, the cylinder charged with the bones is to be wrapped in blanket stuff; and whenever the grease ceases to drop, the stopcock which admits the cold water is to be shut, as also that at the bottom of the cylinder, which is to be opened only at the end of every hour, and so little as to let the gelatinous solution run out, without allowing any of the steam to escape with it.

Butcher's meat contains on an average in 100 pounds, 24 of dry flesh, 56 of water, and 20 of bones. These 20 pounds can furnish 6 pounds of alimentary substance in a dry state; whence it appears that, by the above means, one fourth more nutritious matter can be obtained than is usually got. I am aware that a keen dispute has been carried on for some time in Paris, between the partisans and adversaries of gelatine as an article of food. It is probable that both parties have pushed their arguments too far. Calf's-foot jelly is still deemed a nutritious article by the medical men of this country, at least, though it is not to be trusted to alone, but should have a due admixture or interchange of fibrine, albumine, caseum, &c.

GILDING. See ELECTRO-METALLURGY.

GLASS. Duty collected on it in the United Kingdom. In 1831, 732,455*l.*; 1832, 751,448*l.*; 1833, 828,558*l.*; 1834, 916,822*l.*; 1835, 966,121*l.*; 1836, 933,281*l.*; 1837, 903,846*l.*; 1838, 879,859*l.*; 1839, 868,193*l.*; 1840, 965,967*l.*

Crystal glass is rapidly corroded by the sulphate of ammonia, at a heat of 600° F.

GLOVE. See LEATHER.

GLUCOSE, the name given to grape and starch sugar by M. Dumas.

GROWAN. The name given by the Cornish miners to *granite*, and to rocks of like structure.

GUANO. This extraordinary excrementitious deposit of certain sea-fowls, which occurs in immense quantities upon some parts of the coasts of Peru, Bolivia, and Africa, has lately become an object of great commercial enterprise, and of intense interest to our agricultural world. Four or five years ago it was exhibited and talked of merely as a natural curiosity. No one could then have imagined that in a short period it would be imported from the coasts of the Pacific in such abundance, and at such a moderate price, as to cheer by its fertilizing powers the languid and depressed spirits of the farmers throughout the United Kingdom. Such, however, is now the result, as attested by the concurring Reports of almost all the Agricultural Societies of Great Britain and Ireland. No less than 28,500 tons of guano have been already imported from Peru and Bolivia, 1500 from Chile, and 8000 from Africa, altogether 38,000 tons, while more is on the way. The store of it, laid up from time immemorial in the above localities, seems to be quite inexhaustible; especially since it is receiving constant accessions from myriads of cormorants, flamingos, cranes, &c.

Having been much occupied with the chemical analyses of guano during the last two years for Messrs. Gibbs, of London, and Messrs. Myers, of Liverpool, who are the co-agents of the Peruvian and Bolivian governments, I have enjoyed favourable opportunities of examining samples of every description, and hope to show that many of the analyses of guano hitherto published have been made upon specimens not in their normal or sound state, like the best imported by the above houses from Chincha and Bolivia, but in a certain state of *eremacausis* and decay.

Huano, in the language of Peru, signifies dung: a word spelt by the Spaniards, guano. The natives have employed it as a manure from the remotest ages, and have by its means given fertility to the otherwise unproductive sandy soils along their coasts. While Peru was governed by its native Incas, the birds were protected from violence by severe laws. The punishment of death was decreed to the persons who dared to land on the guaniferous islands during the breeding period of the birds, and to all persons who destroyed them at any time. Overseers were appointed by the government to take care of the guano districts, and to assign to each claimant his due share of the precious dung. The celebrated Baron Von Humboldt first brought specimens to Europe in 1804, which he sent for examination to Fourcroy, Vauquelin, and Klaproth, the best analytical chemists of the day; and he spoke of it in the following terms: — "The guano is deposited in layers of 50 or 60 feet thick upon the granite of many of the South-sea islands off the coast of Peru. During 300 years the coast birds have deposited guano only a few lines in thickness. This shows how great must have been the number of birds, and how many centuries must have passed over in order to form the present guano beds." The strata have undergone many changes, according to the length of time they have been deposited. Here and there they are covered with siliceous sand, and have thus been protected from the influence of the weather; but in other places, they have lain open to the action of light, air, and water, which have produced important changes upon them. Fresh guano is of a whitish or very pale drab colour, but it becomes progressively browner and browner by the joint influence of the above three atmospherical agents. Only *one* guano examined by Fourcroy and Vauquelin was found to contain a fourth of its weight of uric acid combined with ammonia, whence *that* appears to have been well selected by Baron Von Humboldt. They also found phosphates of ammonia, of lime, with urate and oxalate of ammonia, and some other constituents of little value in agriculture. Klaproth's analysis reported 16 per cent. of urate of ammonia, no less than 12·75 of oxalate of lime, 10 of phosphate of lime, 32 of clay and sand, with 28·75 of water and indeterminate organic matter. From the great proportion of clay and sand, Klaproth's sample of guano was obviously not genuine. I have met with no specimen of Peruvian guano that contained any appreciable quantity of clay, and none that contained above 4 or 5 per cent. of siliceous sand.

To Mr. Bland, of the firm of Messrs. Myers and Co., I am indebted for the following valuable information: —

The Chincha islands, which afford the best Peruvian guano, are three in number, and lie in one line from north to south, about half a mile apart. Each island is from 5 to 6 miles in circumference, and consists of granite covered with guano in some places to a height of 200 feet, in successive horizontal strata, each stratum being from 3 to 10 inches thick, and varying in colour from light to dark brown. No earthy matter whatever is mixed with this vast mass of excrement. At Mr. Bland's visit to these islands in 1842, he observed a perpendicular surface of upwards of 100 feet of perfectly uniform aspect from top to bottom. In some parts of these islands, however, the deposit does not exceed 3 or 4 feet in thickness. In several places, where the surface of the guano is 100 feet or more above the level of the sea, it is strewed here and there with masses of granite, like those from the Alpine mountains, which are met with on the slopes of the Jura chain. These seem to indicate an ancient formation for the guano, and terraqueous convulsions since that period. No such granite masses are found imbedded within the guano, but only skeletons of birds.

The good preservation of the Chincha guano is to be ascribed to the absence of rain; which rarely, if ever, falls between the latitude of 14° south, where these islands lie, about 10 miles from the main land, and the latitude of Paquica, on the coast of Bolivia, in 21 S. L. By far the soundest cargoes of guano which I have analysed have come from Chincha and Bolivia. Beyond these limits of latitude, where rain falls in greater or less abundance, the guano is of less value — and what has been imported from Chile has been found by me far advanced in decay — most of the ammonia and azotized animal substances having been decomposed by moisture, and dissipated in the air (by the *eremacausis* of Liebig), leaving phosphate of lime largely to predominate along with effete organic matter. The range of the American coast from which the guano is taken must therefore be well considered; and should not extend much beyond the Chincha islands as the northern limit, and Paquica, in Bolivia, as the southern.

The relative estimation of guano and nitrate of soda among the Peruvians is well shown by the following facts communicated to me by Mr. Bland: — "Near the coast of Peru, about 45 miles from Iquique (the shipping port of guano) there is the chief deposit of nitrate of soda. The farmers, who collect and purify this natural product, carry it to the place of shipment, and always require to be paid in return with an equivalent quantity of guano, with which they manure their land, to the exclusion of the far cheaper nitrate of soda. We cannot be surprised at this preference, when we learn that in the valley of Chancay, about 40 miles distant from Lima, the soil produces, when farmed with irrigation in the natural way, a return upon maize of only 15 for 1; whereas, with the aid of guano, it produces 300 for 1! Hence the Peruvian proverb: — Huano, though no saint, works many miracles.

In the pamphlet recently published by Messrs. Gibbs and Myers, entitled "Peruvian and Bolivian Guano, its nature, properties, and results," we have a very interesting view of the best established facts with regard to its operation and effects upon every variety of soil, and in every variety of circumstance, as ascertained by the most intelligent agriculturists of the United Kingdom. The general conclusion that may be fairly deduced from the whole evidence is, that good guano will, under judicious application, increase the crops of grain, turnips, potatoes, and grass by about 33 per cent.; and with its present price of 10*l.* per ton, at a cost considerably under the average cost of all other manures, whether farm-yard dung and composts, or artificial compounds. Guano is, moreover, peculiarly adapted to horticultural and floricultural improvement, by its relative cleanliness and facility of application.

The following observations upon guano, by Dr. Von Martius, of Munich, addressed to the agricultural society of Bavaria, deserve attention. Among animal manures, says he, it clearly claims the first place. It is uncommonly rich in ammoniacal salts, which act very favourably on vegetation. The ease with which these salts are decomposed, and exhale their ammonia into the air, is by him assigned as the reason why plants manured with guano generally present early in the morning accumulations of dew on the points of their leaves. The guano absorbs the atmospheric vapour, as well as carbonic acid; whereby it becomes so valuable a manure in dry barren regions. If we compare guano with other excrementitious manures, we shall find it far preferable to those afforded by man or other mammalia, which do not generally contain more than 20 per cent. of food that can be appropriated by plants. It is therefore 5 times better than night-soil, and also very superior to the French *poudrette*, (which, being dried night-soil,) loses, through putrefaction and evaporation, the greater proportion of its ammoniacal elements. In birds, the excretions both of the kidneys and intestines are contained in the cloaca; whereby the volatile elements of the former get combined with the more fixed components of the latter. The guano is also a richer manure, on account of its being produced by sea-fowl, which live entirely on fish, without admixture of vegetable matter. The exposure also of the guano as soon as deposited to the heat of a tropical sun, in a rainless climate, prevents the components from fermenting, and *mummifies* them, so to speak, immediately into a concrete substance not susceptible of decomposition till it gets moisture; whereas the dung of our dove-cots suffers a considerable loss by exposure to our humid atmosphere. But in their action on vegetation, and in their chemical composition, these two bird excrements are analogous. Davy found in fresh dove-cote manure 23 parts in 100 soluble in water, which yielded abundance of carbonate of ammonia by distillation, and left carbonaceous matter, saline matter, principally common salt, and carbonate of lime as a residuum. Pigeons' dung readily ferments, but after fermentation afforded only 8 per cent. of soluble matter, which gave proportionably less carbonate of ammonia in distillation than the dung recently voided. Dr. Von Martius proceeds to compare the proportion of soluble salts in guano and pigeons' dung, and thinks that by that comparison alone he can establish the superiority of the former; but he should have considered that the insoluble urate of ammonia, which is so powerful and copious a constituent of good guano, and is present in much smaller proportion in pigeons' dung, is sufficient of itself to turn the balance greatly in favour of the Peruvian manure. His general estimate however, that the manuring power of genuine guano, is four times greater than that of pigeons' dung, is probably not wide of the truth. Besides the above-mentioned constituents, guano derives no small portion of its fertilizing virtue from the great store of phosphoric acid which it contains, in various states of saline combination, with lime, magnesia, and ammonia. Of all the principles furnished to plants by the soil, the phosphates are, according to Liebig, the most important. They afford, so to speak, the bones and sinews of vegetable bodies, while ammonia supplies them with their indispensable element, azote. Their carbon, hydrogen, and oxygen are derived from the air and water. Those products of vegetation which are most nutritious to man and herbivorous animals, such as bread-corn, beans, peas, and lentils, contain the largest proportion of phosphates. The ashes of these vegetable substances afford no alkaline carbonates. A soil in which phosphates are not present, is totally incapable of producing the above cereals. Agreeably to these views, Liebig believes that the importation of 1 cwt. of guano is equivalent to the importation of 8 cwt. of wheat; so that 1 cwt. of that manure assumes, with due culture, the form of 8 cwt. of substantial food for man.

Since all these testimonies concur to place this remarkable excrementitious product in such high estimation, it becomes a paramount duty of the chemist to investigate its composition, and to discover certain means of distinguishing what may be termed the sound or normal state of guano, from the decomposed, decayed, and effete condition. The analysis by Fourcroy and Vauquelin of a sample of guano presented to them by Baron Von Humboldt, gave the following composition in 100 parts:—

Urate of ammonia - - - -	9·0
Oxalate of ammonia - - - -	10·6
Oxalate of lime - - - -	7·0
Phosphate of ammonia - - - -	6·0

Phosphate of ammonia and magnesia - - -	2·6
Sulphate of potash - - - -	5·5
———— soda - - - -	3·3
Sal ammoniac - - - - -	4·2
Phosphate of lime - - - -	14·3
Clay and sand - - - - -	4·7
Water and organic matters - - - -	32·3

How different are these constituents from those assigned by Klaproth,—a no less skilful analyst than the French chemists! and how much this difference shows not only the complexity of the substance, but its very variable nature!

The general results of an analysis by professor Johnston, published in his paper on guano, in the 3d part of the 2d vol. of the Journal of the Royal Agricultural Society of England, are as follows:—

Ammonia - - - - -	7·0
Uric acid - - - - -	0·8
Water and carbonic and oxalic acids, &c. expelled by a red heat	51·5
Common salt, with a little sulphate and phosphate of soda -	11·4
Phosphate of lime, &c. - - - -	29·3
	100·0

The specimen of guano represented by this analysis must have been far advanced in decomposition, as shown by the very scanty portion of uric acid; and must have been originally impure, (*spurious?*) from the large proportion of common salt, of which I have not found above 4 or 5 per cent. in any of the genuine guanos which I have had occasion to analyze. In another sample, Professor Johnston found 44·4 of phosphate of lime, with a little phosphate of magnesia, and carbonate of lime. These results resemble, to a certain degree, those which I have obtained in analyzing several samples of Chilian and African guanos, especially in the predominance of the earthy phosphates. The proportion of ammonia which can be extracted by the action of hydrate of soda and quicklime, at an elevated temperature, is the surest criterion of the soundness of the guano; for by this process we obtain not only the *ready formed* ammonia, from its several saline compounds, but also the ammonia producible from its uric acid, and undefined animal matter. These two latter quantities have been hitherto too little regarded by most analysts, though they constitute the most durable fund of azote for the nutrition of plants. Uric acid, and urate of ammonia, which contains 10-11ths of uric acid, being both nearly insoluble in water, and fixed at ordinary temperatures, continue to give out progressively to plants in the soil, the azote, of which they contain fully one-third of their weight. Under the influence of oxygen and a certain temperature, uric acid passes through a very remarkable series of transformations; producing allantoin, urea, and oxalic acid, which eventually becomes carbonic acid. These changes are producible immediately by the action of boiling water and peroxide of lead. From these metamorphoses, we can readily understand how so much oxalate of ammonia and of lime is reported in many analyses of guano, though none, I believe, is to be found in the normal state, as it is occasionally imported from the Chincha Islands and Bolivia; nor were any oxalates found in the dung of the gannet, as analyzed by Dr. Wollaston, or of the sea eagle, according to the following analysis of Coindet:—ammonia, 9·21 per cent.; uric acid, 84·65; phosphate of lime, 6·13 = 100. The Peruvian sea-fowl, by feeding exclusively on fish, would seem to swallow a large proportion of earthy phosphates; since, in the purest guano that has come in my way, I have found these salts to amount to from 10 to 15 per cent.

Dr. Von Martius proposes to use the degree of solubility of the guano in water as a good criterion of its quality; but this is a most fallacious test. Sound guano contains from 15 to 25 per cent. of insoluble urate of ammonia; nearly as much undefined animal matter, along with from 15 to 20 of earthy phosphates, leaving no more than 50 or 55 per cent. of soluble matter, exclusive of moisture; whereas decayed guano yields often 60 or 70 per cent. of its weight to water, in consequence of the uric acid and animal matter being wasted away, and the large portion of moisture in it, the latter amounting very often to from 25 to 35 per cent. The good Peruvian guano does not lose more than from 7 to 9 per cent. by drying, even at a heat of 212° F.; and this loss necessarily includes a little ammonia. Each analysis of guano executed for the information of the farmer should exhibit definitely and accurately to at least 1 per cent:—

1. The proportion of *actual* ammonia.

2. The proportion of ammonia producible also from the uric acid and azotized animal matter present; and which may be called the *potential* ammonia. This is a

most valuable product, which is, however, to be obtained only from well-preserved dry guano.

3. The proportion of uric acid, to which, if 1-10th of the weight be added, the quantity of urate of ammonia is given.

4. The proportion of the phosphates of lime and magnesia.

5. The proportion of fixed alkaline salts, distinguishing the potash from the soda salts; the former being more valuable, and less readily obtainable, than the latter can be by the use of common salt. Wheat, peas, rye, and potatoes require for their successful cultivation, a soil containing alkaline salts, especially those of potash.

6. The proportion of sandy or other earthy matter, which, in genuine guano, carefully collected, never exceeds 2 per cent. and that is silica.

7. The proportion of water, separable by the heat of 212° F.

The farmer should never purchase guano except its composition in the preceding particulars be warranted by the analysis of a competent chemist. He should cork up in a bottle a half-pound sample of each kind of guano that he buys; and if his crop shall disappoint reasonable expectation, he should cause the samples to be analyzed; and should the result not correspond to the analysis exhibited at the sale, he is fairly entitled to damages for the loss of his labour, rent, crop, &c. The necessity of following this advice will appear on considering the delusive, if not utterly false analyses, under which cargoes of guano have been too often sold. In a recent case which came under my cognizance, in consequence of having been employed professionally to analyze the identical cargo, I found the guano to be nearly rotten and effete; containing altogether only 2¼ per cent. of ammonia, ½ per cent. of urate of ammonia, nearly 9 of sea salt, 24 of water, and 45½ of earthy phosphates. Now, this large cargo, of many hundred tons, fetched a high price at a public sale, under the exhibition of the following analysis by a chemist of some note—

Urate of ammonia, ammoniacal salts, and decayed animal matter	17·4
Phosphate of lime, phosphate of magnesia, and oxalate of lime	48·1
Fixed alkaline salts - - - -	10·8
Earthy and stony matter - - - -	1·4
Moisture - - - - -	22·3
	100·0

The purchasers, I was told by the broker, bought it readily under a conviction that the guano contained 17·4 of ammonia, though the proportion of ammonia is not stated, but merely mystified, and adroitly confounded with the decayed animal matter.

By the following hypothetical analysis, much guano has been well sold:—

"Bone earth, 35; lithic acid, &c., 15; carbonate of ammonia, 14; organic matter, 36 = 100." I am quite certain that no sample of guano can contain 14 per cent. of carbonate of ammonia—a very volatile salt. We shall see presently the state of combination in which the ammonia exists. It may contain at the utmost 4 or 5 per cent. of the carbonate; but such guano must have been acted upon powerfully by humidity, and will therefore contain little or no uric acid.

In the very elaborate examination of guano by T. Oellacher, apothecary at Innsbruck, published in a recent number of Buchner's *Repertorium of Pharmacy*, it is said, that if a glass rod dipped into muriatic acid be held over guano, strong fumes are developed; and the solution of guano has an alkaline reaction with litmus-paper. These phenomena evidently indicate the presence of carbonate of ammonia, and of course a partially decomposed guano; for sound Chincha and Bolivian guanos have an *acid* reaction, proceeding from the predominance of phosphoric acid. Farmers frequently judge of the goodness of guano by the strength of the ammoniacal odour; but in this judgment they may egregiously err, for the soundest guano has no smell of ammonia whatever; and it begins to give out that smell only when it is more or less decomposed and wasted.

Oellacher could find no evidence of urea in his guano; I have obtained fully 5 per cent. of this substance from good Peruvian guano.

I shall now describe my own system of analysis:—

1. In every case I determine, first of all, the specific gravity of the guano; which I take by means of spirits of turpentine, with a peculiar instrument contrived to render the process easy and precise. If it exceeds 1·75 in density, water being 1·0, it must contain sandy impurities, or has an excess of earthy phosphates, and a defect of azotized animal matter.

2. I triturate and digest 200 grains of it with distilled water, filter, dry the insoluble matter, and weigh it.

3. The above solution, diffused in 2000 gr. measures, is examined as to its specific gravity, and then with test paper, to see whether it be acid or alkaline.

4. One half of this solution is distilled along with slaked lime in a matrass connected with a small quintuple globe condenser, containing distilled water, and immersed in a basin of the same. As the condensing apparatus terminates in a water-trap, no part of the ammonia can be lost; and it is all afterwards estimated by a peculiar meter, whose indications make manifest one hundredth part of a grain.

5. The other half of the solution is mixed with some nitric acid, and divided into 3 equal portions.

a, the first portion, is treated with nitrate of barytes, and the resulting sulphate of barytes is collected, ignited, and weighed.

b, the second portion, is treated with nitrate of silver, and the resulting chloride of silver ignited and weighed.

c, the third portion, has a certain measure of a definite solution of ferric nitrate mixed with it, and then ammonia in excess. From the weight of the precipitated sub-phosphate of iron after ignition, the known amount of oxide used being deducted, the quantity of phosphoric acid in the soluble portion of the guano becomes known.

d, the three above portions are now mixed, freed by a few drops of dilute sulphuric and hydrochloric acids from any barytes and silver left in them, and then tested by nitrate of lime for oxalate of ammonia. The quantity of oxalate of lime obtained, determines that point.

6. The last liquor filtered, being freed from any residuary particles of lime by oxalate of ammonia, is evaporated to dryness and ignited, to obtain the fixed alkaline matter. This being weighed, is then dissolved in a little water, neutralized with acid, and treated with soda-chloride of platinum. From the quantity of potash-chloride of platinum, which precipitates, after being filtered, dried, and weighed, the amount of potash present is deducted — the rest is soda. These bases may be assigned to the sulphuric, hydrochloric, and phosphoric acids, in proportions corresponding to their respective affinities.

7. The proportion of organic matter in the above *solution* of guano, is determined directly by evaporating a certain portion of it to dryness, and igniting. The loss of weight, minus the ammonia and oxalic acid, represents the amount of organic matter.

8. A second portion of a solution of the guano is evaporated to dryness by a gentle steam heat, weighed, inclosed in a stout well-closed phial along with alcohol of 0·825, and heated to 212°. After cooling, the alcoholic solution is decanted or filtered clear, evaporated to dryness by a gentle heat, and weighed. This is urea, which may be tested by its conversion into carbonate of ammonia, when heated in a test tube or small retort. In this way, I have obtained from Bolivian guano, 5 per cent. of urea; a certain proof of its entire soundness.

9. *Analysis of the insoluble matter.* One third of it is digested with heat in abundance of Borax-water, containing $\frac{1}{100}$ of the salt, filtered, and the filter dried by a steam heat. The loss of weight indicates the amount of uric acid, which is verified by supersaturating the filtrate with acetic or hydrochloric acid, thus precipitating the uric acid, throwing it upon a filter, drying, and weighing it. This weight should nearly agree with the above loss of weight, the small difference being due to soluble organic matter, sometimes called geine and ulmic acid. The uric acid is evidenced, 1. by its specific gravity, which I find to be only 1·25, as also that of the urate of ammonia; 2. by its affording fine purple *murexide* when heated in a capsule along with nitric acid, and then exposed to the vapour of ammonia from a feather held over it; 3. by its dissipation when heated, without emitting an empyreumatic odour.

10. Another third of the solid matter is distilled along with half its weight of slaked lime, and 10 times its weight of water, in the apparatus already described, and the ammonia obtained from it estimated.

11. The remaining third having been ignited, is digested with a gentle heat in weak hydrochloric acid, and the undissolved silica and alumina washed on a filter, dried, and weighed. To the hydrochloric solution, dilute sulphuric acid is added, and the mixture is heated till all the hydrochloric acid be expelled, with the greater part of the water. Alcohol of 0·850 is now poured upon the pasty residuum, and the whole, after being well stirred, is thrown upon a filter. The phosphoric acid passes through, as also the magnesia in union with sulphuric acid. The sulphate of lime, which is quite insoluble in spirits of wine, being washed with them, is dried, ignited, and weighed. From the weight of sulphate of lime, the quantity of phosphate of that earth, that was present, becomes known.

12. Ammonia in excess is now added to the filtrate, which throws down the granular phosphate of ammonia and magnesia. After washing and drying this powder at a heat of 150°, its weight denotes the quantity of that compound in the guano.

13. To the filtered liquor (of 12.), if a little ammonia be added, and then muriate of magnesia be slowly dropped in, phosphate of ammonia and magnesia will precipitate, from the amount of which the quantity of phosphoric acid may be estimated.

14. The proportion of oxalate of lime is determined by igniting the washed residuum

(of 9.), and placing it in an apparatus for estimating the quantity of carbonic acid given off in dissolving carbonate of lime. The apparatus, either *fig.* 1. or 2. described in my little Treatise on Alkalimetry, will serve that purpose well. I have rarely obtained more than ½ gr. of carbonic acid from the insoluble residuum of 100 gr. of good guano, and that corresponds to less than 1½ per cent. of oxalate of lime in the guano. Sometimes no effervescence at all is to be perceived in treating the washed residuum with acid after ignition.

15. The carbonate of ammonia in guano is readily determined by filtering the solution of it in cold water, and neutralising the ammonia with a test or alkalimetrical acid. (See the Treatise on Alkalimetry above referred to.)

16. Besides the above series of operations, the following researches must be made to complete our knowledge of guano. The insoluble residuum (of 10.) which has been deprived by two successive operations of its uric acid and ammonia, may contain azotized organic matter. It is to be therefore well dried, mixed with 5 times its weight of the usual mixture of hydrate of soda and quicklime, and subjected to gentle ignition in a glass or iron tube closed at one end, and connected at the other with an ammonia condensing apparatus. The amount of ammonia being estimated by a proper ammonia meter, represents the quantity of azote, allowing 14 of this element for 17 of ammonia, being the potential ammonia corresponding to the undefined animal matter. In a sample of Peruvian guano I obtained 5 per cent. of ammonia from this source.

17. The whole quantity of ammonia producible from guano is to be determined by gently igniting 25 gr. of it well dried, and mixed with 10 times its weight of the mixture of hydrate of soda and quicklime (2 parts of the latter to 1 of the former). The ammonia disengaged is condensed and measured, as described above.

18. The ready formed ammonia is in all cases determined by distilling a mixture of 100 gr. of it with 50 gr. of slaked lime, condensing the disengaged ammonia, and estimating it exactly by the meter.

19. The relation of the combustible and volatile to the incombustible and fixed constituents of guano, is determined by igniting 100 gr. of it in a poised platinum capsule. The loss of weight denotes the amount of combustible and volatile matter, including the moisture, which is known from a previous experiment.

20. The insoluble matter is digested in hot water, thrown upon a filter, dried, and weighed. The loss of weight is due to the fixed alkaline salts, which, after concentrating their solutions, are investigated by appropriate tests — 1. nitrate of barytes for the sulphates; 2. nitrate of silver for the chlorides and sulphates; and 3. soda-chloride of platinum, for distinguishing the potash from the soda salts.

21. The insoluble matter (of 20.) is digested with heat in dilute nitric or hydrochloric acid, and the whole thrown upon a filter. The silica which remains on the filter is washed, ignited, and weighed. The lime, magnesia, and phosphoric acid may be determined as already pointed out.

22. I have endeavoured to ascertain if muriate of ammonia be present in guano, by evaporating its watery solution to dryness, and subliming the residuum, but I have never obtained a satisfactory portion of sal ammoniac; and therefore I am inclined to think there is little of it. The quantity of chlorine to be obtained from guano is too inconsiderable to lead to a suspicion of its presence, except in combination with sodium and potassium. Phosphate of soda is also a doubtful product — but if present, it may be obtained from the saline matter (of 20.), by acidulating it with nitric acid; precipitating first with nitrate of barytes, next with nitrate of silver, taking care to use no excess of these two re-agents, then supersaturating the residuum with ammonia, and adding acetate of magnesia, when the characteristic double phosphate of this earth should fall, in case phosphate of soda be present.

By the preceding train of researches, all the constituents of this complex product may be exactly disentangled and estimated; but they manifestly require much care, patience, time, and dexterity, and also a delicate balance, particularly in using the appropriate apparatus for generating the potential ammonia, and for measuring the whole of this volatile substance separated in the several steps of the process. It may be easily imagined how little confidence can be reposed in many of the analyses of guano, framed, I fear, too often with the view of promoting the sale of an indifferent or even spurious article of commerce.

A. I shall now give in detail my analytical results upon three different samples of a good South American guano; and next the general results upon three samples of African and Chilian guanos: —

I. Guano from Bolivia, imported by the Mary and Anne. This sample was taken by myself, as an average out of several bags in the Lighter, before the cargo was landed. Pale yellow brown colour, dry, partly pulverulent, partly concreted, in small lumps, with a few small fragments of granite interspersed, and which, being obvious, were separated prior to the analysis. Specific gravity of the pulverulent portion without the granite, 1·60; of the concretions, 1·66; mean 1·63. Water digested on the former portion is neutral to litmus, that on the latter is faintly acid.

2. 100 parts lose 6·5 by the heat of boiling water, and exhale no ammonia. When digested and triturated with cold water, 30·5 parts dissolve, and 69·5 are obtained after drying, at 212° F. Of those 30·5 parts, 6·5 are therefore water, easily separable, and 24·5 parts are solid matter.

3. 100 parts, mixed with 9 times their weight of water, and 50 of lime, being distilled in an alembic connected with the five-globe condenser, &c., afforded exactly 4·2 of ammonia. 20 grains in fine powder, along with 200 of a mixture, consisting of 2 parts of dry lime and 1 of hydrate of soda, were gently ignited in a combustion tube connected with the ammonia condensing apparatus, and they produced 4·25 grains of ammonia — equivalent to 21·25 from 100 grains of the guano. Thus only 4·2 per cent. of ammonia were ready formed; while 17·05 lurked, so to speak, in their azotized elements.

From its aspect, and its want of ammoniacal odour, this guano, the first cargo received from Bolivia, was imagined by the importers to be of bad quality; and, accordingly, my very favourable report of its analysis surprised them not a little, and rather unsettled the little faith they at that time (January, 1843) had in chemistry. But about a fortnight after the date of my report they received a letter from Peru, apprising them of the excellence of that cargo of Bolivian guano, and of its being prized by the Americans, as possessing fertilising powers in a pre-eminent degree. I consider this guano therefore as a type of the substance in its best state.

II. The *soluble* matter was analyzed, in the manner already detailed, and was found to consist of —

1.	Urea	5·00
2.	Sulphate of potash	7·90
3.	Chloride of sodium	5·00
4.	Biphosphate of ammonia	5·50
5.	Oxalate of ammonia	0·60
		24·0

In these ammoniacal salts there are only 1·65 parts of ammonia; but I obtained 2·55 grains in distilling the soluble matter of 100 grains of the guano. The remaining 0·9 parts, therefore, must have proceeded from the partial decomposition of the urea during the long ebullition necessary to extract every particle of ammonia, in distilling the guano along with lime.

III. The *insoluble* matter =69·5 parts, was found to consist of —

1.	Silica	2·25
2.	Subphosphate of lime	9·00
3.	Phosphate of magnesia and ammonia	1·25
4.	Urate of ammonia	15·27
5.	Undefined azotized organic matter, affording, with the 14 parts of uric acid, by ignition with hydrate of soda, 17·05 parts of ammonia	41·73
		69·50

This result as to the large proportion of organic matter in the dried insoluble residuum was verified by igniting a given quantity of it, when it was found to lose, out of 69·5 parts, 57; corresponding to the 15·27 urate of ammonia, 41·73 of undefined organic matter, and 0·08 of ammonia, in the double magnesian phosphate. In the urate and double phosphate are 1·35 of ammonia, which, with the 2·55, make 3·9 parts; the other 0·3 parts may be traced to the urea.

As these results differ very considerably in many respects from those of the analyses made by respectable German chemists, I was careful to verify them by manifold variations of the process, as follows:

1. The soluble matter, with *acid* reaction, of 100 parts of the *lumps* of the Bolivian guano, was examined by per-acetate of iron and ammonia, for phosphoric acid, and afforded 4 parts of it, which is more than had been found in the *neutral* pulverulent guano. After the phosphoric acid was separated by that method, chloride of calcium gave no cloud with the filtered liquor, proving that no oxalic acid was present in these nodules. The washed insoluble matter, when gently ignited, and treated with dilute nitric acid, afforded no effervescence whatever, and therefore showed that no oxalate of lime had been present, for it would have become a carbonate.

It is necessary to determine from time to time the quantity of ferric oxide in the acetate or nitrate, as it is liable to be deposited from the solution, when this is kept for some time. If this point be not attended to, serious errors would be committed in the estimation of the phosphoric acid.

2. The quantity of uric acid was verified by several repetitions, and found to be 14 per cent.

3. The undefined organic matter, when deprived of the uric acid by prolonged digestion with weak borax, being subjected to ignition along with hydrate of soda, yielded the quantity of ammonia requisite to constitute the whole sum, that producible from the uric acid also being taken into account.

4. The little lumps of the guano afforded, by distillation along with quicklime, 5·27 per cent. of ready formed ammonia, probably from the uric acid having been partially decomposed by the moisture which had caused them to concrete. It is a curious fact, that the solution of borax, from being of an alkaline, becomes of an acid reaction, after digestion with the Bolivian guano.

5. For distinguishing and separating the soda salts from those of potash, I tried the antimoniate of potash, according to Wackenroder's prescription, but I found reason to prefer very much the crystallised soda-chloride of platinum, for that purpose.

From another specimen of the Bolivian guano, I extracted 3·5 per cent. of the ammonia-phosphate of magnesia.

B. A sample of guano from the Chincha Islands, of nearly the same light colour as the preceding, and the same dryness, being an early importation of 250 tons in the present year, was subjected by me to a careful analysis.

1. The solution in water of this guano had an alkaline reaction from carbonate of ammonia, which, being neutralised by test acid, indicated 0·34 per cent. of ammonia, equivalent to about 1 of the smelling sesqui-carbonate.

2. Of this guano, 47 per cent. were soluble in water, and 53 per cent. remained, after drying at a heat of 212° F. Of the above 47 parts, 8·5 were moisture in the guano.

3. The solution being acidulated with nitric acid, was treated with acetate of barytes, in a quantity equivalent to the sulphuric acid present, and it afforded 12 parts of sulphate of barytes. With the filtered liquor, 700 water grain measures of ferric acetate were mixed, and then ammonia in excess; 18·5 parts of washed and ignited sub-phosphate of iron were obtained, from which deducting 8·8 parts present in the acetate, 9·7 remain as the quantity of phosphoric acid; but 9·7 of acid produce 13·25 of biphosphate of ammonia, which contain only 2·3 of ammonia, combined with 0·95 of water, or its elements. From the alkaline excess in the guano, there can be no doubt, however, that it contained the sub-phosphate (*found in the urine of Carnivora*), and not the bi-phosphate of that base. In this case, 9·7 of acid produce 14·32 of dry saline compound, containing 4·62 of ammonia, which, with the 0·34 of ammonia in the carbonate, constitute a sum of 4·96. To the liquor freed from the phosphate of iron, and acidulated with nitric acid, acetate of lime being added, 3·33 parts of oxalate of this base were obtained, which are equivalent to 3·23 oxalate ammonia, containing 0·89 of ammonia.

4. Nitrate of silver now produced from the filtered residual solution 8 parts of chloride, corresponding to nearly 3 of sal ammoniac, which contain nearly 0·95 of ammonia.

5. The 53 parts insoluble in water were digested with weak solution of borax at a boiling heat, thrown on a filter, and the uric acid being precipitated from the filtrate by means of a little hydrochloric acid, washed and dried, was found to weigh 13·5 parts. There were left on the filter 36·5 parts, dried at 212° F., so that 3 parts of soluble organic matter had passed through the filter. These 36·5 parts lost by ignition only 9·7 parts in organic matter, became white, and afforded a very faint effervescence with hydrochloric acid, showing that a very little oxalate of lime had been present. 1·25 parts of silica were left after the action of the acid. To the solution of the 26·55 parts, sulphuric acid was added, and the mixture being heated to expel the hydrochloric acid and the excess of the sulphuric, the residuary matter was digested and washed with dilute alcohol, and thrown on a filter; the solution of magnesia passed through, while the sulphate of lime remained. After ignition, this weighed 27·5 parts, equivalent to 22 of subphosphate of lime. On supersaturating the filtrate with ammonia, 4·5 parts of the magnesian ammonia phosphate were precipitated, containing 0·32 of ammonia. With the 13·5 parts of uric acid, 1·23 of ammonia had been originally combined, forming 14·73 of urate.

6. 25 grains of the dry guano afforded, by ignition in the combustion-tube along with 200 grains of the mixed lime and hydrate of soda, 4·165 of ammonia, which correspond to 16·66 in 100 parts of the dry, or to 15·244 in the natural state; leaving therefore 5 parts for the quantity of potential ammonia, or of ammonia producible from the decomposition of its azotized organic matter. This guano is therefore well adapted to promote permanently the fertility of a soil. It yields besides to alcohol a notable quantity of urea, which I did not think it worth while to determine quantitively, and

from which undoubtedly a portion of the ammonia proceeded, in the distillation with milk of lime.

7. 100 parts afforded by distillation with milk of lime, 10·2 of ammonia.

8. The total constituents of that guano, being tabulated, are—

I. Matter soluble in water - - - 47·00

consisting of—

		Ammonia.
1. Sulphate of potash, with a little sulphate of soda	6·00	
2. Muriate of ammonia	3·00	0·95
3. Phosphate of ammonia	14·32	4·62
4. Sesqui-carbonate of ammonia	1·00	0·34
5. Sulphate of ammonia	2·00	0·50
6. Oxalate of ammonia	3·23	0·89
8. Water	8·50	
9. Soluble organic matter and urea	8·95	
	47·00	

II. Matter insoluble in water - - - 53·00

consisting of—

1. Silica	1·25	
2. Undefined organic matter	9·52	
3. Urate of ammonia	14·73	1·23
4. Oxalate of lime	1·00 ?	
5. Subphosphate of lime	22·00	
6. Phosphate of magnesia and ammonia	4·50	0·32
	53·00	9·80

The remaining 1·25 of *actual* ammonia may be fairly traced to the partial decomposition of the urea during the distillation with lime; whereas the 5 per cent. of potential ammonia proceeded from the transforming decomposition of the uric acid.

C. *Foliated guano*, from Peru, in caked pieces, the layers very thin, parallel, and interspersed with white streaks. This guano was somewhat dense for a pure specimen, having a specific gravity of 1·7. The insoluble matter afforded by digestion with borax water, no less than 25·2 per cent. of pale yellow uric acid; 9 of other combustible organic matter, and 15 of earthy matter: consisting of silica, 3·5; phosphate of magnesia and ammonia, 6·5; and only 5 of subphosphate of lime or bone earth. It lost 10 per cent. when dried in a heat of 212° F. The remaining 30·8 parts soluble in water, had a strong acid reaction, and afforded, by ferric acetate and ammonia, 6 of phosphoric acid, equivalent to 9·7 of crystallized bi-phosphate of ammonia, after acetate of barytes had separated the sulphuric acid. No less than 17 parts of chloride of silver were obtained, by precipitating with nitrate of silver the liquor filtered from the phosphate of iron, and acidulated with nitric acid. As the present is an accidental sample, and not an average of any importation, I did not prosecute the research further.

D. *Chincha Guano,* of a somewhat darker colour than the preceding, and alkaline reaction; specific gravity, 1·62. Digested with water and strained, 56·75 parts remained after drying it at 212° F. The solution, evaporated and dried also at 212°, afforded 31·25 of saline matter. This saline mass being mixed with four-fifths of its weight of slaked lime, nine times its weight of water, and distilled, afforded of ammonia 14·28 per cent. Some chemists have prescribed potash instead of lime, for separating the ammonia in distillation; but no person of intelligence who has made the experiment once will choose to repeat it, because the potash forms with the organic matter of the guano a viscid compound, that froths up like a mass of soap bubbles, and coming over with the vapours, obstructs and vitiates the result.

2. When dried altogether by a steam heat, 100 parts lost 12 in moisture; whereas by evaporating and drying the soluble matter by itself, the loss amounted to 16·3, no doubt by the dissipation of some of the ammoniacal salts; for 100 parts of the entire guano afford, by distillation with quicklime, 9 parts of ammonia, and by the transforming decomposition with hydrate of soda and lime 16·25, indicating 7·25 of *potential* ammonia, in addition to the 9 of ready formed. The insoluble matter of 100 parts afforded to borax water a solution containing 16·5 of uric acid, corresponding to 18 of urate of ammonia. There remained on the filter, after drying it at 212° F., only 33·8 parts; so that about 5 parts of soluble organic matter had passed through the filter in

the borax water. These 33·8 consisted of subphosphate of lime 17, magnesian phosphate of ammonia 5·5, silica 0·7, and combustible organic matter 10·6.

The ammonia in the soluble portion was in the state chiefly of phosphate; there was merely a faint trace of oxalate of ammonia.

E. *African Guano.* — Among the many samples of African guano which I have had occasion to analyze for the importers, none has contained any appreciable quantity of uric acid, or by consequence of potential ammonia. The best afforded me 10 per cent. of ready-formed ammonia, existing chiefly in the state of a phosphate, though they all contain carbonate of ammonia, and have of consequence an alkaline reaction. The said sample contained 21·5 of moisture, separable by a heat of 212° F. Its specific gravity was so low as 1·57, in consequence of the large proportion of moisture in it. It contained 23 per cent. of subphosphate of lime, 3 of magnesian phosphate of ammonia, 1 of silica, and 1·5 of alkaline sulphate and muriate. The remaining 50 parts consisted of decayed organic matter, with phosphate of ammonia, and a little carbonate, equivalent to half a grain of ammonia, which is the largest quantity in such guanos. Other African guanos have afforded from 24 to 36 of moisture; no uric acid; no potential ammonia; but decayed organic matter; from 5 to 7 of ready formed ammonia in the state of phosphate, with a little carbonate; from 25 to 35 per cent. of subphosphate of lime; 5 or 6 of the magnesian phosphate of ammonia; more or less oxalates from the decomposition of the uric acid, and 3 to 5 per cent. of fixed alkaline salts.

F. The *Chilian Guano* gathered on the coast, already adverted to, contained a remarkable proportion of common salt, derived probably from the sea spray.

The following is the General Report of the chemical examination of several samples of guano, which I made for Messrs. Gibbs of London, and Messrs. Myers of Liverpool.

" In these various analyses, performed with the greatest care, and with the aid of the most complete apparatus for both inorganic and organic analysis, my attention has been directed not only to the constituents of the guano which act as an immediate manure, but to those which are admitted by practical farmers to impart durable fertility to the grounds. The admirable researches of Professor Liebig have demonstrated that Azote, the indispensable element of the nourishment of plants, and especially of wheat and others abounding in gluten (an azotized product), must be presented to them in the state of *Ammonia*, yet not altogether ammonia in the pure or saline form, for, as such, it is too readily evaporated or washed away; but in the dormant, or as one may say, in the *potential* condition in contradistinction from the *actual*. Genuine Peruvian and Bolivian guanos, like those which I have minutely analyzed, surpass very far all other species of manure, whether natural or artificial, in the quantity of *potential* ammonia, and, therefore, in the permanency of their action upon the roots of plants, while, in consequence of the ample store of *actual* ammonia which they contain ready formed, they are qualified to give immediate vigour to vegetation. Urate of ammonia constitutes a considerable portion of the azotized organic matter in well-preserved guano; it is nearly insoluble in water, not at all volatile, and is capable of yielding to the soil, by its slow decomposition, nearly one-third of its weight of ammonia. No other manure can rival this animal saline compound. One of the said samples of guano afforded me no less than 17 per cent. of potential ammonia, besides 4½ per cent. of the actual or ready formed; others from 7 to 8 per cent. of ammonia in each of these states respectively. The guanos which I have examined are the mere excrement of birds, and are quite free from the sand, earth, clay, and common salt, reported in the analyses of some guanos, and one of which (sand) to the amount of 30 per cent. I found myself in a sample of guano from Chile.

" The Peruvian guano, moreover, contains from 10 to 25 per cent. of phosphate of lime, the same substance as bone-earth, but elaborated by the birds into a pulpy consistence, which, while it continues insoluble in water, has been thereby rendered more readily absorbable and digestible (so to speak) by the roots of plants. I have therefore no doubt, that by the judicious application of these genuine guanos, mixed with twice or thrice their weight of a marly or calcareous soil, to convert their phosphate of ammonia into phosphate of lime and carbonate of ammonia, as also to dilute all their ammoniacal compounds, — such crops will be produced, even on sterile lands, as the farmer has never raised upon the most improved soil by the best ordinary manure. To the West India planter, guano will prove the greatest boon, since it condenses in a portable and inoffensive shape the means of restoring fertility to his exhausted cane fields, a benefit it has long conferred on the poorest districts of Peru.

" I respectfully observe, that no analysis of guano hitherto made public at all exhibits the value of the cargoes referred to above, while none gives the quantity of ammonia dormant in the azotized animal matter of the bird's dung, which, called into activity with the seeds in the soil, becomes the most valuable of its constituents, as a source of perennial fertility. In the detailed account of my analyses of this complex excretion (now preparing for publication), all the above statements will be brought within the scope of general comprehension. I shall also describe my 'ammonia generator,' based on the process invented in the laboratory of Professor Liebig, and also my 'ammonia meter,' which, together, can detect and measure one-hundredth part of a grain weight of absolute ammonia, whether potential or actual, in any sample of guano.

"Meanwhile the following may be offered as the average result of my analyses of genuine guano in reference to its agricultural value: —

" 1.	Azotized animal matter, including urate of ammonia, together capable of affording from 8 to 16 per cent. of ammonia by slow decomposition in the soil - -	50
2.	Water - - - - - -	8 to 11
3.	Phosphate of lime - - - -	12 to 25
4.	Phosphate of ammonia, sulphate of ammonia, ammonia-phosphate of magnesia, together containing from 5 to 9 parts of ammonia - - - - -	13
5.	Siliceous sand - - - - - -	1
		100

"Very moist guano has in general more actual and less potential ammonia than the dry guano.

"Andrew Ure.

"*London*, 13. *Charlotte Street, Bedford Square,*
"*February* 14. 1843."

Oellacher's analysis of a brownish yellow guano is as follows: —

			Ammonia.
1.	Urate of ammonia - - -	12·20	1·06
2.	Oxalate of ammonia - - -	17·73	6·50
3.	Oxalate of lime - - - -	1·30	
4.	Phosphate of ammonia - - -	6·90	1·79
5.	Phosphate of ammonia and magnesia -	11·63	1·68
6.	Phosphate of lime - - -	20·16	
7.	Muriate of ammonia - - -	2·25	0·72
8.	Chloride of sodium (common salt) -	0·40	
9.	Carbonate of ammonia - - -	0·80	0·23
10.	Carbonate of lime - - -	1·65	
11.	Sulphate of potash - - -	4·00	
12.	Sulphate of soda - - -	4·92	
13.	Humate of ammonia - - -	1·06	0·09
14.	Substance resembling wax - -	0·75	
15.	Sand - - - - - -	1·68	
16.	Water (hygroscopic) - - -	4·31	
17.	Undefined organic matter - -	8·26	
		100·00	12·07

I am satisfied from its large proportion of oxalate of ammonia, that the sample thus analyzed was by no means a fair or normal specimen of guano; and it is in fact widely different from all the fresh samples which have passed through my hands. It is described as "Knobby, being mixed with light laminated crystalline portions, in white grains, from the size of a pea to that of a pigeon's egg." Having some lumpy concretions of a similar aspect in my possession, I submitted them to chemical examination.

G. 1000 grains being digested in boiling water and strained, afforded a nearly colourless solution. This was concentrated till crystals of oxalate of ammonia appeared. It was then acidulated with hydrochloric acid, to protect the phosphoric acid from precipitation, and next treated carefully with solution of nitrate of lime equivalent to the oxalic acid present. The oxalate of lime thus obtained being converted into carbonate weighed 80·5 grains, corresponding to 100 of oxalate of ammonia, being 10 per cent. of the weight of the guano.

The liquor filtered from the oxalate was precipitated by nitrate of barytes, and afforded 112 grains of sulphate of barytes = 38 sulphuric acid; and the last filtrate being mixed with a given measure of ferric acetate, and the mixture supersaturated with ammonia, yielded subphosphate of iron, equivalent to 5 per cent. of phosphoric acid. I digested with heat other 500 grains of the same guano in a weak solution of borax, filtered, acidulated the liquid, but obtained merely a trace of uric acid. It is clear therefore that the oxalate of ammonia had been formed in this guano at the expense of the uric acid, and that its concreted state, and the crystalline nodules disseminated through it were the result of transformation by moisture in a hot climate, which had agglomerated it to a density of 1·75; whereas clean fresh guano, friable and dry like the above, is seldom denser than 1·65. This guano contained only 3·23 of ammonia; 65 of insoluble matter, 53 of earthy phosphates, 5 silica, 3 alkaline salts (fixed), and 7 organic matter.

Oxalate of ammonia, being readily washed away, is a bad substitute for the urate of ammonia, urea, and azotized animal matter, which it has replaced. Oellacher could find no urea in the guano which he analyzed; another proof of its disintegration.

Bartels' analysis of a brown-red guano is as follows: —

1.	Muriate of ammonia - - - -	6·500
2.	Oxalate of ammonia - - - -	13·351
3.	Urate of ammonia - - - -	3·244
4.	Phosphate of ammonia - - - -	6·450
5.	Substances resembling wax and resin - -	0·600
6.	Sulphate of potash - - - -	4·277
7.	Sulphate of soda - - - -	1·119
8.	Phosphate of soda - - - -	5·291
9.	Phosphate of lime - - - -	9·940
10.	Phosphate of ammonia and magnesia - -	4·196
11.	Common salt - - - - -	0·100
12.	Oxalate of lime - - - - -	16·360
13.	Alumina - - - - -	0·104
14.	Sand insoluble in nitric acid, and iron - -	5·800
15.	Loss (water and volatile ammonia and undefined organic matter) - - - -	22·718
		100·000

Voelckel, in his analysis of guano, states 7 per cent. of oxalate of lime — a result quite at variance with all my experience — for I have never found so much as 2 per cent. of carbonate of lime in the washed and gently ignited insoluble matter; whereas, according to Bartels and Voelckel, from 10 to 5 per cent. of carbonate should be obtained, as the equivalents of the proportions of the oxalate assigned by them.

All these analyses are defective moreover in not showing the total quantity of ammonia which the guano is capable of giving out in the soil; and since it appears that the freshest guano abounds most in what I have called *potential* ammonia, it must possess, of consequence, the greatest fertilizing virtue.

A sample of *decayed dark-brown* moist guano from Chile, being examined as above described, for oxalate of ammonia, was found to contain none whatever; and it contained less than 1 per cent. of uric acid.

H. An article offered to the public, by advertisement, as Peruvian guano, was lately sent to me for analysis. I found it to be a spurious composition; it consisted of —

1.	Common salt - - - - -	32·0
2.	Common siliceous sand - - - -	28·0
3.	Sulphate of iron or copperas - - -	5·2
4.	Phosphate of lime - - - -	4·0, with
5.	Organic matter from bad guano, &c. (to give it smell)	23·3
6.	Moisture - - - - - -	7·5
		100·0

Genuine guano, when burned upon a red hot shovel, leaves a white ash of phosphate of lime and magnesia; whereas this factitious substance left a black fused mass of sea salt, copperas, and sand. The specific gravity of good fresh guano is seldom more than 1·66, water being 100; whereas that of the said substance was so high as 2·17; produced by the salt, sand, and copperas.

GUMS. Under the generic name Gum several substances have been classed, which differ essentially, though they possess the following properties in common; viz. forming a thick mucilaginous liquid with water, and being precipitable from that solution by alcohol. Properly speaking, we should style gums only such substances as are transformed into mucic acid by nitric acid; of which bodies there are three: 1. *Arabine*, which constitutes almost the whole of gum arabic; 2. *Bassorine*, which forms the chief part of gum tragacanth; and 3. *Cerasine*, which occurs in cherry-tree gum, and is convertible into gum arabic by hot water.

1. Gum arabic, in its ordinary state, contains 17 per cent. of water, separable from it by a heat of 212° F.

2. Cherry-tree gum consists of 52 per cent. of arabine, and 35 of a peculiar gum, which has been called *Cerasine.* This latter substance is convertible into grape sugar by boiling it with very dilute sulphuric acid.

GUNPOWDER, ANALYSIS OF. M. Bolley dissolves out the sulphur from charcoal in gunpowder (previously freed from its nitre by water), by digesting it, at a boiling heat for 2 hours, with the solution of 20 times its weight of sulphite of soda, which is thereby converted into hyposulphite. To the mixture water must be added, as it is wasted by the boiling. If the residuum be heated on platinum foil, it will exhale sulphur, if this had not been all removed by the sulphurous salt.

H.

HAIR CLOTH. See WEAVING.

HATS. The body of a beaver hat is made of fine wool and coarse fur mixed and felted together, then stiffened and shaped; the covering consists of a coat of beaver fur felted upon the body. Cheap hats have their bodies made of coarse wool, and their coverings of coarse fur or fine wool. The body or foundation of a good beaver hat, is at present made of 8 parts of rabbit's fur, 3 parts of Saxony wool, and 1 part of lama, vicunia, or red wool. About two ounces and a half of the above mixture are sufficient for one hat, and these are placed in the hands of the *bower;* his tool is a bow or bent ashen staff, from 5 to 7 feet long, having a strong catgut string stretched over a bridge at each end, and suspended at its middle by a cord to the ceiling, so as to hang nearly level with the work-bench, and a small space above it. The wool and coarser fur are laid in their somewhat matted state upon this bench, when the bower, grasping the bent rod with his left hand, and *by means of a small wooden catch plucking the string with his right,* makes it vibrate smartly against the fibrous substances, so as to disentangle them, toss them up in the air, and curiously arrange themselves in a pretty uniform layer or fleece. A skilful bower is a valuable workman. The bowed materials of one hat are spread out and divided into two portions, each of which is compressed first with a light wicker frame, and next under a piece of oil cloth or leather, called a hardening skin, till by pressing the hands backwards and forwards all over the skin, the filaments are linked together by their serrations into a somewhat coherent fleece of a triangular shape. The two halves or "bats" are then formed into a cap; one of them is covered in its middle with a 3-cornered piece of paper, smaller than itself, so that its edges may be folded over the paper, and by overlapping each other a little, form a complete envelope to the paper; the junctions are then partially felted together by rubbing them hard, care being taken to keep the base of the triangle open by means of the paper; the second bat being made to enclose the first by a similar process of folding and friction. This double cap, with its enclosed sheet of paper, is next rolled up in a damp cloth and kneaded with the hands in every direction, during which it is unfolded and creased up again in different forms, whereby the two layers get thoroughly incorporated into one body; thus, on withdrawing the paper, a hollow cone is obtained. The above operations have been partially described in the body of the Dictionary, and the remaining steps in making a hat are there sufficiently detailed.

In a great hat factory women are employed, at respectable wages, in plucking the beaver skins, cropping off the fur, sorting various qualities of wool, plucking and cutting rabbits' fur, shearing the nap of the blocked hat, picking out unseemly filaments of fur, and in trimming the hats; that is, lining and binding them.

The annual value of the hats manufactured at present in the United Kingdom is estimated at 3,000,000*l.* sterling. The quantity exported in 1840, was 22,522 dozens, valued at 81,583*l.*

With regard to the *stiffening* of hats, I have been furnished by a skilful operator with the following valuable information:—"All the solutions of gums which I have hitherto seen prepared by hatters, have not been perfect, but, in a certain degree, a mixture, more or less, of the gums, which are merely suspended, owing to the consistency of the composition. When this is thinned by the addition of spirit, and allowed to stand, it lets fall a curdy looking sediment, and to this circumstance may be ascribed the frequent breaking of hats. My method of proceeding is, first to dissolve the gums by agitation in twice the due quantity of spirits, whether of wood or wine, and then, after complete solution, draw off one half the spirit in a still, so as to bring the stiffening to a proper consistency. No sediment subsequently appears on diluting this solution, however much it may be done.

"Both the spirit and alkali stiffenings for hats made by the following two recipes, have been tried by some of the first houses in the trade, and have been much approved of: —

Spirit Stiffening.

7 pounds of fine orange shellac.
2 pounds of gum sandarac.
4 ounces of gum mastic.
Half a pound of amber rosin.
1 pint of solution of copal.
1 gallon of spirit of wine or wood naphtha.

"The shellac, sandarac, mastic, and rosin, are dissolved in the spirit, and the solution of copal is added last.

Alkali Stiffening.

7 pounds of common block shellac.
1 pound of amber rosin.
4 ounces of gum thus.
4 ounces of gum mastic.
6 ounces of borax.
Half a pint of solution of copal.

" The borax is first dissolved in a little warm water (say 1 gallon); this alkaline liquor is now put into a copper pan (heated by steam), together with the shellac, rosin, thus, and mastic, and allowed to boil for some time, more warm water being added occasionally until it is of a proper consistence; this may be known by pouring a little on a cold slab somewhat inclined, and if the liquor runs off at the lower end, it is sufficiently fluid; if, on the contrary, it sets before it reaches the bottom, it requires more water. When the whole of the gums seem dissolved, half a pint of wood naphtha must be introduced, and the solution of copal; then the liquor must be passed through a fine sieve, and it will be perfectly clear and ready for use. This stiffening is used hot. The hat bodies, before they are stiffened, should be steeped in a weak solution of soda in water, to destroy any acid that may have been left in them (as sulphuric acid is used in the making of the bodies). If this is not attended to, should the hat body contain any acid when it is dipped into the stiffening, the alkali is neutralized, and the gums consequently precipitated. After the body has been steeped in the alkaline solution, it must be perfectly dried in the stove before the stiffening is applied; when stiffened and stoved it must be steeped all night in water, to which a small quantity of sulphuric acid has been added; this *sets* the stiffening in the hat body, and finishes the process. A good workman will stiffen 15 or 16 dozen hats a day. If the proof is required cheaper, more shellac and rosin must be introduced."

HIDES, untanned; buffalo, bull, cow, ox, or horse. Imported in 1840, 352,867; retained for consumption, 302,789. Rates of duty: from west coast of Africa, not exceeding 14 pounds, 2*s.* 4*d.*; from British possessions, dry, 2*s.*, wet, 1*s.* 2*d.*; from other places, dry, 4*s.* 8*d.*, wet, 2*s.* 4*d.* Net revenue, 40,139*l.* in 1840, and 45,328*l.* in 1839. In 1839, 16,557 pounds of tanned hides were imported for home consumption, and in 1840 only 5,822: at the rate from foreign parts of 6*d.* per pound, but if cut and trimmed, 9*d.*; from British possessions 3*d.*, if cut and trimmed 4½*d.* per pound.

HOPS.

Annual Amount of Hop Duty.

Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.
1711	£43,437	1733	£70,215	1755	£82,157	1777	£43,581	1799	£73,279	1821	£154,609
1712	30,278	1734	37,716	1756	48,106	1778	159,891	1800	72,928	1822	203,724
1713	23,018	1735	42,745	1757	69,713	1779	55,800	1801	241,227	1823	26,058
1714	14,457	1736	46,482	1758	72,896	1780	122,724	1802	15,463	1824	148,832
1715	44,975	1737	56,492	1759	42,115	1781	120,218	1803	199,305	1825	24,317
1716	20,354	1738	86,575	1760	117,992	1782	14,895	1804	177,617	1826	269,331
1717	54,669	1739	70,742	1761	79,776	1783	75,716	1805	32,904	1827	140,848
1718	15,005	1740	37,875	1762	79,295	1784	94,359	1806	153,102	1828	172,027
1719	90,317	1741	65,222	1763	88,315	1785	112,684	1807	100,071	1829	38,398
1720	38,169	1742	45,550	1764	17,178	1786	95,973	1808	251,089	1830	88,047
1721	61,362	1743	61,072	1765	73,778	1787	42,227	1809	63,452	1831	174,864
1722	49,443	1744	46,708	1766	116,445	1788	143,168	1810	73,514	1832	139,018
1723	30,279	1745	34,635	1767	25,997	1789	104,063	1811	157,025	1333	156,905
1724	61,271	1746	91,879	1768	114,002	1790	106,841	1812	30,633	1834	189,713
1725	6,526	1747	62,993	1769	16,201	1791	90,059	1813	131,482	1835	235,207
1726	80,031	1048	87,155	1770	101,131	1792	162,112	1814	140,202	1836	200,332
1727	69,409	1749	36,805	1771	33,143	1793	22,619	1815	123,878	1837	178,578
1728	41,494	1750	72,138	1772	102,650	1794	203,063	1816	46,302	1838	171,556
1729	48,441	1751	73,954	1773	45,847	1795	82,342	1817	66,522	1839	205,537
1730	44,419	1752	82,163	1774	138,887	1796	75,223	1818	199,465	1840	34,091
1731	22,600	1753	91,214	1775	41,597	1797	157,458	1819	242,476	1841	146,159
1732	35,135	1754	102,012	1776	125,691	1798	56,032	1820	138,330	1842	169,776

Number of Acres under the Cultivation of Hops in England.

1807	38,218	1813	39,521	1819	51,014	1825	46,718	1831	47,129	1837	56,323
1808	38,436	1814	40,571	1820	50,148	1826	50,471	1832	47,101	1838	55,045
1809	38,357	1815	42,150	1821	45,[illegible]62	1827	49,485	1833	49,187	1839	52,305
1810	38,265	1816	44,219	1822	43,766	1828	48,365	1834	51,273	1840	44,805
1811	38,401	1817	46,493	1823	41,458	1829	46,135	1835	53,816	1841	45,769
1812	38,700	1818	48,593	1824	43,449	1830	46,726	1836	55,422	1842	

Hop Duties of particular Districts.

	1839.	1840.	1841.	1842.
Rochester - -	60,802 16 6	23,256 19 8	51,490 3 8	58,812 4 7
Canterbury - -	50,649 3 0	5,757 0 4	33,960 14 10	31,019 13 5
Kent - - -	111,451 19 6	29,014 0 0	85,450 18 6	90,731 18 0
Sussex - - -	65,026 19 7	3,080 12 9	38,086 13 10	43,561 10 0
Worcester - -	16,639 16 4	239 19 0	12,076 19 8	19,825 2 11
Farnham - -	7,730 7 2	1,643 18 7	7,702 10 2	11,678 18 4
North Clays - -	2,005 13 10	57 4 1	1,159 7 10	1,724 2 7
Essex - - -	1,624 5 9	35 17 1	977 3 0	2,050 19 11
Sundries - - -	1,058 11 5	20 4 8	705 8 7	203 14 3
	£205,538 12 7	34,091 17 2	146,159 1 7	169,776 6 0

HORN. Mr. J. James has contrived a method of opening up the horns of cattle, by which he avoids the risk of scorching or frizzling, which is apt to happen in heating them over an open fire. He takes a solid block of iron pierced with a conical hole, which is fitted with a conical iron plug, heats them in a stove to the temperature of melting lead, and having previously cut up the horn lengthwise on one side with a saw, he inserts its narrow end into the hole, and drives the plug into it with a mallet. By the heat of the irons, the horn gets so softened in the course of about a minute, as to bear flatting out in the usual way.

HYPOSULPHITE OF SODA. This salt, so extensively used in the practice of *Daguerreotyping*, may be easily prepared in quantities by the following process: — Mix one pound of finely pulverised ignited carbonate of soda with ten ounces of flowers of sulphur, and heat the mixture slowly in a porcelain dish till the sulphur melts. Stir the fused mass, so as to expose all its parts freely to the atmosphere, whereby it passes from the state of a sulphuret, by the absorption of atmospherical oxygen, into that of a sulphite, with the phenomenon of very slight incandescence. Dissolve in water, filter the solution, and boil it immediately along with flowers of sulphur. The filtered concentrated saline liquid will afford, on cooling, a large quantity of pure and beautiful crystals of hyposulphite of soda.

I.

ILLUMINATION, COST OF. The production, diffusion, and economy of light, are subjects of the highest interest both to men of science and men of the world; leading the former to contemplate many of the most beautiful phenomena of Physics and Chemistry, while they provide the latter with the artificial illumination so indispensable to the business and pleasures of modern society. The great cost of light from wax, spermaceti, and even stearic candles, as also the nuisance of the light from tallow ones, have led to the invention of an endless variety of lamps, of which the best hitherto known is undoubtedly the mechanical or Carcel lamp, so generally used by the opulent families in Paris. In this lamp the oil is raised through tubes by clock-work, so as continually to overflow at the bottom of the burning wick; thus keeping it thoroughly soaked, while the excess of the oil drops back into the cistern below. I have possessed for several years an excellent lamp of this description, which performs most satisfactorily; but it can hardly be trusted in the hands of a servant; and when it gets at all deranged, it must be sent to its constructor in Paris to be repaired. The light of this lamp, when furnished with an appropriate tall glass chimney, is very brilliant, though not perfectly uniform; since it fluctuates a little, but always perceptibly to a nice observer, with the alternating action of the pump-work; becoming dimmer after every successive jet of oil, and brighter just before its return. The flame, moreover, always flickers more or less, owing to the powerful draught, and rectangular reverberatory shoulder of the chimney. The mechanical lamp is, however, remarkable for continuing to burn, not only with unabated but with increasing splendour for seven or eight hours; the vivacity of the combustion increasing evidently with the increased temperature and fluency of the oil, which, by its ceaseless circulation through the ignited wick, gets eventually pretty warm. In the comparative experiments made upon different lights by the Parisian philosophers, the mechanical lamp is commonly taken as the standard. I do not think it entitled to this pre-eminence: for it may be made to emit very different quantities of light, according to differences in the nature and supply of the oil, as well as variations in the form and position of the chimney. Besides, such lamps are too rare in this country to be selected as standards of illumination.

After comparing lights of many kinds, I find every reason to conclude that a large wax candle of three to the pound, either long or short, that is, either 12 or 15 inches in length, as manufactured by one of the great wax-chandlers of London, and furnished with a wick containing 27 or 28 threads of the best Turkey cotton, is capable of furnishing a most uniform, or nearly invariable standard of illumination. It affords one-tenth of the light emitted by one of the Argand lamps of the Trinity House, and one-eleventh of the light of my mechanical lamp, when each lamp is made to burn with its maximum flame, short of smoking.

The great obstacle to the combustion of lamps, lies in the viscidity, and consequent sluggish supply of oil, to the wicks; an obstacle nearly insuperable with lamps of the common construction during the winter months. The relative viscidity, or relative fluency of different liquids at the same temperature, and of the same liquid at different temperatures, has not, I believe, been hitherto made the subject of accurate researches. I was, therefore, induced to make the following experiments with this view.

Into a hemispherical cup of platinum, resting on the ring of a chemical stand, I introduced 2000 water-grain measures of the liquid whose viscidity was to be measured, and ran it off through a glass syphon, $\frac{1}{8}$ of an inch in the bore, having the outer leg $3\frac{1}{4}$ inches, and the inner leg 3 inches long. The time of efflux became the measure of the viscidity; and of two liquids, if the specific gravity, and consequent pressure upon the syphon, were the same, that time would indicate exactly the relative viscidity of the two liquids. Thus, oil of turpentine and sperm oil have each very nearly the same density; the former being, as sold in the shops, $=0.876$, and the latter from 0·876 to 0·880, when pure and genuine. Now I found that 2000 grain-measures of oil of turpentine ran off through the small syphon in 95 seconds, while that quantity of sperm oil took 2700 seconds, being in the ratio of 1 to $28\frac{1}{2}$; so that the fluency of oil of turpentine is $28\frac{1}{2}$ times greater than that of sperm oil. Pyroxilic spirit, commonly called naphtha, and alcohol, each of specific gravity 0.825, were found to run off respectively in 80 and 120 seconds; showing that the former was 50 per cent. more fluent than the latter. Sperm oil, when heated to 265° Fahr., runs off in 300 seconds, or one-ninth of the time it took when at the temperature of 64°. Southern whale oil, having a greater density than the sperm oil, would flow off faster were it not more viscid.

2000 grain-measures of water at 60° run off through the said syphon in 75 seconds, but when heated to 180°, they run off in 61.

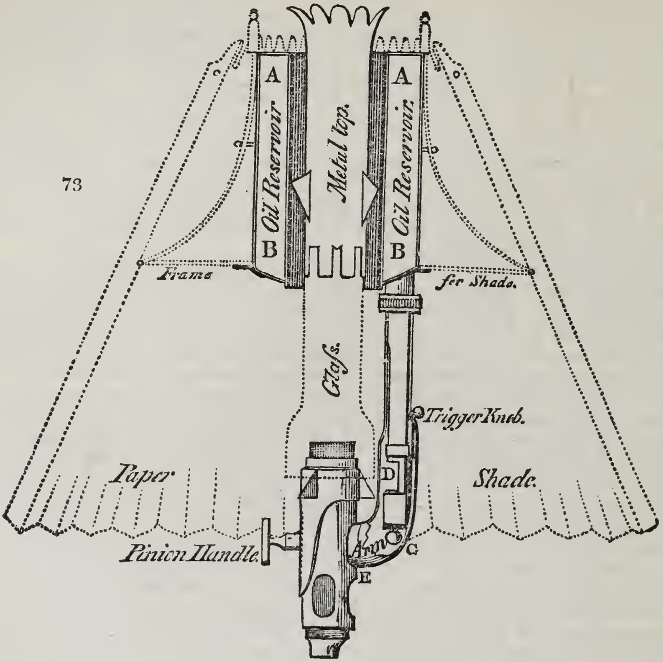
Concentrated sulphuric acid, though possessing the great density of 1.840, yet flows off very slowly at 64°, on account of its viscidity; whence its name of oil of vitriol. 2000 grain-measures of it took 660 seconds to discharge.

Mr. Samuel Parker, long advantageously known to the public for his sinumbral and pneumatic fountain lamps, as well as other inventions subservient to domestic comfort, having obtained a patent for a new lamp, in which the oil is heated by a very simple contrivance, in the cistern, to any desired degree, before arriving at the wick, I instituted an extensive series of experiments to determine its value in the production of light, and consumption of oil, compared to the value of other lamps, as well as candles, in these respects.

In *fig.* 73. A, A, B, B, is a section of the cylinder which constitutes the cistern; the oil being contained between the inner and outer cylinders, and receiving heat from the flame of the lamp which passes up through the inner cylinder, and is reverberated more or less against its sides by the top of the metal chimney, being notched and bent back. D is a slide-valve which is opened to allow the oil to descend to the wick, and is shut when the cistern is to be separated from the pipe of supply, at E, for the purpose of recharging it with oil. The flame is modified, not by raising or lowering the wick, as in common lamps, but by raising or lowering the bell-mouthed glass chimney which rests at its bottom on three points, and is moved by means of the rack-work mechanism F. The concentric cylindric space A, A, and B, B, contains a pint imperial, and should be made entirely full before lighting the lamp; so as to leave no air in the cistern, which, by its expansion with the heat, would inevitably cause an overflow of the oil.

The following arrangement was adopted in these experiments for determining the relative illumination of the different lights. Having trimmed, with every precaution, my French mechanical lamp, and charged it with pure sperm oil, I placed it upon an oblong table, at a distance of 10 feet from a wall, on which a white sheet of paper was stuck. One of Mr. Parker's hot-oil lamps, charged with a quantity of the same oil, was placed upon the same table; and each being made to burn with its maximum brilliancy, short of smoking, the relative illumination of the two lamps was determined by the well-known method of the comparison of shadows; a wire a few inches long, and of the thickness of a crow-quill, being found suitable for enabling the eye to estimate very nicely the shade of the intercepted light. It was observed in numerous trials, both by my own eyes and those of others, that when one of the lamps was shifted half an inch nearer to or further from the paper screen, it caused a perceptible difference in the tint of the shadow. Professor Wheatstone kindly enabled me to verify the precision of the above method of shadows, by employing, in some of the experiments, a photometer of his own invention, in which the relative brightness of the two lights was determined by the relative brightness of the opposite sides of a revolving silvered ball, illuminated by them.

73



1. The mechanical lamp was furnished with a glass chimney 1·5 inches in diameter at the base, and 1·2 at top; the wide bottom part was 1·8 inches long, and the narrow upper part 8 inches. When placed at a distance of 10 feet from the wall its light there may be estimated as the square of this number, or 100. In the first series of experiments, when burning with its maximum flame, with occasional flickerings of smoke, it emitted a light equal to that of 11 wax candles, and consumed 912 grains of oil per hour. The sperm oil was quite pure, having a specific gravity of 0·874 compared to water at 1000. In a subsequent series of experiments, when its light was less flickering, and equal only to that of 10 wax candles, it consumed only 815 grains, or 0·1164 of a lb. per hour. If we multiply this number into the price of the oil (8*s.* per gallon) per lb. 11*d.*, the product 1·2804*d.* will represent the relative cost of this illumination, estimated at 100.

2. The hot-oil lamp burns with a much steadier flame than the mechanical, which must be ascribed in no small degree to the rounded slope of the bell-mouthed glass chimney, whereby the air is brought progressively closer and closer into contact with the outer surface of the flame, without being furiously dashed against it, as it is by the rectangular shoulder of the common contracted chimney. When charged with sperm oil, and made to burn with its maximum flame, this lamp required to be placed one foot further from the screen than the mechanical lamp, in order that its shadow should have the same depth of tint. Hence, its relative illumination was, in that case, as the square of 11 to the square of 10; or as 121 to 100. Yet its consumption of oil was

only 696 grains, or somewhat less than 0·1 of a lb. per hour. Had its light been reduced to 100, it would have consumed only 576 grains per hour, or 0·82 of a lb. If we multiply this number by 11*d.*, the product 0·902*d.* will represent the relative cost of 100 of this illumination.

3. The hot-oil lamp being charged with the southern whale oil, of specific gravity 0·926, at 2*s.* 6*d.* per gallon, or $3\frac{3}{4}$*d.* per lb., when burning with its maximum flame, required to be placed 9 feet and 1 inch from the screen to drop the same tint of shadow upon it as the flames of the other two lamps did at 10 and 11 feet with the sperm oil. The square of 9 feet and 1 inch = 82 is the relative illumination of the hot-oil lamp with the southern whale oil. It consumed 780 grains, or 0·111 of a pound per hour; but had it given 100 of light it would have consumed 911 grains, or 0·130 of a pound, which number being multiplied by its price $3\frac{3}{4}$*d.*, the product 0·4875*d.* will represent the relative cost of 100 of this light.

4. A hot-oil lamp charged with olive oil of specific gravity 0·914, at 5*s.* 6*d.* per gallon, or $7\frac{1}{2}$ per lb. when burning with its maximum flame, required to be placed at 9 feet 6 inches, to obtain the standard tint of shadow upon the screen. It consumed 760 grains per hour. The square of $9\frac{1}{2}$ feet is $90\frac{1}{4}$, which is the relative intensity of the light of this lamp. Had it emitted a light = 100, it would have consumed 840 grains, or 0·12 of a pound per hour — which number multiplied by the price per pound, gives the product 0·9*d.* as the relative cost of 100 of this light.

5. A hot-oil lamp charged with Price and Co.'s cocoa-nut oil (oleine), of specific gravity 0·925, at 4*s.* 6*d.* per gallon, or $5\frac{3}{4}$*d.* per lb., had to be placed 9 feet from the screen, and consumed 1035 grains per hour. Had its light been 100 instead of 81 (9^2), the consumption would have been 1277 grains, or 0·182 of a pound per hour! which number multiplied by its price per pound, the product 1·031*d.* will represent the cost of 100 of this illumination.

6. In comparing the common French annular lamp in general use with the mechanical lamp, it was found to give about one-half the light, and to consume two-thirds of the oil of the mechanical lamp.

7. Wax candles from some of the most eminent wax-chandlers of the metropolis were next subjected to experiment; and it is very remarkable that, whether they were threes, fours, or sixes in the pound, each afforded very nearly the same quantity of light, for each required to be placed at a distance of three feet from the screen to afford a shadow of the same tint as that dropped from the mechanical lamp, estimated at 100. The consumption of a genuine wax candle, in still air, is upon an average of many experiments, 125 grains per hour, but as it affords only $\frac{1}{11}$ of the light of the mechanical lamp, 11 times 125 = 1375 grains, or 0·1064 of a pound is the quantity that would need to be consumed to produce a light equal to that of the said lamp. If we multiply that number by the price of the candles per lb. = 30*d.* the product = 5·892*d.* is the cost of 100 of illumination by wax. A wax candle, three in the pound (short), is one inch in diameter, 12 inches in length, and contains 27 or 28 threads, each about $\frac{1}{10}$ of an inch in diameter. But the quality of the wick depends upon the capillarity of the cotton fibrils, which is said to be greatest in the Turkey cotton, and hence the wicks for the best wax candles are always made with cotton yarn imported from the Levant. A wax candle, three in the pound (long), is $\frac{7}{8}$ of an inch in diameter, 15 inches long, and has 26 threads in its wick. A wax candle, six to the pound, is 9 inches long, $\frac{4}{5}$ of an inch in diameter, and has 22 threads in its wick. The light of this candle may be reckoned to be, at most, about $\frac{1}{11}$ less than that of the threes in the pound. A well-made short three burns with surprising regularity in still air, being at the rate of an inch in an hour and a half, so that the whole candle will last 18 hours. A long three will last as long, and a six about $9\frac{1}{2}$ hours. Specific gravity of wax = 0·960.

8. A spermaceti candle, three in the pound, is $\frac{9}{10}$ of an inch in diameter, 15 inches long, and has a plaited wick, instead of the parallel threads of a wax candle. The same candles four in the pound, are $\frac{8}{10}$ of an inch in diameter, and $13\frac{1}{2}$ inches long. Each gives very nearly the same quantity of light as the corresponding wax candles: viz. $\frac{1}{11}$ of the light of the above mechanical lamp, and consumes 142 grains per hour. Multiplying the last number by 11, the product, 1562 grains = 0·223 of a pound would be the consumption of spermaceti requisite to give 100 of illumination. Multiplying the last number by 24*d.*, the price of the candles per pound, the product 5·352*d.* is the relative cost of 100 of this illumination.

9. *Stearic Acid* candles, commonly called German wax, consume 168·5 grains, or 0.024 of a pound per hour, when emitting the same light as the standard wax candle. Multiplying the latter number by 11, and by 16*d.* (the price of the candles per lb.), the product 4·224*d.* will represent the relative cost of 100 of this illumination.

10. Tallow candles: moulds, short threes, 1 inch in diameter, and $12\frac{1}{2}$ in length; ditto long threes, $\frac{9}{10}$ of an inch in diameter, and 15 in length; ditto, long fours, $\frac{8}{10}$ of

an inch in diameter, and $13\frac{3}{4}$ in length. Each of these candles burns with a most uncertain light, which varies from $\frac{1}{12}$ to $\frac{1}{16}$ of the light of the mechanical lamp — the average may be taken at $\frac{1}{14}$. The threes consume each 144 grains, or 0·2 of a pound, per hour; which number, multiplied by 14, and by 9*d.* (the price per pound,) gives the product 2·52*d.* for the relative cost of 100 of this illumination.

11. *Palmer's* spreading wick candles. Distance from the screen 3 feet 4 inches, with a shadow equal to the standard. Consumption of tallow per hour 232·5 grains, or 0·0332 of a pound. The square of 3 feet 4 inches = 11·9 is the relative illumination of this candle = 11·9 :: 0·3332 :: 100 : 0·28 × 10*d.* = 11·9 is the relative cost of this illumination.

12. Cocoa-nut stearine candles consumed each 168 grains per hour, and emitted a light equal to $\frac{1}{16}$ of the standard flame. Multiplying 168 by 16, the product 30·88 grains, or 0·441 of a lb., is the quantity which would be consumed per hour to afford a light equal to 100. And 0·441 multiplied by 10*d.*, the price per lb., gives the product 4·441*d.* as the cost of 100 of this illumination per hour.

13. A gas Argand London lamp, of 12 holes in a circle of $\frac{3}{4}$ of an inch in diameter, with a flame 3 inches long, afforded a light = $78\frac{1}{2}$ compared to the mechanical lamp: and estimating the light of the said mechanical lamp as before, at 100, that of the hot-oil lamp is 121, and that of the above gas flame 78·57, or in round numbers 80, *and the common French lamp in general use* 50.

Collecting the preceding results, we shall have the following tabular view of the cost per hour of an illumination equal to that of the mechanical lamp, reckoned 100, or that of eleven wax candles, three to the pound.

Table of Cost per Hour of One Hundred of Illumination.

		Pence.		Pence.
1.	Parker's hot-oil lamp, with southern whale oil	0·4875	or about	$\frac{1}{2}$*d.*
2.	Mechanical or Carcel lamp, with sperm oil	1·2804		$1\frac{1}{4}$
3.	Parker's hot-oil lamp, with sperm oil	0·902		1
4.	Ditto ditto common olive oil	0·900		1
5.	Ditto ditto cocoa-nut oleine or oil	1·031		1
6.	French lamp in general use, with sperm oil	1·7072		$1\frac{3}{4}$
7.	Wax candles	5·892		6
8.	Spermaceti candles	5·352		$5\frac{1}{4}$
9.	German wax (Stearic acid) ditto	4·224		$4\frac{1}{4}$
10.	Palmer's spreading wick candles	2·800		$2\frac{3}{4}$
11.	Tallow (mould) candles	2·520		$2\frac{1}{2}$
12.	Cocoa-nut stearine of Price and Co.	4·41		$4\frac{1}{2}$

Since the hot-oil lamp affords sufficient light for reading, writing, sewing, &c. with one-fifth of its maximum flame, it will burn at that rate for 10 hours at the cost of about ONE PENNY, and it is hence well entitled to the inventor's designation, "The Economic."

Sir D. Brewster, in his examination lately before the committee of the House of Commons on lighting the house, stated, that the French light-house lamp of Fresnel emitted a light equal to that of forty Argand flames: whereas, according to other accounts, it gave much less light. With the view of settling this point, before being examined by the said committee, I repaired to the Trinity House, and tried one of the two original Fresnel lamps, which had been deposited there by that eminent French engineer himself. This lamp consists of four concentric circular wicks, placed in one horizontal plane; the innermost wick being $\frac{7}{8}$ of an inch in diameter, and the outermost $3\frac{1}{2}$ inches. Being carefully trimmed, supplied with the best sperm oil, surmounted with its great glass chimney, burning with its maximum flame, and placed at a distance of 13 feet 3 inches from the screen, it let fall a shadow of the same tint as that let fall by the flame of my mechanical lamp, placed at a distance of 4 feet 6 inches from the screen. The squares of these two numbers are very nearly as $8\frac{3}{4}$ to 1 (175·5625 to 20·25); showing that the Fresnel lamp gives less than 9 times the light of my mechanical lamp, and about 9·6 times the light of one of the Trinity House Argand lamps. The Fresnel lamp is exceedingly troublesome to manage, from the great intensity of its heat, and the frequent fractures of its chimneys — two having been broken in the course of my experiments at the Trinity House.

Mr. Goldsworthy Gurney, the ingenious inventor of the new light-house lamp, in which a stream of oxygen gas is sent up through a small tube within the burning circular wick of a small Argand lamp, having politely sent two of his lamps to my house, along with a bag of oxygen gas, I made the following experiments, to ascertain their illuminating powers compared to those of the mechanical lamp and wax candles.

His larger lamp has a wick $\frac{5}{8}$ of an inch in diameter, but emits an oxygen flame of only $\frac{3}{8}$ of an inch. The flame is so much whiter than that of the best lamp or candle, that it becomes difficult to determine, with ultimate precision, the comparative depths of the shadows let fall by them. The mean of several trials showed that the above *Bude*-light (as Mr. Gurney calls it, from the name of his residence in Cornwall,) has an illuminating power of from 28 to 30 wax candles. His smaller lamp has a flame ¼ of an inch in diameter, and a wick ½ of an inch. Its light is equal to that of from 18 to 20 wax candles.

The committee of the House of Commons on lighting it, having asked me what was the relative vitiation of air by the breathing of men and the burning of candles, I gave the following answer: —

Wax contains 81·75 parts of carbon in 100, which generate by combustion 300 parts of carbonic acid gas. Now, since 125 grains of wax constitute the average consumption of a candle per hour, these will generate 375 grains of carbonic acid; equivalent in volume to 800 cubic inches of gas. According to the most exact experiments on respiration, a man of ordinary size discharges from his lungs 1632 cubic inches of carbonic acid gas per hour, which is very nearly the double of the quantity produced from the wax candle: Hence the combustion of two such candles vitiates the air much the same as the breathing of one man. A tallow candle, three or four in the pound, generates nearly the same quantity of carbonic acid as the wax candle; for though tallow contains only 79 per cent. of carbon, instead of 81·75, yet it consumes so much faster, as thereby to compensate fully for this difference.

When a tallow candle of 6 to the lb. is not snuffed, it loses in intensity, in 30 minutes, 80 hundredths; and in 39 minutes 86 hundredths, in which dim state it remains stationary, yet still consuming nearly the same proportion of tallow. A wax candle attains to its greatest intensity of light when its wick has reached the greatest length, and begins to bend out of the flame. The reason of this difference is, that only the lower part of the wick in the tallow candle is charged with the fat, so as to emit luminiferous vapour, while the upper part remains dry; whereas, in the wax candle, the combustible substance being less fusible and volatile, allows a greater length of the wick to be charged by capillary attraction, and of course to emit a longer train of light.

The following table contains, according to Péclet, the illuminating powers of different candles, and their consumption of material in an hour; the light emitted by a *Carcel* Argand lamp, consuming 42 grammes (= 42 × 15½ grains) in an hour, being called 100: —

	Intensity of Light.	Consumption per Hour.
Tallow Candles 6 in lb. - -	10·66	8·51
Stearine, or Pressed Tallow, 8 in lb. -	8·74	7·51
——————— 5 in lb. -	7·50	7·42
Wax Candles, 5 in lb. - -	13·61	8·71
Spermaceti, 5 in lb. - - -	14·40	8·92
Stearic Acid, commonly called Stearine, 5 in lb. - - -	14·40	9·33

The subjoined table shows the economical ratios of the candles, where the second column gives the quantity of material in grammes which is requisite to produce as much light as the Carcel lamp: —

	Quantity of Material.	Price per Kilogramme.	Cost of Light per Hour.
Tallow Candle, 6 per lb. -	70·35	1 f. 40 c.	9·8 c.
——————— 8 per lb. -	85·92	1 f. 40 c.	12·0 c.
Pressed Tallow, 5 per lb. -	98·93	2 f. 40 c.	23·7 c.
Wax Candle, 5 per lb. -	64·04	7 f. 60 c.	48·6 c.
Spermaceti ditto, 5 per lb.	61·94	7 f. 60 c.	47·8 c.
Stearine ditto, 5 per lb. -	65·24	6 f.	37·1 c.

These results may be compared with mine given above. A kilogramme, or 1000 grammes = 15,440 grains = 2¼ lbs, avoirdupois.

INDIGO. Imported for home consumption, in 1839, 2,704,396 pounds; in 1840, 2,996,215; duty 3*d.* on West Indian, 4*d.* on East Indian.

INK. Mr. Stephen's patent blue ink is made by dissolving Prussian blue in a solution of oxalic acid.

IRON. For certain new processes for making malleable iron, Mr. W. N. Clay has obtained two successive patents. Under the first, of December, 1837, he mixed bruised hematite, with one fifth of its weight of clean carbonaceous matter in coarse powder, and subjected the mixture in a ⌓ shaped retort to a bright red heat for twelve or more hours, till the ore be reduced to the metallic state, as is easily ascertained by applying a file to one of the fragments. When discharged, the metal is to be transferred into a balling or puddling furnace, along with about five per cent. of ground coke or anthracite, and worked therein in the usual way. He also proposes to use a conical kiln, like that for burning lime, instead of the retorts.

In his second patent, dated March, 1840, Mr. Clay prescribes above 28 per cent. (from 30 to 40) of carbonaceous matter to be mixed with the ground-iron ore, containing at least 45 per cent. of metal, which mixture is to be directly treated in a puddling furnace. He also proposes to use a mixture of pig or scrap iron and ore, in equal quantities.

The application of the waste gases (carbonic oxide chiefly) of the blast furnace to the purpose of heating the puddling or balling furnace, was made the subject of a patent in June, 1841, by a foreigner not named. The process had been previously practised in Germany, and is fully described in the *Annales des Mines*, about two years ago.

In *fig.* 74. the manner of conveying the waste carbonic oxide from a blast furnace is shown. *a, a, a,* are openings leading into the vertical channels or passages *b*, and from thence into the chamber *c*. There is a top to this chamber, with openings corresponding to the passages *b*. These openings are closed with cast-iron plates that can be taken off for the purpose of clearing out the passages *b*, and the chamber *c*. From the chamber *c*, the gas may be conducted in any direction, and to a distance of several hundred feet.

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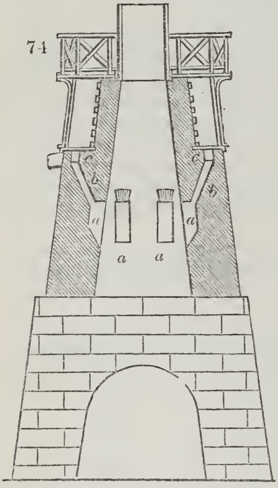
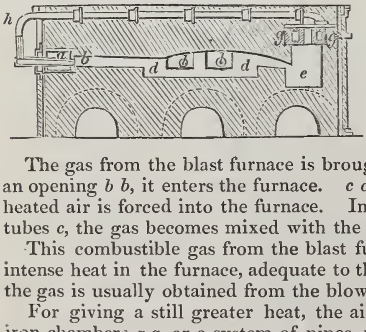


In some localities, and in cases where it is required to take the gas from a blast furnace in operation, a metal cylinder, of a smaller diameter than the top of the furnace, and of a depth equal to its diameter, is suspended vertically within the top of the blast furnace the whole of its length. The space between the cylinder and the furnace at the top or mouth is to be hermetically sealed, and the furnace is to be charged through the cylinder, which must be kept full of minerals and combustibles. Thus the space between the cylinder and the interior of the furnace remains vacant, but the gas may be conducted out of that part laterally, if required. The gases led off from the blast furnace may, if need be, pass through heated pipes, as for the hot blast.

Figs. 75. and 76. represent a refining furnace for iron, with the necessary apparatus for working it with the gases, without the use of other fuel; *fig.* 75. being a vertical section, and *fig.* 76. a sectional plan view.

75



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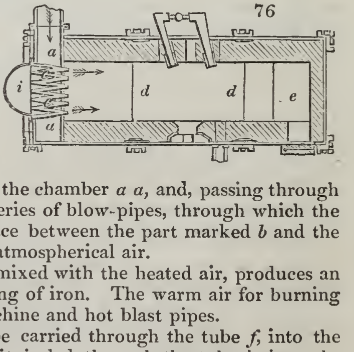

The gas from the blast furnace is brought into the chamber *a a,* and, passing through an opening *b b,* it enters the furnace. *c c* are a series of blow-pipes, through which the heated air is forced into the furnace. In the space between the part marked *b* and the tubes *c*, the gas becomes mixed with the heated atmospherical air.

This combustible gas from the blast furnace, mixed with the heated air, produces an intense heat in the furnace, adequate to the refining of iron. The warm air for burning the gas is usually obtained from the blowing machine and hot blast pipes.

For giving a still greater heat, the air may be carried through the tube *f*, into the iron chambers *g g*, or a system of pipes, whence it is led through the tube *h*, into the semi-circular chamber *i*, and then through the small pipes *c, c, c,* into the furnace.

The metal to be refined is placed in the space *d d,* in a liquid state, if the arrangement of the furnaces will admit of its being so taken from the blast furnace; if not, it may be nearly melted by the waste heat in the chamber *e e*. In order to decarbonise the metal, a quantity of warm air, from the pipe *h*, is conducted through the pipe *k*, which is divided into two nozzles or *tuyères l l*, and blown upon the fluid metal in the space *d d*. After having been thus exposed for an hour or two, it is run off through the opening *m*, and will be found in a refined state.

Figs. 77. 78. show the application to a puddling furnace. The openings *n n* admit a stream of cold water to flow through the cast-iron piece *o o*, to preserve it from injury by the fire.

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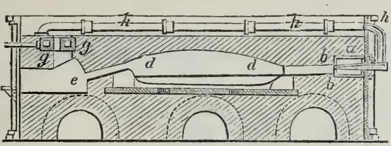

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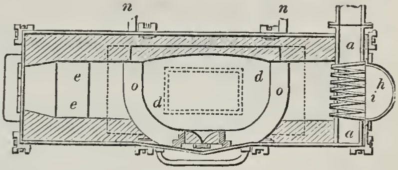

Fig. 79. is a welding furnace; the interior dimensions and the casing of the hearth being different, as well as the fire bridge, from those of the puddling furnace. The pipes for conducting the gases are made of cast-iron, and must have at least a sectional area of one foot for every furnace that is to be heated.

Figs. 80, 81, 82, 83, 84. show the application of this invention to the generation of steam. A chimney is here employed only at the commencement of the operation. The air is forced into the furnace by any sort of blowing machine, or in any other convenient way. The fuel is introduced into the fire-place, upon the grate *n n*, through the door *a*, which can be closed. The fire-place must contain as much fuel as will last for several hours. When the fire is first lighted, the combustion takes place in the ordinary way, on opening the door *d*, and the slide-valve *b*, and carrying through them a current of air by the chimney draught. This is continued till the steam-engine furnace, or any working (power) engine is in operation, after which a blowing apparatus is employed to force the air through the tube *c*, as shown in *fig.* 81. The openings *d* and *b* are then closed; the air forced in now passes through the flues *f, f, f*, placed round and beneath the boiler. The air, on arriving at the point *g*, is divided, one portion passes through the opening *h*, regulated by a valve, into the open space beneath the grate *n n*, to assist in the slow combustion of the fuel. The other part of the air passes through *g*, into *h h*, round the fire-place, in order to heat the air to an intense degree. After the second portion of the air has passed into the chamber *h h*, it enters another *i i*, thence through a series of blowpipes, or through *o*, into *p p*, beneath the

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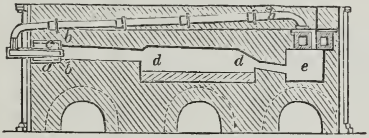

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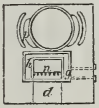

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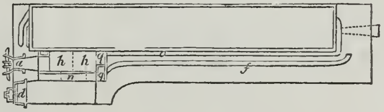

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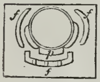

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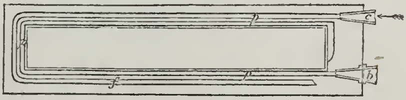

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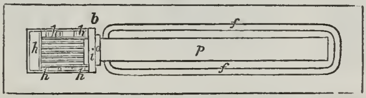

boiler. The burnt air goes off through *pp* into a small chimney, through the opening *b b*, which is regulated by a valve.

IRON, Cast, Strength of.

In the following Table, each bar is reduced to exactly one inch square; and the transverse strength, which may be taken as a criterion of the value of each iron, is obtained from a mean between the experiments upon it, given in the Memoirs; — first on bars 4 ft. 6 in. between the supports, and next on those of half the length, or 2 ft. 3 in. between the supports. All the other results are deduced from the 4 ft. 6 in. bars. In all cases the weights were laid on the middle of the bar.

Table of Results obtained from Experiments on the Strength and other Properties of Cast Iron, from the principal Iron Works in the United Kingdom. By Mr. Wm. Fairbairn.

Number of Iron in the scale of strength.	Names of Irons.	Number of Experiments on each.	Specific gravity.	Modulus of elasticity in lbs. per square inch, or stiffness.†	Breaking weight in lbs. of bars 4 ft. 6 in. between supports.	Breaking weight in lbs. of bars 2 ft. 3 in. reduced to 4 ft. 6 in. between supports.	Mean breaking weight in lbs. (S.)	Ultimate deflection of 4 ft. 6 in. bars, in parts of an inch.	Power of the 4 ft. 6 in. bars to resist impact.	Colour.	Quality.
1	Ponkey, No. 3. Cold Blast	4	7·122	17211000	567	595	581	1·747	992	Whitish grey	Hard.
2	Devon, No. 3. Hot Blast *	2	7·251	22473650	537	—	537	1·09	589	White	Hard.
3	Oldberry, No. 3. Hot Blast	5	7·300	22733400	543	517	530	1·005	549	White	Hard.
4	Carron, No. 3. Hot Blast *	2	7·056	17873100	520	534	527	1·365	710	Whitish grey	Hard.
5	Beaufort, No. 3. Hot Blast	5	7·069	16802000	505	529	517	1·599	807	Dullish grey	Hard.
6	Butterley	4	7·038	15379500	489	515	502	1·815	889	Dark grey	Soft.
7	Bute, No. 1. Cold Blast	4	7·066	15163000	495	487	491	1·764	872	Bluish grey	Soft.
8	Wind Mill End, No. 2. Cold Blast	4	7·071	16490000	483	495	489	1·581	765	Dark grey	Hard.
9	Old Park, No. 2. Cold Blast	5	7·049	14607000	441	529	485	1·621	718	Grey	Soft.
10	Beaufort, No. 2. Hot Blast	4	7·108	16301000	478	470	474	1·512	729	Dull grey	Hard.
11	Low Moor, No. 2. Cold Blast	4	7·055	14509500	462	483	472	1·852	855	Dark grey	Soft.
12	Buffery, No. 1. Cold Blast *	5	7·079	15381200	463	—	463	1·55	721	Grey	Rather hard.
13	Brimbo, No. 2. Cold Blast	5	7·017	14911666	466	453	459	1·748	815	Light grey	Rather hard.
14	Apedale, No. 2. Hot Blast	3	7·017	14852000	457	455	456	1·730	791	Light grey	Stiff.
15	Oldberry, No. 2. Cold Blast	4	7·059	14307500	453	457	455	1·811	822	Dark grey	Rather soft.
16	Pentwyn, No. 2.	4	7·038	15193000	438	473	455	1·484	650	Bluish grey	Hard.
17	Maesteg, No. 2.	5	7·038	13959500	453	455	454	1·957	886	Dark grey	Rather soft.
18	Muirkirk, No. 1. Cold Blast *	4	7·113	14003550	443	464	453	1·734	770	Bright grey	Fluid.
19	Adelphi, No. 2. Cold Blast	5	7·080	13815500	441	457	449	1·759	777	Light grey	Soft.
20	Blania, No. 3. Cold Blast	5	7·159	14281466	433	464	448	1·726	747	Bright grey	Hard.
21	Devon, No. 3. Cold Blast *	4	7·285	22907700	448	—	448	·790	353	Light grey	Hard.
22	Gartsherrie, No. 3. Hot Blast	5	7·017	13894000	427	467	447	1·557	998	Light grey	Soft.
23	Frood, No. 2. Cold Blast	5	7·031	13112666	460	434	447	1·825	841	Light grey	Open.
24	Lane End, No. 2.	3	7·028	15787666	444	—	444	1·414	629	Dark grey	Soft.
25	Carron, No. 3. Cold Blast *	5	7·094	16246966	444	443	443	1·336	593	Grey	Soft.
26	Dundivan, No. 3. Cold Blast	4	7·087	16534000	456	430	443	1·469	674	Dull grey	Rather soft.
27	Maesteg (Marked Red)	5	7·038	13971500	440	444	442	1·887	830	Bluish grey	Fluid.
28	Corbyns Hall, No. 2.	5	7·007	13845866	430	454	442	1·687	727	Grey	Soft.
29	Pontypool, No. 2.	5	7·080	13136500	439	441	440	1·857	816	Dull blue	Rather soft.
30	Wallbrook, No. 3.	5	6·979	15394766	432	449	440	1·443	625	Light grey	Rather hard.
31	Milton, No. 3. Hot Blast	4	7·051	15852500	427	449	438	1·368	585	Grey	Rather hard.
32	Buffery, No. 1. Hot Blast *	3	6·998	13730500	436	—	436	1·64	721	Dull grey	Soft.
33	Level, No. 1. Hot Blast	5	7·080	15452500	461	403	432	1·516	699	Light grey	Soft.
34	Pant, No. 2.	5	6·975	15280900	408	455	431	1·251	511	Light grey	Rather hard.
35	Level, No. 2. Hot Blast	6	7·031	15241000	419	439	429	1·358	570	Dull grey	Soft
36	W. S. S., No. 2.	5	7·041	14953333	413	446	429	1·339	554	Light grey	Soft
37	Eagle Foundry, No. 2. Hot Blast	4	7·038	14211000	408	446	427	1·512	618	Bluish grey	Soft
38	Elsicar, No. 2. Cold Blast	4	6·928	12586500	446	408	427	2·224	992	Grey	Soft
39	Varteg, No. 2. Hot Blast	4	7·007	15012000	422	430	426	1·450	621	Grey	Har
40	Coltham, No. 1. Hot Blast	5	7·128	15510066	464	385	424	1·532	716	Whitish grey	Rather soft.
41	Carroll, No. 2. Cold Blast	4	7·069	17036000	430	408	419	1·231	530	Grey	Hard.
42	Muirkirk, No. 1. Hot Blast *	4	6·953	13294400	417	419	418	1·570	656	Bluish grey	Soft.
43	Bierley, No. 2.	5	7·185	16156133	404	432	418	1·222	494	Dark grey	Soft.
44	Coed-Talon, No. 2. Hot Blast *	4	6·969	14322500	409	424	416	1·882	771	Bright grey	Soft.
45	Coed-Talon, No. 2. Cold Blast *	5	6·955	14304000	408	418	413	1·470	600	Grey	Rather soft.
46	Monkland, No. 2. Hot Blast	3	6·916	12259500	402	404	403	1·762	709	Bluish grey	Soft.
47	Ley's Works, No. 1. Hot Blast	3	6·957	11539333	392	—	392	1·890	742	Bluish grey	Soft.
48	Milton, No. 1. Hot Blast	4	6·976	11974500	353	386	369	1·525	538	Grey	Soft & fluid
49	Plaskynaston, No. 2. Hot Blast	5	6·916	13341633	378	337	357	1·366	517	Light grey	Rather sof

Rule. — To find from the above table the breaking weight in rectangular bars, generally, calling b and d the breadth and depth in inches, and l the distance between the supports in feet, and putting 4·5 for 4 ft. 6 in., we have $\frac{4{\cdot}5 \times bd^2 S}{l}$ = breaking weight in lbs., the value of S being taken from the table above.

For example: — What weight would be necessary to break a bar of Low Moor iron, 2 inches broad, 3 inches deep, and 6 feet between the supports? According to the rule given above, we have $b = 2$ inches, $d = 3$ inches, $l = 6$ feet, $S = 472$ from the table. Then $\frac{4{\cdot}5 \times bd^2 S}{l} = \frac{4{\cdot}5 \times 2 \times 3^2 \times 472}{6} = 6372$ lbs., the breaking weight.

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* The irons with asterisks are taken from the experiments on hot and cold blast iron, made by Mr. Hodgkinson and myself for the British Association for the Advancement of Science. — See Seventh Report, vol. vi.

† The modulus of elasticity was usually taken from the deflection caused by 112 lbs. on the 4 ft. 6 in. bars.

IRON. *Hot Blast.* To the account of this interesting innovation in the smelting of iron ores, given in the dictionary, I have now the pleasure of representing in accurate plans, the complete system mounted at the Codner Park Works belonging to William Jessop, Esq. For the drawings, from which the woodcuts are faithfully copied, I am indebted to Mr. Joseph Glynn, F.R.S., the distinguished engineer of the Butterley Iron Works.

Figs. 85, 86, 87. exhibit the apparatus of the hot blast in every requisite detail. The smelting furnaces have now generally three tuvères, and three sets of air heating furnaces. The figures show two sets built together; the third set being detached on account of peculiar local circumstances. The air enters the horizontal pipe A, in the ground plan, *fig.* 85., on one side of the arched or syphon pipes, shown in upright section in *fig.* 86., and passes through these pipes to the horizontal pipe, B, on the other side; whence it proceeds to the blast furnace. These syphon pipes are flattened laterally, their section being a parallelogram, to give more heating surface, and also more depth of pipe (in the vertical plane), so as to make it stronger, and less liable to bend by its own weight when softened by the red heat. This system of arched pipe apparatus is set in a kind of oven, from which the flue is taken out at the top of it; but it thence again descends, before it reaches the chimney, entering it nearly at the level of the fire grate (as with coal gas retorts). By this contrivance, the pipes are kept in a bath of ignited air, and not exposed to the corroding influence of a current of flame. The places and directions of these oven flues are plainly marked in the drawing.

85

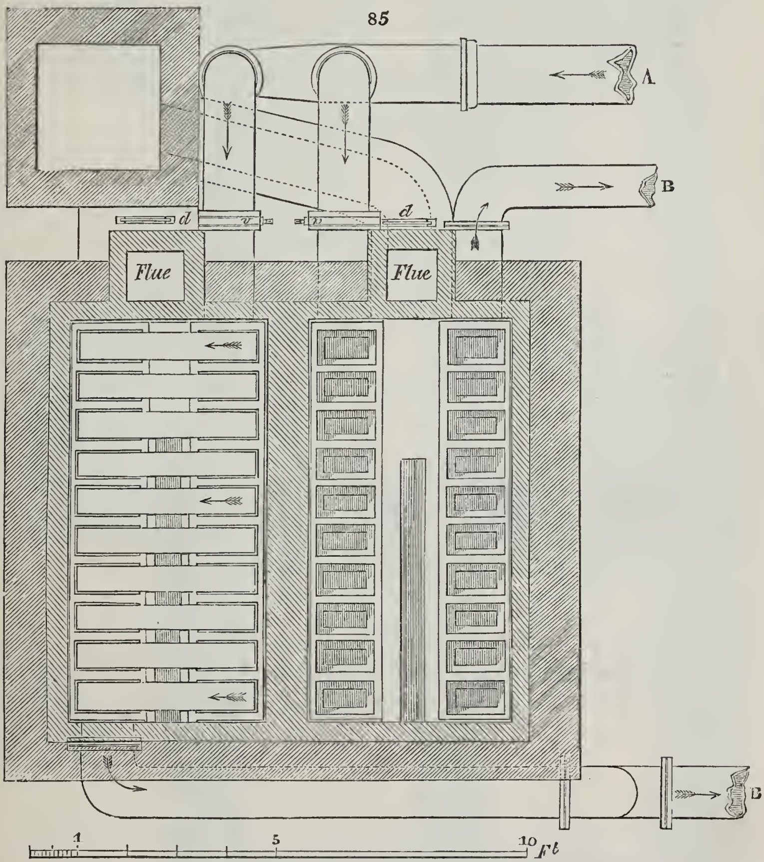
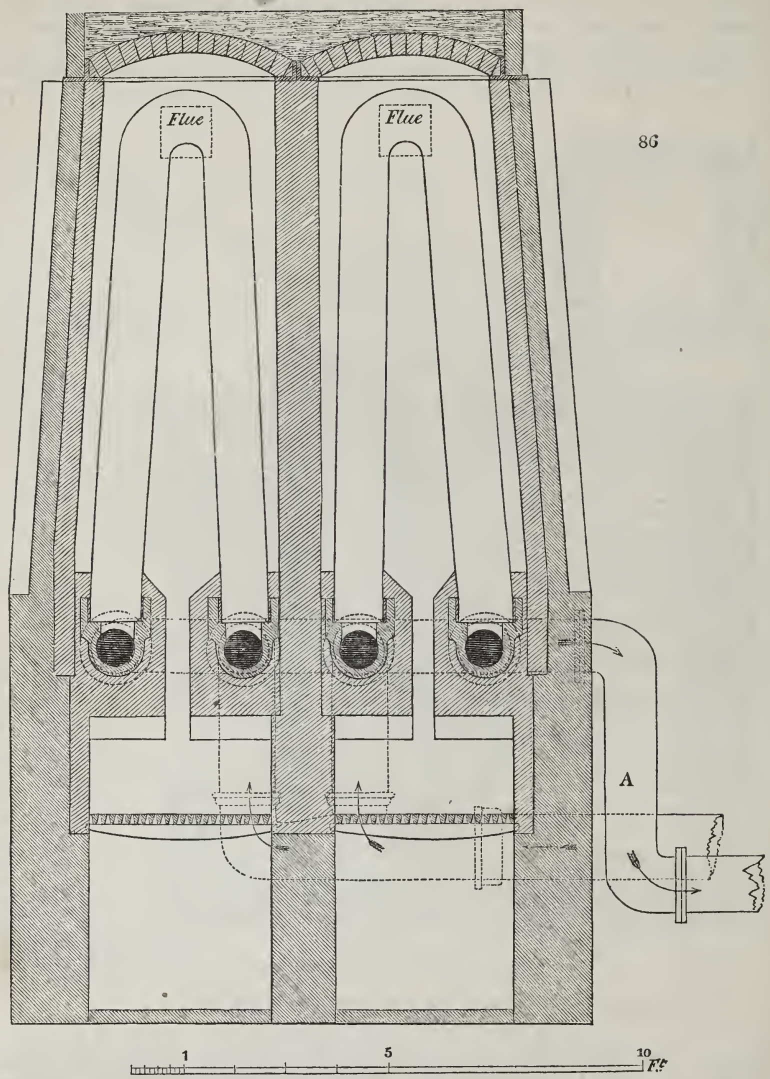


Fig. 87. is a plan of the blast furnace, drawn to a smaller scale than that of the preceding figures.



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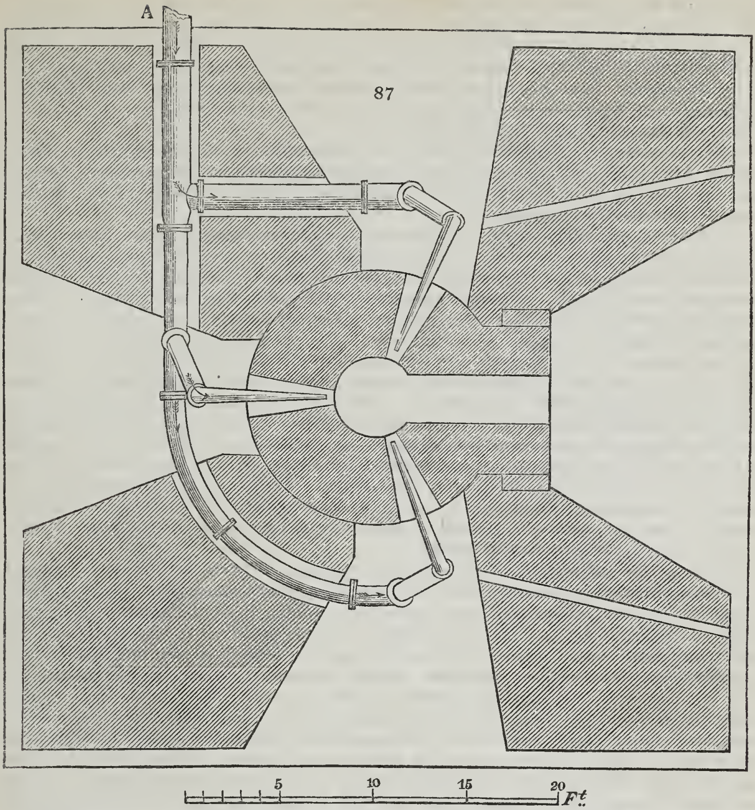
The three sets of hot-blast apparatus, all communicate with one line of conducting pipes, A, which leads to the furnace. Thus in case of repairs being required in one set, the other two may be kept in full activity, capable of supplying abundance of hot air to the blast, though of a somewhat lower temperature. See Smelting for constructions of different blast furnaces; also Puddling.

During a visit which I have recently made to Mr. Jessop, at Butterley, I found this eminent and very ingenious iron-master had made several improvements upon his hot-blast arrangements, whereby he prevented the alteration of form to which the arched pipes were subject at a high temperature, as also that he was about to employ five tuyères instead of three. For a drawing and explanation of his furnace-feeding apparatus, see Smelting.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ISINGLASS. Imported for home consumption in 1839, 1,644 cwts.; in 1840, 1,589 cwts. See Gelatin for excellent substitutes for isinglass in culinary operations. Were beer brewed by the Bavarian plan of fermentation, it would require no isinglass for fining it.

IVORY. Imported of elephant's teeth for home consumption in 1839, 3,929 cwts.; in 1840, 4,491 cwts. Duty 1*s*.

K.

KILLAS. The name given by the Cornish miners to *clay slate*, commonly of a greenish colour, in which the richest deposits of copper and tin occur.

L.

LAC DYE. Imported for home consumption in 1839, 532,881 pounds; in 1840, 644,092 pounds; 6*s*. per cwt. duty.

LACTIC ACID. See Fermentation.

LAMPS. The leading novelty under this title, is the construction of lamps for burning spirits of turpentine, in the place of the fat oils which alone have been in use from the most remote ages down to the present year. Two patents have recently been obtained for these lamps, under the fantastic title of *Camphine;* one by Mr. William Young, and another by Messrs. Rayner and Carter, as the invention of a working miner — Roberts. Having been employed by the proprietors of these patents to examine the performances of their respective lamps, I here insert the two reports drawn up by me on these occasions: —

" The *Vesta Lamp*, burning with its utmost brilliancy, without smoke, emits a light equal to very nearly twelve wax or sperm candles of three or four to the pound; and in so doing, it consumes exactly one imperial pint of spirits of turpentine (value sixpence retail) in ten hours, hence the cost per hour for a light equal to ten such candles is one halfpenny; whereas that from wax candles would be nearly sixpence; from spermaceti ditto, fivepence; from stearine ditto, fourpence; from Palmer's spreading wick ditto, nearly threepence; from tallow moulds 2¼*d.*; from sperm oil in Carcel's Mechanical French Lamp, 1½*d.*

"One peculiar advantage of the Vesta Lamp is the snowy whiteness of its light, which is such as to display the more delicate colours of natural and artificial objects, flowers, paintings, &c. in their true tints, instead of the degraded hues visible by the light of candles and ordinary oil lamps.

"The size of the flame from which so much light is emitted in the Vesta Lamp, is greatly smaller than that of oil or gas Argand flames of equal intensity; a circumstance to be accounted for from the difference in chemical composition, between spirits of turpentine and fat oils. The spirits consist entirely of carbon and hydrogen; in the proportion of 88½ of the former element, and 11½ of the latter, in 100 parts; and they consume 328 parts of oxygen; whereas, sperm and other unctuous oils consist of 78 parts of carbon, 11½ of hydrogen, and 10½ of oxygen, in 100 parts; and these consume only 287.2 of oxygen, in being burnt; because the oxygen already present in the oil neutralises 2.6 parts of the carbon and 0.4 of the hydrogen, thus leaving only 85½ parts of the combustible elements for the atmosphere to burn. For this reason, 87½ parts by weight of spirits of turpentine, will consume as much oxygen as 100 parts of sperm oil; and will afford, moreover, a more vivid light, because they contain no oxide, as fat oils do, which serves to damp the combustion. In the spirits of turpentine, the affinity of its elements for oxygen is entire, whereas in fat oil the affinity is partially neutralized by the oxides it contains; somewhat as the flame of spirits of wine is weakened by their dilution with water.

"Among the many applications of science to the useful arts, for which the present age is so honourably distinguished, few are more meritorious than the Camphine Lamps, by which we can produce a snow-white flame from the cleanly, colourless spirits of turpentine, — a pure combustible fluid, in place of the smeary rank oils which contain a seventh part of incombustible matter. Being so rich in hydro-carbon, the spirits require peculiar artifices for complete consumption and the development of their full power of yielding light without smoke or smell. This point of perfection seems to be happily attained by the invention of the two parallel flat rings, in the Paragon Lamp, a larger and smaller, forming a cone round the margin of the wick, which cause a rapid reverberation of the air against the flame: thus consuming every particle of volatilized vapour, and adding energy to the luminous undulations. Hence the patent Paragon Lamp in full action emits a light equal to that of sixteen wax candles, three to the pound, but of better quality, approaching in purity to that of the sun-beam, — therefore capable of displaying natural and artificial objects in their true colours.

"One imperial pint of rectified spirits of turpentine, value 6*d.* retail, will burn for twelve hours in this lamp, affording all the time the illumination of eleven wax candles.

"The Paragon Camphine Lamp is attended with no danger in use.

"The Cost, as compared with other Lamps or Candles, is as follows: viz. —

	PER HOUR.
Paragon Camphine Lamp (equal to 11 wax candles,)	less than One Halfpenny.
Wax Candles	6½*d.*
Spermaceti ditto	5¾
Adamantean Wax (Stearic Acid)	4½
Palmer's Spread-Wick Candles	3¼
Cocoa Nut Candles	4¾
Moulds (Tallow)	2¾
Carcel's Lamp, with Sperm Oil	2"

See Illumination, cost of, for a description of an excellent oil lamp.

LEAD. The total produce of the lead mines of Great Britain was estimated in 1822, at 31,900 tons, which were distributed as follows: —

Wales (Flintshire and Derbyshire)	7,500 tons.
Scotland	2,800
Cornwall and Devonshire	800
Shropshire	800
Derbyshire	1,000
Cumberland, Durham, and Yorkshire	19,000
	31,900

And in the year 1835, the total produce was estimated, by Mr. John Taylor, at 46,112 tons; of which 19,626 were furnished by Northumberland, Durham, and Cumberland; the mines of Mr. Beaumont alone, yielding 10,000. See SOLDER.

LEATHER. In the Franklin Institute for February 1843, Mr. Gideon Lee has published some judicious observations on the process of tanning. He believes that much of the original gelatine of the hides is never combined with the tannin, but is wasted; for he thinks that 100 lbs. of perfectly dry hide, when cleansed from extraneous matter, should, on chemical principles, afford at least 180 lbs. of leather. The usual preparation of the hide for tanning he believes to be a wasteful process. In the liming and bating, or the unhairing and the cleansing, the general plan is first to steep the hides in milk of lime for one, two, or three weeks, according to the weather and texture of the skin, until the hair and epidermis be so loosened as to be readily removed by rubbing down, by means of a knife, upon a beam or block. Another mode is to suspend the hides in a close chamber heated slightly by a smouldering fire, till the epidermis gets loosened by incipient putrefaction. A third process, called sweating, used in Germany, consists in laying the hides in a pack or pile, covered with tan, to promote fermentative heat, and to loosen the epidermis and hairs. These plans, especially the two latter, are apt to injure the quality of the hides.

The *bate* consists in steeping the haired hides in a solution of pigeon's dung, containing, Mr. Lee says, muriate of ammonia, muriate of soda, &c.; but most probably phosphates of ammonia and lime, with urate of ammonia, and very fermentable animal matter. The dry hides are often subjected first of all to the operation of the fulling-stocks, which opens the pores, but at the same time prepares them for the action of the liming and bate; as also for the introduction of the tanning matter. When the fulling is too violent, the leather is apt to be too limber and thin. Mr. Lee conceives that the liming is injurious, by carrying off more or less of the gelatine and albumen of the skin. High-limed leather is loose, weighs light, and wears out quickly. The subsequent fermentation in the bating aggravates that evil. Another process has therefore been adopted in New York, Maine, New Hampshire, and some parts of Philadelphia, called, but incorrectly, *cool sweating*, which consists in suspending the hides in a subterranean vault, in a temperature of 50° Fahr., kept perfectly damp, by the trickling of cold spring water from points in the roof. The hides being first soaked, are suspended in this vault from 6 to 12 days, when the hair is well loosened, by the mere softening effect of moisture, without fermentation.

LEATHER, MOROCCO. (*Maroquin*, Fr. *Saffian*, Germ.) Morocco leather of the finer quality is made from goat-skins tanned with sumach; inferior morocco leather from sheep skins. The goat skins as imported are covered with hair; to remove which they are soaked in water for a certain time, and they are then subjected to the operation called breaking, which consists in scraping them clean and smooth on the flesh side, and they are next steeped in lime pits (milk of lime) for several days, during which period they are *drawn out*, with a hook, from time to time, laid on the side of the pit to drain, and replunged alternately, adding occasionally a little lime, whereby they are eventually deprived of their hair. When this has become sufficiently loose, the skins are taken out one by one, laid on convex beams, the work benches, which stand in an inclined position, resting on a stool at their upper end, at a height convenient for the workman's breast, who scrapes off the hair with a concave steel blade or knife, having a handle at each end. When unhaired, the skins are once more soaked in milk of lime for a few days, and then scraped on the flesh side to render it very even. For removing the lime which obstructs their pores, and would impede the tanning process, as well as to open these pores, the skins are steeped in a warm semi-putrid alkaline liquor, made with pigeons' and hens' dung diffused in water. Probably some very weak acid, such as fermented bran water, would answer as well, and not be so offensive to the workmen. (In Germany the skins are first washed in a barrel by a revolving axle and discs.) They are again scraped, and then sewed into bags, the grain outermost, like bladders, leaving a small orifice, into which the neck of a funnel is inserted, and through which is poured a certain quantity of a strong infusion of the sumach; and they are now rendered tight round the orifices, after being filled out with air, like a blown bladder. A parcel of these inflated skins are thrown into a very large tub, containing a weaker infusion of sumach, where they are rolled about in the midst of the liquor, to cause the infusion within to act upon their whole surface, as well as to expose their outsides uniformly to the tanning action of the bath. After a while these bladder skins are taken out of the bath, and piled over each other upon a wooden rack, whereby they undergo such pressure as to force the enclosed infusion to penetrate through their pores, and to bring the tannin of the sumach into intimate contact, and to form a chemical combination with the skin fibres. The tanning is completed by a repetition of the process, of introducing some infusion or decoction into them, blowing them up, and floating them with agitation in the bath. In this way goat skins may be well tanned in the course of one day.

The bags are next undone by removing the sewing, the tanned skins are scraped as before on the currier's bench, and hung up in the drying loft or shed; they are said now to be "in the crust." They are again moistened and smoothed with a rubbing tool before being subjected to the dyeing operations, in which two skins are applied face to face to confine the dye to one of their surfaces only, for the sake of economising the dyeing materials which may be of several different colours. The dyed skins are grained by being strongly rubbed with a ball of box wood, finely grooved on its surface.

Tawing of Skins. (*Megisserie*, Fr.; *Weissgerberei*, Germ.). The kid, sheep, and lamb skins, are cleaned as has been described under leather in the Dictionary. In some factories they receive the tanning power of the submuriate of alumina (from a solution of alum and common salt) in a large barrel-churn apparatus; in which they are subjected to violent agitation, and thereby take the *aluming* in the course of a few minutes. In other cases, where the yolks of eggs are added to the above solution, the mixture, with the skins, is put into a large tub, and the whole trampled strongly by the naked feet of the operator, till the emulsion of the egg be forced into the pores of the skin. The tawed skins, when dry, are "staked," that is stretched, scraped, and smoothed by friction against the blunt edge of a semi-circular knife, fixed to the top of a short beam of wood set upright. The workman holding the extremities of the skin with both hands, pulls it in all directions forcibly, but skilfully, against the smoothing "stake."

In an entertaining article on tanning in the 11th vol. of the Penny Magazine, at page 215., the following description is given of one of the great tawing establishments of London.

"In the production of 'imitation' kid leather, the skin of lambs is employed; and for this purpose lamb-skins are imported from the shores of the Mediterranean. They are imported with the wool yet on them; and as this wool is valuable, the leather manufacturer removes this before the operations on the pelt commence. The wool is of a quality that would be greatly injured by the contact of lime, and therefore a kind of natural fermentation is brought about as a means of loosening the wool from the pelt. At the *Neckinger* establishment of Messrs. Bevington and Co. Bermondsey, one of the buildings presents, on the ground floor, a flight of stone steps, leading down to a range of subterranean vaults or close rooms, into which the lamb-skins are introduced in a wet state, after having been steeped in water, 'broken' on the flesh side, and drained. The temperature of these rooms is nearly the same all the year round, a result obtained by having them excluded as much as possible from the variations of the external atmosphere; and the result is, that the skins undergo a kind of putrefactive or fermenting process, by which the wool becomes loosened from the pelt. During this chemical change ammonia is evolved in great abundance; the odour is strong and disagreeable; a lighted candle, if introduced, would be instantly extinguished, and injurious effects would be perceived by a person remaining long in one of the rooms. Each room is about ten feet square, and is provided with nails and bars whereon to hang the lamb-skins. The doors from all the rooms open into one common passage or vault, and are kept close, except when the skins are inspected. It is a point of much nicety to determine when the fermentation has proceeded to such an extent as to loosen the wool from the pelt; for if it be allowed to proceed beyond that stage, the pelt itself would become injured."

When the fermentation is completed, generally in about five days, the skins are removed to a beam, and there 'slimed,' that is scraped on the flesh side, to remove a slimy substance which exudes from the pores. The wool is then taken off, cleaned, and sold to the hatters, for making the bodies of common hats. The stripped pelts are steeped in lime-water for about a week, to kill the grease; and are next 'fleshed on the beam.' After being placed in a 'drench,' or a solution of sour bran for some days to remove the lime and open the pores, the skins are alumed, and subjected to nearly the same processes as the true kid-skins. (See Leather.) These Mediterranean lamb-skins do not in general measure more than about 20 inches by 12; and each one furnishes leather for two pairs of small gloves. These kinds of leather generally leave the leather-dresser in a white state; but undergo a process of dyeing, softening, 'stroking,' &c., before being cut up into gloves.

The tanning of one average-sized skin requires about 1¼ lbs. of good Sicilian sumach; but for leather which is to receive a bright scarlet dye, from one half to three quarters of a pound of gall-nuts are employed in preference. Inferior goat skins are tanned with a willow bark infusion, in pits, in which they are turned repeatedly, and laid out to drain, as in tanning sole leather. The finest skins for the brightest scarlet are cured with salt, to prevent their receiving damage in the transport, and are dyed before being tanned. This method is practised in Germany and France.

Leather of deer and sheep-skins is prepared with oil, for the purpose of making breeches, &c., and for wash-leather, used in cleaning plate. After they are completely washed, limed, and beamed, as above described, they have their 'grain'-surface removed, to give them greater softness and pliability. This removal of the grain is called 'frizing,' and it is done either with the round edge of a blunt knife, or with pumice-stone. After being freed from the lime by steeping in fermented bran-water, they are pressed as dry as may be, and are then impregnated with cod-oil, by beating with stocks in the trough of a kind of a fulling-mill. Previously to the application of the oil, they are usually beat for some time alone to open their substance. The oiled skins are stretched, hung up for some time in the air, then fulled with oil as before — a process which is 8 or 9 times repeated. The oil is slowly and evenly poured upon the skins in the trough, during the action of the beaters. One hundred skins usually take up in this way from two to three gallons of oil. The fulled oiled skins are thrown into large tubs, and left for some time to ferment, and thereby to combine more intimately with the oil. They are lastly subjected to a weak potash ley bath, to strip them of the loosely adhering oil. They are then hung up in the air to dry, and dressed for the market.

The quantity of hides and skins converted into leather yearly in England is almost incredibly large. At Messrs. Bevington's establishment alone there are about 250,000 skins annually converted into leather by the aluming or tawing process; 220,000 by the sumach tanning process; as also a small number by the oil-dressing process. For the importation and exportation of *skins* untanned and tanned, see *Hides*.

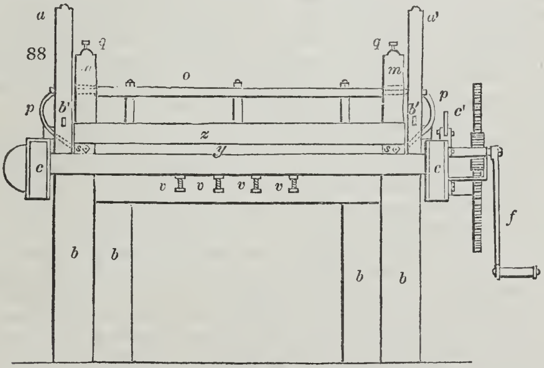
In 1839, 5,149 Russian tanned hides were imported for home consumption; and in 1840, 4,664; of 5*s*. of duty on the entire hide; and pieces 2*s*. 6*d*. per lb.

The declared value of leather exported in 1840 was 320,912*l*.; weight, 2,404,667 lbs. Saddlery and harness of 96,167*l*. declared value were exported.

Leather gloves imported for home consumption in 1839, 991,623 pairs; in 1840, 1,503,862; average duty, 5*s*. a dozen.

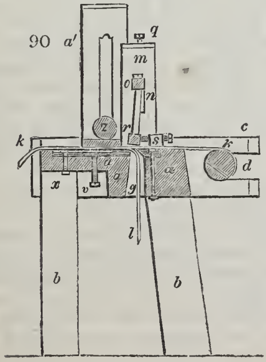
LEATHER SPLITTING. This operation is employed sometimes upon certain sorts of leather for glovers, for bookbinders, sheath-makers, and always to give a uniform thickness to the leather destined for the cotton and wool card-makers.

88

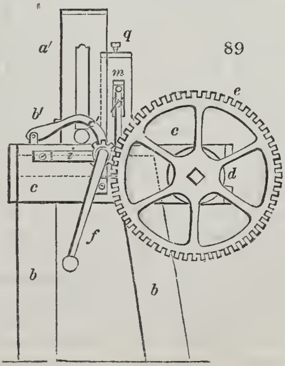


Figs. 88, 89, 90, 91. represent a well contrived machine for that purpose; of which *fig*. 88. shows the front view, *fig*. 89. a view from the left side, *fig*. 91. a ground plan,

90



89

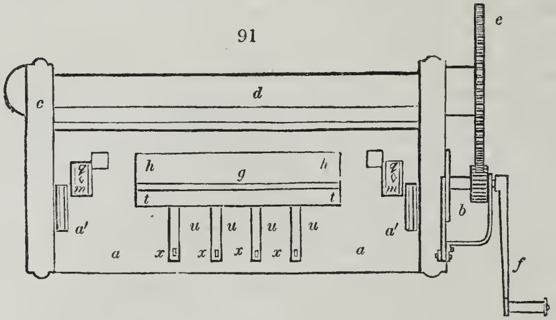


and *fig.* 90. a vertical section across the machine. *a* is a strong table, furnished with four legs *b*, which to the right and left hand bears two horizontal pieces *c*. Each of these pieces is cut out in front, so as to form in its substance a half-round fork, that receives a cylinder *d*, carrying on its end a toothed spur-wheel *e*. Motion is communicated to the wheel by means of the handle *f*, upon whose axis the pinion, *i*, is fixed, working into the wheel *d*, made fast to the end of the cylinder round which the leather is rolled. The leather is fixed at one of its ends or edges to the cylinder, either with a wedge pressed into a groove, or by a moveable segment of the cylinder itself.

The table, *a*, is cut out lengthwise with a slot, that is widened below, as shown in *fig.* 90.

The knife *h* (*figs.* 90. and 91.) is fixed flat upon the table with screw bolts, whose heads are countersunk into the table, and secured with taps beneath (*fig.* 90.), the edge of the knife being placed horizontally over the opening, and parallel with it.

91



In *fig.* 90. the leather, *k*, is shown advancing against the knife, getting split, and has a portion coiled round the cylinder, which is made to revolve in proportion as the leather is cleft. The upper portion of the leather is rolled upon the cylinder *d*, while the under half, *l*, falls through the oblong opening upon the ground.

In regulating the thickness of the split leather, the two supports, *m*, act; they are made fast to the table *a* (one on each side of the knife), and are mortised into the table by two tenons secured beneath. These supports are furnished near their tops with keyed slots, by means of which the horizontal iron rod *o* (*figs.* 88. 90.) is secured, and outside of the uprights they press upon the springs *p p*, which tend to raise the rod, *o*, in its two end slots; but the adjusting screws *q*, which pass down through the tops of the supports into the mortise *n* (*fig.* 90.), and press upon the upper half of the divided tenon, counteract the springs, and, accordingly, keep the rod, *o*, exactly at any desired height or level. The iron rod, *o*, carries another iron bar, *r*, beneath it, parallel and also rectangular, *fig.* 90. This lower bar, which is rounded at its under face, lies upon and presses the leather, by the action of two screws, which pass through two upright pieces *s* (*figs.* 88. and 90.), made fast to the table; thus the iron bar, *r*, may be made to press forwards the edge of the knife, and it may be adjusted in its degree of pressure, according to the desired thickness of the leaf of split leather, that passes through under it.

Fig. 90. shows that the slant or obliquity of the knife is directed downwards, over one of the edges of the oblong opening *g*; the other edge of this opening is provided with an iron plate *t* (*figs.* 90, 91.), which serves to guide the blade in cutting the leather to the proper depth. For this purpose the plate is made adjustable by means of the four springs *u* (*figs.* 90, 91.), let into the table, which press it downwards. Four screws, *v*, pass down through the table, each belonging to its respective springs *u*, and by means of these screws the plate, *t*, may be raised in any desired degree. Each of the screws, *u*, has besides a small rectangular notch, through which a screw bolt, *x*, passes, by which the spring is made fast to the table. Thus also the plate, *t*, may be made to approach to or recede from the knife.

y, in *figs.* 88. and 90., is a flat board, laid upon the leather a little behind the edge of the plate *t*; this board is pressed by the cylinder *z*, that lies upon it, and whose tenons rest in mortises cut out in the two supports *a'*. The cylinder, *z*, is held in its position by a wedge or pin *b* (*figs.* 88. and 89.), which passes through the supports. When the leather has been split, these pins are removed, and the cylinder rises then by means of two counter weights, not shown in the figures.

The operation of the machine is as follows: — The edge or end of the leather being secured to the cylinder *d*, the leather itself having the direction upon the table, shown in *fig.* 90., and the bar, *r*, its proper position over the knife, the edge begins to enter in this position into the leather, while the cylinder, *d*, is moved by the handle or winch, and the piece gets split betwixt the blade and the roller *d*. When the other end of the leather, *k*, advances to the knife, there is, consequently, one half of the leather split; the skin is to be then rolled off the cylinder *d*; it is turned; the already split half, or the end of the leather *k*, is made fast into the wood of the cylinder, and the other half is next split; while the knife now acts from below, in an opposite direction to what it did at first.

That the unrolling of the leather from the cylinder, *d*, may not be obstructed by the pinion *i*, the stop-wedge *e* (*figs.* 88, 89.) is removed from the teeth. In the process of splitting, the grain side of the leather is uppermost, and is therefore cut of an uniform thickness, but the under side varies in thickness with the inequality of the skin.

LINSEED. Imported for home consumption, in 1839, 3,852,359 bushels; in 1840, 3,256,257; 1½*d.* duty.

LODES. The name given by the Cornish miners to metallic veins: as, tin lodes, copper lodes, &c.

LOGWOOD; imported for home consumption in 1839, 17,209 tons; in 1840 18,683 tons; duty 3*s.*, foreign 4*s.* 6*d.*

M.

MACE. Imported for home consumption, in 1839, 21,154 pounds; in 1840, 16,813, duty 2*s.* 6*d.* per pound.

MADDER, GROUND; imported for home consumption in 1839, 96,702 cwts.; in 1840, 134,179 cwts.; duty 2*s.* per cwt.

MADDER ROOT; in 1839, 80,259 cwts.; in 1840, 112,714 cwts.; duty 6*d.* per cwt.

A patent was granted in August, 1843, to Mr. F. Steiner, for the manufacture of *Garancine* from used madder, formerly thrown away, as being exhausted of its dyeing principle. His process is as follows: — " A large filter is constructed outside the building in which the dye-vessels are situated, formed by sinking a hole in the ground, and lining it at the bottom and sides with bricks without any mortar to unite them. A quantity of stones or gravel is placed upon the bricks, and over the stones or gravel common wrappering, such as is used for sacks. Below the bricks is a drain to take off the water which passes through the filter. In a tub adjoining the filter is kept a quantity of dilute sulphuric acid, of about the specific gravity of 105, water being 100. Hydrochloric acid will answer the several purposes, but sulphuric acid is preferred as more œconomical. A channel is made from the dye-vessels to the filter. The madder which has been employed in dyeing is run from the dye-vessels to the filter; and while it is so running, such a portion of the dilute sulphuric acid is run in and mixed with it as changes the colour of the solution and the undissolved madder to an orange tint or hue. This acid precipitates the colouring matter which is held in solution, and prevents the undissolved madder from fermenting or otherwise decomposing. When the water has drained from the madder through the filter, the residuum is taken from off the filter and put into bags. The bags are then placed in an hydraulic press, to have as much water as possible expressed from their contents. In order to break the lumps which have been formed by compression, the madder or residuum is passed through a sieve. To 5 cwt. of madder in this state, placed in a wood or lead cistern, 1 cwt. of sulphuric acid of commerce is sprinkled on the madder through a lead vessel similar in form to the ordinary watering-can used by gardeners. An instrument like a garden spade or rake is next used, to work the madder about so as to mix it intimately with the acid. In this stage the madder is placed upon a perforated lead plate, which is fixed about five or six inches above the bottom of a vessel. Between this plate and the bottom of the vessel is introduced a current of steam by a pipe, so that it passes through the perforated plate and the madder which is upon it. During this process, which occupies from one to two hours, a substance is produced of a dark brown colour approaching to black. This substance is garancine and insoluble carbonized matter. When cool, it is placed upon a filter and washed with clear cold water until the water passes from it without an acid taste. It is then put into bags and pressed with an hydraulic press. The substance is dried in a stove and ground to a fine powder under ordinary madder stones, and afterwards passed through a sieve. In order to neutralize any acid that may remain, from 4 to 5 lbs. of dry carbonate of soda for every hundred weight of this substance is added and intimately mixed. The garancine in this state is ready for use.

MALT.

The Quantity of Malt consumed by the undermentioned Brewers of London and its Vicinity, from 10th October, 1830, to 10th October, 1842.

	1831.	1832.	1833.	1834.	1835.	1836.	1837.	1838.	1839.	1840.	1841.	1842.
	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.
Barclay and Co. -	97,198	96,612	93,175	99,674	106,098	108,715	100,326	107,455	114,827	115,561	106,345	114,090
Hanbury and Co. -	50,724	58,512	58,497	74,982	78,087	89,303	81,440	90,140	91,069	98,210	88,132	92,466
Whitbread and Co. -	49,713	53,541	50,067	49,105	55,209	53,694	47,012	45,460	51,979	53,622	51,457	52,098
Reid and Co. - -	43,380	44,420	40,810	44,210	49,430	49,831	42,700	44,928	44,010	48,130	47,980	50,120
Meux and Co. - -	24,339	22,062	20,718	26,161	24,376	30,775	30,623	35,065	38,466	40,787	49,797	43,340
Combe and Co. -	34,684	36,948	36,070	35,438	36,922	42,169	40,454	43,444	40,712	38,368	36,460	40,484
Calvert and Co. -	30,525	32,812	31,433	31,460	33,263	30,859	32,325	31,529	31,028	30,872	30,614	30,660
Hoare and Co. - -	24,102	26,821	25,407	29,796	31,525	32,623	32,347	31,278	31,008	30,310	29,450	29,607
Elliot and Co. - -	19,444	20,061	19,899	25,009	28,728	28,338	24,150	22,486	22,990	25,367	25,379	27,050
Thorne, T. and Son -	1,445	2,543	5,136	8,496	10,913	12,657	16,404	18,545	19,578	20,864	22,413	22,022
Charrington and Co.	10,531	9,648	15,617	18,197	19,213	19,445	18,842	20,290	18,688	18,328	17,840	20,423
Steward and Co. -	8,116	6,872										
Taylor and Co. -	21,845	21,735	21,115	20,835	23,885	24,971	23,556	27,320	25,955	27,300	21,424	19,430
Goding, J. and Co. -	16,307	14,874	14,279	15,256	16,312	¼ 3,321	11/12 14,023	14,028	12,145	18,517	16,018	17,071
Goding, Thomas -	9,987	8,971	7,630	8,824	7,618	11,784	7,095	7,551	¾ 5,758			
Ramsbottom and Co.	- -	- -	- -	- -	- -	¾ 15,364	15,227	13,012				
Broadwood and Co. -	- -	- -	- -	- -	- -	- -	- -	- -	10,610	14,630	15,791	16,688
Gardner, H. W. and P.	6,666	5,904	7,471	11,429	14,699	15,369	15,256	16,921	17,504	15,559	13,126	14,546
Mann, James - -	- -	1,056	1,332	1,757	2,780	4,840	6,588	10,326	11,599	11,679	12,111	13,539
Courage and Co. -	8,116	7,607	7,546	8,079	8,790	9,239	9,286	10,723	10,456	11,532	12,328	13,016
Wood and Co. - -	5,469	5,560	5,547	7,602	7,320	7,961	7,834	8,506	7,607	7,194	7,268	7,652
More, Robert - -	2,535	1,040	1,890	4,713	4,130	5,255	6,025	6,129	6,413	6,954	7,175	7,026
Harris, Thomas -	4,778	4,780	4,540	4,940	4,964	4,998	5,042	5,888	5,256	5,152	5,291	6,022
Hazard and Co. -	- -	6,126	6,203	7,094	- -	6,597	6,674	6,552	6,250	6,729	5,758	5,556
Tubb, William -	- -	- -	- -	80	200	1,516	2,826	3,365	4,060	4,478	4,944	5,503
Richmond and Co. -	3,785	3,503	3,256	3,520	3,268	3,551	3,174	4,058	4,536	4,964	5,030	5,424
Hodgson and Co. -	4,206	3,522	3,870	2,080	2,414	3,400	2,400	1,790	5,358	5,704	5,862	
Abbott, E. - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	4,983
Manners and Co. -	- -	- -	- -	- -	- -	- -	4,552	6,121	7,030	5,334	4,8[illegible]9	4,831
Hale, George - -	4,584	4,322	3,633	3,281	3,466	3,768	4,547	5,039	4,816	4,443	4,418	4,468
Halford and Co.	3,215	3,187	3,330	3,545	- -	3,763	3,786	4,685	3,967	3,585		
Kempson and Co.	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	3,155	3,878
Farren and Till -	-	3,139	3,217	- -	- -	4,048	4,783	4,599	4,400	4,425		
Thorne, J. M. and Son	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	3,860	3,676
Duggan and Co. -	-	- -	- -	- -	-	2,201	2,665	2,288	3,020	3,001	2,574	
Gaskell and Downs -	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	3,354
Mc. Leod, B. - -	1,656	2,947	4,236	5,479	5,360	4,689	4,960	4,700	4,300	3,410	3,305	3,125
Plimmer - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	788	1,653	3,001
Laxton and Bryan -	4,048	3,020	2,941	3,508	4,187	3,573	3,583	3,167	3,213	2,658	2,579	2,797
Draper and Co. -	- -	- -	- -	- -	- -	- -	- -	- -	1,658	1,711	1,787	2,777
Miller and Co. -	- -	- -	- -	- -	- -	- -	- -	- -	855	1,167	1,740	2,685
Keene and Co. -	- -	- -	- -	- -	- -	- -	- -	- -	2,326	2,345	2,645	2,445
Lane and Bowden -	- -	- -	- -	- -	- -	- -	88	393	1,275	1,964	2,010	2,432
Fleming and Co. -	- -	- -	- -	- -	- -	- -	- -	1,787	1,795	2,159	2,417	2,256
Clarke, Charles -	814	857	1,006	1,003	1,006	1,249	1,330	1,624	1,848	1,934	2,124	2,255
Gurney, J. and Co. -	- -	- -	- -	- -	- -	- -	- -	- -	5/12 614	1,903	2,597	2,211
Stains and Fox -	2,235	1,832	2,163	2,266	3,106	3,738	3,783	3,749	3,072	2,406	2,528	2,050
Verey, W. and G.	- -	- -	844	1,140	1,208	1,302	1,573	1,735	1,749	1,762	1,825	1,840
Jones, T. - - -	585	463	337	375	248	700	956	1,338	1,555	1,879	1,810	1,808
Herington and Wells	- -	- -	- -	- -	- -	- -	- -	- -	1,538	1,905	1,746	1,806
Hill and Rice - -	2,910	1,748	1,974	1,963	2,042	1,872	1,853	1,911	1,835	1,677	1,697	1,628
Holt and Sons - -	1,113	754	717	794	734	813	756	846	807	1,093	972	1,583
Cox, John - -	2,302	2,279	4,371	2,446	2,499	2,018	2,151	1,991	1,861	1,723	1,528	1,520
Griffith, P. - -	2,146	1,530	1,063	1,693	2,120	2,394	2,221	1,884	1,553	1,916	1,419	1,429
Ufford and Co. -	- -	- -	- -	203	472	731	953	1,291	1,241	1,201	1,350	1,360
Masterman and Co. -	1,704	1,803	1,830	1,810	1,877	1,789	1,914	1,847	1,789	1,672	1,892	1,295
Johnson and Co. -	- -	- -	- -	- -	- -	2,809	2,809	2,428	2,412	2,413	2,204	
Wyatt - - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1,267
Turner, R. - -	98	128	218	341	531	716	712	897	1,013	1,077	1,219	1,254
Dickenson, G. - -	901	719	801	793	838	1,037	1,025	1,010	1,020	1,100	1,092	1,135
Honeyball, Edward -	- -	- -	269	471	800	1,103	1,512	1,714	1,402	1,155	1,053	1,087
Jenner, R. and H. -	- -	202	355	529	734	772	833	925	856	929	955	1,067
Church, J. L. - -	- -	- -	- -	- -	- -	756	742	672	975	949	1,049	1,065
Blogg, B. - - -	603	684	594	752	968	1,067	943	1,006	1,143	1,034	1,113	1,045
M'Leod, J.M. and Co..	- -	- -	- -	- -	- -	748	820	978	877	782	797	1,025
Satchell and Son -	2,508	3,117	1,906	2,515	2,147	2,177	1,441	1,431	1,475	1,308	1,063	945
Knight - - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	78	883	865
Chadwick, W. -	- -	- -	- -	- -	- -	- -	169	361	532	775	820	846
Turner, John - -	674	584	640	677	709	786	766	821	853	728	768	754
Lock, R. - - -	- -	99	259	422	496	620	651	725	760	776	765	737
Hume, George - -	1,018	985	975	1,427	1,256	1,235	1,126	1,160	812	791	718	708
Collins, W. L. - -	205	176	254	441	519	527	598	407	362	620	627	705
West, J. H. - -	846	577	394	322	406	406	565	749	594	627	708	702
Mantell and Son -	1,187	840	914	850	757	807	693	650	694	723	641	650
Addison - - -	756	590	596	653	671	619	768	812	637	72	638	642
Martin and Co. -	- -	- -	- -	- -	- -	- -	397	501	549	592		
Allan - - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	637	640
Hodd and Co. - -	- -	- -	271	488	671	839	649	531	504	594	644	624
Clarke, W - -	- -	- -	- -	- -	- -	- -	- -	- -	- -	462	506	529
Clarke, S. - -	722	841	876	938	793	837	741	768	547	450	502	520
Bye, W. and H. -	- -	- -	- -	- -	- -	- -	201	260	346	433	489	510
Clark - -	545	719	780	747	706	853	834	983				
Rudge - -	- -	- -	- -	- -	- -	- -	- -	- -	886	555	449	501

	1831.	1832.	1833.	1834.	1835	1836.	1837.	1838.	1839.	1840.	1841.
	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.
Bricheno, Henry -	5,637	5,732	7,120	9,950	9,762	9,885	9,863	8,857	8,699	13,475	13,087
Lamont and Co. -	1,646	356	883	657	403	2,085	3.600	5,251	7,638		
Filmer and Gooding -	- -	- -	- -	- -	- -	1,039	1,298	1,291	1,674	1,633	1,514
Wood and Co. - -	- -	- -	- -	- -	- -	- -	- '	- -	1,493	1,442	1,484
Brown, late Hicks -	- -	- -	- -	- -	- -	- -	- -	- -	1,351	1,450	1,300
Manvell, Isaac - -	752	713	924	875	834	805	824	756	579	732	770
Abbott, E. - -	691	- -	525	634	654	2,305	560	441	312	487	490
Cooper, W. - -	244	- -	443	- -	199	310	315	370	434	503	485
Saunders - - -	- -	- -	- -	- -	- -	- -	- -	81	311	362	471
West, J. W. - -	- -	- -	179	255	406	295	306	251	290	353	444
Harris, Robert - -	- -	- -	451	490	557	497	470	456	405	447	441

Barrels of Beer brewed by each of the Twelve principal Brewers in London.

1782.		1808.	
Whitbread - - - - -	42,497	Meux - - - - - -	190,169
Calvert, Felix - - - -	38,304	Barclay - - - - -	184,196
Truman - - - - -	32,134	Golden Lane - - - -	131,647
Calvert, John - - - -	31,853	Hanbury - - - - -	117,574
Thrale, Mrs. - - - -	29,695	Whitbread - - - -	112,472
Hammond - - - - -	28,715	Combe - - - - -	70,547
Phillips - - - - -	16,527	Goodwyn - - - - -	70,232
Goodwyn - - - - -	16,228	Calvert, Felix - - - -	68,894
Meux - - - - -	14,969	Elliot - - - - -	48,660
Jordan - - - - -	11,246	Biley - - - - -	38,029
Dawson - - - - -	11,077	Harford - - - - -	32,800
Dickinson - - - - -	10,900	Calvert, John - - - -	32,022
	284,145		2,097,231

Quarters of Malt consumed in the undermentioned Years ending 10th October.

By the Brewers of London and its Vicinity.

1831	622,549	1833	578,588	1835	702,533	1837	714,488	1839	750,176	1841	734,295
1832	604,477	1834	662,713	1836	754,313	1838	742,597	1840	776,219	1842	741,651

By the Twelve principal Brewers of London.

1831	432,521	1833	427,087	1835	503,048	1837	490,179	1839	528,259	1841	517,292
1832	438,046	1834	470,123	1836	526,092	1838	517,940	1840	547,908	1842	541,710

MANGANESE, OXIDE OF; for a simple method of ascertaining the value of this substance in the production of chlorine, and the manufacture of the chlorides and chlorates, see CHEMISTRY SIMPLIFIED, in the APPENDIX.

MANURE. A patent for an excellent article of this kind was obtained in May, 1842, by J. B. Lawes, Esq. He decomposes bones, apatite, and other subphosphates of lime by mixing them in powder with as much sulphuric acid as will liberate enough of the phosphoric to dissolve the phosphate of lime. The free phosphoric acid is thereby ready to combine with the various alkaline earths contained in the soil, while the phosphate of lime is brought to a state of more minute division than is possible by mechanical means. Mr. Lawes also proposes to mix the above soluble superphosphate with such alkalies as are deficient in the soil, and thus to form a manure adapted to fertilise it. His third improvement in manure is the formation and application of a liquor of flints, for such soils as are deficient in soluble silica. The last compound he considers to be valuable for grounds much cropped with wheat and other cereals that require a good deal of silica for their growth.

MARGARIC ACID is obtained most easily by the distillation of stearic acid. The humidity at the beginning of the process must be expelled by a smart heat, otherwise explosive ebullitions are apt to occur. Whenever the ebullition becomes uniform, the fire is to be moderated.

MATCHES, LUCIFER. According to Dr. R. Boettger, in *Annalen der Chemie und Pharmacie*, vol. xlvii. p. 334., take

Phosphorus - - - -	4 parts
Nitre - - - - -	10 —
Fine glue - - - -	6 —
Red ochre, or red lead - - -	5 —
Smalt - - - -	2 —

Convert the glue with a little water by a gentle heat into a smooth jelly, put it into a slightly warm porcelain mortar to liquefy; rub the phosphorus down through this gelatine at a temperature of about 140° or 150° Fahr.; add the nitre, then the red powder, and lastly the smalt, till the whole forms a uniform paste. To make writing-paper matches, which burn with a bright flame and diffuse an agreeable odour, moisten each side of the paper with tincture of benzoin, dry it, cut it into slips, and smear one of their ends with a little of the above paste by means of a hair pencil. On rubbing the said end after it is dry against a rough surface the paper will take fire, without the intervention of sulphur.

To form lucifer wood matches, that act without sulphur, melt in a flat-bottomed tin pan as much white wax as will stand one-tenth of an inch deep; take a bundle of wooden matches free from resin, rub their ends against a red hot iron plate till the wood be slightly charred; dip them now in the melted wax for a moment, shake them well on taking them out, and finally dip them separately in the above viscid paste. When dry, they will kindle readily by friction.

For the rapid manufacture of the wooden splints for lucifer matches, a patent was granted to Mr. Reuben Partridge, in March, 1842. He employs a perforated metallic plate, having a steel face, strengthened by a bell metal back; see *figs.* 92, 93. The size of the perforations must depend on that of the desired splints, but they must be as close together as possible, that there may be a very small blank space between them, otherwise the plate would afford too great resistance to the passage of the wood. By this construction, the whole area of the block of wood may be compressed laterally into the countersunk openings, and forced through the holes, which are slightly countersunk to favour the entrance and separation of the wooden fibres. *Fig.* 92. represents the face of one of these plates; and *fig.* 93. is a rectangular section through the plate. A convenient size of plate is three inches broad, six inches long, and one thick. The mode of pressing is by fixing the back of the plate against a firm resisting block or bearing, having an aperture equal to the area of the perforations in the plate, and then placing the end of the piece or pieces of wood in the direction of the grain against the face of the plate within the area of the perforated portion. A plunger or lever or other suitable mechanical agent being then applied to the back or reverse end of the piece of wood, it may be forced through the perforations in the plate, being first split as it advances by the cutting edges of the holes, and afterwards compressed and driven through the perforations in the plate, coming out on the opposite side or back of the plate in the form of a multitude of distinct splints, agreeably to the shapes and dimensions of the perforations. — (*Newton's Journal*, C. S. vol. xxii. 268.)

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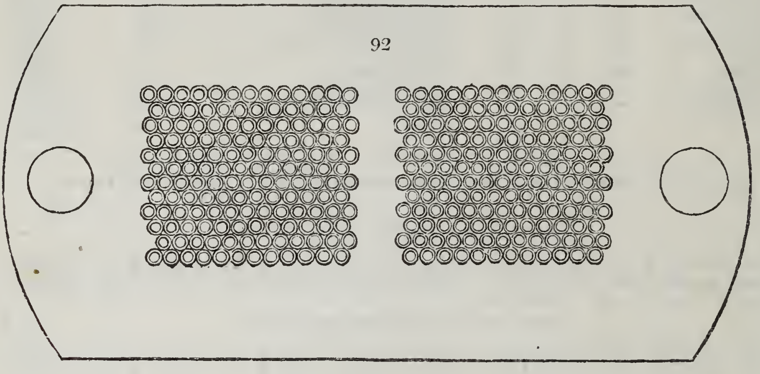
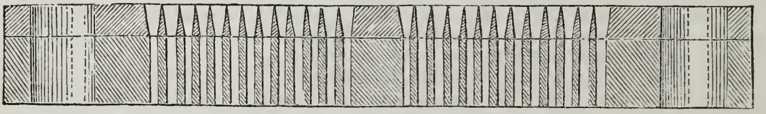


93



MERCURY; imported for home consumption in 1839, 340,469 pounds; in 1840, 330,070 pounds; duty 1*d*. per pound.

METALLIC ANALYSIS. Professor Liebig has lately enriched this most useful department of practical chemistry, by the employment of the cyanide of potassium prepared in his economical method (see this article). This salt is the best re agent for detecting nickel in cobalt. The solution of the two metals being acidulated, the cyanide is to be added until the precipitate that first falls is redissolved. Dilute sulphuric acid is then added, and the mixture being warmed and left in repose, a precipitate does not fail to appear sooner or later, which is a compound of nickel. Cyanide of potassium serves well to separate lead, bismuth, cadmium, and copper, four metals often associated in ores. On adding the cyanide in excess to the solution of these metals in nitric acid, lead and bismuth fall as carbonates, and may be parted from each other by sulphuric acid. Sulphuretted hydrogen is passed in excess through the residuary solution, and the mixture being heated, a small quantity of cyanide is added: a yellow precipitate indicates cadmium; and a black precipitate falls on the addition of hydrochloric acid, if copper be present.

If into a crucible (containing the cyanide fused by heat), a little of any metallic oxide be thrown at intervals, it will be almost immediately reduced to the reguline state. When the fluid mass is afterwards decanted, the metal will be found mixed with the white saline matter, from which it may be separated by water.

Even metallic sulphurets are reduced to the state of pure metals by being projected in a state of fine powder into the fused cyanide. When an iron ore is thus introduced, along with carbonate of potash or soda, and the mixture is heated to fusion, which requires a strong red heat, the alumina and silica of the ore fuse into a slag; from which, on cooling, the metallic iron may be separated by the action of water, and then weighed. If manganese exist in the ore, it remains in the state of protoxide; to be determined by a separate process. When oxide of copper is sprinkled on the surface of the fused cyanide, it is immediately reduced, with the disengagement of heat and light. The mixture being poured out of the crucible and concreted, is to be ground and washed, when a pure regulus of copper will be obtained.

The process of reduction is peculiarly interesting with the oxides of antimony and tin; being accomplished at a low red heat, hardly visible in day-light. Even the sulphurets of these metals are immediately stripped of their sulphur, with the formation of sulpho-cyanide of potassium.

Cyanide of potassium, mixed with carbonate of soda, is an excellent re-agent in blow-pipe operations for distinguishing metals. The reductions take place with the utmost facility, and the fused mixture does not sink into the charcoal, as carbonate of soda alone is apt to do in such cases. Hence the grains or beads of metal are more visible and can be better examined.

When the cyanide is heated along with the nitrates and chlorates (of potash), it causes a rapid decomposition, accompanied with light and explosions.

Arsenic may be readily detected in the commercial sulphuret of antimony, by fusing it with three-fourths of its weight of the cyanide in a porcelain crucible over a spirit lamp, when a regulus of antimony is obtained. The metal may then be easily tested for arsenic, since none of this volatile substance can have been lost, owing to the low temperature employed.

When arsenious acid, or orpiment, or any of the arseniates, are mixed with six times their weight of the mixture of cyanide and carbonate of soda in a tube with a bulb at one end, and heat applied with a spirit lamp to the glass, very beautiful rings of metallic mirror are formed by the reduced arsenic. The arseniates of lead and of peroxide of iron, however, do not answer to this test.

When sulphates of lead and barytes, along with silica, are mixed with four or five times their weight of the above mixed cyanide and carbonate, and fused, the sulphate of lead is reduced to the metallic state, the sulphate of barytes becomes a carbonate, and the silica gets combined with the alkali into a soluble glass.

METALLIC STATISTICS. By the returns to five several orders made by the House of Commons, which were obtained by the exertions and perseverance of Sir J. J. Guest, Sir C. Lemon, and Mr. Evans (M.P. for North Derbyshire), we are enabled to lay before our readers a most correct account of the various exports and imports of iron and iron ore, hardware, cutlery, &c., copper ore, copper, tin, zinc, lead ore, and lead, for the year ending Jan. 5. 1844.

Commencing with iron, it appears there was imported in the year, iron ore, 131 tons; chromate of iron, 1393 tons; pig-iron, 243 tons; unwrought iron in bars, 12,795 tons; bloom, 563 tons; rod-iron, 12 tons; old, broken, and cast-iron, 286 tons; cast-iron, only 8 tons; steel, unwrought, 1697 tons — of these, 97 tons only were entered by weight, the remainder by value, 11,035*l.* 6*s.* 9*d.* Of the several countries from which these importations came the principal is Sweden, whence we have received of iron 10,909 tons, and steel 1558 tons, leaving but a small portion to divide between twenty other places. — Our exports of foreign iron have been, unwrought in bars, 3986 tons; rod, 10 tons; hoops, 2 tons; cast-iron, 11 cwt.; steel, unwrought, 1456 tons. The total quantity of foreign iron retained for home consumption was

14,782 tons, upon which the net amount of duty was 14,563*l.* — The exportation of that staple produce of our own country, British iron, was as follows: — Bar-iron, 176,148 tons; bolt and rod, 22,625 tons; pig-iron, 154,770 tons; cast-iron, 16,449 tons; iron wire, 1508 tons; wrought-iron, consisting of anchors, grapnels, &c., 3058 tons; hoops, 14,591 tons; nails, 6020 tons; and all other sorts, except ordnance, 44,577 tons; old iron for manufacture, 5924 tons; and unwrought steel, 3199 tons. Those places which have taken the greatest portions of this produce are — Russia, 10,963 tons of bar-iron; Denmark, 10,447 tons bar, and 7010 tons pig; Prussia, 12,009 tons bar, 17,480 tons pig; Germany, 13,298 tons bar, 6322 tons pig, 1339 tons cast; Holland, 17,509 tons bar, 75,953 tons pig; 4317 tons cast; Belgium, 4279 tons cast; France, 4237 tons bar, 22,103 tons pig; Italy, 21,930 tons bar, 3982 tons bolt and rod, 3005 tons pig; Turkey, and Continental Greece, 6412 tons bar; East Indies and Ceylon, 20,620 tons bar, 2967 tons bolt; British North American Colonies, 6837 tons bar, 1995 tons cast; Foreign West Indies, 5043 tons bar, 1646 tons cast; and to the United States, 21,336 tons bar, and 7148 tons pig. The largest quantity of unwrought steel has been to the latter place — viz., 1336 tons.

Of British hardware and cutlery, we exported in the year 17,183 tons, valued at 1,745,518*l.*; the principal of which has been — to Germany, 1237 tons, value 159,889*l.*; East Indies, 1402 tons, value 142,607*l.*; British North American Colonies, 1129 tons, value 102,260*l.*; British West Indies, 997 tons, value 80,040*l.*; Foreign West Indies, 657 tons, value 48,609*l.*; United States, 4282 tons, value 448,341*l.*; Brazil, 943 tons, value 80,070*l.*; and divers other places, varying from 100 to 500 tons.

We now come to copper. Of foreign copper ores, we have imported 55,720 tons; and of metallic copper, unwrought and wrought plates, and coins, 805 tons. Of the ores, the greatest quantities have come from Cuba and Chili.

We have exported 1819 tons of British, and 650 tons of foreign tin — of which France has taken 626 tons, Russia 480 tons, Italy 183 tons, Turkey 250 tons, and the remainder distributed among twenty-seven places.

Of foreign zinc, we have imported as follows: —

Countries from whence imported.	Tons.	cwt.	qrs.	lbs.
Denmark	268	19	2	21
Prussia	6860	15	3	22
Germany	3000	1	2	11
Holland	20	3	2	1
Belgium	21	9	0	9
Syria and Palestine	1	15	0	15
Total import of foreign zinc - Tons	10,173	4	3	23

Of this, we retained for home consumption 4102 tons, on which the net duty was 223*l.* 2*s.* 10*d.*; and we have exported 1395 tons of British, and 6445 tons of foreign spelter.

Of foreign lead, we have imported 2863 tons — of which 2775 tons were pig and sheet, 68 tons ore, and 19 tons white lead; 157 tons were retained for home consumption, on which the duty was 165*l.*; and we imported from the Isle of Man, duty free, 2415 tons of lead ore. Our exportation of foreign lead amounted to 2439 tons — while of British, we exported, 176 tons of ore, 14,610 tons pig and sheet, 378 tons litharge, 707 tons red lead, and 1224 tons white lead — making a total of 17,097 tons. — *Railway and Commercial Gazette*, May 18. 1844.

METER, GAS. Since the article GAS was printed I have had occasion to examine very carefully the construction, performance, and comparative merits of the four gas-meters most generally used in Great Britain, and have been led to conclude that the surmises concerning the correctness of the indications of several of them are but too well founded. The instruments on which my observations were made were all new, and just out of the hands of their respective patentees.

1. The meter of Mr. West is, no doubt, accurate while the water-line is rightly adjusted; but as I find that it will admit an extra pint of water, it may be rendered unjust towards the consumers of gas; and then if it receives a little more water by condensation of vapour, or by accident, its siphon gets filled, which causes the extinction of the lights.

2. The meter of Mr. Bottom has also several defects, and occasions nuisance by letting its overflow water trickle upon the floor.

3. The meter of Mr. Crossley may be made to err in its measurements fully 20 per cent. by dexterous repletion with water, and that in favour of the gas companies.

These three meters are furnished with the vertical float-valve, so apt to rust and stick;

they also allow gas to escape at the discharge plug, to the imminent risk of occasioning fire with ignorant or careless servants; and finally, they have the complex dial-plate indexes, so liable to misapprehension.

4. The meter of Mr. Edge. This instrument is quite exempt from all the above defects, and is equally delicate and just in its indications, being mounted with a lever valve of great mobility, and a new index, which any one who knows numbers cannot miscount. I have subjected this meter to every kind of test, and find that it cannot be made to give false indications, either by awkwardness or intention. Its inventor is therefore well entitled to the warm patronage both of the public and all gas companies who love fair dealing.

MILK has been adulterated with a solution of potato starch, from which it derives a creamy consistence. This fraud may be detected by pouring a few drops of iodine water into it, which immediately causes it to assume a blue or purple tint. Emulsion of sweet almonds, with which the milk at Paris has been adulterated, may be readily detected by the taste.

MINES. The miner, in sinking into the earth, soon opens up numerous springs, whose waters, percolating into the excavations which he digs, constitute one of the greatest obstacles that nature opposes to his toils. When his workings are above the level of some valley and at no great distance, it is possible to get rid of the waters by leading them along a *trench* or a *gallery of efflux*. This forms always the surest means of drainage; and notwithstanding the great outlay which it involves, it is often the most economical. The great advantages accruing from these galleries, lead to their being always established, and without risk, in mines which promise a long continuance. There are many galleries several leagues in length; and sometimes they are so contrived as to discharge the waters of several mines, as may be seen in the environs of Freyberg. Merely such a slope should be given them as is barely sufficient to make the water run, at the utmost from $\frac{1}{300}$ to $\frac{1}{400}$, so as to drain the mine to the lowest possible level.

Whenever the workings are driven below the natural means of drainage, or below the level of the plain, recourse must be had to mechanical aids. In the first place, the quantity of percolating water is diminished as much as possible by planking, walling, or caulking-up with the greatest possible care those pits and excavations which traverse the water levels; and the lower workings are so arranged that all the waters may unite into wells placed at the bottom of the shafts or inclined galleries; whence they may be pumped up to the day, or to the level of the *gallery of efflux*. In most mines, simple sucking pumps are employed, because they are less subject to give way, and more easy of repair; and as many of these are placed over each other, as the shaft is ten yards deep, below the point where the waters have a natural run.

These draining machines are set in motion by that mechanical power which happens to be the least costly in the place where they are established. In almost the whole of England, and over most of the coal mines of France and Silesia, the work is done by steam engines; in the principal metallic mines of France, and in almost the whole of Germany and Hungary, by hydraulic machines; and in other places, by machines moved by horses, oxen, or even by men. If it be requisite to lift the waters merely to the level of a *gallery of efflux*, advantage may be derived from the waters of the upper parts of the mine, or even from waters turned in from the surface, in establishing in the mine of the gallery-level, water-pressure machines, or overshot water-wheels, for pumping up the lower water. This method is employed with success in several mines of Hungary, Bohemia, Germany, Derbyshire, Cornwall, in those of Poullaouen in Brittany, &c. It has been remarked, however, that the copious springs are found rather towards the surface of the soil than in the greatest depths.

TRANSPORT OF ORES TO THE SURFACE.

The ore being extracted from its bed, and having undergone, when requisite, a first sorting, it becomes necessary to bring it to the day, an operation performed in different ways according to circumstances and localities, but too often according to a blind routine. There are mines at the present day, where the interior transport of ores is executed on the backs of men; a practice the most disadvantageous possible, but which is gradually wearing out. The carriage along galleries is usually effected by means of hurdles, barrows, or, still better, by little waggons. These consist of frames resting on four wheels; two larger, which are placed a little behind the centre of gravity, and two smaller, placed before it. When this carriage is at rest, it bears on its four wheels, and leans forwards. But when the miner, in pushing it before him, rests on its posterior border, he makes it horizontal; in which case it rolls only upon the two larger wheels. Thus, the friction due to four wheels is avoided, and the roller or driver bears no part of the burden, as he would do with ordinary wheelbarrows. To ease the draught still more, two parallel rails of wood or iron are laid along the floor of the gallery, to which the wheels of the carriage are adjusted. It is especially in metallic mines, where the ore is heavy, and the galleries straight, that these peculiar waggons are employed. In coal mines, carriages formed with a much larger basket, borne on a rail-road by four equal wheels, are preferred. Sometimes the above wain, called on the Continent a *dog* (*chien*), is merely a simple frame on four wheels, on which a basket is set. In the great mines, such as many of the coal and salt mines of Great Britain, the salt mines of Gallicia, the copper mines of Fahlun, the lead mines of Alston-Moor, horses and asses are introduced into the workings to drag heavier waggons, or rather a train of waggons attached to one another. These animals often live many years under ground, without ever revisiting the light of day. In other mines, such as those of Worsley, in Lancashire, subterranean canals are cut, upon which the ore is transported in boats.

When the workings of a mine are beginning, when they are still of little depth, and employ few hands, it is sufficient to place over the shaft a simple wheel and axle, by means of which a few men may raise the water pails, and the baskets or tubs filled with ore; but this method becomes soon inadequate, and should be replaced by more powerful machines.

ACCESSORY DETAILS.

Few mines can be penetrated entirely by means of galleries. More usually there are shafts for mounting and descending. In the pits of many mines, the workmen go down and come up by means of the machines which serve to elevate the ores. In several mines of Mexico, and the north of Europe, pieces of wood, fixed on each side of the pit, form the rude steps of a ladder by which the workmen pass up and down. In other mines, steps are cut in the rock or the ore; as in the quicksilver mines of Idria and the Palatinate, in the salt mines of Wieliczka, and in some of the silver mines of Mexico. In the last they serve for the transport of the ore, which is carried up on men's backs. Lastly, certain mines are entered by means of slopes, some of which have an inclination of more than 30°. The workmen slide down these on a kind of sledge, whose velocity of descent they regulate by a cord firmly fixed at the upper end.

Miners derive light from candles or lamps. They carry the candles in a lump of soft clay, or in a kind of socket terminated by an iron point, which serves to fix it to the rock, or to the timbering. The lamps are made of iron, hermetically closed, and suspended, so that they cannot droop, or invert, and spill the oil. They are usually hung on the thumb by a hook. Miners also employ small lanterns, suspended to their girdles. Many precautions and much experience are requisite to enable them to carry these lights in a current of air, or in a vitiated atmosphere. It is especially in coal mines liable to the disengagement of carburetted hydrogen, that measures of safety are indispensable against the explosions. The appearance of any halo round the flame should be carefully watched as indicating danger; and the lights should be carried near the bottom of the gallery. The great protector against these deplorable accidents, is the safety lamp. See LAMP OF DAVY.

We cannot conclude this general outline of the working of mines, without giving some account of the miners. Most men have a horror at the idea of burying themselves, even for a short period, in these gloomy recesses of the earth. Hence mining operations were at first so much dreaded, that, among the ancients, they were assigned to slaves as the punishment of their crimes. This dislike has diminished with the improvements made in mining; and, finally, a profitable and respected species of labour has given mining its proper rank among the other departments of industry. The *esprit de corps*, so conspicuous among seamen, has also arisen among miners, and has given dignity to their body. Like every society of men engaged in perilous enterprizes, and cherishing the hopes of great success, miners get attached to their profession, talk of it with pride, and eventually in their old age regard other occupations with contempt. They form, in certain countries, such as Germany and Sweden, a body legally constituted, which enjoys considerable privileges. Miners work usually 6 or 8 hours at a time. This period is called a *journey* (*poste*, in French).

Miners wear, in general, a peculiar dress, the purpose of which is to protect them, as much as possible, from the annoyances caused by water, mud, and sharp stones, which occur in the places where they work. One of the most essential parts of the dress of a German miner is an apron of leather fitted on behind, so as to protect them in sitting on moisture or angular rubbish. In England, the miners wear nothing but flannels; though they frequently strip off all their clothes, except their trowsers. In many countries the mallet and the pick, or *pointerolle* (called in German, *Schegel* and *Eisen*), disposed in a Saint Andrew's cross, are the badge of miners, and are engraved on their buttons, and on every thing belonging to mines.

Several of the enterprises executed in mines, or in subserviency to them, merit a distinguished rank among the history of human labours. Several mines are worked to a depth of more than 600 yards, some even to a thousand yards below the surface of the soil. A great many descend beneath the level of the ocean; and a few even extend under its billows, and are separated from them by a thin partition of rock, which allows their noise, and the rolling of the pebbles, to be heard.

In 1792, there was opened, at Valenciana, in Mexico, an octagonal pit, fully 7½ yards wide, destined to have a depth of 560 yards, to occupy 23 years in digging, and to cost 240,000*l.*

The great drainage gallery of the mines of Clausthal, in the Hartz, is 11,377 yards, or 6½ miles long, and passes upwards of 300 yards below the church of Clausthal. Its excavation lasted from the year 1777 till 1800, and cost about 66,000*l.* Several other galleries of efflux might also be adduced, as remarkable for their great length and expense of formation.

The coal and iron mines subservient to the iron works of Mr. Crawshay, at Merthyr-Tydvil, in Wales, have given birth to the establishment interiorly and above ground, of iron railways, whose total length, many years ago, was upwards of 100 English miles.

The carriage of the coal extracted from the mines in the neighbourhood of Newcastle to their points of embarkation, is executed almost entirely, both under ground and on the surface, on iron railways, possessing an extent of upwards of 500 miles.

There is no species of labour which calls for so great a development of power as that of mines; and accordingly, it may be doubted if man has ever constructed machines so powerful as those which are now employed for the working of some mineral excavations. The waters of several mines of Cornwall are pumped out by means of steam engines, whose force is equivalent, in some instances, to the simultaneous action of many hundred horses.

MINES, GENERAL SUMMARY OF.

Mines may be divided into three great classes: 1. Mines in the geological formations anterior to the coal strata; 2. Mines in the secondary formations; 3. Mines in alluvial districts.

The first are opened, for the most part, upon veins, masses, and metalliferous beds.

The second, on strata of combustibles, as coal; and metalliferous or saliferous beds.

The last, on deposits of metallic ores, disseminated in clays, sands, and other alluvial matters, usually superior to the chalk; and even of far more recent formation.

The mines of these three classes, placed, for the most part, in very different physical localities, differ no less relatively to the mode of working them, and their mechanical treatment, than in a geological point of view.

MINES OF FORMATIONS ANTERIOR TO THE COAL.

These mines are situated in a few mountainous regions, and their whole amount forms but a small portion of the surface of the earth. The most remarkable of these are: — The Cordilleras of South America; the mountains of Hungary; the Altayan mountains; the Ural mountains; the Vosges and the Black Forest; the Harz, and the east of Germany; the centre of France; the north of Portugal, and the adjacent portions of Spain; Britanny; the corresponding coasts of Great Britain and Ireland; the north of Europe; the Alleghany chain; the south of Spain; the Pyrenees; the Alps; the schistose districts on the banks of the Rhine and the Ardennes; the calcareous mountains of England and of Daouria.

MINES OF THE CORDILLERAS OF SOUTH AMERICA.

Few regions are so celebrated for their mineral wealth as the great chain which, under the name of the Cordillera of the Andes, skirts the shores of the Pacific ocean, from the land of the Patagonians to near the north-west point of the American continent. Who has not heard of the mines of Mexico and Potosi? The mineral wealth of Peru has passed into a proverb.

The most important mines of the Cordilleras are those of silver; but several of gold, mercury, copper, and lead, have likewise been opened. These mountains are not equally metalliferous in their whole extent. The workings occur associated in a small number of districts far distant from each other.

In the Andes of Chili, particularly in the province of Coquimbo, some silver mines are explored, which afford chiefly ores of an earthy or ferruginous nature, mingled with imperceptible portions of ores with a silver base, known there under the name of Pacos. The same province presents also copper mines of considerable importance, from which are extracted native copper, orange oxide of copper, carbonate of copper (malachite), and copper pyrites, associated with some muriate of copper. In a few mines, masses of native copper of extraordinary magnitude have been found.

The second metalliferous region of the Andes occurs between the 21st and 15th degrees of south latitude. It includes the celebrated mountain of Potosi, situated in nearly the 20th degree of south latitude, on the eastern slope of the chain, and several other districts likewise very rich, which extend principally towards the north-west, as far as the two banks of the lake Titicaca, and even beyond it, through a total length of nearly 150 leagues. All these districts, which formerly depended on Peru, were united in 1778, to the government of Buenos Ayres. The mines of Potosi were discovered in 1545, and have furnished since that period till our days, a body of silver which M. Humboldt values at 230,000,000*l.* sterling. The first years were the most productive. At that time ores were often found which afforded from 40 to 45 per cent. of silver. Since the beginning of the eighteenth century, the average richness of the ores does not exceed above from 3 to 4 parts in 10,000. These ores are therefore very poor at the present day; they have diminished in richness in proportion as the excavations have become deeper. But the total product of the mines has not diminished in the same proportion; abundance of ore having made up for its poverty. Hence, if the mountain of Potosi is not, as formerly, the richest deposit of ore in the world, it may, however, be still placed immediately after the famous vein of Guanaxuato. The ore lies in veins in a primitive clay state, which composes the principal mass of the mountain, and is covered by a bed of clay porphyry. This rock crowns the summit, giving it the form of a basaltic hill. The veins are very numerous; several, near their outcrop, were almost wholly composed of sulphuret of silver, antimoniated sulphuret of silver, and native silver. Others which offered near the surface merely sulphuret of tin, became richer as they descended. In 1790, seven copper mines were known in the vice-royalty of Buenos Ayres, seven of lead, and two of tin; the last being merely washings of sands found near the river Oraro.

On the opposite flank of the chain, in a low, desert plain, entirely destitute of water, which adjoins the harbour of Iquiqua, and forms a part of Peru, occur the silver mines of Huantajaya, celebrated for the immense masses of native silver, which have been sometimes found in them. In 1758, one was discovered weighing eight cwts.

M. Humboldt quotes 40 cantons of Peru as being at the present day most famous for their subterranean explorations of silver and gold. Those of gold are found in the provinces of Huaailas and Pataz; the silver is chiefly furnished by the districts of Huantajaya, Pasca, and Chota, which far surpass the others in the abundance of their ores.

The silver mines of the district of Pasco are situated about 30 or 40 leagues north of Lima, in 10½ degrees of south latitude, 4400 yards above the sea-level, on the eastern slope of the Cordilleras, and near the sources of the river Amazons. They were discovered in 1630. These mines, and especially those of Cero of Yanricocha, are actually the richest in all Peru. The ore is an earthy mass of a red colour, containing much iron, mingled with particles of native silver, horn silver, &c., constituting what they call *Pacos.* At first nothing but these *pacos* was collected; and much gray copper and antimoniated sulphuret of silver were thrown among the rubbish. The mean product of all the ores is $\frac{1}{1250}$; or an ounce and $\frac{28}{100}$ per cwt.; although some occur which yield 30 or 40 per cent. These rich deposits do not seem to be extended to a great depth; they have not been pursued farther than 130 yards, and in the greater part of the workings only to from 85 to 45. Forty years ago, these mines, which produced nearly 2,000,000 of piastres annually, were the worst worked in all South America. The soil seemed as if riddled with an immense number of pits, placed without any order. The drainage of the waters was effected by the manual labour of men, and was extremely expensive. In 1816, some Europeans, among whom were several miners from Cornwall, mounted several high-pressure steam engines, imported from England, which introduced a considerable improvement in the workings.

The mines of the province of Chota are situated in about seven degrees of south latitude. The principal ones are those of Gualcayoc, near Mecuicampa, discovered in 1771; their outcrop occurs at the height of 4500 yards above the sea; the city of Mecuicampa itself has 4000 yards of elevation, that is, higher than the highest summits of the Pyrenees. The climate is hence very cold and uncomfortable. The ore is a mixture of sulphuret of silver and antimoniated sulphuret, with native silver. It constitutes veins of which the upper portion is formed of *pacos,* and they sometimes traverse a limestone and sometimes a hornstone, which occurs in subordinate beds. The annual produce of the mines is 67,000 marcs of silver, according to Humboldt.

In the districts of Huaailas and Pataz, which are at a little distance from the former two, gold mines are worked. This metal is extracted chiefly from the veins of quartz, which run across the primitive schistose mountains. The district of Huaailas contains besides lead mines. Peru possesses, moreover, some mines of copper.

The quicksilver mine of Huancavelica, the only important mine of this species which has been worked in the New World, occurs on the eastern flank of the Andes of Peru, in 13 degrees of south latitude, at upwards of 6000 yards above the level of the sea. It does not seem referrible to the same class of deposits with the mines hitherto mentioned.

Indications of mercurial deposits have been observed in several other points of the Andes of Northern Peru, and of the south of New Granada.

Lastly, mines of sal-gem are known to exist in Peru, especially near the silver mines of Huantajaya.

On receding from the district of Chota, the Cordilleras are very indifferently stored with metallic wealth, to the isthmus of Panama, and even far beyond it. The kingdom of New Granada offers but a very small number of silver mines. There are some auriferous veins in the province of Antioquia, and in the mountains of Guamoco. The province of Caracas, the mountains of which may be considered as a ramification of the Cordilleras, presents at Aroa a copper mine which furnishes annually from 700 to 800 metric quintals (1400 to 1600 cwt.) of this metal. Finally, we may state in passing, that there is a very abundant salt mine at Zipaquira, in the province of Santa Fé, and that between this point and the province of Santa-Fé-de-Bogota, a stratum of coal occurs at the extraordinary height of 2700 yards.

Although Mexico presents a great variety of localities of ores, almost the only ones worked are those of silver. Nearly the whole of these mines are situated on the back or the flanks of the Cordilleras, especially to the west of the chain, nearly at the height of the great table land which traverses this region of the globe, or a little below its level in the chains which divide it. They lie in general between 2000 and 3000 yards above the sea; a very considerable elevation, which is favourable to their prosperity, because in this latitude there exists at that height a mean temperature mild, salubrious, and most propitious to agriculture. There were at the time of Humboldt's visit, from 4000 to 5000 deposits of ore exploited. The workings constituted 3000 distinct mines, which were distributed round 500 head quarters or *Reales*. These mines are not, however, uniformly spread over the whole extent of the Cordilleras. They may be considered as forming eight groups, which altogether do not include a greater space than 12,000 square leagues; viz. hardly more than the tenth part of the surface of Mexico.

These eight groups are, in proceeding from south to north,

1. The group of *Oaxuaca*, situated in the province of this name at the southern extremity of Mexico properly so called, towards the 17th degree of north latitude. Besides silver mines, it contains the only veins of gold explored in Mexico. These veins traverse gneiss and mica-slate.

2. The group of *Tasco*. The most part of the mines which compose it are situated 20 or 25 leagues to the south west of Mexico, towards the western slope of the great *plateau*.

3. The group of *Biscania*, about 20 leagues north east of Mexico. It is of moderate extent, but it comprehends the rich workings of Pachuca, Real del Monte, and Moram. The district of Real del Monte contains only a single principal vein, named *Veta Bezicana* of Real del Monte, in which there are several workings; it is, however, reckoned among the richest of Mexico.

4. The group of *Zimapan*. It is very near the preceding, about 40 leagues north west of Mexico, towards the eastern slope of the plateau. Besides numerous silver mines, it includes abundant deposits of lead, and some mines of yellow sulphuret of arsenic.

5. The *Central group*, of which the principal point is *Guanaxuato*, a city of 70,000 inhabitants, placed at its southern extremity, and 60 leagues N. N. W. of Mexico. It comprises among others the famous mine districts of *Guanaxuato*, *Catorce*, *Zacatecas*, *Sombrerete*; the richest in Mexico, and which alone furnish more than half of all the silver which this kingdom brings into circulation.

The district of *Guanaxuato* presents only one main vein, called the *Veta Madre*. This vein is enclosed principally in clay-state, to whose beds it runs parallel, but occasionally it issues out of them to intersect more modern rocks. The vein is composed of quartz, carbonate of lime, fragments of clay slate, &c.; and includes the sulphurets of iron, of lead, and of zinc in great quantities, some native silver, sulphuret of silver, and red silver; its power (thickness of the vein) is from 43 to 48 yards. It is recognised and worked throughout a length of upwards of 13,000 yards; and contains 19 exploitations, which produced annually well on to 1,200,000*l.* in silver. One of the explorations, that of Valenciana, produces 320,000*l.*; being equal to about one-fifteenth of the total product of the 3000 mines of Mexico. Since 1764, the period of its discovery, its neat annual product has never been less than from two to three millions of francs (80,000*l.* to 120,000*l.*); and its proprietors, at first men of little fortune, became, in ten years, the richest individuals in Mexico, and perhaps in the whole globe.

The workings of this mine are very extensive, and penetrate to a depth of 550 yards. They employ a great many labourers.

The district of Zacatecas presents in like manner only a single vein in greywacke; which, however, is the seat of several workings.

The deposits mined at Catorce are in limestone; the mine called *Purissima de Catorce* has been explored to about 650 yards in depth; and yielded, in 1796, nearly 220,000*l.* There are also mines of antimony in the district of Catorce.

Towards the western part of the group of which we are now speaking, copper mines are worked in the provinces of Valladolid and Guadalaxara; the ores being chiefly composed of protoxide of copper (orange copper), sulphuret of copper, and native copper. These mines produce about 2000 metric quintals of copper annually (440,000lbs. English). In the same district, ores of tin are collected in the alluvial soils, particularly near Mount Gigante. The concretionary oxide of tin, so rare in Europe, is here the most common variety. This metal occurs also in veins.

The central part of Mexico contains many indications of sulphuret of mercury (cinnabar); but in 1804 it was worked only in two places, and to an inconsiderable extent.

6. *The group of new Gallicia* is situated in the province of this name, about 100 leagues N. W. from Mexico. It comprises the mines of Balanos, one of the richest districts.

7. *The group of Durango and Sonora*, in the intendancies of the same name. It is very extensive. The mines are situated in part on the table land, and in part on the western slope. Durango is 140 leagues N. N. W. of Mexico.

8. *The group of Chinuahua.* It takes its name from the town of Chinuahua, situated 100 leagues N. of Durango. It is exceedingly extensive, but of little value; and terminates at 29° 10′ of north latitude.

Mexico possesses, besides, several mines which are not included in the eight preceding groups. Thus the new kingdom of Leon, and the province of New Saint-Ander, present abundant mines of lead. New Mexico contains copper mines and many others.

Lastly, rock salt is mined in several points of New Spain; and coal seems to occur in New Mexico.

The richness of the different districts of the *silver mines* or *reales* is extremely unequal. Nineteen twentieths of these *reales* do not furnish altogether more than one-twelfth of the total product. This inequality is owing to the excessive richness of some deposits. The ores of Mexico are principally veins; beds and masses are rare. The veins traverse chiefly, and perhaps only primitive and transition rocks, among which certain porphyries are remarked as very rich in deposits of gold and silver. The silver ores are mostly sulphuret of silver, black antimoniated sulphuret of silver, muriate of silver (hornsilver), and gray copper. Many explorations are carried on in certain earthy ores, called *colloradOS*, similar to the *pacos* of Peru. Lastly, there are ores of other metals, which are worked principally, and sometimes exclusively, for the silver which they contain; such are the argentiferous sulphuret of lead, argentiferous sulphuret of copper, and argentiferous sulphuret of iron.

Ores of very great richness occur in Mexico; but the average is only from 3 to 4 ounces per cwt., or from 18 to 25 in 10,000. There are some, indeed, whose estimate does not exceed $2\frac{1}{3}$ ounces. Almost all the argentiferous veins afford a little gold; the silver of Guanaxuato, for example, contains $\frac{1}{360}$. The enormous product of the Mexican mines is to be ascribed rather to the great facility of working them, and the abundance of ores, than to their intrinsic richness.

The art of mining was little advanced in this country at the period of Humboldt's journey; the workings presented a combination of small mines, each of which had only one aperture above, without any lateral communications between the different shafts.

The form of these explorations was too irregular to admit of their being called *workings by steps.* The shafts and the galleries were much too wide. The interior transport of the ores is generally effected on the back of men; rarely by mules. The machines for raising the ore and drawing off the water are in general ill combined; and the horse gigs for setting them in motion ill constructed. The timbering of the shafts is very imperfectly executed; the walled portions alone are well done. There are some galleries of drainage, but they are too few, and ill directed. Latterly, English capitalists and miners have formed companies for working the silver mines of Mexico; which will probably produce in time a happy revolution.

The silver ores of Spanish America are treated partly by fusion, and partly by amalgamation, but more frequently by the latter mode; hence the importation of mercury forms there an object of the highest importance, especially since the quicksilver mine of *Huancavelica* fell in, and ceased to be worked. This mine is the only one in Spanish America which belongs to the government. For the modern state of these mines, see SILVER.

The following table shews, according to M. de Humboldt, what was the annual product of the silver mines of South America, at the beginning of this century. It is founded in a great measure, upon official documents:—

Mexico - - -	2,196,140 marcs, or	537,512 kil., worth	£4,778,000
Peru - -	573,958	140,478	1,250,000
Buenos-Ayres - -	463,098	110,764	984,600
Chili - -	25,957	6,827	060,680
Total -	3,259,153	795,581	7,073,280

To complete our picture of the mineral wealth of Spanish America, it remains to speak of its principal *gold mines*; but these belong to a geological locality, alluvial sand and gravel, very different from that of our present objects. The most important of these gold sands are washed on the western slope of the Cordilleras; viz. in New Granada, from the province of Barbacoas, to the isthmus of Panama, to Chili, and even to the shores of the seas of California. There are likewise some on the eastern slope of the Cordilleras, in the high valley of the river Amazons. The washings of New Granada produce also some platina.

The mines, properly so called, and the washings of South America, furnish, altogether, 42,575 marcs, or 10,418 kilogrammes (22,920 lbs. Eng.) of gold, worth 1,435,720*l.*

MINES OF HUNGARY.

The metallic mines of this kingdom, including those of Transylvania, and the Bannat of Temeschwar, form four principal groups, which we shall denote by the group of the N. W., group of the N. E., group of the E., and group of the S. E.

The group of the N. W. embraces the districts of Schemnitz, Kremnitz, Kœnigsberg, Neuhsohl, and the environs of Schmœlnitz, Bethler, Rosenau, &c.

Schemnitz, a royal free city of mines, and the principal centre of the mines of Hungary, lies 25 leagues to the north of Buda, 560 yards above the sea, in the midst of a small group of mountains covered with forests. The most part of these mountains, the highest of which reaches an elevation of 1130 yards above the ocean, are formed of barren trachytes (rough trap rocks); but at their foot below the trachytic formation, a formation is observed consisting of green-stone porphyries, connected with syenites, passing into granite and gneiss, and including subordinate beds of mica-slate and limestone. It is in this formation that all the mines occur.

It has been long known that the greenstone porphyries of Schemnitz have intimate relations with the metalliferous porphyries of South America. M. Beudant, on comparing them with those brought by M. de Humboldt from Guanaxuato, Real del Monte, &c., has recognised an identity in the minutest details of colour, structure, composition, respective situation of the different varieties, and even in the empirical character of effervescence with acids. The metalliferous rocks appear at Schemnitz only in a space of small extent, comprehended partly in a small basin, of which the city occupies the south border. They are traversed by veins which, for the most part, cut across the stratification, but which also are sometimes obviously parallel to it. These veins are in general very powerful; their thickness amounting even to more than 40 yards, but their extent in length seems to be usually inconsiderable. They are numerous and parallel to each other. It appears that they have no side plates of vein stones (*sallebandes*), but that the metalliferous mass reposes immediately on the cheeks or sections of the rock, which is usually more or less altered, and includes always much pyrites near the point of contact, and even to a distance of several feet. The substances which constitute the body of these veins, are drusy quartz, carious quartz, ferriferous carbonate of lime, and sulphate of barytes, with which occur sulphuret of silver mixed with native silver containing more or less gold, which is rarely in visible scales; sulphuret of silver, argentiferous galena, blende, copper and iron pyrites, &c. The sulphuret of silver and the galena are the two most important ores. Sometimes these two substances are insulated, sometimes they are mixed in different manners so as to furnish ores of every degree of richness, from such as yield 60 per cent. of silver down to the poorest galena. The gold seldom occurs alone; it generally accompanies the silver in a very variable proportion, which most usually approaches to that of 1 to 30.

The ores of Schemnitz are all treated by fusion; the poor galenas at the smelting house of Schemnitz (bleyhutte), and the resulting lead is sent as working lead to the smelting houses of Kremnitz, Neusohl, and Schernowitz, whither all the silver ores prepared in the different spots of the country are transported in order to be smelted

The mines of Schemnitz, opened 800 years ago, have been worked to a depth of more than 350 yards. The explorations are in general well conducted. Excellent galleries of efflux have been excavated; the waters for impulsion are collected and applied with skill. It may be remarked, however, that these mines begin to decline from the state of prosperity in which they stood several years ago; a circumstance to be ascribed probably to the same pains being no longer bestowed on the instruction of the officers appointed to superintend them. Maria Theresa established in 1760, at Schemnitz, a school of mines. This acquired at its origin, throughout Europe, a great celebrity, which it has not been able to maintain.

Kremnitz lies about 5 leagues N. N. W. of Schemnitz, in a valley flanked on the right by a range of hills formed of rocks quite analogous to the metalliferous rocks of Schemnitz. In the midst of these rocks, veins are worked nearly similar to those of Schemnitz; but the quartz which forms their principal mass is more abundant, and contains more native gold. Here also are found sulphuret and hydrosulphuret of antimony, which do not occur at Schemnitz. The metalliferous district is of very moderate extent, and is surrounded by the trachytic district which overlies it, forming to the East and West considerable mountains.

The city of Kremnitz is one of the most ancient free royal cities of mines in Hungary, It is said that mines were worked there even in the times of the Romans; but it is the Germans who, since the middle ages, have given a great development to these exploitations. There exists at Kremnitz a Mint-office, to which all the gold and silver of the mines of Hungary are carried in order to be parted, and where all the chemical processes, such as the fabrication of acids, &c., are carried on in the large way.

About 6 leagues N. N. E. from Schemnitz, on the banks of the Gran, lies the little village of *Neusohl*, founded by a colony of Saxon miners. The mountains surrounding it include mines very different from those of which we have been treating. At *Herrengrand*, 2 leagues from Neusohl, greywacke forms pretty lofty mountains; this rock is covered by transition limestone, and is supported by mica slate. The lower beds contain bands of copper ores, chiefly copper pyrites. The mica-slate includes likewise masses of ore, apparently constituting veins in it. These ores have been worked since the 13th century. The copper extracted contains in a hundred weight 6 ounces of silver.

Eighteen or twenty leagues to the east of *Neusohl*, we meet with a country very rich in iron and copper mines, situated chiefly in the neighbourhood of Bethler, Schmœlnitz, Einsiedael, Rosenau, &c. Talcose and clay slates form the principal body of the mountains here, along with hornblende rocks. The ores occur most usually in strata. Those of iron, are sparry ore, and especially hydrate of iron, compact and in concretions, accompanied with specular iron ore. They give employment to a great many large smelting houses. The county of Gœmar alone contains 22 works; and that of Zips also a great number. The copper mines lie chiefly in the neighbourhood of Schmœlnitz and Gœlnitz. The copper extracted contains about 6 or 7 ounces of silver in the hundred weight. Near Zalathna there is a quicksilver mine nearly inactive; and near Rosenau one of antimony.

To conclude our enumeration of the mineral wealth of this country, it remains merely to state that there are *opal* mines in the envirous of Czervenitza, placed in the trachytic conglomerate.

GROUP OF THE NORTH EAST, OR OF NAGABANYA.

The mines of this group lie in a somewhat considerable chain of mountains, which, proceeding from the frontiers of Buchowina, where it is united to the Carpathians, finally disappears amidst the saliferous sandstones between the *Theiss*, *Lapos*, and *Nagy Szamos*, on the northern frontiers of Transylvania. These mountains are partly composed of rocks analogous to those of Schemnitz, traversed by veins which have much resemblance to the veins of this celebrated spot. Into these veins a great many mines have been opened, the most important of which are those of Nagabanya, Kapnick, Felsobanya, Miszbanya, Laposbanya, Olaposbanya, Ohlalapos. All these mines produce gold. Those of Laposbanya furnish, likewise, argentiferous galena; those of Olaposbanya contain copper and iron; and those of Kapnick copper. Realgar occurs in the mines of Felsobanya; and orpiment in those of Ohlalapos. Several of them produce manganese and sulphuret of antimony. Lastly, towards the north, in the county of Marmarosh, lies the important iron mine of *Borscha*, and on the frontiers of Buchowina the lead mine of *Radna*, in which also much zinc ore occurs.

The mines composing the group of the East, or of Abrudbanya, occur almost all in the mountains which rise in the western part of Transylvania, between *Lapos* and *Maros*, in the environs of *Abrudbanya*. M. Beudant notices in this region, limestones, sandstones, trachytes, basalts, and sienite porphyries, apparently quite analogous to the greenstone porphyries of Schemnitz. It seems to be principally in the latter rocks that the mines forming the wealth of this country occur; but some of them exist also in the mica-slate, the greywacke, and even in the limestone. The principal mines are at Nagyag, Korosbanya, Vorospatak, Boitza, Csertesch, Fatzbay, Almas, Porkura, Butschum, and Stonischa. There are, in all, 40 exploitations; the whole of which produce auriferous ores smelted at the foundry of Zalathna. These mines contain also copper, antimony, and manganese. They are celebrated for their *tellurium* ore, which was peculiar to them prior to the discovery of this metal a few years back in Norway. The auriferous deposits contained in the greenstone porphyry are often very irregular. The mines of Nagyag are the richest and best worked. The numerous veins occur partly in the sienite porphyry, and partly in the greywacke. The auriferous ore is accompanied with galena, realgar, manganese, iron, and zinc. There are iron mines in great beds near Vayda-Huniad and Gyalar. Some cobalt mines are also noticed.

The group of the S. E., or of the Bannat of Temeschwar, occurs in the mountains which block up the valley of the Danube at Orschova, through a narrow gorge of which the river escapes. The principal mines are at Oravitza, Moldawa, Szaska, and Dognaaczka.

They produce chiefly argentiferous copper, yielding a marc of silver (nearly ½ pound) in the hundred weight, with occasionally a little gold. Ores of lead, zinc, and iron, are also met with. The mines are famous for their beautiful specimens of blue carbonate of copper, and various other minerals. The mine of Moldawa affords likewise orpiment. These metallic deposits lie in beds and veins; the former occurring particularly between the mica-slate and the limestone, or sometimes between the limestone and the sienite porphyry. Well defined veins also are known to exist in the sienite and the mica-slate. The Bannat possesses moreover important iron-mines at Dombrawa and Ruchersberg; near Dombrawa sulphuret of mercury is found. Cobalt mines occur likewise in these regions.

The mines constituting the four groups now described are not the sole metallic mines possessed by Hungary. A few others, but generally of little importance, are scattered over different parts of this kingdom. Several have been noticed in the portion of the Carpathians which separates Transylvania from Moldavia and Wallachia. Their principal object is the exploration of some singular deposits of galena.

Besides the mines just noticed, Hungary contains some coal mines, numerous mines of rock-salt, and several deposits of golden sands situated chiefly on the banks of the Danube, the Marosch, and the Nera.

The mines of the kingdom of Hungary produce annually, according to M. Heron de Villefosse, 5218 marcs, or 2810 pounds English of gold, worth 175,976*l.*; and about 85,000 marcs, or 45,767 pounds of silver, worth 186,132*l.* The mines of Transylvania furnish nearly the half of the whole quantity of gold, and one seventeenth of the silver now stated. The other mines of Europe produce together nearly twice as much silver, but merely a few marcs of gold. Hungary affords besides from 18 to 20 thousand metric quintals (about 4,000,000 libs. Eng.) of copper annually, and a great deal of iron.

From these mines proceed likewise from 3000 to 4000 metric quintals (660,000 to 880,000 libs. E.) of lead; a quantity not more than is needed by the refining-houses for the ores of silver and gold.

MINES OF THE ALTAYAN MOUNTAINS.

At the western extremity of the chain of the Altayan mountains, which separate Siberia from Chinese Tartary, there exists a number of metalliferous veins, in which several important workings have been established since the year 1742. They constitute the locality of the mines of Kolywan; the richest in the precious metals of the three districts of this kind existing in Siberia.

These mines are opened up in the schistose formations which surround to the N. and W. and to the S. W. the western declivity of the high granitic chain, from which they are separated by formations consisting of other primitive rocks. These schists alternate in some points with quartzose rocks, called by M. Renovantz hornstone, and with limestone. They are covered by a limestone, replete with ammonites. The metalliferous region forms a semicircle, of which the first lofty mountains occupy the centre.

The most important exploration of this country is the silver mine of Zméof, or Zmeinogarsk, in German Schlangenberg, situated to the N. W. of the high mountains in 51° 9′ 25″ N. L. and 79° 49′ 50″ long. east of Paris. It is opened on a great vein, which contains argentiferous native gold, auriferous native silver, sulphuret of silver, hornsilver, gray copper, sulphuret of copper, green and blue carbonated copper, red oxide of copper, copper pyrites, sulphuret of lead, and great masses of testaceous arsenic slightly argentiferous. There occur likewise sulphuret of zinc, iron pyrites, and sometimes arsenical pyrites. The gangues (vein stones) of these different ores are sulphate of baryta, carbonate of lime, quartz, but rarely fluate of lime. The principal vein, which is of great power, has been traced through a length of several hundred fathoms, and to a depth of no less than 96 fathoms. In its superior portion, it has an inclination of about 50 degrees; but lower down it becomes nearly vertical. Its roof is always formed of clay-slate. On the floor of the vein, the slate alternates with hornstone. This vein pushes out branches in several directions; it is intersected by barren veins, and presents successive stages of different richness. The first years were the most productive. The German miners employed subsequently by the Russian government have introduced regularity into the workings; and have excavated a gallery of efflux 585 fathoms long.

The most important of the other silver mines of this department are those of Tcherepanofski, 3 leagues S. E. of Zméof; those of Smenofski, 10 leagues S. E.; those of Nicolaiski, 20 leagues to the S. S. W.; and of Philipofski, 90 leagues S. E. of the same place. The last mine lies on the extreme frontier of Chinese Tartary. It is not known whether the southern slope of the Altaic chain within the Chinese territories, contains metalliferous deposits.

The ores extracted from these different mines yield on an average per quintal an ounce of silver, which contains 3 per cent. of gold. Their annual product was towards 1786, according to M. Patrin, 3000 marcs, or 1615 libs. avoirdupois of gold, worth 101,151*l.*; and 60,000 marcs, or 31,020 libs. avoird. of silver, worth 130,520*l.*

The precious metals are not the sole product of this mineral district. There is an important copper-mine 15 leagues N. W. of Zméof, in a chain of hills formed of granitic rocks, schists, porphyries, and shell-limestone, graduating into the plain. The vein presents copper pyrites, sulphuret of copper, and native copper, disseminated in argillaceous substances, more or less ferruginous, and of different degrees of hardness. This mine, which bears the name of Aleiski-Loktefski, furnished annually at the date of 1782, 1500 quintals (metric), or 330,000 libs. avoird. of copper, which was coined into money in the country itself.

At Tchakirskoy, on the banks of the Tscharisch, towards the northern extremity of the metalliferous semicircle, mentioned above, there is a mine of argentiferous copper and lead, opened in a very large but extremely short vein. Besides the lead and copper ores, including a little silver, this mine affords a great quantity of calamine (carbonate of zinc), which forms occasionally fine stalactites of a white or green colour.

The northern flank of the Altaï mountains presents few mines. Some veins of copper exist 2000 leagues east of Zméof, near the spot where the river Janissei issues from the Saïanean mountains, which are a prolongation of the Altayan chain.

There is no lead-mine, properly so called, in the Altaï mountains. Almost all the lead which is required for the treatment of the silver and gold ores is obtained from the department of Nertchinsk, situated 700 leagues off, on the borders of the river *Amour*.

The first smelting-house erected in this district was in the middle of the metalliferous region at *Kolywan*, the place from which it takes its name. It has been suppressed on account of the dearth of wood in the neighbourhood of the mines. The principal existing foundry is that of Bornaoul on the Ob, 50 leagues north of Zméof.

MINES OF THE URAL MOUNTAINS.

This chain of mountains, which begins on the coasts of the icy sea, and terminates in the 50th degree of latitude amidst the steppes of the *Kerguis*, after having formed, through an extent of more than 40 leagues, the natural limit between Europe and Asia, contains very rich and very remarkable deposits of metallic ores, which have given rise to important mines of iron, copper, and gold. These explorations are situated on the two slopes, but chiefly on the one that looks to Asia, from the environs of Ekaterinbourg to about 120 or 130 leagues north of that city. They constitute the department of the mines of Ekaterinbourg, one of the three belonging to Siberia.

The copper-mines are pretty numerous, and lie almost wholly on the oriental slope of the chain. They are opened into veins of a very peculiar nature, and which although very powerful at the surface, do not extend to any considerable depth. These veins are in general filled with argillaceous matters, penetrated with red oxide of copper, and mingled with green and blue carbonated copper, sulphuret of copper, and native copper. The most important workings are those of *Tourinski* and *Gonmechafski.*

The first are situated 120 leagues north of Ekaterinbourg, towards the 60th degree of N. latitude, at the eastern base of the Uralian mountains, near the banks of the *Touria.* They amount to three, opened in the same vein, which turns round an angle presented by the chain in this place. The ground is composed of a porphyry with a hornstone basis, of clay-slate, and of a white or grayish limestone, which form the roof and floor of the vein. The ore yields from 18 to 20 per cent., and these mines produced annually in 1786, 10,000 metric quintals (2,200,000 libs avoird.) of copper.

The mine of Goumechefski lies 12 or 15 leagues S. W. of Ekaterinbourg, near a lake bordered by primitive mountains, which form in this region the axis of the chain of the Urals. This mine is celebrated for the beautiful malachites that occur in it. It has furnished almost all the fine specimens of this substance employed in jewellery. The vein, of which the sides are calcareous, is vertical, and runs north and south. It does not sink deeper than about 50 yards, and is filled with a species of coarse pudding-stone, composed of masses of primitive rocks. The ore yields from 3 to 4 per cent. of copper, and the mine furnished about the year 1786, 4,400,000 libs. avoird. of this metal *per annum.*

The beds of iron ore occur generally at a certain distance from the axis of the central chain. Those of the western slope lie sometimes in a gray compact limestone, which contains *entrochi* and other petrifactions, and whose geological age has not been ascertained, but it appears to be much more modern than the rocks of the central chain. Both the one and the other seem to form large veins, which extend little in depth, or rather fill irregular and shallow cavities. The most common ore is the hydrate of iron (bog ore), hematite, or compact iron ore, sometimes mixed or accompanied with hydrate of manganese, and occasionally with ores of zinc, copper, and lead. Black oxide of iron, possessing magnetic polarity, likewise frequently occurs, particularly in the mines of the eastern slope, on which, in fact, entire mountains of loadstone repose. All these ores, mixed with a greater or less quantity of clay differently coloured, are worked by open quarries, and most usually without using gunpowder, or even iron wedges. They yield rarely less than 50 or 60 per cent., and keep in action numerous smelting-houses situated on the two flanks of the chain; the oldest of them have been established since 1628, but the greater number date only from the middle of the 18th century. The most celebrated mines are those of *Balgodat* and *Keskanar*, situated on the eastern slope from 30 to 50 leagues north of *Ekaterinbourg*. In the foundries of the eastern slope, anchors, cannons, bullets, &c. are fabricated; and in the whole a considerable quantity of bar iron. The products of the works on the western side are directly embarked on the different feeders of the Volga, from which they are at no great distance. Those of the eastern slope are transported during winter on sledges to the same feeder streams, after crossing the least elevated passages of the Urals.

The quantity of materials fabricated by the iron works of both slopes, amounted annually, towards the year 1790, to more than 11,000,000 libs. avoird. This country is peculiarly favoured by nature for this species of industry; for vast deposits of excellent iron ores occur surrounded by immense forests of firs, pines, and birches; woods, whose charcoal is excellently adapted to the fabrication of iron.

The copper-mines of the Uralian mountains, and the greater part of the iron mines and foundries, form a portion of the properties of some individuals, who may be instanced as among the richest in Europe. The Russian government has neglected no opportunity of promoting these enterprizes. It has established at Tourinsky a considerable colony, and at Irbitz a fair which has become celebrated.

There is only one gold mine in the Ural mountains, that of *Beresof*, situated three leagues N. E. of Ekaterinbourg, at the foot of the Urals, on the Asiatic side. It is famous for the chromate of lead, or red lead ore, discovered there in 1776, and worked in the following years, as also for some rare varieties of minerals. The ore of Beresof is a cavernous hydrate of iron (bog ore), presenting here and there some small striated cubes of hepatic iron, and occasionally some pyrites. It contains 5 parts of native gold in 100,000. This deposit appears to have a great analogy with the deposits of iron ore of the same region. It constitutes a large vein, running from N. to S., encased in a formation of gneiss, hornblende schists, and serpentine, and which does not appear to dip to any considerable depth. It becomes poor in proportion to its distance from the surface. The exploitation, which is in the open air, has dug down 25 yards; having been carried on since the year 1726. The gold is extracted from the ore by stamping and washing. In 1786, 500 marcs were collected; but the preceding years had furnished only 200, because they then worked further from the surface. German miners were called in to direct the operations. On some points of the Ural mountains, and the neighbouring countries, deposits of an auriferous clay have been noticed; but they have not hitherto been worked.

Beds of chromate of iron have also been discovered in these mountains.

The beautiful plates of mica, well known in mineral cabinets, and even in commerce, under the name of Muscovy talc, or Russian mica, come from the Urals. There are explorations for them near the lake Tschebarkoul, on the eastern flank of this chain. From the same canton there is exported a very white clay, apparently a *kaolin*.

25 leagues north of Ekaterinbourg, near the town of Mourzinsk, there occur in a graphic granite, numerous veins, containing amethysts, several varieties of beryl, emeralds, topazes, &c.

Table of the production of the Russian Mines during the years 1830, 1831, 1832, 1833, and 1834; by M. Teploff, one of their Officers.

Substances.	1830.	1831.	1832.	1833.	1834.
	kil.	*kil.*	*kil.*	*kil.*	*kil.*
Gold - -	6,260	6,582	6,916	6,706	6,626
Platinum -	1,742	1,767	1,907	1,919	1,695
Auriferous silver	20,974	21,563	21,454	20,552 (3)	20,666
Copper - -	8,860,696	3,904,533	3,620,201	3,387,252	?
Lead - -	698,478	792,935	688,351	716,500 (3)	?
Cast iron -	182,721,274	180,043,730 (2)	162,480,224	159,118,372	?
Salt - -	342,240.893	282,821,358	372,776,283	491,862,299	?
Coal - -	7,863,642	9,774,998	6,596,034	8,227,528	?
Naphtha -	4,253,000	4,253,000	4,253,000	4,253,000	?

MINES OF THE VOSGES AND THE BLACK FOREST.

These mountains contain several centres of exploration of argentiferous ores of lead and copper, iron ores, and some mines of manganese and anthracite.

At the *Croix-aux-mines*, department of the Vosges, a vein of argentiferous lead has been worked, which next to the veins of Spanish America, is one of the greatest known. It is several fathoms thick, and has been traced and mined through an extent of more than a league. It is partly filled with debris, among which occurs some argentiferous galena. It contains also phosphate of lead, antimoniated sulphuret of silver, &c. It runs from N. to S. nearly parallel to the line of junction of the gneiss, and a porphyroid granite, that passes into sienite and porphyry. In several points it cuts across the gneiss; but it probably occurs also between the two rocks. It has never been worked below the level of the adjoining valley. The mines opened on this vein produced, it is said, at the end of the 16th century, 26,000*l.* per annum; they were still very productive in the middle of the last century, and furnished, in 1756, 2,640,000 lbs. avoird. of lead, and 6000 marcs, or 3230 pounds avoird. of silver.

The veins explored at *Sainte Marie of the mines*, also traverse the gneiss; but their direction is nearly perpendicular to that of the vein of the *Croix*, from which they are separated by a barren mountain of sienite. They contain besides galena, several ores of copper, cobalt, and arsenic; all more or less argentiferous. There is found also at a little distance from *Saint Mary of the mines*, a vein of sulphuret of antimony The mines of *Sainte Marie*, opened several centuries ago, are among the most antient in France; and yet they have been worked only down to the level of the adjoining valleys.

There has been opened up in the environs of *Giromagny*, on the southern verge of the Vosges, a great number of veins, containing principally argentiferous ores of lead and copper. They run nearly from N. to S., and traverse porphyries and clay-slates; a system which has some analogy with the metalliferous district of Schemnitz. The workings have been pushed so far as 440 yards below the surface. These mines were in a flourishing state in the 14th and 16th centuries; and became so once more at the beginning of the 17th, when they were undertaken by the house of Mazarin. In 1743 they still produced 100 marcs, fully 52 libs. avoird. of silver in the month.

The mines of *la Croix*, of *Sainte-Marie-aux-mines*, and of *Giromagny*, are now abandoned; but it is hoped that those of the first two localities will be resumed ere long.

In the mountains of the Black Forest, separated from the Vosges by the valley of the Rhine, but composed of the same rocks, there occur at *Badenweiler* and near *Hochberg*, not far from Freyburg, workings of lead in great activity. These form six distinct mines, and annually afford 88,000 *libs. avoird.* of lead, and 200 marcs of silver. In the Furstenberg near *Wolfach*, particularly at *Wittichen*, there are mines of copper, cobalt, and silver. The mines of Wittichen produced, some years ago, 1600 marcs, or near 880 *libs. avoird.* of silver *per annum.* They supply a manufactory of smalt, and one of arsenical products. A few other inconsiderable mines of the same kind exist in the grand duchy of Baden, and in the kingdom of Wurtemberg.

Several important iron mines are explored in the Vosges; the principal are those of *Framont*, in the department of the Vosges, whose ores are red oxide of iron and brown hematite, which appear to form veins of great thickness, much ramified, and very irregular, in a district composed of greenstone, limestone and greywacke. The subterranean workings, opened on these deposits, have been hitherto very irregular. There has been discovered lately in these mines, an extremely rich vein of sulphuret of copper. At *Rothau*, a little to the east of Framont, thin veins of red oxide of iron are worked; sometimes magnetic, owing probably to an admixture of protoxide of iron. These veins run through a granite, that passes into sienite. At Saulnot near Belfort, there are iron mines, analogous to those of Framont.

In the neighbourhood of Ihann and Massovaux, near the sources of the Moselle, veins are worked of an iron ore, that traverse formations of greywacke, clay-slate, and porphyry. Lastly, in the north of the Vosges, near Bergzabern, Erelenbach, and Schenau, several mines have been opened on very powerful veins of brown hematite and compact bog ore, accompanied with a little calaminе, and a great deal of sand and debris. In some points of these veins, the iron ore is replaced by various ores of lead, the most abundant being the phosphate, which are explored at *Erlenbach* and *Katzenthal.* These veins traverse the sandstone of the Vosges, a formation whose geological position is not altogether well known, but which contains iron mines analogous to the preceding at *Langenthal*, at the foot of Mount Tonnerre, and in the Palatinate. Many analogies seem to approximate to the sandstone of the Vosges, the sandstone of the environs of Saint Avold (Moselle), which include the mine of brown hematite of *Creutzwald*, and the lead mine of Bleyberg, analogous to the lead mine of Bleyberg, near Aix-la-Chapelle.

At *Cruttnich* and *Tholey*, to the north of the Sarrebruck, mines of manganese are worked, famous for the good quality of their products. The deposit exploited at Cruttnich, seems to be inclosed in the sandstone of the Vosges, and to constitute a vein in it, analogous to the iron veins mentioned above.

There has been recently opened a manganese mine at *Lavelline* near *La Croix-aux-mines*, in a district of gneiss with porphyry.

In the *Vosges* and the *Black Forest* there are several deposits of anthracite (stone-coal), of which two are actually worked, the one at Zunswir near Offenbourg, in the territory of Baden, and the other at Uvoltz, near Cernay, in the department of the Upper Rhine. There are also several deposits of the true coal formation on the flanks of the Vosges.

MINES OF THE HARTZ.

The name Hartz is given generally to the country of Forests, which extends a great many miles round the *Brocken*, a mountain situated about 55 miles W.S.W. of Magdeburg, and which rises above all the mountains of North Germany, being at its summit 1226 yards above the level of the sea. The Hartz is about 43 miles in length from S.S.E. to N.N.W., 18 miles in breadth, and contains about 450 square miles of surface. It is generally hilly, and covered two-thirds over with forests of oaks, beeches, and firs. This rugged and picturesque district corresponds to a portion of the *Silva Hercynia* of Tacitus. As agriculture furnishes few resources there, the exploration of mines is almost the only means of subsistance to its inhabitants, who amount to about 50,000. The principal cities, *Andreasberg*, *Clausthal*, *Zellerfeld*, *Altenau*, *Lautenthal*, *Wildemann*, *Grund*, and *Goslar*, bear the title of mine-cities, and enjoy peculiar privileges; the people deriving their subsistence from working in the mines of lead, silver, and copper, over which their houses are built.

The most common rock in the Hartz is greywacke. It encloses the principal veins, and is covered by a transition limestone. The granite of which the Brocken is formed supports all this system of rocks. forming as it were, their nucleus. Trap and hornstone rocks appear in certain points.

The veins of lead, silver, and copper, which constitute the principal wealth of the Hartz, do not pervade its whole extent. They occur chiefly near the towns of Andreasberg, Clausthal, Zellerfeld, and Lautenthal; are generally directed from N.W. to S.E., and dip to the S.W., at an angle of 80° with the horizon.

The richest silver mines are those of the environs of Andreasberg, among which may be distinguished the Samson and Neufang mines, worked to a depth of 560 yards. In the first of them, there is the greatest *step* exploitation to be met with in any mine. It is composed of 80 *direct steps*, and is more than 650 yards long. These mines were discovered in 1520, and the city was built in 1521. They produce argentiferous galena, with silver ores properly so called, such as red silver ore, and ore of cobalt.

The district which yields most argentiferous lead, is that of Clausthal. It comprehends a great many mines, several of which are worked to a depth of 550 yards. Such of the mines as are at the present day most productive, have been explored since the first years of the 18th century. The two most remarkable ones are the mines of Dorothy, and the mine of Caroline, which alone furnish a large proportion of the whole neat product. The grant of the Dorothy mine extends over a length of 257 yards, in the direction of the vein, and through a breadth of nearly 22 yards perpendicularly to that direction. Out of these bounds, apparently so small, but which however surpass those of the greater part of the *concessions* in the Hartz, there was extracted from 1709 to 1807 inclusively, 883,722 marcs of silver, 768,845 quintals of lead, and 2385 quintals of copper. This mine and that of Caroline have brought to their shareholders in the same period of time, more than 1,120,000*l.*; and have besides powerfully contributed by loans without interest to carry on the exploration of the less productive mines. It was in order to effect the drainage of the mines of the district of Clausthal, and those of the district of Zellerfeld adjoining, that the great gallery of efflux was excavated.

Next to the two districts of Clausthal and Zellerfeld, and Andreasberg, comes that of Goslar, the most important working in which is the copper mine of Rammelsberg, opened since the year 968, on a mass of copper pyrites, disseminated through quartz, and mingled with galena and blende. It is worked by shafts and galleries, with the employment of fire to break down the ore. This mine produces annually from 1200 to 1300 metric quintals (about 275,000 libs. avoird.) of copper. The galena extracted from it yields a small quantity of silver, and a very little gold. The latter metal amounts to only the five millionth part of the mass explored; and yet means are found to separate it with advantage. The mine of *Lauterberg* is worked solely for the copper, and it furnishes annually near 66,000 libs. avoird. of that metal.

Besides the explorations just noticed, there are a great many mines of iron in different parts of the Hartz, which give activity to important forges, including 21 smelting cupolas. The principal ores are sparry iron, and red and brown hematites, which occur in veins, beds, and masses. Earthy and alluvial ores are also collected.

The territory of Anhalt-Bernbourg presents, towards the S. E. extremity of the Hartz, lead and silver mines, which resemble closely those of the general district. They produce annually 33,000 libs. avoird. of lead.

At the southern foot of the Hartz, at Ilefeld, there is a mine of manganese.

The exploration of the Hartz mines may be traced back for about 900 years. The epoch of their greatest prosperity was the middle of the 18th century. Their gross annual amount was in 1808, upwards of one million sterling. Lead is their principal product, of which they furnish annually 6,600,000 libs. avoird., with 36,000 marcs, or 18,700 libs. avoird. of silver, about 360,000 libs. avoird. of copper, and a very great quantity of iron. They are celebrated for the excellence of the mining operations; and the activity, patience, and skill of their workmen.

The Hartz is referred to especially for the manner in which the waters are collected, and economised for floating down the timber, and impelling the machinery. With this view, dams or lakes, canals and aqueducts, have been constructed, remarkable for their good execution. The water-courses are formed either in the open air round the mountain sides, or through their interior as subterranean galleries. The open channels collect the rain waters, as well as those proceeding from the melting of snows, from the springs and streamlets, or small rivers that fall in their way. The subterranean conduits are in general the continuation of the preceding, whose circuits they cut short. These water-courses present a development in whole, of 125 miles. The banks of some of the reservoirs are of an extraordinary height. In the single district of Clausthal there are 34 tanks, which supply water to 92 wheels of nearly 30 feet diameter. 55 of these serve for the drainage of water; and 37 for the extraction of ores.

MINES OF THE EAST OF GERMANY.

We shall embrace under this head the mines opened in the primitive and transition territories, which constitute the body of a great portion of Bohemia, and the adjacent parts of Saxony, Bavaria, Austria, Moravia, and Silesia.

Among the several chains of small mountains that cross these countries, the richest in deposits of ore is the one known under the name of the *Erzgebirge*, which separates Saxony from Bohemia on the left bank of the Elbe.

The *Erzgebirge* contains a great many mines whose principal products are *silver, tin,* and *cobalt.* These mines, whose exploration remounts to the 12th century, and particularly those situated on the northern slope within the kingdom of Saxony, have been long celebrated. The school of mines established at Freyberg, was at one time considered as the first in the world. This is a small city near the most important workings, 8 leagues W. S. W. of Dresden, towards the middle of the northern slope of the Erzgebirge, 440 yards above the level of the sea, in an agricultural and trading district, well cleared of wood. These circumstances have modified the working of the mines; and render it difficult to draw an exact parallel between them, and those of the Hartz, which are their rivals in good exploration. They are peculiarly remarkable for the perfection with which the engines are executed both for drainage and extraction of ores, all moved by water or horses; for the regularity of almost all the subterranean labours; and for the beauty of their *walling* masonry. In the portion of these mountains belonging to Saxony, the underground workings employ directly from 9000 to 10,000 men, who labour in more than 400 distinct mines, all associated under the same plan of administration.

The *silver* mines of the *Erzgebirge* are opened on veins which traverse gneiss, and though quite different in this respect from the argentiferous veins of *Guanaxuato, Schemnitz,* and *Zmeof,* present but a moderate thickness, never exceeding a few feet. They form several groups, whose relative importance has varied very much.

For a long time back, those of the environs of Freyberg are much the most productive; and their prosperity has been always on the advance, notwithstanding the increasing depth of the excavations. The deepest of the whole is that of Kuhschacht, which penetrates to 450 yards beneath the surface, that is nearly down to the sea-level. The most productive and the most celebrated is the mine of Himmelsfürst; that of Beschertgluck is also very rich.

Among the explorations of the Erzgebirge, there are none which were formerly so flourishing as those of Marienberg, a small town situated seven leagues S. S. W. of Freyberg. In the 16th century, ores were frequently found there, even at a short distance from the surface, which yielded 85 per cent. of silver. The disasters of the thirty years' war put a term to their prosperity. Since that period they have continually languished; and their product now is nearly null.

Our limits do not permit us to describe in detail the silver mines that occur near

Ehrenfriedersdorf, Johanna-Georgenstadt, Annaberg, Oberwiesenthal, and *Schneeberg.* Those of the last three localities produce also cobalt.

The mines of Saint-Georges, near Schneeberg, opened in the 15th century as iron mines, became celebrated some time after as mines of silver. Towards the end of the 15th century, a mass of ore was found there which afforded 400 quintals of silver. On that lump, Duke Albert kept table at the bottom of the mine. Their richness in silver has diminished since then; but they have increased more in importance during the last two hundred years, as mines of cobalt, than they had ever been as silver mines. Saxony is the country where cobalt is mined and extracted in the most extensive manner. It is obtained from the same veins with the silver. Smalt, or cobalt-blue, is the principal substance manufactured from it. The lead and the copper are in this country only accessory products of the silver mines, from which 120,000 lbs. avoird. of the first of these metals are extracted, which are hardly sufficient for the metallurgic operations; and from 50,000 to 60,000 lbs. of copper. A little bismuth is extracted from the mines of Schneeberg and Freyberg. Some manganese is found in the silver mines of the Erzgebirge, and particularly at Johann-Georgenstadt.

The mines of Saxony produce a little argentiferous galena, and argentiferous gray copper; the minerals with a base of native silver are the principal ores. They are treated in a great measure by amalgamation. All those of Freyberg are carried to the excellent smelting house of Halsbrück, situated on the Malde, near that city. The average richness of the silver ores throughout Saxony is only from 3 to 4 oz. per quintal; viz. nearly equal to that of the ores of Mexico, and very superior to the actual richness of the ores of Potosi. The silver extracted from them contains a little gold. The Saxon mines produce annually 52,000 marcs of silver. Of these, the district of Freyberg alone furnishes 46,000; and among the numerous mines of that district, that of Himmelsfurst of itself produces 10,000 marcs.

Silver mines exist also on the southern declivity of the Erzgebirge, which belongs to Bohemia, at *Joachimsthal* and *Bleystadt*, to the N. E. of Eger. Argentiferous galena is chiefly extracted from these. The mines of Joachimsthal have been explored to a depth of 650 yards. They were formerly very flourishing; but in 1805 they were threatened with an impending abandonment. The ancient mines of Kuttenberg, situated in the same region, have been excavated, according to Agricola, to upwards of 1000 yards from the surface soil.

The southern slope of the Erzgebirge possesses cobalt mines like the northern slope; but they are of much less importance. Some occur, particularly in the neighbourhood of Joachimsthal. Lastly, on the same slope, slightly productive copper mines are mentioned at Gröslitz, near Joachimsthal; at Catharineberg, eight leagues N. of Saatz; and at Kupferberg, lying between the two. At Gröslitz, the ore is a cupreous pyrites, accompanied by blende. The ores of Catharineberg are argentiferous.

Next to the silver mines, the most important explorations of the Erzgebirge are those of tin. This metal occurs in veins, massive, and disseminated in masses of hyalin gray quartz, imbedded in the granite. It is also found in alluvial sands. The most important tin mine of the Erzgebirge is that of Altenberg, in Saxony, which has been under working since the 15th century. Some tin is mined also near Gayer, Ehrenfriedersdorf, Johann-Georgenstadt, Scheibenberg, Annaberg, Seiffen, and Marienberg, in Saxony. At Zinnwald it is also found; where the stanniferous district belongs partly to Saxony, and partly to Bohemia; as also important mines occur in the latter territory at Schlackenwald and Abertham, and slightly productive ones at Platten and Joachimsthal. In several of these mines, particularly at Altenberg and Gayer, fire is employed for attacking the ore, because it is extremely hard. In almost the whole of them, chambers of too great dimensions have been excavated, whence have arisen, at different epochs, vexatious sinkings of the ground. One of these may still be seen at Altenberg, which is 130 yards deep, and nearly 50 in breadth. The mines of Abertham are explored to a depth of 550 yards; and those of Altenberg to 330. The tin mines of the Erzgebirge produce annually 484,000 lbs. avoird. of this metal.

The tin ores are accompanied by arsenical pyrites, which, in the roasting that it undergoes, produces a certain quantity of arsenious acid.

The Erzgebirge presents also a great many iron mines, particularly in Saxony, at *Rodenberg*, near Cradorf, in the county of Henneberg, where the workings penetrate to a depth of 220 yards, and in Bohemia, at *Platten*, where may be remarked especially the great explorations opened on the vein of the *Irrgang*.

There is also in the Erzgebirge a mine of anthracite (stone coal) at *Schœnfeld*, near Frauenstein in Saxony.

The ancient rock formations which appear in the remainder of Bohemia, and in the adjacent portions of Bavaria, Austria, Moravia, and Silesia, are much less rich in metals than the Erzgebirge. No explorations of much importance exist there.

The *Fichtelgebirge*, a group of mountains standing at the western extremity of the

Erzgebirge, between Hoff and Bayreuth, contains some mines, among which may be noticed, principally, mines of magnetic black oxide of iron.

Argentiferous lead mines have been mentioned at *Miess*, 25 leagues W. S. W. of Prague, at the N.E. base of the western part of *Bomerwaldgebirge*, a chain of mountains which separates Bohemia from Bavaria. There are some also at *Prszibram*, 12 leagues S. W. of Prague, at the extremity of the mountains which separate Behrun from Moldau. In the latter, the argentiferous galena is accompanied by blende, in which the presence of cadmium has been observed. These mines, and those of Joachimsthal and of Bleystadt, furnish annually at present 220,000 pounds avoird. of lead, and from 2000 to 3000 marks of silver. The circle of Behrun, to the S.W. of Prague, contains some inconsiderable mines of mercury. The eastern part of the Bomerwaldgebirge, which separates Bohemia from Austria and Moravia, presents some mines on its S.E. slope. Those of the environs of *Iglau*, in Moravia, and some others situated in Austria, produce annually from 4000 to 5000 marks of silver. The mines of these two countries yield also copper, and in several the copper ores are argentiferous. Moravia comprehends several iron works, which are in part supplied by magnetic iron ores analogous to those of Sweden.

The N. E. slope of the Riesengebirge (giant mountains), which separate Bohemia from Silesia, presents also several explorations. The argentiferous copper mines of *Rudolstadt* and of *Kupferberg*, have been stated as producing annually a considerable quantity of copper, and from 600 to 700 marcs of silver; as also the cobalt mine of Maria-anna Querback, the whole in the circle of Qauer; and the mines of arsenical pyrites at Reichenstein, in the circle of Glatz. A mine of chrysoprase exists in the mountain of Kosennitz.

MINES OF THE CENTRE OF FRANCE.

The antient formations, principally granitic, which constitute the ground of several departments of the centre and south of France, are hardly any richer in explorations than the districts mentioned at the end of the Black Forest. Only some insulated mines are to be observed here, of which a very few possess any importance. These all occur towards the eastern border of the mass of primitive formations, in a zone characterised by a great abundance of schistose rocks.

At Villefort and at Viallaze, in the department of the Lozère, and in some places adjoining, several veins of argentiferous galena are worked which traverse the gneiss and the granite. These mines, remarkable at present for the regularity of their workings, employ 300 labourers, and produce annually about 220,000 lbs. avoird. of lead, and 1600 marks of silver.

The city of Vienne, in Dauphiny, is built on a hill of gneiss separated by the Rhone from the main body of the primitive formations, and in which veins of galena occur, which are now imperfectly mined. Other lead mines of less importance are observed at *St. Julien-Molin-Molette*, department of the Loire, and at *Joux*, department of the Rhone.

At Chessy, a village situated 7 leagues N. W. of Lyons, there occur in a talcose schist very extensive veins of cupreous pyrites, by no means rich, but which have, nevertheless, been worked successfully during the latter part of the 18th century, and several years of the present. At that period, there was found in a sandstone which covers the talcose schist, and which appears referrible to the red sandstone or the variegated sandstone, a bed containing a great quantity of blue carbonate of copper and protoxide of copper, to the working of which the miners have since directed their principal attention. There exists at Saint-Belle, 2 leagues to the south of Chessy, a deposit of copper pyrites like that of Chessy, which was at one time worked, but is now standing still. At Romanèscho, in the department of Saone et Loire, a very abundant deposit of oxide of manganese is observed, apparently forming a mass in the granite, or perhaps above it. The workings are very irregular.

In the mountain of Ecouchettes near Couches, in the same department, an ore of oxide of chrome has been occasionally worked.

At Malbosc, in the department of the Lozère, a feeble vein of sulphuret of antimony is mined.

There are also in the centre of France some explorations of galena, antimony, and manganese, which appear to be of too little importance to be noticed in detail.

Some years ago a tin ore was discovered at Vaubry, six leagues N. N. W. of Limoges. At present researches are making with a view of discovering deposits of such magnitude as to pay the expense of working it.

MINES OF THE NORTH OF PORTUGAL AND THE ADJOINING PARTS OF SPAIN.

The Carthaginians appear to have worked tin mines in this part of the Peninsula. It is said that some formerly existed in Portugal, in the environs of Viseu, a province of Beira, at a place called *Burraco de Stanno.* Some veins of the same metal were discovered in 1787, near Monte-Rey, in the south of Gallicia. They were fully two yards thick, and were incased in granite. This province presents also deposits of sulphuret of antimony. Some analogous ores are found in Castille and Estremadura. Lead ores were worked in the last century not far from Mogadouro, on the banks of the Sabor, in the province of Tras-los-Montes, and near Longroiva on the banks of the Rio-Prisco. Mines of plumbago occur near Mogadouro. There are also some iron mines in the same country near Felguiera and Torredemnacorvo. They supply the iron-works of Chapa-cunha. Two very ancient establishments of the same kind exist in the Estremadura of Portugal; the one in the district of Thomar, and the other in that of Figuiero dos Vinhoss: they are supplied by mines of red oxide of iron, situated on the frontiers of this province and of Beira. One deposit of quicksilver ore occurs at Couna in Portugal. At Rio Tinto in Spain, on the frontiers of Portugal, there is a copper mine which produces about 33,000 *libs. avoird.* of this metal per annum. The ore is a copper pyrites. The mountains in the environs of Oporto present everywhere indications of the ores of copper and other metals; and it appears that all this part of the Peninsula is in general rich in metallic treasures, but that the want of wood prevents their being mined to advantage.

Besides, many of the deposits which originally existed there must be in a great measure exhausted. It was in these countries chiefly that the gold and silver mines lay, which the Carthaginians and Romans worked with so much advantage, and contested in so keen a manner. Near Loria (the ancient Numantium), Azagala, and Burgos, considerable vestiges of the ancient workings may still be seen.

MINES OF BRITANNY.

Britanny has hardly a better share in mineral wealth than the countries we have just passed in review. There exist in it at this moment only two important exploitations; which are, the lead mines of *Poullaouen* and *Huelgoat*, situated near Carhaix. The mine of Huelgoat, celebrated for the plomb-gomme (hydro-aluminate) discovered in it, is opened on a vein of galena, which traverses transition rocks. The workings have subsisted for about three centuries, and have attained to a depth of 220 yards. The vein of Poullaouen, called the New Mine, was discovered in 1741. It was powerful and very rich near the surface; but it became subdivided and impoverished with its depth, notwithstanding which the workings have been sunk to upwards of 180 yards below the surface. In these mines there are fine hydraulic machines for the drainage of the waters, with wheels from 14 to 15 yards in diameter; and water-pressure machines have been recently constructed. The mines employ more than 900 workmen, and furnish annually more than 1,200,000 lbs. avoird. of lead, several thousand pounds of copper, and 2000 marks, or 1034 lbs. avoird. of silver. These are the most important metallic mines of France. Several veins of galena exist at *Chatelâudren*, near Saint-Briex, but they are not worked at present. There is also one at Pompean, near Rennes, which has been worked to a depth of 140 yards, but is in like manner now abandoned. It affords, besides the galena, a very large quantity of blende (sulphuret of zinc), of which attempts are making to take advantage. There occurs, also, a lead mine at Pierreville, department of the Channel, in a formation connected with the system of Brittany. It is opened on a vein which traverses a limestone pretty analogous to that of Derbyshire. The same department presents a deposit of sulphuret of mercury at Méníldot. A few years ago, some tin ore was discovered at Pyriac, near Guérande, in the department of the Loire Inférieur, but the researches since made to find workable deposits have been unsuccessful. A mine of antimony was worked at La Ramée, department of La Vendée. Several of the coal deposits lately mined in the departments of La Sarthe, La Mayenne, and Mayenne-et-Loire, ought probably to be regarded as more ancient than the genuine coal measures.

Table of the Production of the French Mines, during the year 1832.*

Species of Mine.	Number of Mines.	Extent of Surface conceded,	Number of Workmen.	Production is in 10ths of a ton.	Value of the rough product in francs.
Metallic Substances.		*Kilom. carrés.*			
Antimony -	16	93,8954	130	Melted antim. 1·030 98	71·232,75
Copper - -	8	274,18	258	Black copper 1·376	247·680
Iron - -	131	1·051,391	8917	Rough ore 15·814,690	3,630·806,81
Manganese -	8	16,54	66	6·087	66·849,88
Gold - -	1	0·49			
Lead and Silver -	33	614,23	1259	8·505	742·051
Zinc - -	1	6,80			

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* (*Annales des Mines*, tom. v., 1834, p. 676.)

MINES OF THE CORRESPONDING COASTS OF GREAT BRITAIN AND IRELAND.

The mines comprehended in this section are situated, 1. in Cornwall and Devonshire; 2. in the S. E. of Ireland; 3. in the island of Anglesey and the adjoining part of Wales; 4. in Cumberland, Westmoreland, the north of Lancashire, and the Isle of Man; 5. in the south of Scotland; 6. in the middle part of the same country.

Cornwall and Devonshire present three principal mining districts; viz. the portion of Cornwall situated in the environs and S.W. of Truro, the environs of St. Austle, and the environs of Tavistock.

The first of these districts is the most important of the three in the number and richness of its mines of copper, tin, and lead. The ores of copper, which consist almost entirely of copper pyrites and common sulphuret of copper, constitute very regular veins running nearly from east to west, and incased most frequently in a clay-slate of a talcose or hornblende nature, called *killas*, and sometimes in granite, which forms protuberances in the middle of the schists. The tin occurs principally in veins, which, like the preceding, traverse the killas and the granite. They are also very often directed nearly from east to west, but they have a different inclination, or dip, from that of the copper veins, which cut them across and interrupt them, and are consequently of more recent formation. The tin ore forms also masses, which appear most usually attached to the veins by one of their points. Lastly, it is found in small veins which traverse the granite, principally near the points where this rock touches the killas. Certain veins present the copper and tin ores together; a mixture which occurs chiefly near the points of intersection of the two metallic veins. Certain mines furnish at once both copper and tin; but the most part produce in notable quantity only one of these metals. The most important copper mines are situated near Redruth and Camborn; amongst which may be noted particularly those called *Consolidated Mines*, *United Mines*, Huel-Alfred, Dolcoath, Poldice, &c. The principal tin mines are situated still farther to the south-west, near Helston, Saint-Yues, &c. Those called Huel Vor, Great Huas, are particularly noticed. There are several mines in Cornwall, of which the crossing veins which at once intersect and throw out the veins of copper and tin, contain argentiferous galena and several ores of silver. There existed formerly mines of argentiferous lead near Helston and Truro. There may be now seen near Saint Michael an ore which, melted and cupelled on the spot, yields from an ounce and a half to two ounces of silver per quintal. Near Calstock a silver mine is worked, called *Huel-Saint-Vincent*, which has afforded, it is said, in some months, from 900 to 1000 *lbs. avoird.* of that metal. The ore, consisting of hornsilver and native silver, is treated on the spot.

In the environs of Saint Austle, the copper mines of *East Crinnis* and *West Crinnis* deserve to be noticed, as well as the tin mine of Polgooth, opened on a tin vein; and the mine of Carclaise, explored in the open air on a system of small veins of this metal.

Near Tavistock there occur mines of copper, tin, and lead. Among the last may be remarked particularly that called *Huel Betsey*, of which the ores melted and cupelled on the spot, afford an ounce and a half of silver per cwt.; and that of Beeralston, whose ore is sent to Bristol to be smelted there. It yields from four to five ounces of silver per cwt.

There are mines of antimony at *Huel-Boys* in Devonshire, and at Saltash in Cornwall.

The tin and copper ores of Cornwall are accompanied with arsenical pyrites, which is turned to some account by the fabrication of white arsenic (arsenious acid).

Cornwall and Devonshire produce annually about 6,160,000 *lbs. avoird.* of tin; 18,700,000 *lbs. avoird.* of copper; and 1,760,000 *lbs. avoird.* of lead. See Copper and Tin.

The tin is treated at the mine localities; but the copper ores are sent in their natural state to Swansea in South Wales, to be smelted.

Wood and labour being very dear in Cornwall and Devonshire, the mineral deposits of these counties cannot be worked out so completely, nor can the mechanical preparation of the ores be so far pushed, as in several other parts of the world. But all the operations which appear advantageous are conducted in the most judicious, most economical, and most expeditious manner. Steam engines are erected there, some of them possessing the power of several hundred horses. Many of the mines are explored to a depth of upwards of 400 yards; and several are celebrated for the boldness of their workings. The one called *Botallock* Mine, situated in the parish of St. Just, near the Cornwall cape, is opened amid rocks which form the sea-coast, and stretches several hundred yards under the sea, and upwards of 200 yards beneath its level. In some points so small a thickness of rock has been left to support the weight of the waters, that the rolling of pebbles on the bottom is distinctly heard by miners during a storm. The mine of Huel-werry, near Penzance, was worked by means of a single shaft opened on the coast, in a space left dry by the sea only for a few hours at every ebb. A small wooden tower was built over the mouth of the shaft, which, being carefully caulked, kept out the waters of the ocean when the tide rose, and served to support the machines for raising the ore and drainage. A vessel driven by a storm overturned it during the night, and put a period to this hazardous mode of mining, which has not been resumed.

The most considerable mines of Ireland are those of Cronebane and Tingrony, and of Ballymartagh, situated three leagues S.W. of Wicklow, in the county of the same name. Their object is to work the copper pyrites, accompanied with some other ores of copper, galena, sulphuret of antimony, as well as pyrites of iron, which forms several flattened masses in the clay-slate. Pretty extensive workings have been made here; and the ore was transported in its natural state to Swansea. Veins or masses of copper pyrites and galena are mined in some other points of the south-east of Ireland, but none of them with any notable advantage. The principal is the lead mine situated in the county of Tipperary, near the village called Silver Mines, absurdly enough, because, though silver was sought for in the lead, none was extracted. Many iron mines anciently existed in Ireland, but the destruction of the forests has considerably diminished their number and activity, so that only a few remain in Kilkenny, Wicklow, and Queen's County.

The isle of Anglesey is celebrated for its copper mines, the principal of which are Mona-mine and Parys-mountain. The ore is a copper pyrites, sometimes of considerable volume, lying in masses in a formation containing serpentines and different talcose rocks. For a long time the workings were carried on in the open air, but the exterior exploration has been thereby compromised. The neighbouring coasts of Wales present some mines of the same nature. All the ores are treated in a smelting-house established in the isle of Anglesey. The formation of slate-clay and greywacke, which constitutes the greater part of Wales, and some of the adjoining districts of England, includes several lead mines, of which we shall presently speak in noticing those of far greater importance contained in the more recent limestone formations of the same regions.

Pretty important mines of copper pyrites and red hematitic iron are worked in Westmoreland, and in the neighbouring parts of Cumberland and Lancashire. The copper ores, and a portion of the iron ones, are embarked for Swansea. The rest of the iron ore is treated on the spot in blast furnaces supplied with wood charcoal. The isle of Man affords indications of lead, copper, and iron in the mountains of Snafle, which constitute its centre. At Borrowdale in Westmoreland, a mine of graphite (plumbago) has been worked for a long period. It furnishes the black lead of the English pencils, so celebrated over the world. The mineral occurs in mass in a talcose formation.

There are famous lead mines in the south of Scotland, at Leadhills in Lanarkshire; the veins of which are incased in greywacke. Some manganese has also been found. At Cally, in Kirkcudbrightshire, a copper mine has been lately discovered; and a mine of antimony has been known for some time at West Kirk in Dumfriesshire; but neither has been turned to good account.

In the middle part of Scotland, the lead mines of Strontian in Argyleshire deserve to be noticed, opposite to the north-east angle of the isle of Mull. They are opened on veins which traverse gneiss. According to Mr. John Taylor, these mines and those of Leadhills produce annually 5,610,000 *lbs. avoird.* of lead.

Explorations of manganese were begun at Grantown on the banks of the Don, a river which falls into the German Ocean at Aberdeen. A mine of coarse graphite has also been worked at Huntley.

A copper mine was discovered some years back in one of the Shetland isles; and chromate of iron is now extensively worked there in serpentine and talc.

MINES OF THE NORTH OF EUROPE.

These mines are situated for the most part in the south of Norway, towards the middle of Sweden, and in the south of Finland, a little way from the shortest line drawn from the lake Onega to the south-west angle of Norway. A few mines occur in the northern districts of Norway and Sweden. The main products of these several mines are iron, copper, and silver.

The iron mines of Norway lie on the coasts of the Gulph of Christiania, and on the side facing Jutland, principally at Arendal, at Krageroe, and the neighbourhood. The ores consist almost solely of black oxide of iron, which forms beds or veins of from 4 to 60 feet thick, incased in gneiss, which is accompanied with pyroxène (augite), epidotes, garnets, &c. These iron ores are reduced in a great many smelting forges, situated on the same coast, and particularly in the county of Laurwig. Their annual product is about 16½ millions of pounds *avoird.* of iron, in the form of cast iron, bar iron, sheet iron, nails, &c.; of which one half is exported.

Norway possesses rich copper mines, some of which lie towards the south and the centre of the country, but the most considerable occur in the north, at *Quikkne*, *Læken*, *Selboe*, and *Rœraas*, near Drontheim. The mine of Rœraas, 16 miles from Drontheim to the S. E. of this city, is opened on a very considerable mass of copper pyrites, and has been worked in the open air since 1664. It has poured into the market from that time, till 1791, 77 millions of pounds avoird. of copper. In 1805, its annual production was 864.600 libs.; while all the other mines of Norway together do not furnish quite one-fourth of that amount.

Norway comprehends also some celebrated silver mines. They are situated from 15 to 20 leagues S. W. of Christiania, in a mountainous country near the city of Kongsberg, which owes to them its population. Their discovery goes back to the year 1623, and their objects are veins of carbonate of lime, accompanied with asbestos and other substances in which native silver occurs, usually in small threads or networks, and sometimes in considerable masses, along with sulphuret of silver. These veins are very numerous, and run through a considerable space, divided into four districts (arrondissemens), each of which contains more than 15 distinct explorations. When a new mine is opened, an excavation in the open air is first made, which embraces several veins, and they then prosecute by subterranean workings only those that appear to be of consequence. The workings do not exceed 1000 feet in depth. Fire is employed for attacking the ore. In 1782, the formation of a new gallery of efflux was commenced, destined to have a length of 10,000 yards, and to cost 60,000*l.* These mines, since their discovery till 1792, have afforded a quantity of silver equivalent to four millions of pounds sterling. The year 1768 was the most productive, having yielded 38,000 marcs of silver. At present they give but a very slender return; in 1804 they were threatened with a complete abandonment. The ore is treated by fusion; the lead necessary for this operation being imported from England. There are, however, lead and silver mines in the county of Jarlsberg, but they are very slenderly worked.

At *Edswald*, 50 leagues N. of Christiania, a mine is worked of auriferous pyrites, with a very inconsiderable product.

Cobalt mines may be noticed at Modum or Fossum, 8 leagues W. of Christiania; they are extensive, but of little depth.

Lastly, graphite is explored at *Englidal*; and chromite of iron deposits have been noticed in some points of Norway.

The irons of Sweden enjoy a merited reputation, and form one of the chief objects of the commerce of that kingdom. Few countries, indeed, combine so many valuable advantages for this species of manufacture. Inexhaustible deposits of iron ore are placed amid immense forests of birches and resinous trees, whose charcoal is probably the best for the reduction of iron. The different groups of iron mines and forges form small districts of wealth and animation in the midst of these desolate regions.

The province of Wermeland, including the north bank of the lake Wener, is one of the richest of Sweden in iron mines. The two most important are those of Nordmarck, 3 leagues N. of Philipstadt, and those of Persberg, 2½ leagues E. from the same city. Philipstadt is about 50 leagues W. ¼ N. W. from Stockholm. Both mines are opened on veins or beds of black oxide of iron several yards thick, directed from N. to S. in a ground composed of hornblende, talcose and granitic rocks. These masses are nearly vertical, and are explored in the open air to a depth of 130 yards. Formerly this exploitation was effected by iron wedges and pickaxes; but they have been superseded by gunpowder, since 1650. The province of Wermeland, and that of Dahl which adjoins it, forming the west border of the Wener lake, contained in 1767, 48 smelting cones, each going from 4 to 5 months every year.

The principal iron mines of Rosslagie (part of the province of Upland) are those of Dannemora, situated 11 leagues from Upsal. They stand in the first rank of those of Sweden, and even of Europe. The masses worked upon are flattened and vertical, running from N. E. to S. W., and are incased in a ground formed of primitive rocks, among which gneiss, petrosilex and granite are most conspicuous. They amount to three in number, very distinct, and parallel to each other; and are explored through a length of more than 1500 yards, and to a depth of above 80, by the employment of fire, and blasting with gunpowder. The explorations are mere quarries; each presenting an open trench 65 yards wide, by a much more considerable length, and an appalling depth. Magnetic iron ore is extracted thence, which furnishes the best iron of Sweden and Europe; an iron admirably qualified for conversion into steel. In 1767, these minings supplied for a long time, 15 smelting cones situated in Rosslagie, at a distance of 10 leagues.

The island of Utoe, situated near the coast of the province of Upland, presents also rich iron mines. The protoxide of iron there forms a thick bed in the gneiss. It is worked in trenches far below the level of the sea. The ore cannot be smelted in the island itself; but is transported in great quantities to the continent.

The province of Smoland includes also very remarkable mines. Near Jonköping, a hill called the *Taberg* occurs, formed in a great measure of magnetic black oxide of iron, contained in a greenstone reposing on gneiss.

In several parts of Lapland, the protoxide of iron occurs in great beds, or immense masses. At Gellivara, 200 leagues N. of Stockholm, towards the 67th degree of latitude, it constitutes a considerable mountain, into which an exploitation has been opened. The iron is despatched on small sledges drawn by rein-deer to streams which fall into the Lutea; and thence by water carriage to the port of Lutea, where it is embarked for Stockholm.

There are a great many iron works in Dalecarlia, but a portion of the ores are got from alluvial deposits. Similar deposits exist also in the provinces of Wermeland and Smoland.

The mines and forges of Sweden produce annually about 165 millions of pounds avoird. (74,000 tons nearly) of cast iron or bar iron; of which two thirds are exported chiefly from the harbours of Stockholm, Gottenburg, Geffle, and Norkoping.

The copper mines of Sweden are scarcely less celebrated than its iron mines. The principal is that of Fahlun or Kopparberg, situated in Dalecarlia, near the town of Fahlun, 40 leagues N. W. of Stockholm. It is excavated in an irregular and very powerful mass of pyrites, which in a great many points is almost entirely ferruginous, but in others, particularly near the circumference, it includes a greater or less portion of copper. This mass is enveloped in talcose or hornblende rocks. More to the west, there are three other masses almost contiguous to each other, which seem to bend in an arc of a circle around the principal mass. They are explored as well as the last. This was at first worked in the open air; but imprudent operations having caused the walls to crumble and fall in, since 1647 the excavation presents near the surface nothing but frightful precipices. The workings are now prosecuted by shafts and galleries into the lower part of the deposit, and have arrived at a depth of 194 famnars (nearly 430 yards). They display excavations spacious enough to admit the employment of horses, and the establishment of forges for repairing the miners' tools. It is asserted that the exploration of this mine goes back to a period anterior to the Christian era. During its greatest prosperity, it is said to have produced 11 millions of pounds avoird. of copper annum, or about 5000 tons. It furnishes now about the seventh part of that quantity; yielding at the same time about 70,000 lbs. of lead, with 50 marcs of silver, and 3 or 4 of gold. The ores smelted at Fahlun produce from 2 to 2½ of copper per cent. But the extraction of the metal is not the sole process; the sulphur is also procured; and with it, or the pyrites itself, sulphuric acid and other chemical products are made. Round Fahlun, within the space of a league, 70 furnaces or factories of different kinds may be seen. The black copper obtained at Fahlun is converted into rose copper, in the refining hearths of the small town of *Ofwostad.*

In the copper mine of *Garpenberg,* situated 18 leagues from Fahlun, there occur 14 masses of ore quite vertical, and parallel to each other, and to the beds of mica-slate or talc-slate, amid which they stand. This mine has been worked for more than six hundred years.

The mine of *Nyakopparberg,* in Nericia, 20 leagues W. of Stockholm, presents masses of ores parallel to each other, the form and arrangement of which are very singular. It is worked by open quarrying, and with the aid of fire.

We may notice also the copper mines of Atwidaberg, in Ostrogothia, which furnish annually the sixth part of the whole copper of Sweden.

There are several other copper mines in Sweden. Their whole number is ten; but it was formerly more considerable. They yield at the present day in all, about 2,420,000 *libs. avoird.* (1000 tons) of copper.

The number of the silver mines of Sweden has in like manner diminished. In 1767, only 3 were reckoned under exploration, viz. that of *Hellefors* in the province of Wermeland; that of *Segersfors* in Nericia; and that of *Sahla* or *Sahlberg,* in Westmannia, about 23 leagues N. W. of Stockholm. The last is the only one of any importance. It is very ancient, and passes for having been formerly very productive; though at present it yields only from 4 to 5000 marcs of silver *per annum.* Lead very rich in silver is its principal product. It is explored to a depth of more than 200 yards. The soundness of the rock has allowed of vast excavations being made in it, and of even the galleries having great dimensions; so that in the interior of the workings there are winding machines, and carriages drawn by horses for the transport of the ores.

At Sahlberg, there are deposits of sulphuret of antimony.

For the last 30 or 40 years mines of cobalt have been opened in Sweden, principally at Tunaberg and Los, near Nyköping, and at Otward in Ostrogothia. The first are worked upon veins of little power, which become thicker and thinner successively; whence they have been called *bead-veins.* It appears that the products of these mines, though of good quality, are inconsiderable in quantity.

Lastly, there is a gold mine in Sweden; it is situated at Adelfors, in the parish of Alsfeda, and province of Smoland. It has been under exploration since 1737, on veins of auriferous iron pyrites, which traverse schistose rocks; presenting but a few inches of ore. It formerly yielded from 30 to 40 marcs of gold *per annum*, but for the last few years it has furnished only from 3 to 4.

The mines and smelting works of Sweden gave annually, in 1809, a gross product worth 1,463,600*l*.

The south of Finland and the bordering parts of Russia contain some mines, but they are far from having any such importance as those of Sweden.

At Orijerwy near Helsingfors, a mine of copper occurs whose gangue is carbonate of lime, employed as a limestone.

Near Cerdopol, a town situated at the N. W. extremity of the Ladoga lake, veins of copper pyrites were formerly mined.

Under the reign of Peter the Great, an auriferous vein was discovered in the granitic mountains which border the eastern bank of the lake Ladoga, near Olonetz. It was rich only near the surface; and its working was soon abandoned.

Latterly, an attempt has been made to mine copper and iron ores near Eno, above and to the N. W. of Cerdopol, but with little success.

Some time ago rich ores of iron, lying in veins, were worked near the lake Shuyna, N. W. from Cerdopol; but this mine has been also relinquished.

On the west bank of the Onega lake, there is an iron work at Petrazavodsk, called a *zavode*, which is the greatest establishment of this kind existing in the north of Russia.

Nothing is now reduced there except bog iron ore, or swamp ore extracted from small lakes in the neighbourhood.

The transition limestone which constitutes the body of Esthonia contains lead ore at *Arossaar* near *Fellin*. These ores were worked when these provinces belonged to the Swedes. It was attempted in 1806 to resume the exploitation, but without success.

MINES OF THE ALLEGHANY MOUNTAINS.

The chain of the Alleghanys, which traverses the United States of America from N. W. to S. E. parallel to the coasts of the Atlantic Ocean, includes a considerable number of deposits of iron, lead, and copper ores; along with some ores of silver, plumbago, and chromite of iron. Attempts have been made to mine a great many of these deposits; but most of these have been unsuccessful.

A bed of black oxide of iron occurs in gneiss near Franconia in New Hampshire. It has a power of from 5 to 8 feet; and has been mined through a length of 200 feet, and to a depth of 90 feet. The same ore is found in veins in Massachusetts and Vermont, accompanied by copper and iron pyrites. It is met with in immense quantities on the western bank of the lake Champlain, forming beds of from 1 to 20 feet in thickness, almost without mixture, encased in granite. It is also found in the mountains of that territory. These deposits appear to extend without interruption from Canada to the neighbourhood of New York, where an exploration on them may be seen at Crown-Point. The ore there extracted is in much esteem. Several mines of the same species exist in New Jersey. The primitive mountains which rise in the north of this state near the Delaware, include a bed almost vertical of black oxide of iron, which has been worked to 100 feet in depth. In the county of Sussex the same ore occurs, accompanied with Franklinite. At New Milford in Connecticut, a pretty abundant mine of sparry iron occurs; the only one of the kind known in the Alleghanys. The United States contain a great many iron works, some of which prior to the year 1773, sent over iron to London. They are principally supplied from alluvial iron ore.

The most remarkable lead mines of the Alleghanys, are those of Southampton in Massachusetts, and of Perkiomen Creek in Pennsylvania, 8 leagues from Philadelphia. The first furnishes a galena, slightly argentiferous; an ore accompanied with various minerals, with base of lead, copper, and zinc, and with *gangues* (vein-stones) of quartz, sulphate of baryta, and fluor spar. These substances form a vein which traverses several primitive rocks, and is said to be known over a length of more than 6 leagues. At Perkiomen Creek a vein of galena is mined, which traverses a sandstone, referred by many geologists to the old red sandstone. Along with galena a great variety of minerals is found with a basis of lead, zinc, copper, and iron. The mines of lead worked in Virginia, on the banks of the Kanhawa, deserve also to be mentioned.

None of the copper mines actually in operation in the United States seem to merit particular attention. The mine of Schuyler in New Jersey had excited high hopes, but after the workings had been pushed to a depth of 300 feet, they have been for some years abandoned. The ore, which consisted of sulphuret of copper, with oxide and carbonate of copper, occurred in a red sandstone.

In some points of the Alleghanys, deposits have been noticed of chromite of iron and graphite.

Coal-measures occur in several points of the United States, especially on the N. W.

slope of the Alleghany mountains. The coal is mined successfully on the banks of the Ohio, towards the upper part of its course. See ANTHRACITE.

MINES OF THE SOUTH OF SPAIN.

The mountains which separate Andalusia from Estremadura, Leon and La Mancha, and those of the kingdoms of Murcia and Grenada, include some celebrated mines.

We shall mention first the silver mines of *Guadalcanal* and *Cazalla*, situated in the Sierra-Morena, 15 leagues N. of Seville. Among the ores, red silver and argentiferous gray copper have been specified. Their product is inconsiderable; but this territory presented formerly much more important mines at Villa-Guttiera, not far from Seville. At the beginning of the 17th century they are said to have been worked with such activity, that they furnished daily 170 marcs of silver. More to the east, there exists in the mountains of La Mancha, a mine of antimony, at Santa-Crux-de-Mudela. On the southern slope of the Sierra-Morena, very important lead mines occur, particularly at Linares, 12 leagues N. of Jaen. The veins are very rich near the surface, which causes them not to be mined much in depth; so that the ground is riddled, as it were, with shafts. More than 5000 old and new pits may be counted; the greater part of which is ascribed to the Moors. Six of these mines are now explored on account of the crown, and they produce on an annual average, according to M. Laborde, 1,320,000 *libs. avoird.* (about 600 tons) of lead, which is too poor in silver for this precious metal to be extracted with advantage. Bowles states, that there was found at the mines of Linares, a mass of galena, whose dimensions were from 21 to 24 yards in every direction. Abundant mines of zinc occur near Alcaras, 15 leagues N. E. of Linares; which supply materials to a brass manufactory established in that town. There are also lead mines in the kingdoms of Murcia and Grenada. Very productive ores have been worked for some time near Almeria, a harbour situated some leagues to the west of the cape of Gates. The ore is in part treated on the spot with coal brought from Newcastle, and in part sent to Newcastle to be reduced there. The kingdoms of Murcia, Grenada, and Cordova, include several iron mines. Near Casalla and Ronda, in the kingdom of Grenada, mines of plumbago are explored.

On the northern flank of the Sierra-Morena, lie the famous quicksilver mines of Almaden, situated near the town of the same name in La Mancha. They consist of very powerful veins of sulphuret of mercury, which traverse a sandstone, evidently of a geological age as old at least as the coal formation. Hard by, beds of coals are mined.

MINES OF THE PYRENEES.

The Pyrenees and the mountains of Biscay, of the Asturias, and the north of Galicia, which are their prolongation, are not very rich in deposits of ores. The only important mines that occur there, are of iron; which are widely spread throughout the whole chain, except in its western extremity. We may mention particularly in Biscay, the mine of *Sommorostro*, opened on a bed of red oxide of iron; and in the province of Guipuscoa, the mines of Mondragon, Oyarzun, and Berha, situated on deposits of sparry iron. There are several analogous mines in Arragon and Catalonia. In the French part of the Pyrenees, veins of sparry iron are worked which traverse the red sandstone of the mountain Ustelleguy, near Baygorry, department of the Basses-Pyrenees. The same department affords in the valley of Asson the mine of Haugaron, which consists of a bed of hydrate of iron, subordinate to transition limestone. The deposit of hydrate of iron, worked for an immemorial time at Rancié, in the valley of Viedessos, department of the Arriège, occurs in a similar position. The ancient workings have been very irregular and very extensive; but the deposit is still far from being exhausted. There are also considerable mines o sparry iron at *Lapinouse*, at the tower of Batera, at Escaron, and at Fillols, at the foot of the *Canigou*, in the department of the Oriental Pyrenees. The iron mines of the Pyrenees keep in activity 200 Catalanian forges. Although there exists in these mountains, especially in the part formed of transition rocks, a very great number of veins of lead, copper, cobalt, antimony, &c., one can hardly mention any workings of these metals; and among the abandoned mines, the only ones which merit notice are, the mine of argentiferous copper of *Baygorry*, in the department of the Low Pyrenees, the lead and copper mine of *Aulus*, in the valley of the Erce, department of the Arriège, and the mine of cobalt, of the valley of Gistain, situated in Arragon, on the southern slope of the Pyrenees. It is asserted, however, that a lead mine is in actual operation near Bilboa in Biscay. The mines of plumbago opened at Sahun in Arragon, should not be forgotten. Analogous deposits are known to exist in the department of the Arriège, but they are not mined.

MINES OF THE ALPS.

The mines of the Alps by no means correspond in number and richness with the extent and mass of these mountains. On their eastern slope, in the department of the high and the low Alps, several lead and copper mines are mentioned, all inconsiderable and abandoned at the present time, with the exception of some workings of galena, which furnish also a little graphite.

During some of the last years of the 18th century, there was mined at *la Gardette* in the *Oisans*, department of the Isère, a vein of quartz which contained native gold and auriferous pyrites; but the product has never paid the expenses, and the mine has been abandoned. The *Oisans* presented a more important mine, but it also has been given up; it was the silver mine of *Allemont* or *Chalanches*. The ore consisted of different mineral species more or less rich in silver, disseminated in a clay which filled the clefts and irregular cavities in the middle of talcose and hornblende rocks. This mine yielded annually towards the conclusion of the 18th century, so much as 2000 marcs of silver; along with some cobalt ore. Among the great number of mineral species, which occurred in too small quantities to be worked to advantage, there was native antimony, sulphuret of mercury, &c. The *Oisans* present, moreover, some rather unproductive mines of anthracite. Mines of an analogous nature, but more valuable, are in activity at the western foot of the Alps, at *la Mothe, Notre-des-Vaux et Putteville*, a few leagues S. E. of Grenoble.

From the entrance of the valley of the *Oisans* to the valley of the *Arc* in Savoy, there occur on the N. W. slope of the Alps, a great many mines of sparry iron. The locality of this ore is here very difficult to define. It appears to form sometimes beds or masses, and sometimes veins amid the talcose rocks. Some is also found in small veins in the first course of the calcareous formation which covers these rocks. These mines are very numerous, the most productive occur united in the neighbourhood of *Allevard*, department of the Isère, and of *Saint Georges d'Huretières* in Savoy. Those of *Forneaux* and *Laprat*, in the latter country, are also mentioned. The irregularity of the mining operations surpasses that of the deposits. The mines have been from time immemorial in the hands of the inhabitants of the adjoining villages, who work in them, each on his own account, without any pre-arrangement, or other rule than following the masses of ore which excite hopes of the most considerable profit in a short space of time. What occurs in almost every mine of sparry iron, is also to be seen here, most imprudent workings. The mine called the *Grande Fosse*, at *Saint Georges d'Huretières*, is prolonged without pillars or props, through a height of 130 yards, a length of 220 yards, and a breadth equal to that of the deposit, which amounts in this place to from 8 to 13 yards; thus a void space is exhibited of nearly 300,000 square yards. The sparry iron extracted from these different mines supplies materials to 10 or 12 smelting furnaces, the cast iron of which, chiefly adapted for conversion into steel, is manufactured in part in the celebrated steel works of *Rives*, department of the Isère. There occurs in some parts of the mines of *Saint Georges d'Huretières* copper pyrites, which is smelted at *Aiguebelle*.

Savoy presents celebrated lead mines at *Pescy* and at *Macot*, 7 leagues to the E. of Moutiers. Galena, accompanied with quartz, sulphate of baryta, and ferriferous carbonate of lime, occurs in mass in talcose rocks. The mine of Pescy had been restored to activity by the French government, which established there a practical school of mines; and in its hands the mine produced annually as much as 440,000 *libs. avoird.* of lead, and 2500 marcs of silver. It is now explored on account of the king of Sardinia; but it begins to be exhausted, and yields less products. That of *Macot*, opened a few years ago, begins to give considerable returns. The mine of copper pyrites of Servoz in the valley of the Arve, may also be mentioned. The ore occurs both in small veins, and disseminated in a clay slate; but the exploration is now suspended. Lastly, slightly productive workings of anthracite are mentioned in several points of these mountains and in the conterminous portions of the Alps.

There exist in Piedmont some small mines of argentiferous lead. The copper mines of *Allagne*, and those of Ollomont, formerly yielded considerable quantities of this metal. Their exploration is now on the decline. The manganese mines of Saint-Marcel have few outlets; whence they have been feebly developed. Mines of plumbago, little worked, occur in the neighbourhood of *Vinay* and in the valley of *Pellis*, not far from *Pignerol*. Some mines of auriferous pyrites have also been worked in this district of country; among others, those of *Macugnaga*, at the eastern foot of Monte-Rosa. The pyrites of this mine afforded by amalgamation only 11 grains of gold per quintal; and this gold, far from being fine, contained $\frac{1}{4}$ of its weight of silver. They became less rich in proportion as they receded from the surface. The explorations of auriferous pyrites in Piedmont are now abandoned, or nearly so. The only important mines in this country are those of iron. These generally consist of masses of black oxide of iron, of a nature analogous to those of Sweden; the principal ones being those of Cogne and Traverselle, which are worked in open quarries. Some others, less considerable, are explored by shafts and galleries. These ores are reduced in 33 smelting cupolas, 55 Catalan forges, and 105 refinery hearths. The whole produce about 10,000 tons of bar iron.

There is a mine of black oxide of iron, at present abandoned, at *Bovernier*, near Martigny, in the Valais. There is also another iron mine at Chamoissons, in a lofty calcareous mountain on the right bank of the Rhone. The ore presents a mixture of oxide of iron and some other substances, of which it has been proposed to make a new mineral species, under the name of Chamoissite.

The district of the Grisons possesses iron mines with very irregular workings, situated a few leagues from *Coire*.

The mountain of Falkenstein, in the Tyrol, formed of limestone and clay-slate, not far from Schwatz, a little below Inspruck, in the valley of the Inn, contains mines of argentiferous copper. At one of them, that of Kütz-Pühl, the workings reached, in 1759, according to the report of MM. Jars and Duhamel, nearly 1100 yards in depth; and were reckoned the deepest in Europe. But it was intended to abandon them. Analogous ores are explored in several other points of the same country. The most part of the products of these mines are carried to the foundry of Brixlegg, 4 leagues from Schwatz. The mines of the Tyrol furnished, on an average of years, towards 1759, 10,000 marcs of silver; at anterior periods, their product had been double; but now it is a little less. This region contains also gold mines whose exploration goes back a century and a half. They occur near the village of Zell, 8 leagues from Schwatz. The auriferous veins traverse clay-slates, and quartz rocks. Lately, a deposit of oxide of chrome, similar to that of the *Ecouchets* (Saône and Loire) has been discovered in the Tyrol. An unimportant mine of mercury has also been mentioned in that country, near *Brenner*.

In the territory of Saltzburg there are some copper mines. In the environs of Muerwinkel and of Gastein, some veins are worked for the gold they contain; of which the annual return is valued at 118 marcs of this metal. There is an inconsiderable mine of quicksilver at Leogang.

In the Tyrol and in Saltzburg there are iron mines in a very active state; principally those of Kleinboden, near Schwatz. But the portion of the Alps most abundant in mines of this metal, is the branch stretching towards Lower Austria. We find here, both in Styria and in Austria, a very great number of explorations of sparry iron. The deposits of the ores of sparry iron of Eisenerz, Erzberg, Admont, and Vordenberg, deserve notice. The latter are situated about 25 leagues S.W. of Vienna.

The southern flank of the Alps contains also a great many mines of the same kind, from the Lago Maggiore to Carinthia. Those situated near Bergamo, and those of Huttenberg and Waldenstein, in Carinthia, are especially mentioned.

All these mines of sparry iron are opened in the midst of rocks of different natures, which belong to the old transition district of the Alps. They seem to have close geological relations with those of Allevard.

The branch of the Alps which extends towards Croatia, presents important iron mines, in the mountains of Adelsberg, 10 leagues S.W. from Laybach in Carniola.

The iron mines just now indicated in the part of the Alps that forms a portion of the Austrian states, supply materials to a great many smelting-works. In Styria and in Carinthia, more than 400 furnaces or forges may be enumerated, whose annual product is nearly 25,000 tons of iron. These two provinces are famous for the steel which they produce, and for the steel tools which they fabricate, such as scythes, &c. Carniola contains also a great many forges, and affords annually about 5000 tons of iron.

There are mines of argentiferous copper analogous to those of the Tyrol, at Schladming in Styria, at Kirchdorf in Carinthia, at Agordo in the territory of Venice, and at Zamabor in Croatia. The latter are remarkable for the great irregularity of the deposits, and for the richness of the copper pyrites that is mined; which produces 12 and sometimes 27 per cent. of copper. There are some deposits of antimony, mined to a trifling extent in Carinthia; and there are a few cobalt mines in Styria, not more actively worked. In the environs of *Raibel*, in Carinthia, mines of calamine exist, yielding annually about 200 tons of this substance. Of late, some of it has also been explored in Styria.

The limestones that cover the northern slopes of the Alps, present, like those of the departments of the lower and upper Alps, several lead mines of little consequence. They also include several celebrated mines of rock salt.

The analogous limestones which repose on the slopes of the Alps in Carinthia, and in the neighbouring provinces, afford likewise lead mines, especially near Willach and Bleyberg. These mines are very numerous, forming more than 500 *arrondissemens* of concessions. They furnish annually about 1800 tons of a lead too poor in silver to pay the expense of extracting that precious metal. At the mines of Bleyberg, the galena forms 14 beds or strata, inclined at an angle of from 40 to 50 degrees from the horizon, and alternating with a like number of calcareous strata. The latter are extremely full of shells. They of course belong to secondary limestone.

The limestones surmounting the southern slope of the Alps, contain also some lead mines; but the quicksilver mine of Idria, situated at the foot of the Alps, 10 leagues N.W. of Trieste, is worthy of particular notice; it lies in a limestone which every thing leads us to refer to the *zechstein*, the most ancient of the secondary limestones.

The Apennines, which may be considered as a dependence of the Alps, present a small number of mines. At Chiavary and Pignone, manganese is mined; and at the beginning of the 18th century a vein of mercury was worked at Levigliani in Tuscany. An antimonial mine is mentioned at Pereta in the marshes of Sienna.

Before quitting these regions, we ought to notice the iron mines of the isle of Elba. They have been famous for 18 centuries; Virgil denotes them as inexhaustible, and supposes them to have been open at the arrival of Eneas in Italy. They are explored by open quarries, working on an enormous mass of specular iron ore, perforated with cavities bespangled with quartz crystals. The island possesses two explorations, called Rio and Terra-Nuova; the last having been brought into play at a recent period. The average amount extracted per annum is 15,000 tons of ore, which are smelted in the foundries of Tuscany, Liguria, the Roman states, the kingdom of Naples, and the island of Corsica.

There has been worked for a few years a mine of chromite of iron, at Carrada, near Gassino, department of the Var.

MINES SITUATED IN THE SCHISTOSE FORMATIONS OF THE BANKS OF THE RHINE, AND IN THE ARDENNES.

The transition lands, which form, in the N. W. of Germany and in Flanders, a pretty extensive range of hills, include several famous mines of iron, zinc, lead, and copper. The latter lie on the right bank of the Rhine, in the territories of Nassau and Berg, at Baden, Augstbach, Rheinbreitenbach, and near Dillenburg. That of Rheinbreitenbach yielded formerly 110,000 libs. avoird. of copper per annum, and those of the environs of Dillenburg now furnish annually 176,000 libs. There are also some mines of argentiferous lead in the same regions. The most remarkable are in the territory of Nassau, such as those of Holzapfel, Pfingstiviese, Lœwenburg, and Augstbach on the Wiede, and Ehrenthal on the banks of the Rhine, which all together produce 600 tons of lead, and 3500 marcs of silver. To the above, we must add those of the environs of Siegen and Dillenburg, in the territories of Berg. A little cobalt is explored in the neighbourhood of Siegen, and some mines of the same nature are mentioned in the grand duchy of Hesse-Darmstadt, and in the duchy of Nassau Usingen.

But iron is the most important product of the mines on the right bank of the Rhine. Veins of hydrate of iron, or brown hematite, are explored in a great many points of Hessia, and the territory of Nassau, Berg, Marck, Tecklenbourg, and Siegen, along with veins or masses of sparry iron, and beds of red oxide of iron. We may note particularly; 1. The enormous mass of sparry iron, known under the name of Stahlberg, mined since the beginning of the 14th century in the mountain of Martinshardt, near Müssen, where improvident excavations have occasioned, at several times, considerable downfallings of rubbish; 2. The abundant and beautiful mines of hydrate of iron and sparry iron on the banks of the Lahn and the Sayn, and among those of the mine of Bendorf; 3. The mine of Hohenkirchen in Hessia, where a powerful bank of manganesiferous ore is worked, and where the mines are kept dry by a gallery more than one thousand yards long, walled over its whole extent. These several mines supply a great many iron works, celebrated for their steel, and for the objects of hardware, scythes, &c. fabricated there.

The Prussian provinces of the left bank of the Rhine, the duchy of Luxembourg and the Low Countries, include also many iron furnaces, of which a great number are supplied, in whole or in part, by ores of hydrate of iron, occasionally zinciferous, extracted from the transition rocks, where they form sometimes veins, and sometimes also very irregular deposits. A portion is explored by open quarrying, and a portion by underground workings. Some of these mines penetrate to a depth of 87 yards, and galleries may be observed in them cut in the form of vaults, and timbered with hooped stays. The Hundsrück, the Eiffel, and the territory of Luxembourg, present a great many of them.

The Eiffel formerly possessed important lead mines. Some still exist, which are feebly worked at Berncastle, 8 leagues below Trèves, on the banks of the Moselle. Those of Trarbach, situated two leagues lower, are now completely abandoned. The same holds with those of Bleyalf, which were opened on veins incased in the greywacke-slate, 3 leagues W. N. W. of Prüm, not far from the line of separation of the waters of the Moselle and the Meuse, in a district from which manufactures and comfort have disappeared since the mines were given up which sustained them.

More to the north a great many deposits of calamine occur. The most considerable, and the one explored with most activity, is situated in the territory of Limburg (kingdom of the Netherlands), and known under the name of the *Great mountain.* It presents a mass about 45 yards wide, from 400 to 550 long, and of an unknown depth. The first labours, undertaken several centuries ago by the Spaniards, were executed by open quarrying, and pushed down 32 yards from the surface. The miners were obliged to renounce this mode of operation, and have since penetrated to the depth of 88 yards by means of subterranean workings. From 50 to 60 men work in this excavation, and extract annually from 700 to 800 tons of calamine, worth from 2400*l.* to 2700*l.* In the adjacent parts of the Prussian territory, not far from Aix-la-Chapelle, calamine is also mined, with ores of lead and iron, with which it is associated, in deposits regarded by M. Bouesnel, as analogous to the vein of Vedrin, to be noticed presently. The exploration is effected by means of small round shafts, from 34 to 44 yards deep, which are often wooded only with flexible branches of trees, or a kind of barrel-hoops. These workings may furnish annually from 1500 to 2000 tons of calamine, to the brass factories of Stollberg. On the right bank of the Rhine, in the country of la Marck, several small zinc mines furnish annually about 130 tons of calamine to the brass manufactures of Iserlohn.

The lead mine of Vedrin, alluded to above, lies at some distance N. of Namur. It is opened on a vein of galena nearly vertical, which crosses from N. to S. a limestone in nearly vertical strata, probably analogous into the limestone of Derbyshire. The vein is from 4 to 15 feet thick, and is recognised through a length of half a league. The mine, worked for two centuries, presents very extensive excavations; particularly a fine gallery of efflux. It has produced annually 900 tons of lead. At the present day the mine of Vedrin, and some adjoining exploitations, afford per annum only about 200 tons of lead, and 700 marcs of silver.

MINES OF THE CALCAREOUS MOUNTAINS OF ENGLAND.

The limestone formation immediately subjacent to the coal measures, or the mountain limestone, constitutes almost alone several mountainous regions of England and Wales; in which three districts very rich in lead mines deserve to be noted.

The first of these districts comprehends the superior parts of the valleys of the Tyne, the Wear, and the Tees, in the counties of Cumberland, Durham, and York. Its principal mines are situated near the small town of Alston-Moor, in Cumberland. The veins of galena which form the object of the workings, traverse alternate beds of limestone and sandstone; and are very remarkable for their becoming suddenly thin and impoverished on passing from the limestone into the sandstone; and for resuming their richness, and usual size, on returning from the sandstone into the limestone. The exploitations are situated in the flanks of considerably high hills, bare of wood, and almost wholly covered with marshy heaths. The waters are drawn off by galleries of efflux; and the ores are dragged out by horses to the day. The galena extracted from these mines is smelted by means of coal and a little peat, in furnaces of the Scotch construction. The lead is very poor in silver; and there is hardly a single hearth for the purpose of eliminating this metal by cupellation. The mines of this district produce annually 17,200 tons of lead, according to Mr. Taylor's statement, published in the Geology of England and Wales, by Messrs. Conybeare and Phillips. There is moreover a copper mine 2 leagues S. W. of Alston-Moor. The ore is a copper pyrites, accompanied with galena in a very extensive vein, which does not appear to belong to the same formation as the other veins of this region.

The second metalliferous district lies in the northern part of Derbyshire, and in the conterminous parts of the neighbouring counties. The districts called the Peak and King's-Field are the richest in workable deposits. The mines of Derbyshire are getting exhausted; they are very numerous, but in general inconsiderable. The galena extracted from them is treated with coal in reverberatory furnaces; but the silver is not sought for. They yield annually 900 tons of lead; with a certain quantity of calamine, and a little copper ore. A vein of copper pyrites occurs at Ecton, in Staffordshire, on the borders of Derbyshire. The veins of Derbyshire are famous for the beautiful minerals which they have produced; and particularly for the interruption which they almost constantly suffer at the contact of the trap-rock, called toadstone, which is intruded among the limestone.

The third metalliferous district is situated in Flintshire and Denbighshire, counties forming the N. E. part of Wales. Next to Alston-Moor this is the most productive; furnishing annually 6,900 tons of lead, and a certain quantity of calamine. The galena is smelted in reverberatory furnaces, and affords a lead far from rich in silver, which is therefore seldom subjected to cupellation. The mines occur partly in the metalliferous limestone, and partly in several more ancient rocks.

To the S. E. of this district there exist still some lead mines in Shropshire. They lie, like the preceding, partly in the metalliferous limestone, and partly in the subjacent rocks. They yield annually from 700 to 800 tons of lead.

Some mines of galena and calamine are mentioned in the Mendip hills, to the south of Bristol; but they seem to be for the present abandoned.

Besides the metallic mines just enumerated, the formation of the metalliferous limestone presents, in England, especially in the counties of Northumberland and Cumberland, several coal mines, opened on coal strata included by the sandstone, which alternates with the limestone.

MINES OF DAOURIA.

The name Daouria is given to a great region wholly mountainous, which extends from the Baikal Lake to the Eastern Ocean. There is, perhaps, no other country in the world so rich in deposits of lead ores, as the part of this district which extends from the junction of the rivers Chilca and Argoun, whose united waters form the river Amour, belonging to Russia. The mines opened here constitute the third arrondissement of the Siberian mines, called that of Nertchinsk, from the name of its capital, which lies more than 1800 leagues east of Saint Petersburg.

The ground of the metalliferous portion of Daouria is formed of granite, hornschiefer, and schists, on which reposes a gray limestone, sometimes siliceous and argillaceous, which contains a small number of fossils, and in which the veins of lead occur. The plains of these regions, often salt deserts, exhibit remarkable sandstones and pudding-stones; as also vesicular rocks of a volcanic aspect. It appears that the metalliferous limestone is much dislocated, and the lead veins are subject to several irregularities, which render their exploitation difficult and uncertain. The mines lie chiefly near the banks of the Chilca and the Argoun, in several cantons, at a considerable distance from one another; wherefore it was requisite to build a great number of smelting furnaces. The want of wood has placed difficulties in the working of some of them. The ore is galena, sometimes occurring in masses of several yards in diameter; having commonly for vein-stones ores of iron and zinc, of which no use is made. The galena itself, furnished by these mines in enormous quantities, receives a very different treatment from what it would do in a civilized country; for, though the lead which it produces contains only from 6 to 10 gros (1 to 1½ ounce) of silver per quintal, it is for it alone that these mines are worked. The litharge produced by the cupellation is thrown away as useless; so that heaps of it exist near the smelting-furnaces, says M. Patrin, higher than the houses. Only an insignificant quantity of it is reduced to lead for the uses of the country, or for those of the foundries in the arrondissement of Kolywan. The silver extracted from the mines of Daouria, contains a very small proportion of gold. M. Patrin says that their annual product was, towards the year 1784, from 30 to 35 thousand marcs of silver. The exploitation of some of the mines of Daouria goes back to the end of the 17th century. It had been commenced in some points by the Chinese, who were not entirely expelled from this territory till the beginning of the following century. A great part of the mines, however, has been opened up since 1760.

Besides the lead mines, there are some unimportant mines of copper in Daouria, and in different explorations of this region, arsenical pyrites, from which arsenious acid is sublimed in factories established at Jutlack and at Tchalbutchinsky.

About 45 leagues to the south of Nertchinsk, the mountain of Odon-Tchelon occurs, celebrated for the different gems or precious stones extracted from it. It is formed of a friable granite, including harder nodules or balls which inclose topazes; it is very analogous to the topaz rock of Saxony. In this granite there are several veins filled with a ferruginous clay, which contains a great quantity of wolfram, and many emeralds, aqua marines, topazes, crystals of smoked quartz, &c. Multitudes of these minerals have been extracted by means of some very irregular workings. The mountain of Toutt-Kaltoui, situated near the preceding, offers analogous deposits. The presence of wolfram had excited hopes that tin might be found in these mountains; hopes which have not hitherto been realized. There are some unworked deposits of sulphuret of antimony in this country.

ON SOME OTHER LESS KNOWN MINE COUNTRIES.

There seem to exist in Brazil, besides the washings of the sands that produce the diamonds, the precious stones, the platinum, and almost all the gold of this country, some mines of gold, lead, and iron, opened up in very ancient geological formations; but there is no silver mine, which indicates a great difference between the metalliferous deposits of this district and those of Spanish America. The lead mines occur particularly in the captainry of Minas-Geraes, canton of Abaité. Their exploitation has been undertaken within a few years. The captainry of Minas-Geraes contains extremely abundant deposits of black oxide of iron, and specular iron, which constitute beds or enormous masses, forming sometimes entire mountains; along with numerous veins of hematite and red oxide of iron. Lately these have been opened up, and smelting-houses have been established at Gaspar-Saarez. There are also iron mines and foundries in the captainry of Saint-Paul. A mine of antimony occurs near Sabara, in the captainry of Minas-Geraes.

In Africa, the inhabitants of the countries adjoining to the cape of Good Hope mine and smelt copper and iron; and the Congo produces considerable quantities of these two metals. It is asserted that a great deal of copper exists in Abyssinia. On the banks of the Senegal, the Moors and the Pouls fabricate iron in travelling forges. They employ as the ore the richest portions of a ferruginous sandstone, which seems to be a very modern formation. Lastly, the kingdoms of Morocco and Barbary appear to include several copper and iron mines.

The islands of Cyprus and Negropont, in the Mediterranean, were celebrated, in former times, for their copper mines; and several islands of the Archipelago presented gold mines, now abandoned. The same thing may be said of Macedonia and Thrace. The mountains of Servia and Albania contain iron mines; and lead mines occur in Servia. Natolia possesses iron and copper mines in the neighbourhood of Tokat. Some also occur in Arabia and in Persia; and in the territories round Caucasus, the kingdom of Imeretta is distinguished for its iron mines. The celebrity of the Damascus sabres attests the good quality of the products of some of the mines. Persia includes, besides, mines of argentiferous lead at *Kervan*, a few leagues from Ispahan; and Natolia furnishes orpiment.

Some iron and copper mines have been mentioned in Tartary. Thibet passes for being rich in gold and silver mines. China produces a great quantity of iron and mercury, as well as white brass (*tombac*), which is much admired. The copper mines of this empire lie principally in the province of Yu Nan and the island Formosa. Japan, likewise, possesses copper mines in the provinces of Kijunack and Sarunga. They seem to be abundant; at a period not far back, they exported their products to Europe. Japan presents, moreover, mines of quicksilver. China and Japan contain also mines of gold, silver, tin, red sulphuret of arsenic, &c. Large deposits of the latter ore (realgar) are said to occur in the tin mine of Kian-Fu in China. But in that empire, as in Europe, coal is the most important of the mining products. This combustible is explored, especially in the environs of Pekin, and in the northern parts of the empire.

Iron mines exist in several points of the Burman empire, and of Hindostan. Near Madras, there exist excellent ores of sparry iron, and black oxide, analogous to the Swedish ores. The Indian natural steel, named Wootz, has been held in considerable estimation among some eminent London cutlers; but the iron and steel recently manufactured upon a great scale near Madras, by Messrs. Heath and Co., from the crystallized magnetic ore of that country, will probably ere long rival, and eventually supersede in Europe the product of the Dannemara forges. The islands of Macassar, Borneo and Timor, include copper mines. As to the tin obtained from the island of Banca, from the peninsula of Malacca, and several other points of southern Asia, it proceeds entirely from the washing of sands. The same is undoubtedly true of the gold furnished by the Philippine isles, Borneo, &c. It appears, however, that mines of gold and silver are worked in the island of Sumatra.

MINES OF THE SECONDARY ROCK FORMATIONS.

The most important mines of the secondary rocks, and perhaps of all minerals whatsoever, are those worked in the most ancient of these strata, in the coal-measures.

The British Islands, France, and Germany present several groups of small mountains primitive on the ridge, and transition on the flanks; in the sinuosities between which deposits of coal occur. The principal of these have become great centres of manufactures; for Glasgow, Newcastle, Sheffield, Birmingham, Saint-Etienne, &c., owe their prosperity and their rapid enlargement to the coal, raised, as it were, at their gates in enormous quantities. Wales, Flanders, Silesia, and the adjacent parts of Gallicia, owe equally to their extensive collieries a great portion of their activity, their wealth, and their population. Other coal districts, less rich, or mined on a less extended scale, have procured for their inhabitants less distinguished, but by no means inconsiderable, advantages; such, for examples in Great Britain, are Derbyshire, Cheshire, Lancashire, Shropshire, Warwickshire, the environs of Bristol, &c.; some parts of Ireland; in France, Litry department of Calvados, Comanterie, Saint-Georges-Chatelaison, Aubin, Alais, le Creusot; Ronchamps, in the Prussian provinces of the left bank of the Rhine; the environs of Saarebrück; several points of the north of the territory of Berg and Lamarck, of Mansfeld, of Saxony, Hungary, Spain, Portugal, the United States, &c.

We need not enter here into ampler details on coal mines, reserving these particulars for the article Pitcoal.

Nature has deposited alongside of coal an ore, whose intrinsic value alone is very small, but whose abundance in the neighbourhood of fuel becomes extremely precious to man; we allude to the clay-ironstone of the coal-measures. It is extracted in enormous quantities from the coal-basins of Scotland, Yorkshire, Staffordshire, Shropshire, and South Wales.

Much of it is also raised from the coal strata of Silesia; and the French entertain hopes of finding a supply of this necessary ore in their own country. The iron-works of England, which are supplied almost entirely from this iron-stone reduced with the coke or coal, pour annually into commerce more than one million tons of cast and bar iron, the value of which has been estimated at eight millions sterling; an amount fully equal to the product of all the mines of Spanish America.

The shale or slate-clay of the coal-measures contains sometimes a very large quantity of pyrites, which, decomposing by the action of air, with or without artificial heat, produces sulphate of iron and sulphate of alumina; whence copperas and alum are manufactured in great abundance.

The lead mines of Bleyberg and Gemünd, near Aix-la-Chapelle, are explored in a sandstone referred by many geologists to the red sandstone. The ore consists principally of nodules of galena disseminated in this rock. They are very abundant, and of very easy exploration. These mines produce annually from 700 to 800 tons of lead, which does not contain silver in sufficient proportion to be worth the extracting. 2000 tons of ore are prepared and sold in the form of black lead dust (*alquifoux*).

The manganese mines worked in the open air near Exeter in England, occur in a sandstone analogous to the red.

The calcareous formation which surmounts the coal-sandstone, called by geologists *zechstein*, magnesian limestone, and older Alpine limestone, contains different deposits of metallic ores; the most celebrated being the cupreous schist of Mansfeldt, a stratum of calcareous slate from a few inches to two feet thick, containing copper pyrites in sufficient quantity to afford 2 per cent. of the weight of the ore of an argentiferous copper. This thin layer displays itself in the north of Germany over a length of eighty leagues, from the coasts of the Elbe to the banks of the Rhine. Notwithstanding its thinness and relative poverty, skilful miners have contrived to establish, on different points of this slate, a number of important explorations, the most considerable being in the territory of Mansfeldt, particularly near Rottenburg. They produce annually 2000 tons of copper, and 20,000 marcs of silver. We may also mention those of Hessia, situated near Frankenberg, Bieber, and Riegelsdorf. In the latter, the cupreous schist and its accompanying strata, are traversed by veins of cobalt, mined by the same system of underground workings as the schist. These operations are considerable; they extend, in the direction of the strata, through a length of 8700 yards, and penetrate downwards to a very great depth. Three galleries of efflux are to be observed; two of which pour their waters into the Fulde, and the third into the Verra. One of them runs about 20 yards below the most elevated point of the workings. These mines have been in activity since the year 1530. Analogous mines exist near Saalfeld in Saxony.

To the same geological formation must probably be referred the limestone which contains the sparry iron mine of Schmalcalden at the western foot of Thuringerwald, where there has been explored from time immemorial a considerable mass of this ore known by the name of *Stahlberg*. The working is executed in the most irregular manner, and has opened up enormous excavations; whence disastrous ruins have taken place in the mines. It furnishes annually 4500 tons of ore, which keep in play a great number of furnaces, where a deal of iron and steel is manufactured.

At Tarnowitz, 14 leagues S. E. of Oppeln in Siberia, the zechstein contains, in some of its strata, considerable quantities of galena and calamine; into which, mines have been opened, that yield annually from 600 to 700 tons of lead, 1000 to 1100 marcs of silver, and much calamine. Mines of argentiferous lead are noticed at Olkutch and Jaworno in Gallicia, about 6 leagues N. E. of Cracow, and 15 leagues E. N. E. of Tarnowitz. Their position seems to indicate that they belong to the same formation; and possibly those of Willach and Bleyberg in Carinthia have the same locality.

There has been discovered lately near *Confolens* in the department of *la Charente*, in a secondary limestone, calcareous beds, and particularly subordinate beds of quartz, which contain considerable quantities of galena. At *Figeac* also, in the department of *le Lot*, deposits of galena, blende, and calamine occur in a secondary limestone. At *la Voulte* on the banks of the Rhone, there is mined, in the lower courses of the limestones that constitute a great portion of the department of the Ardèche, a powerful bed of iron ore.

It is in the zechstein, or in the sandstones, and trap rocks of nearly the same age, that the four great deposits of the sulphuret of mercury, of *Idria*, the *Palatinate*, *Almaden*, and *Huancavelica*, are mined.

The formation which separates the *zechstein* from the lias (*calcaire a gryphites*), called new red sandstone and red marl in England, and bunter-sandstein, muschelkalk, and quadersandstein in Germany, presents hardly any important mines except those of rock salt; which enrich it, not only in the centre of Europe, as in Cheshire, at Vic, Wieliczka, Bochnia, and Salzbourg, but in many other parts of the world.

The lias contains often very pyritous lignites, which are mined in many places, and particularly at Whitby and Guisborough in Yorkshire, for the manufacture of alum and copperas.

The oolitic limestones contain strata of iron ore, which are mined in some districts of France.

The iron sand (Hastings sand) beneath the chalk formation, is often so strongly imbued with iron as to be worth the working.

The lowest beds of the chalk contain iron pyrites, which has become the object of an important exploration at *Vissans* on the southern coast of the *Pas-de-Calais*, where it is converted into sulphate of iron. The waves turn the nodules out of their bed, and roll them on the shore, where they are picked up.

If the chalk be poor in useful minerals, this is not the case with the plastic clay formation above it; for it contains important mines. In it are explored numerous beds of lignite (wood-coal), either as fuel or a vitriolic earth. From these lignite deposits, also, the yellow amber is extracted.

The other tertiary formations present merely a few mines of iron and bitumen.

Several of the secondary or tertiary strata contain deposits of sulphur, which are mined in various countries.

The formations of a decidedly volcanic origin afford few mining materials, if we except sulphur, alum, and opals.

MINES OF THE ALLUVIAL STRATA.

This formation contains very important mines, since from it are extracted all the diamonds, and almost all the precious stones, the platinum, and the greatest part of the gold, with a considerable portion of the tin and iron. The diamond mines are confined nearly to Brasil, and to the kingdoms of Golconda and Visapour in the East Indies.

MORTAR, HYDRAULIC. Professor Kuhlmann, of Lisle, obtained a patent in April 1841, in the name of Mr. Newton, for certain improvements in the manufacture of lime-cement and artificial stone; and of which he gave me a sample, possessed of a hardness and solidity fit for the sculptor.

In operating by the dry method, instead of calcining the limestone with sand and clay alone, as has been hitherto commonly practised, the inventor introduces a small quantity of soda or, preferably, potash, in the state of sulphate, carbonate, or muriate; salts susceptible of forming silicates when the earthy mixture is calcined. The alkaline salt, equal in weight to about one fifth that of the lime, is introduced in solution among the earths.

All sorts of lime are made hydraulic, in the humid way, by mixing slaked lime with solutions of common alum or sulphate of alumina; but the best method consists in employing a solution of the silicate of potash, called liquor of flints, or soluble glass, to mix in with the lime, or lime and clay. An hydraulic cement may also be made which will serve for the manufacture of architectural ornaments, by making a paste of pulverized chalk, with a solution of the silicate of potash. The said liquor of flints will likewise give chalk and plaster a stony hardness, by merely soaking them in it after they are cut or moulded to a proper shape. On exposure to the air, they get progressively indurated. Superficial hardness may be readily procured by washing over the surface of chalk, &c., with liquor of flints, by means of a brush. This method affords an easy and elegant method of giving a stony crust to plastered walls and ceilings of apartments; as also to statues and busts, cast in gypsum, mixed with chalk.

The essential constituents of every good hydraulic mortar, are caustic lime and silica; and the hardening of this compound under water consists mainly in a chemical combination of these two constituents through the agency of the water, producing a hydrated silicate of lime. But such mortars may contain other bases besides lime, as for example clay and magnesia, whence double silicates of great solidity are formed; on which account dolomite is a good ingredient of these mortars. But the silica must be in a peculiar state for these purposes; namely, capable of affording a gelatinous paste with acids; and if not so already, it must be brought into this condition, by calcining it along with an alkali or an alkaline earth, at a bright red heat, when it will dissolve, and gelatinize in acids. Quartzose sand, however fine its powder may be, will form no water mortar with lime; but if the powder be ignited with the lime, it then becomes fit for hydraulic work. Ground felspar or clay form with slaked lime no water cement; but when they are previously calcined along with the lime, the mixture becomes capable of hardening under water.

The *mastic* called *Hamelin's*, and so much employed in London, is composed of ground Portland stone (roe stone), sand and litharge in the proportion of 62 of the first, 35 of the second, and 3 of the third, in 100 parts; but other proportions will also answer the purpose. I find that chalk will not make a good mastic; being too compact to permit the air to insinuate between the pores, and to produce the concretion of the linseed oil, with which the above mixture is worked up and applied. This mastic soon acquires great hardness, and is totally impervious to water. The surface to which it is to be applied must be dry, and smeared over with linseed oil. Considerable dexterity is required to make good work with it. The fine dust of sandstone alone, mixed with 10 or 12 per cent. of litharge and 7 per cent. of linseed oil, forms an excellent mastic.

Limestone, which contains as much as 10 per cent. of clay, comports itself after calcination, if all the carbonic acid be expelled, just as pure limestone would do. When it is less strongly burned, it affords however a mass which hardens pretty speedily in water. If the argillaceous proportion of a marl amounts to 18 or 20 per cent., it still will slake with water, but it will absorb less of it, and forms a tolerably good hydraulic mortar, especially if a little good Roman cement be added to it. When the proportion of clay is 25 or 30 per cent. after burning, it heats but little with water, nor does it slake well, and must therefore be ground by stampers or an edge millstone, when it is to be used as a mortar. This kind of marl yields commonly the best water cement without other addition. Should the quantity of clay be increased farther, as up to 40 per cent., the compound will not bear a high or long-continued heat without being spoiled for making hydraulic mortar after grinding to powder. When more strongly calcined, it forms a vitriform substance, and should, after being pulverized, be mixed up with good lime, to make a water mortar. If the marls, in any locality, differ much in their relative proportions of lime and alumina, as may be readily ascertained by the use of my lime-proof apparatus (see *Appendix*), then the several kinds should be mixed in such due proportions as to produce the most speedily setting, and most highly indurating hydraulic cement.

MUNDICK. The name given by the Cornish miners to iron or arsenical pyrites.

MUSK. The musk deer, from the male of which animal species the bag containing this valuable drug is obtained, is a native of the mountainous Kirgesian and Langorian steppes of the Altai, on the river Irtish, extending eastwards as far as the river Jenesi and Lake Baikal; and generally of the mountains of Eastern Asia, between 30° and 60° of N. L. Two distinct kinds of musk are known in commerce, the first being the Chinese Tonquin, Thibetian, or Oriental, and the Siberian or Russian. The Chinese is regarded by Dr. Goebel as the result of ingenious adulterations of the genuine article by that crafty people. The Russian musk is genuine, the bags never being opened, are consequently never sewn, nor artificially closed, like those imported into London from China. The former is sometimes so fresh, that moisture may be expressed from the bag by cutting through its fleshy side. The interior mass is frequently of a soft and pappy consistence; but the surface of the bag is perfectly dry. The Chinese bags are found invariably to have been opened and again glued together, more or less neatly; though sometimes the stitches of the sewing are manifest. Mr. Dyrssen, an eminent merchant at St. Petersburgh, states that during the many years he has been in the trade, although he has received at a time from 100 to 200 ounces from London, yet in no case whatever has he met with a bag which had not been opened, and closed with more or less ingenuity. The genuine contents seem to have been first removed, modified, and replaced. M. Guibourt gives the following as the constituents of a Chinese musk bag: 1. water; 2. ammonia; 3. solid fat or stearine; 4. liquid fat or elaine; 5. cholesterine; 6. acid oil, combined with ammonia; 7. volatile oil; 8—10. hydrochlorates of ammonia, potassa, and lime; 11. an undetermined acid; 12. gelatin; 13. albumen; 14. fibrin; 15. carbonaceous matter soluble in water; 16. calcareous salt; 17. carbonate of lime; 18. hairs and sand.

From June 1841 to June 1842, a duty of 6*d.* per oz. was paid at the port of London alone upon 969 ounces of musk. The prices of grain musk of the best quality (the matter without the bag) varies from 60*s.* to 95*s.* per oz.

There is a superior musk imported now from the United States, which is nearly free from the carbonate of lime, so abundant in the bags of the Siberian musk.

MUSQUET. It is now fourteen years since the Hon. Board of Ordnance, with the view of introducing the use of percussion fire-arms into the British Army, employed me to investigate experimentally the best mode of preparing the priming powder for that purpose. The result of these experiments was presented in a report, the substance of which is given under the article "Fulminate" in the Dictionary. During this long interval, Mr. Lovell, inspector of small arms for her Majesty's service, and director of the Royal Manufactory, at Enfield Chase, has directed his ingenious mind to the construction of a sure, simple, and strong musquet, with which, under his able superintendence, the whole of her Majesty's soldiers are now provided. He has also furnished them with a short, but clear set of instructions for the cleaning and management of these excellent arms, illustrated by a series of wood engravings. From this little work the following notice is copied.

Fig. 94. The barrel, reduced to one-seventh size. *a*, the breech; *b*, the nipple-seat or lump; *c*, the back-sight; *d*, the back loop; *e*, the middle loop; *f*, the swivel-loop; *g*, the front-loop with the bayonet-spring attached; *h*, the front sight; *i*, the muzzle.

Fig. 95. The breech-pin, half size. *a*, the tang; *b*, the neck; *c*, the screw-threads; *d*, the face.

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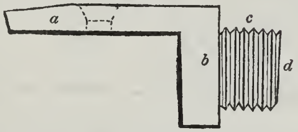

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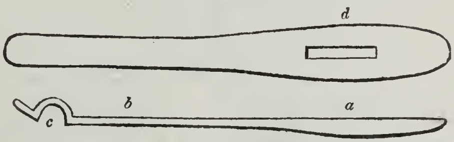

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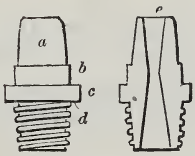

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Fig. 96. The bayonet-spring, two ways, half size. *a*, the shank; *b*, the neck; *c*, the hook; *d*, the mortice.

Fig. 97. The nipple, full size. *a*, the cone; *b*, the squares; *c*, the shoulder; *d*, the screw-threads; *e*, the touch-hole.

Fig. 98. The rammer, reduced to one-seventh size. *a*, the head; *b*, the shaft; *c*, the screw-threads.

Fig. 99. The lock outside, half size. *a*, the plate; *b*, the cock; *c*, the tumbler-pin; *d*, the hollow for the nipple seat.

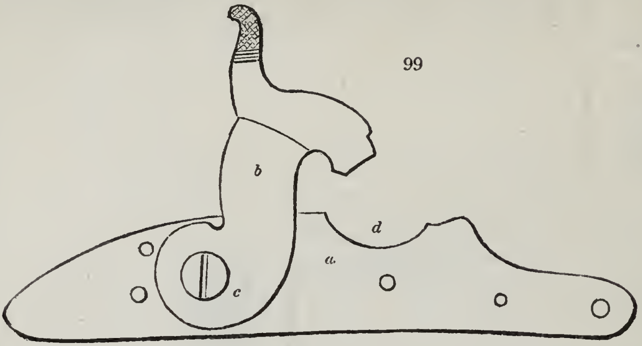
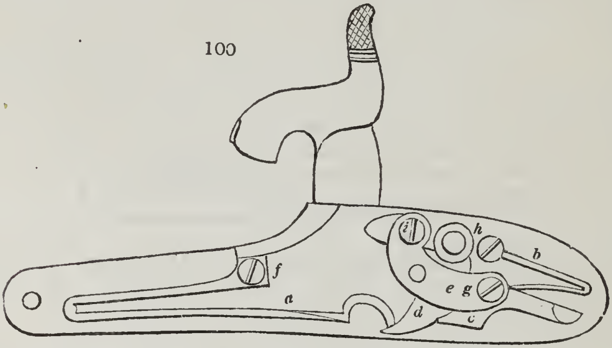


Fig. 100. The lock inside, half size, showing all the parts in their places with the cock down at bearer. *a*, the main-spring; *b*, the sear-spring; *c*, the sear; *d*, the tumbler; *e*, the bridle; *f*, the main-spring-pin; *g*, the sear-pin; *h*, the sear-spring-pin; *i*, the bridle-pin.



N.

NITRE (*Saltpetre*), and NITRATE OF SODA (*Cubic nitre*), imported for home consumption in 1839, 314,543 cwts.; in 1840, 369,204; duty 6*d.* per cwt.

NITROMETER. See *Appendix.*

NUTMEGS; imported for consumption in 1839, 133,470 lbs.; in 1840, 118,554; duty from British possessions, 2*s.* 6*d.*; from foreign, 3*s.* 6*d.* per lb.

O.

OIL, COCOA-NUT; imported for consumption in 1839, 15,153 cwts.; in 1840, 37,269; duty, 1*s.* 3*d.* per cwt.

OIL, OLIVE; imported for consumption in 1839, 1,806,178 gallons; in 1840, 1,985,902; duty 8*d.* per gallon.

OIL, PALM; imported for consumption in 1839, 262,910 cwts.; in 1840, 314,881; duty, 1*s.* 3*d.* per cwt.

OIL, *train, spermaceti,* and *blubber;* imported for consumption in 1839, 21,438 tuns; in 1840, 19,955, of British fishing, 1*s.* per tun; of foreign fishing, 26*l.* 12*s.* per tun.

The numerous uses of unctuous oils give importance to their preparation, as articles of food, or for burning in lamps, and for the manufacture of soaps, &c. The seeds most productive of oil are those of colza (a species of cabbage, *brassica arvensis*), rape, mustard, sesamum, poppy, linseed, hemp, and beechmast. Nuts afford an oil that is much esteemed for certain purposes, and may be easily obtained by pressure. The following Table indicates the quantities of oil which can be extracted from different fruits, and some other substances : —

100 Parts of each.	Oil per Cent.
Walnuts	40 to 70
Castor-oil seeds	62
Hazel nuts	60
Garden cress seed	56 to 58
Sweet almonds	40 to 54
Bitter almonds	28 to 46
Poppy seeds	56 to 63
Oily radish seed	50
Sesamum (jugoline)	50
Lime-tree seeds	48
Cabbage seed	30 to 39
White mustard	36 to 38
Rape, colewort, and Swedish turnip seeds	33·5
Plum kernels	33·3
Colza seed	36 to 40
Rape seed	30 to 36
Euphorbium (spurge seed)	30

100 Parts of each.	Oil per Cent.
Wild mustard seed	30
Camelina seed	28
Weld seed	29 to 36
Gourd seed	25
Lemon seed	25
Onocardium *acanthe*, or bear's foot	25
Hemp seed	14 to 25
Linseed	11 to 22
Black mustard seed	15
Beech mast	15 to 17
Sunflower seeds	15
Stramonium, or thorn-apple, seeds	15
Grape-stones	14 to 22
Horse-chestnuts	1·2 to 8
St. Julian Plum	18

To obtain the above proportions of oil, the fruits must be all of good quality, deprived of their pods, coats, or *involucra*, and of all the parts destitute of oil, which also must be extracted in the best manner.

The following Table is given by M. Dumas, as exhibiting the practical results of the French seed oil manufacturers : —

	Weight per Hectolitre.	Produce in Litres.
Summer Colza	54 to 65 kilogs.	21 to 25
Winter Colza	56 to 70 —	25 to 28
Rape seed	55 to 68 —	23 to 26
Camelina seed	53 to 60 —	20 to 24
Poppy seed	54 to 62 —	22 to 25
Madia sativa	40 to 50 —	12 to 15
Beech mast	42 to 50 —	12 to 15
Hemp seed	42 to 50 —	12 to 15
Linseed	By sample, 67.	10 to 12
Stripped walnuts	From 100 kilogs.	46 to 50
Sweet almonds	— 100 —	44 to 48
Olives	— 100 —	10 to 12

Colza, rapeseed, and cameline oils are employed for lamps; poppy, *madia sativa*, are employed, when recent, as articles of food — or for soaps and paintings; hempseed and linseed for painting, soft soaps, and for printers' ink; walnut oil, for food, painting, and lamps; olive oil, for food, soaps, lamps.

In extracting oil from seeds, two processes are required — 1st, *trituration*; 2d, *expression*; and the steps are as follows : —

1. Bruising under revolving heavy-edge millstones, in a circular bed, or trough of iron, bedded on granite.

2. Heating of the bruised seeds, by the heat either of a naked fire or of steam.

3. First pressure or crushing of the seeds, either by wedges, screw, or hydraulic presses.

4. Second crushing of the seed cakes of the first pressure.

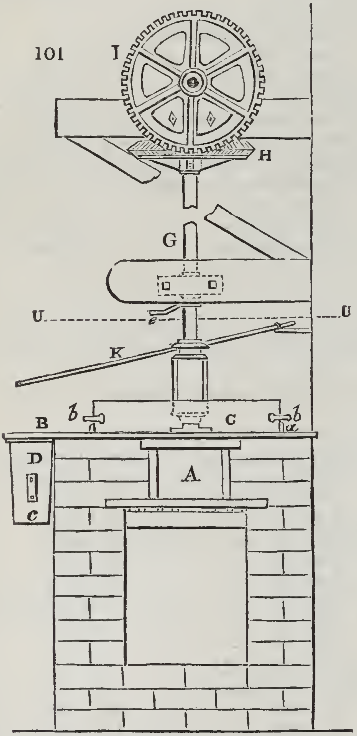
5. Heating the bruised cakes; and, 6. A final crushing.

The seeds are now very generally crushed, first of all between two iron cylinders revolving in opposite directions, and fed in from a hopper above them; after which they yield more completely to the triturating action of the edge stones, which are usually hooped round with a massive iron ring. A pair of edge millstones of about 7 or 7½ feet in diameter, and 25 or 26 inches thick, weighing from 7 to 8 tons, can crush, in 12 hours, from 2½ to 3 tons of seeds. The edge-millstones serve not merely to grind the seeds at first, but to triturate the cakes after they have been crushed in the press. Old dry seeds sometimes require to be sprinkled with a little water to make the oil come more freely away; but this practice requires great care.

The apparatus for heating the bruised seeds consists usually of cast-iron or copper pans, with stirrers moved by machinery. *Figs.* 101, 102, 103, 104. represent the heaters by naked fire, as mounted in Messrs. Maudsley and Field's excellent seed crushing mills, on the wedge or Dutch plan.

Fig. 101. is an elevation, or side view of the fire-place of a naked heater; *fig.* 102. is a plan, in the line UU of *fig.* 101. *Fig.* 103. is an elevation and section parallel to the line VV of *fig.* 102. *Fig.* 104. is a plan of the furnace, taken above the grate of the fire-place.

101



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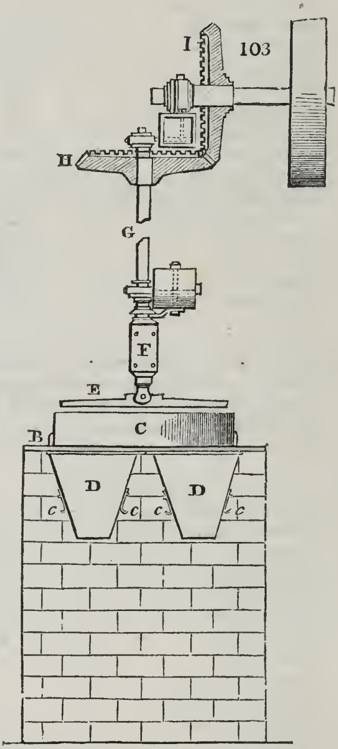

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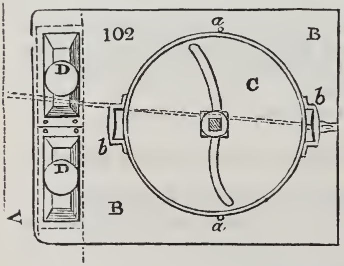

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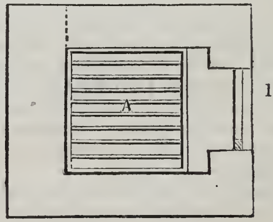

A, fire-place shut at top by the cast-iron plate B.; called the fire-plate.

C, iron ring-pan, resting on the plate B, for holding the seeds; which is kept in its place by the pins or bolts *a*.

D, funnels, *britchen*, into which by pulling the ring-case *c*, by the handles *b*, *b*, the seeds are made to fall, from which they pass into bags suspended to the hooks *c*.

E, *fig.* 103., the stirrer which prevents the seeds from being burned by continued contact with the hot plate. It is attached by a turning-joint to the collar F, which turns with the shaft G, and slides up and down upon it. H, a bevel wheel, in gear with the bevel wheel I, and giving motion to the shaft G.

K, a lever for lifting up the agitator or stirrer E. *e*, a catch for holding up the lever K, when it has been raised to a proper height.

Fig. 105., front elevation of the wedge seed-crushing machine, or wedge-press. *Fig.* 106. section, in the line XX, of *fig.* 107.

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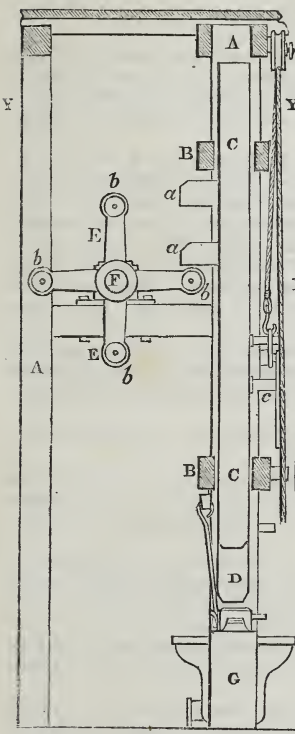

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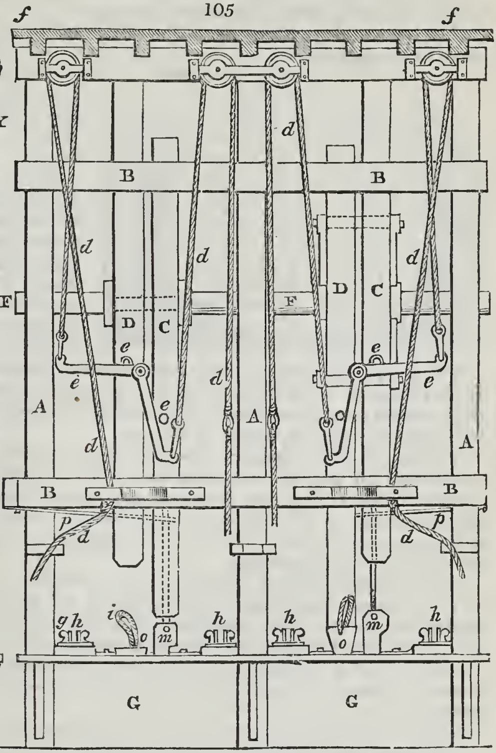
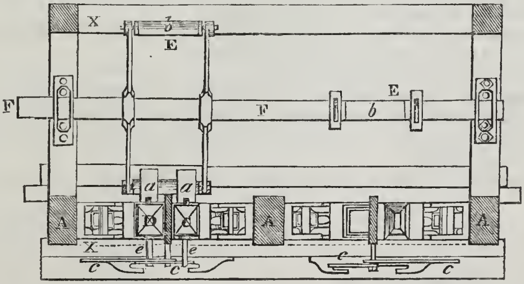


Fig. 107., horizontal section, in the line YY, of *fig.* 106.

107



A, A, Upright guides, or frame-work of wood.

B, B, Side guide-rails.

D, Driving stamper of wood, which presses out the oil; C, spring stamper, or relieving wedge, to permit the bag to be taken out when sufficiently pressed. E is the lifting shaft, having rollers, *b*, *b*, *b*, *b*, *fig.* 106., which lift the stampers by the cams, *a*, *a*, *fig.* 106. F is the shaft from the power-engine, on which the lifters are fixed.

G, is the cast iron press-box, in which the bags of seed are placed for pressure, laterally by the force of the wedge.

o, figs. 105. and 108.; the spring, or relieving wedge.

e, lighter rail; *d*, lifting-rope to ditto.

f, f, f, f, flooring overhead.

g, figs. 105. and 108.; the back iron, or end-plate minutely perforated.

h, the horse-hair bags (called hairs), containing the flannel bag, charged with seed; *i*, the dam-block; *m*, the spring wedge.

Fig. 107. A, upright guides; C, and D, spring and driving stampers; E, lifting roller; F, lifting shaft; *a, a*, cams of stampers.

Fig. 108., a view of one set of the wedge-boxes, or presses; supposing the front of them to be removed.

108

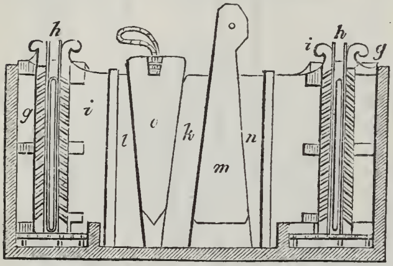


Fig. 108.; *o*, driving wedge; *g*, back iron; *h*, hairs; *i*, dam-block; *k*, speering or oblique block, between the two stampers; *l*, ditto; *n*, ditto; *m*, spring wedge.

When, in the course of a few minutes, the bruised seeds are sufficiently heated in the pans, the double door F F is withdrawn, and they are received in the bags, below the aperture G. These bags are made of strong twilled woollen cloth, woven on purpose. They are then wrapped in a hair-cloth, lined with leather.

The first pressure requires only a dozen blows of the stamper, after which the pouches are left alone for a few minutes till the oil has had time to flow out; in which interval the workmen prepare fresh bags. The former are then unlocked, by making the stamper fall upon the loosening wedge or key, *m*.

The weight of the stampers is usually from 500 to 600 pounds; and the height from which they fall upon the wedges is from 16 to 21 inches.

Such a mill as that now described, can produce a pressure of from 50 to 75 tons upon each cake of the following dimensions: — 8 inches in the broader base, 7 inches in the narrower, 18 inches in the height; altogether nearly 140 square inches in surface, and about ¾ of an inch thick.

OILS, ADULTERATION OF. M. Heidenreich has found in the application of a few drops of sulphuric acid to a film of oil, upon a glass plate, a means of ascertaining its purity. The glass plate should be laid upon a sheet of white paper, and a drop of the acid let fall on the middle of ten drops of the oil to be tried.

With the *oil of rape-seed* and *turnip-seed*, a greenish blue ring is gradually formed at a certain distance from the acid, and some yellowish brown bands proceed from the centre.

With *oil of black mustard*, in double the above quantity, also a bluish green colour.

With *whale and cod-oil*, a peculiar centrifugal motion, then a red colour, increasing gradually in intensity; and after some time, it becomes violet on the edges.

With *oil of cameline*, a red colour, passing into bright yellow.

Olive-oil, pale yellow, into yellowish green.

Oil of poppies and sweet almonds, canary yellow, passing into an opaque yellow.

Of *linseed*, a brown magma, becoming black.

Of *tallow* or *oleine*, a brown colour.

In testing oils, a sample of the oil imagined to be present should be placed alongside of the actual oil, and both be compared in their reactions with the acid. A good way of approximating to the knowledge of an oil is by heating it, when its peculiar odour becomes more sensible.

Specific gravity is also a good criterion. The following table is given by M. Heidenreich: —

	Sp. Gr.	Gay-Lussac's Alcoholm.
Oleine or Tallow Oil - -	0·9003	66
Oil of Turnip Seed - - -	0·9128	60¾
Rape Oil - - - -	0·9136	60⅕
Olive Oil - - - -	0·9176	58⅖
Purified Whale Oil - - -	0·9231	55⅘
Oil of Poppies - - -	0·9243	55¼
Oil of Camelina - - -	0·9252	54¾
Linseed Oil - - -	0·9347	50
Castor Oil - - - -	0·9611	33¾

M. Laurot, a Parisian chemist, finds that colza oil (analogous to rapeseed oil) may be tested for sophistication with cheaper vegetable oils by the increase of density which it therefrom acquires, and which becomes very evident when the several oils are heated to the same pitch. The instrument, which he calls an *oleometer*, is merely a hydrometer, with a very slender stem. He plunges it into a tin cylinder filled with the oil, and sets this cylinder in another containing boiling water. His oleometer is so graduated as to sink to zero in pure colza oil so heated; and he finds that it stops at 210° in linseed oil, at 124° in poppy-seed oil, at 83° in fish oil, and at 136° in hempseed oil—all of the same temperature. By the increase of density, therefore, or the ascent of the stem of the hydrometer in any kind of colza oil, he can infer its degree of adulteration.

The presence of a fish oil in a vegetable oil is readily ascertained by agitation with a little chlorine gas, which blackens the fish oil, but has little or no effect upon the vegetable oil.

I find that lard oil, and also hogs'-lard, are not at all darkened by chlorine.

A specific gravity, bottle or globe, having a capillary tube-stopper, would make an excellent oleometer, on the above principle. The vessel should be filled with the oil, and exposed to the heat of boiling water, or steam at 212°, till it acquires that temperature, and then weighed. The vessel with the pure colza oil will weigh several grains less than with the other oils similarly treated. Such an instrument would serve to detect the smallest adulterations of sperm oil. Its specific gravity at 60° when pure is only 0·875; that of southern whale oil is 0·922, or 0·925; and hence their mixture will give a specific gravity intermediate, according to the proportion in the mixture. Thus I have been enabled to detect sperm oil in pretended lard oil, in my examination of oils for the customs.

OPIUM; imported for consumption in 1839, 41,632 lbs.; in 1840, 46,736; duty, 1*s.* per lb.

P.

PAPER. The construction of wire web cylinders for paper-making machines, and the combination of two such cylinders in one machine, by the use of which two distinct thicknesses of paper pulp are obtained, and applied face-wise, to form one thick sheet, were made the subject of a patent, under the name of John Donkin. Two cylinders are so placed in a vat that their circumferences are nearly in contact, and by being turned in opposite directions, they bring two sheets of paper pulp into contact, and incorporate them into one, by what is technically termed *couching*.

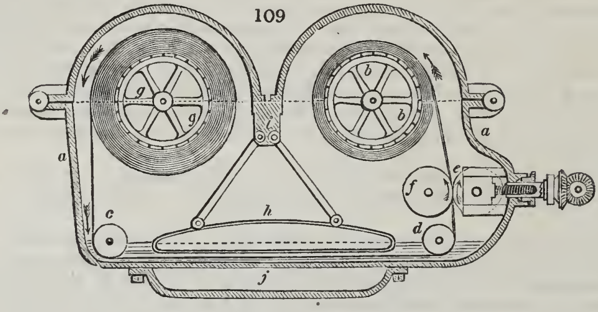
An extensive patent for improvements in the manufacture of paper was granted to Charles Edward Amos in 1840. These consist, first, in gradually lowering the roll of the engine in which the rags are prepared and converted into pulp; secondly, in a mode of regulating the supply of pulp to the paper-making machine, in order to produce papers of any required thickness; thirdly, in an improved sifter or strainer through which the pulp is passed for clearing it of knobs and lumps; fourthly, in certain modifications of the parts of the machine in which the pulp is deposited and moulded into continuous lengths of paper; fifthly, in an improved method of heating the cylinders of the drying apparatus; and, sixthly, in improvements of the machinery for cutting the paper into sheets of any required dimensions. The details of these ingenious contrivances, illustrated with engravings, are given in *Newton's Journal*, xx., p. 153. C. S.

Henry Crossley purposes to manufacture paper from waste tan, and spent hops—with what success I have not heard. Joseph Hughes gives a higher finish to the long web of paper by friction between two cylinders, the one of which moves much quicker than the other, both being covered with felt or not, at pleasure.

Mr. John Dickinson, the eminent paper manufacturer, obtained a patent in 1840 for a new mode of sizing paper continuously, in an air-tight vessel (partly exhausted of air), by unwinding a scroll of dried paper from a reel, and conducting it through heated size; then, after pressing out the superfluous size, winding the paper on to another reel.

A longitudinal section of the apparatus employed for this purpose is represented *fig.* 109.; where *a* is the air-tight vessel; *b*, the reel upon which the paper to be sized is wound; whence it proceeds beneath the guide-roller *c*, and through the warm size to another guide-roller *d*. It thence ascends between the press-rolls, *e*, *f* (by whose revolution the paper is drawn from the reel *b*), and is wound upon the reel *g*. A float *h* is suspended from the cross-bar *i*, of the vessel *a*, for the purpose of diminishing the surface of size exposed to evaporation; and beneath the bottom of the vessel is an enclosed space *j*, into which steam or hot water is introduced for maintaining the temperature of the size.—*Newton's Journal*, xxiii. 20.

109

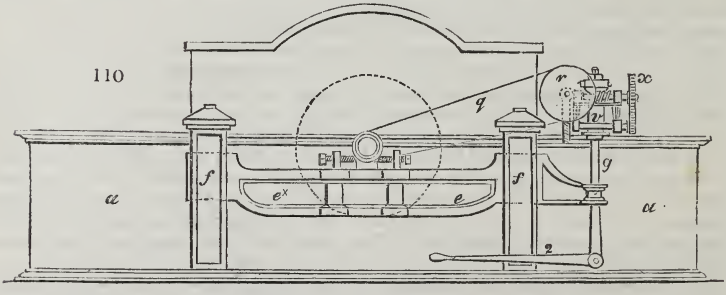


Messrs. Charles Cowan and Adam Ramage, paper makers, patented, in 1840, improved rag machinery; in which a cylindrical sieve or strainer of wire cloth, of a peculiar construction, is substituted for the ordinary strainers, by which the dirty water is separated from the pulp. They do not claim the cylindric form of sieve, but "the adding or applying, and combining within the interior of such drum, scoops, or buckets, for the purpose of elevating the water, which has entered into it through its wire circumference, so that the water when elevated may be able to run by its own gravity out of the hollow around the central axis of the drum into any suitable shoot or trough, and escape at a level above the surface of the water and rags or material contained in the paper-machine."

Thomas Barrett claims, in his patent of 1841, "a mode of drying paper by applying streams of air to its two surfaces, as it passes over the steam cylinders, whether in the state of engine size or water leaf, or after sizing; as also, the application of currents of air to the surfaces of paper, after sizing, in order to cool the size; as the paper is passing to the drying cylinders."

The improvements in paper making, for which T. W. Wrigley, of Bridge Hall Mills, Bury, obtained a patent in 1842, relate to the rag engine, *figs.* 110, 111, 112,

110



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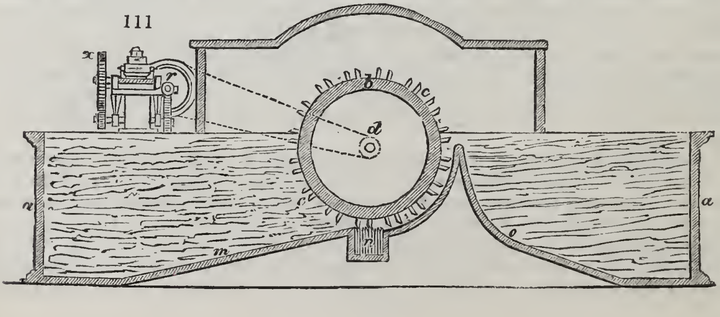

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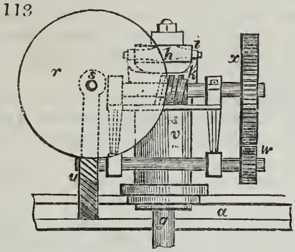

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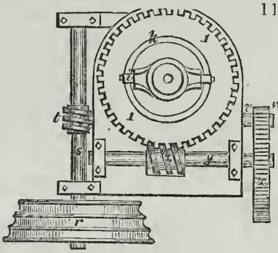


113. *Fig.* 110. is a side elevation; *fig.* 111. a transverse section, taken lengthwise through nearly its middle; *fig.* 112., a plan view of the apparatus detached upon a larger scale; and *fig.* 113. is an elevation. The vessel in which the rags are placed is shown at *a a*, and in about the centre of this vessel the beating or triturating roll, *b b*, is placed: it is surrounded with the blades or roll bars, *c c*, *fig.* 111. The roll is mounted upon a shaft, *d d*, one end of which is placed in a pedestal or bearing on the further side of the chamber *a*, and the other in a bearing upon the arm or lever *e e**, *fig.* 110., which is supported by its fulcrum, at the end *e**, in one of the standards, *f f*, and at the other end by a pin fixed in the connecting rod, *g g*. At the upper end of this connecting rod there is a cross-piece, or head *h*, having turned pivots at each end upon which are placed small rollers, *i i*, resting upon a horizontal cam, *k k*, which is made to revolve. This cam, *k k*, by means of its gearing, causes the roll *b* first of all to wash the rags a short time, then to be lowered at whatever rate is desired for breaking the fibres; to be maintained at the lowest point for the required number of revolutions for beating; and to be raised and retained, as required, for the final purpose of clearing the pulp. The upper or working edge of this cam is to be shaped exactly according to the action required by the engine roll; as, for instance, suppose the previous operation of washing to be completed, and the time required for the operation of the rag machine to be three hours, one of which is required for lowering the roll, that, or the first division of the working surface of the cam, *k k*, must be so sloped or inclined, that, according to the speed at which it is driven, the rollers upon the cross-head shall be exactly that portion of the time descending the incline upon the cam, and consequently lowering the roll upon the plates *n*, *fig.* 111.; and if the second hour shall be required for the roll to beat up the rags, the roll revolving all the time in contact with the plates, the second division of the cam, *k k*, must be so shaped (that is, made level), that the roll shall be allowed to remain, during that period, at its lowest point; and if the third portion of the time, or an hour, be required for raising the roll again, either gradually or interruptedly, then the third division of the cam, *k*, must be suitably shaped or inclined, so as to cause the cross-head to lift the roll during such interval or space of time; the particular shape of the inclined portions of the cam depending on the manner in which the manufacturer may wish the roll to approach to or recede from the bottom plates, during its descent and ascent respectively.

Its mode of connexion and operation in the rag engine is as follows: supposing that the rags intended to be beaten up are placed in the vessel *a*, *fig.* 111., and motion is communicated, from a steam-engine or other power, to the farther end of the shaft *d*, the roll, *b*, will thus be caused to revolve, and the rags washed, broken, and beaten up, as they proceed from the front weir *m*, over the bottom plates *n*, and again round by the back weir *o*. There is a small pulley *p*, upon the near end of the shaft *d*, round which a band *q* passes, and also round another pulley *r*, upon the cross shaft *s*; upon this shaft is a worm *t*, gearing into a worm-wheel *u*, fixed upon another shaft *v*, below; upon the reverse end of which is a pinion *w*, gearing into a spur-wheel *x*, upon the end of a shaft *y*; and upon the centre of this shaft *y*, there is another worm *z*, gearing into a horizontal worm-wheel 1, upon which the cam, *k k*, is fixed. Thus it will be seen, that the requisite slow motion is communicated to the cam, which may be made to perform half a revolution in three hours; or it will be evident, that half a revolution of the cam, *k k*, may be performed in any other time, according to the calculation of the gearing employed. The shaft may also be driven by hand, so as to give the required motion to the cam. Supposing, now, at the beginning of the operation, the cross head bearing the lever and roll, to be at the highest point upon the cam, *k k*, as its revolution commences, the roll will revolve for a short time on the level surface of the cam, and will then be lowered until the cam, *k k*, has arrived at that point which governs the time that the roll remains at the lowest point, for the purpose of beating the rags into pulp, and as the cam, *k k*, continues to revolve, and thus brings the opposite slope upon the third portion of its working surface into action upon the cross head, the roll will be raised, in order to clear the pulp from knots and other imperfections, and thus complete the operation of the engine. In order to raise the cross head and roll to the height from which it descended without loss of time, or to lift the cross-head entirely from off the cam when requisite; a lever 2, or other suitable contrivance may be attached to the apparatus, also a shaft may be passed across the rag-engine, and both ends of the roll may be raised instead of one only, as above described.

The patentee does not claim as his invention the lowering and raising the roll of the rag engine, nor the lowering of it by mechanism, as this was effected in Mr. Amos's patent of 1840; but he claims the above peculiar apparatus for this purpose.—*Newton's Journal*, xxiii. 254. C. S.

PAPER — *Gross produce of revenue from.* In 1831, 723,248*l.*; 1836, 812,782*l.*; 1837, 555,943*l.*; 1840, 626,663*l.*

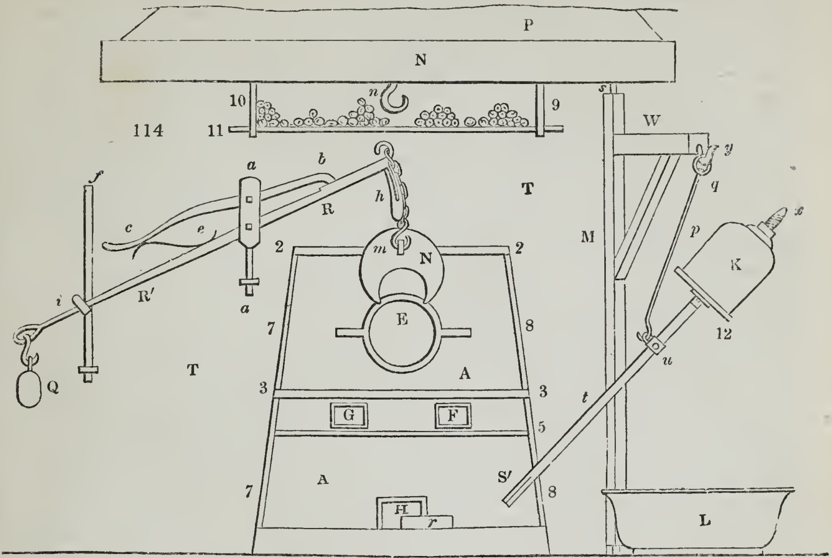
PAPER CLOTH. The preparation of this fabric is thus described in the specification of Mr. Henry Chapman's patent of January 1843. A suitable quantity of canvass, gauze, muslin, calico, linen, &c., is wound upon a roller, which is introduced between the third press felt of a Fourdrinier paper machine; and between the above roller and the endless felt a trough is introduced, containing a solution of gum, glue, &c., with a roller partially immersed in it. Pulp being now allowed to flow upon the endless wire wheel of the machine, paper is made in the ordinary way; and when the endless sheet of paper has been led through the machine, the end of the cloth is brought over the upper part of the roller in the trough, and moved onwards in the direction the paper is proceeding. The motion of the cloth causes the roller to revolve, and the adhesive material carried upon its surface is imparted to the cloth, which is then laid upon the paper, as it passes over the roller immediately preceding the third or last press-roller. By passing between these rollers, the cloth and paper are firmly united, and being dried by the steam cylinders, form the compound fabric. If required, a paper surface may be applied to the other side of the cloth, by repeating the operation. If the cloth be dressed with strong starch, the bath of adhesive solution may be dispensed with. The following prescription is given for making that solution:—

Dissolve in 15 parts of water, 4 of soda, and combine with this solution, by means of heat, 9 parts of yellow rosin; boil for an hour, adding a little linseed oil to prevent frothing, and add 1 part of glue to the mixture; after which dilute the whole with one and a half times its weight of water, and strain through flannel. Thirty parts of this composition are to be mixed with one part of flour-paste, and six parts of paper-pulp, which mixture is to be used warm.

PEARLS, ARTIFICIAL, and BEADS. The material out of which these are formed are small glass tubes like those with which thermometers are made. The tubes for the bright red pearls consist of two layers of glass, a white opaque one internally, and a red one externally; drawn from a ball of white enamel, coated in the Bohemian method with ruby-coloured glass, either by dipping the white ball into a pot of red glass, and thus coating it, or by introducing the ball of the former into a cylinder of the latter glass, and then cementing them so soundly together as to prevent their separation in the subsequent pearl processes. These tubes are drawn in a gallery of the glasshouse to 100 paces in length, and cut into pieces about a foot long. These are afterwards subdivided into cylindric portions of equal length and diameter, preparatory to giving them the spheroidal form. From 60 to 80 together are laid horizontally in a row upon a sharp edge, and then cut quickly and dexterously at once by drawing a knife over them. The broken fragments are separated from the regular pieces by a sieve These cylinder portions are rounded into the pearl shape by softening them by a suitable heat, and stirring them all the time. To prevent them from sticking together, a mixture of gypsum and plumbago, or of ground clay and charcoal, is thrown in among them.

Figs. 114, 115. represent a new apparatus for rounding the beads; *fig.* 114. is a front view of the whole; *fig.* 115. is a section through the middle of the former figure, in the course of its operation. The brick furnace, strengthened with iron bands, 2, 3. 5. 7, 8. has in its interior (see *fig.* 115.) a nearly egg-shaped space B, provided with the following openings: beneath is the fire-hearth, C, with a round mouth, and opposite are the smoke flue and chimney, D; in the slanting front of the furnace is a large opening, E, *fig.* 114. Beneath are two smaller oblong rectangular orifices, F, G, which extend somewhat obliquely into the laboratory, B. H serves for introducing the wood into the fireplace. All these four openings are, as shown in *fig.* 114., secured from injury by iron mouth-pieces. The wood is burned upon an iron or clay bottom piece, *r*. A semi-circular cover, N, closes during the operation the large opening, E, which at other times remains open. By means of a hook, *m*, and a chain, which rests upon a hollow arch, *h*, the cover, N, is connected with the front end of the long iron lever, R, R′. A prop supports at once the turning axis of this lever and the catch, *b*, *c*; the weight, Q, draws the arm, R, down, and thereby holds up N; E therefore remains open. By rods on the back wall, T, T, the hook, *i*, in which R′ rests, proceeds from *f*. When R′

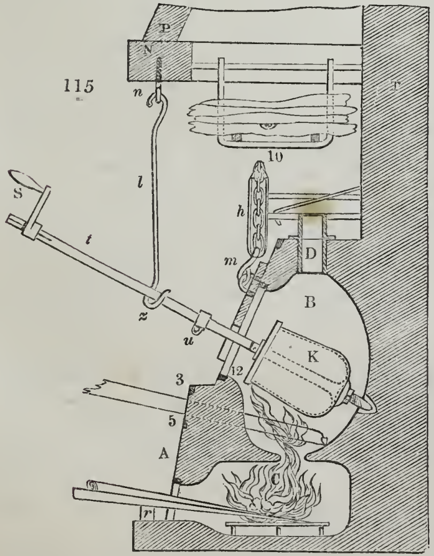
114



is raised R sinks. The catch, *c b*, enters with its front tooth into a slanting notch upon the upper edge of R, spontaneously by the action of the spring, *e*; whereby the opening, E, is shut. The small door, N, rises again with the front arm of the lever by the operation of the weight Q of itself, as soon as the catch is released by pressure upon *c*.

The most important part of the whole apparatus is the drum, K, for the reception and rounding of the bits of glass. It may be made of strong copper, or of hammered or cast iron, quite open above, and pierced at the bottom with a square hole, into which the lower end of the long rod, *t*, is exactly fitted, and secured in its place by a screwed collector nut. The blunt point, *x*, (*fig.* 114.) rests during the working in a conical iron step of the laboratory, *fig.* 115. On the mouth of the drum, K, a strong iron ring is fixed, having a bar across its diameter, with a square hole in its middle point, fitted and secured by a pin to the rod *t*, and turned by its rotation. The vessel K, and its axle, *t*, are laid in a slanting direction; the axle rests in the upper ring, *z*, at the lower end of the rod, *l*, of which the other end is hung to the hook, *n*, upon the mantel beam, N. On the upper end of *t*, the handle, S, is fixed for turning round continuously the vessel, K, while the fire is burning in the furnace, the fuel being put not only in its bottom chamber, but also into the holes, F, G (*fig.* 114.). The fire-wood is made very dry before being used, by piling it in logs upon the iron bars, 9, 10, 11. under the mantelpiece, as shown in *figs.* 114, 115.

115



After the operation is finished, and the cover, N, is removed, the drum is emptied of its contents, as follows. Upon the axle, *t*, there is towards K a projection at *u*. Alongside the furnace (*fig.* 114.) there is a crane, M, that turns upon the step, *s*, *s*, on the ground. The upper pivot turns in a hole of the mantel-beam, N. Upon the perpendicular arm, W, of the crane there is a hook, *y*, and a ring, *q*, in which the iron rod, *p*, is movable in all directions. When the drum is to be removed from the furnace, the crane, with its arm, W, must be turned inwards, the under hook of the rod, *p*, is to be hung in the projecting piece, *u*, and the rod, *l*, is lifted entirely out. After this, by means of the crane, the drum can be drawn with its rod, *t*, out of the furnace; and through the mobility of the crane, and its parts, *p*, *q*, any desired position can be given to the drum. *Fig.* 114. shows how the workman can with his hand applied to s′ depress the axle, *t*, and thereby raise the drum, K, so high that it will empty itself into the pot, L, placed beneath. When left to itself, the drum on the contrary hangs nearly upright upon the crane by means of the rod, *p*, and may therefore be easily filled again in this position. The manner of bringing it into the proper position in the furnace by means of the crane and the rod, *l*, is obvious from *fig.* 115.

The now well-rounded beads are separated from the pulverulent substance with which they were mixed by careful agitation in sieves; and they are polished finally and cleaned by agitation in canvas bags.

PENS, STEEL. When these have been punched out of the softened sheet of steel by the appropriate tool, fashioned into the desired form, and hardened by ignition in an oven and sudden quenching in cold water, they are best tempered by being heated to the requisite spring elasticity in an oil bath. The heat of this bath is usually judged of by the appearance to the eye; but this point should be correctly determined by a thermometer, according to the scale (see *Steel* in the DICTIONARY); and then the pens would acquire a definite degree of flexibility or stiffness, adapted to the wants and wishes of the consumers. They are at present tempered too often at random.

PEPPER. The unripe grains or corns are known under the name of black pepper; the ripe ones, deprived of their epidermis, constitute white pepper. The latter are very generally bleached by steeping for a little while in a solution of chloride of lime, subsequent washing and drying; a process which improves their aspect, but not their flavour. I was recently led to examine the nature of this substance somewhat minutely, from being called professionally to investigate a sample of ground white pepper belonging to an eminent spice-house in the city of London, which pepper had been seized by the Excise on the charge of its being adulterated, or mixed with some foreign matter, contrary to law. I made a comparative analysis of that pepper and of genuine white pepper-corns, and found both to afford like results: viz. in 100 grains, a trace of volatile oil, in which the aroma chiefly resides; about 8½ grains of a pungent resin, containing a small fraction of a grain of piperine; about 60 grains of starch, with a little gum, and nearly 30 grains of matter insoluble in hot and cold water, which may be reckoned lignine. The two chemists in the service of the Excise made oath before the court of judicature, that the said pepper contained a notable proportion of sago, even to the amount of fully 10 per cent; grounding their judgment upon the appearance of certain rounded particles in the pepper, and of the deep blue colour which these assumed when moistened with iodine water. No allegation could be more frivolous. Bruised corns of genuine white pepper certainly acquire as deep a tint with iodine as any species of starch whatever. But the characters of sago, optical and chemical, are so peculiar, as to render the above surmise no less preposterous, than the prosecution of respectable merchants, for such a cause, was unjustifiable. A particle of sago appears in the microscope, by reflected light, to be a spherule of snow, studded round with brilliants; whereas the rounded particles of the *seized* pepper seem to be amorphous bits of grey clay. Had the pepper been adulterated with such a quantity of sago, or anything else, as was alleged, it could not have afforded me, by digestion in alcohol, as much of the spicy essence as the bruised genuine pepper-corns did.

Moreover, sago steeped for a short time in cold water, swells and softens into a pulpy consistence, whereas the particles of the seized pepper, rounded by attrition in the mill, retain, in like circumstances, their hardness and dimensions. Sago, being pearled by heating and stirring the fine starch of the sago palm in a damp state, upon iron or other plates, acquires its peculiar somewhat loose aggregation and brilliant surface; while, in pepper, the starchy constituent is compactly condensed, and bound up with its ligneous matter.

The Excise laws are sufficiently odious and oppressive in themselves without being aggravated by the servile sophistry of pseudo-science.

Four pounds of black pepper yield only about one ounce of piperine, or one 636th part. It is an insipid crystalline substance, insoluble in water, but very soluble in boiling alcohol, and is extracted at first along with the resin, which may be separated from it afterwards, by potash.

PERFUMERY, INDIAN. The natives place on the ground a layer of the scented flowers, about 4 inches thick and 2 feet square; cover them with a layer 2 inches thick of *Tel* or Sesamum seed wetted; then lay on another 4 inch bed of flowers, and cover this pile with a sheet, which is pressed down by weights round the edges. After remaining in this state for 18 hours, the flowers are removed and replaced by a similar fresh layer, and treated as before; a process which is repeated a third time if a very rich perfumed oil be required. The sesamum seeds thus embued with the essential oil of the plant, whether jasmine, Bela, or Chumbul, are placed in their swollen state in a mill, and subjected to strong pressure, whereby they give out their bland oil strongly impregnated with the aroma of the particular flower employed. The oil is kept in prepared skins called *dubbers*, and is largely used by the Indian women. The attar of roses is obtained by distillation at a colder period of the year.

PHOTOGRAPHY is the art of making pictorial impressions of objects by the action of light upon paper, &c., prepared with certain substances, and exposed to the sun or in the focus of a camera obscura to the image of the object to be represented; which impressions are then fixed by other chemical reagents. Photographic paper may be made by dipping Whatman's glazed post paper into brine containing 90 grains of common salt dissolved in an ounce of water, wiping it with a towel, brushing over one side of it with a broad camel-hair brush, a solution of nitrate of silver, containing 50 grains to the ounce of distilled water, and drying it in the dark. The paper may be rendered more sensitive by repeating the above operation; drying it between each step. It affords perfect images of leaves and petals laid upon it, and exposed simply to the sun-beams. A solution of 100 grains of bromide of potassium in an ounce of distilled water answers still better than brine. The paper, when dry, is to be brushed over on one side with a solution containing 100 grains of nitrate of silver to an ounce of water; the paper being brushed, and dried in the dark. If the application of the nitrate of silver be repeated, it will render the paper more sensitive. The silvered side should be marked. This paper laid flat under painted glass, lace, leaves, feathers, ferns, &c., and exposed to the light of day, takes the impression of the objects. It is to be then washed with lukewarm water, and finally dipped in a solution containing one ounce of hyposulphite of soda, in about a pint of distilled water. The design of the object is necessarily reversed; the light parts forming the dark shades of the photogenic impression, and the dark parts the lighter ones. But a direct picture may be obtained by applying that paper, rendered transparent with white wax (see CALOTYPE), upon a sheet of white photogenic paper, and exposing it to the sunbeams, or bright day-light.

A modification of Photography, called Chrysotype by its inventor, Sir John Herschel, consists in washing the paper in a solution of ammonia-citrate of iron, drying it, and brushing it over with a solution of ferro-*sesquicyanure* of potassium. This paper, when dried in a perfectly dark room, is ready for use, the image being finally brought out by a neutral solution of silver.

Another modification by Sir John, called Cyanotype, is as follows:—Brush the paper with the solution of the ammonia-citrate of iron, so strong as to resemble sherry wine in colour; expose the paper in the usual way, and pass over it very sparingly and evenly a wash made by dissolving common ferro-cyanide of potassium. As soon as this liquid is applied, the negative picture vanishes, and is replaced by the positive one, of a violet blue colour, on a greenish yellow ground, which at a certain time possesses a high degree of sharpness, and singular beauty of tint.

The improved process of photography recently contrived by Mr. Robert Hunt is performed by washing over good letter paper with the following liquid:—

A saturated solution of succinic acid - - -	2 drams
Mucilage of gum arabic - - - -	½ do.
Water - - - - - -	1½ do.

When the paper is dry, it is washed over once with a solution containing 1 dram of nitrate of silver in 1 ounce of distilled water. The paper is allowed to dry in the dark, and it is fit for use. It can be preserved in a portfolio, and employed at any time in the camera obscura, exposing it to the light from two to eight minutes according to its vivacity. When the paper is taken out of the camera, no trace of a picture can be seen. To produce this effect mix 1 dram of a saturated solution of sulphate of iron, with 2 or 3 drams of mucilage of gum arabic, and brush over the paper evenly with this mixture. In a few seconds the latent images are seen to develope themselves, producing a negative photographic picture. The excess of the iron solution is to be washed off with a sponge whenever the best effect appears. The drawing is then to be soaked a short time in water, and is fixed by washing over with ammonia, or preferably with hyposulphite of soda; taking care to wash out the excess of salt. From the pictures thus produced, any number of others, corrected in light and shadow, may be produced by using like succinated papers, in the common way of transfer in sunshine. —*Athenæum.*

PICKLES are various kinds of vegetables and fruits preserved in vinegar. The substances are first well cleaned with water, then steeped for some time in brine, and afterwards transferred to bottles, which are filled up with good vinegar. Certain fruits, like walnuts, require to be pickled with scalding hot vinegar; others, as red cabbage, with cold vinegar; but onions, to preserve their whiteness, with distilled vinegar. Wood vinegar is never used by the principal pickle manufacturers, but the best malt or white wine vinegar, No. 22 or 24. Kitchener says, that by parboiling the pickles in brine, they will be ready in half the time of what they require when done cold. Cabbage, however, cauliflowers, and such articles would thereby become flabby, and lose that crispness which many people relish. When removed from the brine, they should be cooled, drained, and even dried before being put into the vinegar. To assist the preservation of pickles, a portion of salt is often added, and likewise to give flavour, various spices, such as long pepper, black pepper, white pepper, allspice, ginger, cloves, mace, garlic, mustard, horse-radish, shallots, capsicum. When the spices are bruised they are most efficacious, but they are apt to render the pickle turbid and discoloured. The flavouring ingredients of Indian pickle are Curry powder mixed with a large proportion of mustard and garlic. Green peaches are said to make the best imitation of the Indian Mango.

I have examined the apparatus in the .great fish-sauce, pickle, and preserved fruit establishment of Messrs. Crosse and Blackwell, Soho Square, and found it arranged on the principles most conducive to economy, cleanliness, and salubrity; no material employed there is ever allowed to come into contact with copper. A powerful steam boiler is placed in one corner of the ground floor of the factory, from which a steam pipe issues, and is laid horizontally along the wall about 4 feet above the floor. Under this pipe a range of casks is placed, into the side of each of which a branch steam-pipe, furnished with a stopcock, is inserted, while the mouth of the cask is exactly closed with a pan of salt-glazed earthenware, capable of resisting the action of every acid, and incapable of communicating any taint to its contents. These casks form, by their non-conducting quality as to heat, the best kind of steam-jackets. In these pans the vinegars with their compounds are heated, and the fish and other sauces are prepared. The waste steam at the farthest extremity of the pipe is conducted into a reservoir of clean water, so as to furnish a constant supply of hot water for washing bottles and utensils.

The confectionary and ham-smoking compartments are placed in a separate fire-proof chamber on the same floor.

The floor above is occupied along the sides with a range of large rectangular cast-iron cisterns, furnished with a series of steam-pipes, laid gridiron-wise along their bottoms, which pipes are covered with a perforated wooden shelf. These cisterns being filled up to a certain height above the shelf with water, the bottles full of green gooseberries, apricots, cherries, &c., to be preserved, are set upon the shelf, and the steam being then admitted into the gridiron pipes, the superjacent water gets gradually heated to the boiling point; the air in the bottles round the fruit is thus partly expelled by expansion, and partly disoxygenated by absorption of the green vegetable matter. In this state the bottles are tightly corked, and being subsequently sealed preserve the fruit fresh for a very long period.

The sauces, pastes, and potted meats prepared in the above described apparatus, can seldom be rivalled and probably not surpassed in the kitchens of the most fastidious *gastronomes.*

PITCOAL, ANALYSIS OF. The greater part of the analyses of coals hitherto published have been confined to the proportions of carbon, hydrogen, and oxygen, to the neglect of the sulphur, which exists in many coals to a degree unwholesome for their domestic use, pernicious for the smelting of iron, and detrimental to the production of gas; since the sulphuretted hydrogen produced requires so much washing and purification as at the same time to impoverish the light, by condensing much of the olefiant gas, its most luminiferous constituent. In the numerous reports upon the composition of coals which I have been professionally called upon to make, I have always sought to determine the proportion of sulphur, which may be done readily to one part in a thousand; as also, that of combustible gaseous matter, of coke, and of incombustible ashes.

The following coals have been found to be of excellent quality, as containing very little sulphur, seldom much above 1 per cent., and little incombustible matter,—hence well adapted as fuel, whether for steam navigation, for iron smelting, for household consumption, or for gas, according to their relative proportions of carbon and hydrogen; a relative excess of carbon constituting a coal best adapted for furnaces of various kinds, while a relative excess of hydrogen forms the best coal for the common grates and gas works.

1. *Mr. Powell's Duffry, or Steam Coal.* — Specific gravity, 1·32; ashes, per cent., 2·6; gaseous products in a luted crucible, 14; brilliant coke, 86; not more than 1 per cent of sulphur; while many of the Newcastle coals contain from 4 to 6, and others which I have examined from 8 to 10 of the same noxious constituent; and which is a less powerful calorific constituent than hydrogen and carbon.

2. *The Blackley Hurst Coal of Lancashire.* — Specific gravity, 1·26; ashes, per cent., 1·2; combustible gases, 41·5; coke, 58·5; sulphur, 1. Another specimen had a specific gravity of 1·244; 2 per cent. of ashes; 38·5 of combustible gases; 1 of sulphur. This is a very good coal for gas, and for domestic use.

3. *The Varley Rock Vein Coal,* near Pontypool; shipped by Mr. John Vipond. — Specific gravity, 1·296; ashes (whitish) 5 per cent.; 32 of combustible gases; 68 of coke. Sulphur from 2 to 3 per cent. A good household coal.

4. *The Llangennech Coal* has a well-established reputation for the production of steam, and is much employed by the British government for steam navigation, as well as at Meux's, and others of the great breweries in London. It affords a very intense heat, with little or no smoke; and sufficiently diffusive, for extending along the flues of the boilers; whereas the Anthracite coal, containing very little hydrogen, yields, in common circumstances, a heat too much concentrated under the bottom of the boilers, and acting too little upon their sides. Specific gravity, 1·337; intermediate between that of the Newcastle and the Anthracite. Ashes per cent. from 3 to 3·5; combustible gases, 17; coke, 83; sulphur, only *one half* per cent. It is therefore a pure and very powerful fuel.

I have examined many coals with my calorimeter; of which some account is given under Fuel.

PLATING. See Electrotype.

PLATINUM MOHR. This interesting preparation, which so rapidly oxidizes alcohol into acetic acid, &c., by what has been called in chemistry the catalytic or contact action, is most easily prepared by the following process of M. Bœttger: — The insoluble powder of potash-chlorure or ammonia-chlorure of platinum, is to be moistened with sulphuric acid (oil of vitriol), and a bit of zinc is to be laid *in* the mixture. The platinum becomes reduced into a black powder, which is to be washed first with muriatic acid, and then with water. The fineness of this powder depends upon that of the saline powders employed to make it; so that if these be previously finely ground, the platinum-mohr will be also very fine, and proportionally powerful as a chemical agent.

POTTER'S OVEN. A patent was obtained in August, 1842, by Mr. W. Ridgway, for the following construction of oven, in which the flames from the fire-places are conveyed by parallel flues, both horizontal and vertical, so as to reverberate the whole of the flame and heat upon the goods after its ascension from the flues. His oven is built square instead of round, a fire-proof partition wall being built across the middle of it, dividing it into two chambers, which are covered in by two parallel arches. The fire-places are built in the two sides of the oven opposite to the partition wall; from which fire-places narrow flues rise in the inner face of the wall, and distribute the flame in a sheet equally over the whole of its surface. The other portion of the heat is conveyed by many parallel or diverging horizontal flues, under and across the floor or hearth of the oven, to the middle or partition wall; over the surface of which the flame which ascends from the numerous flues in immediate contact with the wall is equally distributed. This sheet of ascending flame strikes the shoulder of the arch, and is reverberated from the seggars beneath, till it meets the flame reverberated from the opposite side of the arch, and both escape at the top of the oven. The same construction is also applied to the opposite chamber. In *figs.* 116, 117, *a*, represents the

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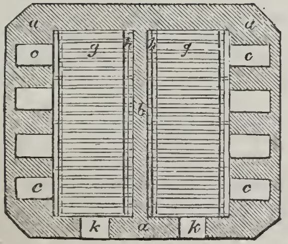

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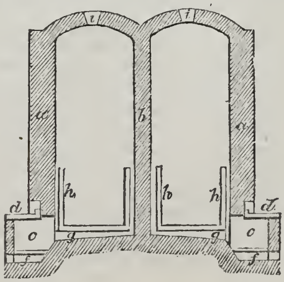

square walls or body of the oven; *b*, the partition wall; *c*, the fire-places or furnaces with their iron boilers; *d*, the mouths of the furnaces for introducing the fuel; *f*, the ash-pits; *g*, the horizontal flues under the hearth of the oven; *h*, the vertical flues; *i*, the vents in the top of the arches; and *k*, the entrances to the chambers of the ovens.

PRUSSIAN BLUE. The following process deserves peculiar notice, as the first in which this interesting compound has been made to any extent, independently of animal matter. Mr. Lewis Thompson, of the Old Barge House, Lambeth, received a well-merited medal from the Society of Arts for this invention. He justly observes, that in the common way of manufacturing prussiate of potash, the quantity of nitrogen furnished by a given weight of animal matter is not large, and seldom exceeds 8 per cent.; and of this small quantity, at least one half appears to be dissipated during the ignition. It occurred to him that the atmosphere might be economically made to supply the requisite nitrogen, if caused to act in favourable circumstances upon a mixture of carbon and potash. He has found the following prescription to answer. Take of pearlash and coke, each 2 parts; iron turnings, 1 part; grind them together into a coarse powder; place this in an open crucible, and expose the whole for half an hour to a full red heat in an open fire, with occasional stirring of the mixture. During this process, little jets of purple flame will be observed to rise from the surface of the materials. When these cease, the crucible must be removed and allowed to cool. The mass is to be lixiviated; the lixivium, which is a solution of ferrocyanide of potassium, with excess of potash, is to be treated in the usual way, and the black matter set aside for a fresh operation, with a fresh dose of pearlash. Mr. Thompson states that one pound of pearlash, containing 45 per cent. of alkali, yielded 1355 grains of pure Prussian blue, or ferrocyanide of iron; or about 3 ounces avoirdupois.

PRUSSIATE OF POTASH. Leuch's Polytechnic Zeitung, June 1837. Manufacture of Kalium Eisen Cyanure, by Hofflmayr and Prükner. — The Potash must be free from sulphate, for each atom of sulphur destroys an atom of the Eisencyankalium. A very strong heat is advantageous. The addition of from 1 to 3 $\frac{0}{0}$ of saltpetre is useful, when the mass is too long of fusing. A reverberatory furnace (flammofen) is recommended; but the flame must not beat too much upon the materials for fear of oxygenating them. When the smoky red flame ceases, it is useful to throw in from time to time small portions of uncarbonised animal matter, particularly where the flame first beats upon the mass, whereby the resulting gases prevent oxidation by the air. The animal matters should not be too much carbonised, but left somewhat brown coloured, provided they be readily pulverised. Of uncarbonised animal matters, the proportions may be 100 parts dried blood, to from 28 to 30 of potash (carbonate), and from 2 to 4 of hammerschlag (smithy scales), or iron filings. 2d. 100 parts of horns or hoofs; from 33 to 35 potash; 2 to 4 iron. 3d. 100 leather, 45 to 48 potash, and 2 to 4 iron. From blood, 8 to 9 per cent. of the prussiate are obtained; from horns, 9 to 10; and from leather, 5 to 6. The potash should be mixed in coarse particles, like peas, with the carbonised animal matter, which may be best done in a revolving pot, containing cannon-balls. Of the animal coal and potash, equal parts may be taken, except with that from leather, which requires a few parts more potash per cent. On the average, blood and horn coal should afford, never less than 20 per cent. of prussiate, nor the leather than 8; but by good treatment, they may be made to yield, the first 25, and the last from 10 to 11.

A patent for a singular process and apparatus, for making this compound, was obtained by a foreigner not named, by Mr. Berry, patent agent, in January, 1840. The prescription is as follows: —

Reduce charcoal into bits of the size of a walnut, soak them with a solution of carbonate of potash in urine; and then pour over them a solution of nitrate or acetate of iron; dry the whole by a moderate heat, and introduce them into the cast-iron tubes, presently to be described. The following proportions of constituents have been found to answer: — Ordinary potash, 30 parts; nitre, 10; acetate of iron, 15; charcoal or coke, 45 to 55; dried blood, 50. The materials, mixed and dried, are put into retorts similar to those for coal gas. The animal matter, however (the blood), is placed in separate compartments of pipes connected with the above retorts. The pipes containing the animal matter should be brought to a red heat before any fire is placed under the retorts.

In *fig.* 118., A, B, C, D, is a horizontal section of a furnace constructed to receive four elliptical iron pipes. The furnace is arched in the part A, C, B, in order to reverberate the heat, and drive it back on the pipes w, w', w'', w'''. These pipes are placed on the plane E, F, of the ellipsoid. *a*, *a*, represents the grating or bars of the furnace to be heated with coal or coke; I, I, is the pot or retort shown in *figs.* 119, 120, 121.

This pot or retort is placed in a separate compartment, as seen in *fig.* 119., which is a vertical section, taken through *fig.* 121., at the line G, H. K, is a connecting tube, from the retort and the elliptical pipes W.

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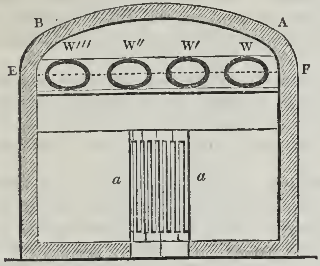

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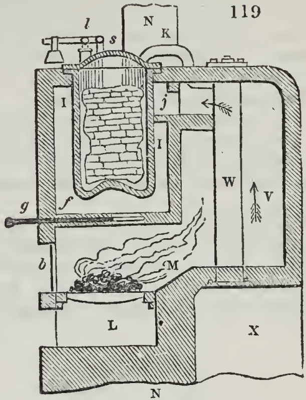

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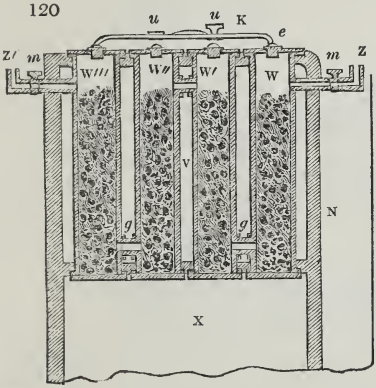

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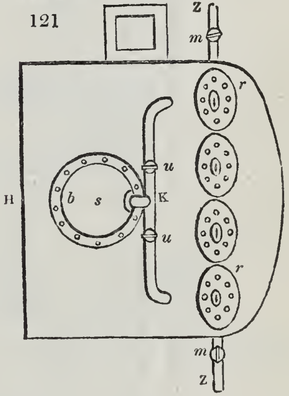


In the section, *fig.* 119., the shape of the tube K, will be better seen; also its cocks *u*, and likewise its connection with the pipes W. *l*, is a safety valve; *s*, the cover of the pot or retort; L, is the ash-pit; and *b*, the door of the furnace; X, is an open space, roofed over, or a kind of shed, close to the furnace, and under it the pipes are emptied.

The arrows indicate the direction of the current of heat. This current traverses the intervals left between the pipes, and ascends behind them, passing through the aperture *j*, in the brickwork, which is provided with a valve or damper, for closing it, as required. The heat passes through this aperture, and strikes against the sides of the pot when the valve is open. Another valve *f*, *g*, must also be open to expose the pot or retort to the direct action of the fire. The smoke escapes by a lateral passage into a chimney N.

It must be remarked, that there is a direct communication between the chimney and that compartment of the furnace which contains the pipes, so that the heat, reflected from the part V, strikes on the pot or retort only when the pipes W, W', W'', W''', are sufficiently heated.

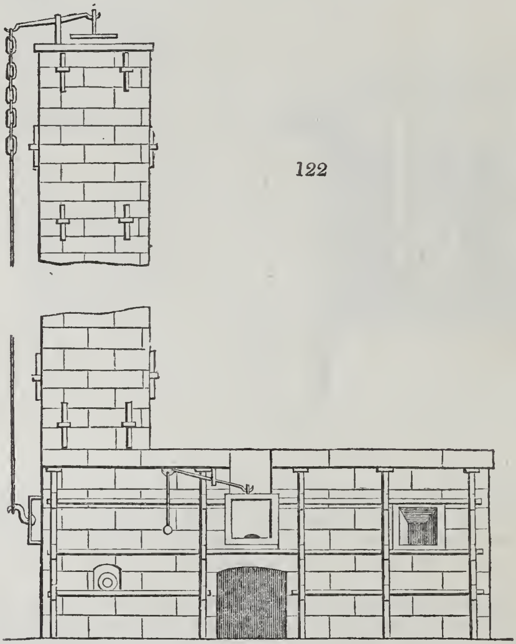
In *fig.* 120. is shown an inclined plane M (also represented in *fig.* 119.) and the junction-tubes which connect the four pipes with their gas-burners Z, Z, and the cocks *m*, *m'*. *r*, *r*, are covers, closing the pipes, and having holes formed in them; these holes are shut by the stoppers *e*.

Whether the pipes are placed in the vertical or horizontal position, it is always proper to be able to change the direction of the current of gas; this is easily done by closing, during one hour (if the operation is to last two hours,) the cocks *u*, *m'*, and opening those *u'*, *m*; then the gas passes through *u'*, into the branch K, and entering W''', passes through *q*, into W'', through *p*, into W', and through *o*, and W, and finally escapes by the burner z. During the following or other hour, the cocks *u′*, *m*, must be closed; the cocks *u*, *m′*, being opened, the current then goes from *u*, into K, W, W′, W″, W‴, and escapes by the burner z′, where it may be ignited.

The changing of the direction of the current dispenses, to a certain degree, with the labour required for stirring, with a spatula, the matters contained in the pipes; nevertheless, it is necessary, from time to time, to pass an iron rod or poker amongst the substances contained in the pipes. It is for this purpose that apertures are formed, so as to be easily opened and closed.

The patentee remarks, that although this operation is only described with reference to potash, for obtaining prussiate of potash, it is evident, that the same process is applicable to soda; and when the above-mentioned ingredients are employed, soda being subsituted for potash, the result will be prussiate of soda. — *Newton's Journal*, C. S. xxi. 96.

PUDDLING OF IRON. This is the usual process employed in Great Britain for converting cast iron into bar or malleable iron — a crude into a more or less pure metal. The following plan of a puddling furnace has been deemed economical, especially with respect to fuel, as two furnaces are joined side by side together, and the workmen operate at doors on the opposite sides. *Fig.* 122. represents this twin furnace in a side elevation; *fig.* 123. in section, according to the line E F, in *fig.* 124., which exhibits a plan of the furnace. The various parts are so clearly shown in form and construction as to require no explanation. The total length outside is 14¾ feet; width, 12¾ feet; from which the dimensions of the other parts may be measured.



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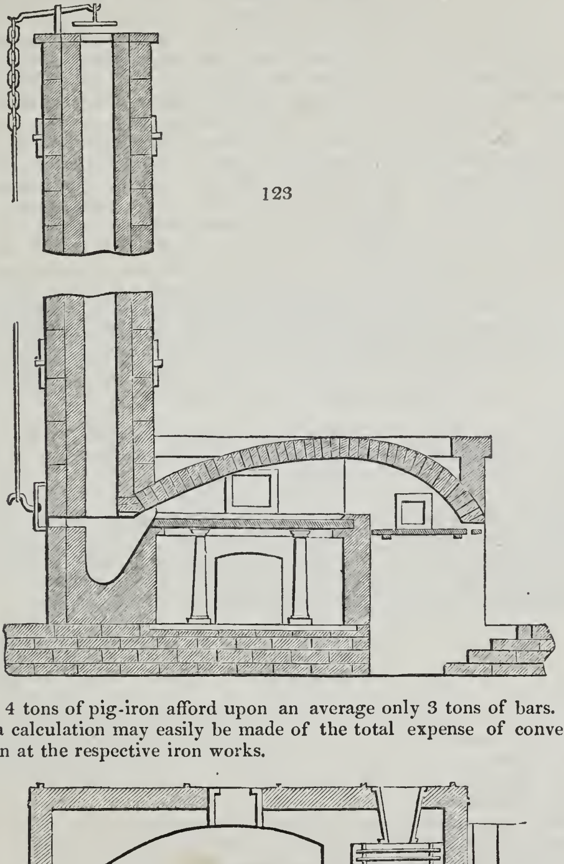
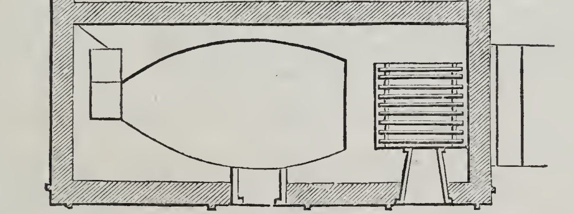
Iron is puddled either from cast pigs, or from the plates of the refinery (finery) furnace. In several iron-works a mixture of these two crude metals is employed. In the refining process, the waste at the excellent establishment of Mr. Jessop, at Codner Park, is from 2½ to 2¾ cwt. per ton; on which process the wages are 1*s.* per ton; and the coke, ½ ton, worth 6*s.*; so that the total cost of refining per ton is 15*s.*, when pig-iron is worth 3*l.* 10*s.*

The puddling is accompanied with a loss of weight of 1½ cwt. per ton; it costs in wages, for puddling refinery plates, 6*s.* 6*d.*, and for pigs, 8*s.*; in which 18 cwt. of coal are consumed; value, 5*s.* per ton.

Shingling (condensing the bloom by the heavy hammer) costs, in wages, 1*s.* 9*d.* per ton; and rough-rolling, 1*s.* 2*d.* Cutting and weighing these bars cost 9*d.* for wages, including their delivery to the mill furnace, were they are re-heated and welded together. The mill furnace heating costs 1*s.* 6*d.* in wages, and consumes in fuel 12 cwt. of coals, at 5*s.* per ton. The rolling and straightening cost 5*s.* 6*d.*; cropping the ends, weighing, and stocking in the warehouse, 1*s.* for wages. Wear and tear of power, 5*s.* Labourers for clearing out the ashes, &c., 1*s.* 6*d.* per ton.



In Wales 4 tons of pig-iron afford upon an average only 3 tons of bars. From the above data a calculation may easily be made of the total expense of converting crude into cast iron at the respective iron works.



A great economy in the conversion of the cast into wrought metal seems about to be effected in our iron works, by the application of a current of voltaic electricity to the crude iron in a state of fusion, whether on the hearth of the blast furnace, on the fused pigs in the sand, or on the metal immediately on its being run from the finery furnace; the voltaic force of from 50 to 100 pairs of a powerful Smee's battery being previously arranged to act upon the whole train of the metal. This process, for which

Mr. Arthur Wall has recently obtained a patent, is founded upon the well-established fact, that when a compound is subjected to an electrical current, its negative and positive elements are detached from one another. Crude iron contains more or less carbon, sulphur, phosphorus, arsenic, oxygen, and silicon—bodies all electro-negative in relation to iron, which is electro-positive. When the impure iron, as it flows from the blast-furnaces, is subjected during its cooling and consolidation to a powerful stream of voltaic electricity, the chemical affinities by which its various heterogeneous components are firmly associated are immediately subverted, whereby, in the case of crude iron, the sulphur, phosphorus, &c., which destroy or impair its tenacity and malleability, become readily separable in the act of puddling. On this principle, I would explain the extraordinary effect of Mr. Wall's patent electric process, as performed in my presence in the excellent iron-works of Mr. Jessop, at Codner Park, Derbyshire, where the electrised forge pigs discharged those noxious elements so copiously in the puddling furnace, as to become after a single re-heating, without piling or fagotting, brilliant bars of the finest fibrous metal. The bars so made have been subjected, under my inspection, to the severest proofs by skilful London blacksmiths, and they have been found to bear piercing, hammering, bending, and twisting, as well as the best iron in the market. I have also analysed the said iron with the utmost minuteness of chemical research, and have ascertained it to be nearly pure metal, containing neither sulphur nor phosphorus, and merely an inappreciable trace of arsenic. I can therefore conscientiously recommend Mr. Wall's patent process to iron-masters as one of the greatest, easiest, and most economical improvements, which that important art has ever received.

The pecuniary advantage of this process, in respect of saving of labour and waste of material, has been estimated by competent judges at from one pound to two pounds sterling per ton.

The effect of electrising iron is displayed in a singular manner by the conversion into steel of a soft rod, exposed in contact with coke, for a few hours, to a moderate red heat; a result which I have witnessed and can fully attest.

PURPLE OF CASSIUS is best made according to the French Pharmacopœia, by dissolving 10 parts of acid chloride of gold in 2000 parts of distilled water; preparing in another vessel a solution of 10 parts of pure tin in 20 of muriatic acid, which is diluted with 1000 of water, and adding this by degrees to the gold solution as long as a precipitate is formed. The precipitate is allowed to subside, and is to be washed by means of decantation: it is then filtered and dried at a very gentle heat.

R.

REFINING OF SILVER. In this process, as effected by sulphuric acid, the arrangements are so complete, that a two thousandth part, or even less, of gold is extracted free of charge to the bullion merchant, and the whole silver returned or accounted for. By mistake, a one thousandth was stated in the article REFINING OF SILVER in the Dictionary.

RESINS. An ingenious memoir upon the resins of dammar, copal, and animé, has lately been published by M. Guibourt, an eminent French *pharmacien*, from which the following extracts may be found interesting.

The *hard* copal of India and Africa, especially Madagascar, is the product of the *Hymenæa verrucosa;* it is transparent and vitreous within, whatever may be its appearance outside; nearly colourless, or of a tawny yellow; without taste or smell in the cold, and almost as hard as amber, which it much resembles, but from which it may be distinguished, 1st, by its melting and kindling at a candle-flame, and running down in drops, while amber burns and swells up without flowing; 2dly, this hard copal or animé, when blown out and still hot, exhales a smell like balsam copaiva or capivi; while amber exhales an unpleasant bituminous odour; 3dly, when moistened by alcohol of 85 per cent., copal becomes sticky, and shows after drying a glazed opaque surface, while amber is not affected by alcohol; 4thly, the copal affords no succenic acid, as amber does, on distillation.

When the pulverised copal is digested in cold alcohol of 0·830, it leaves a considerable residuum, at first pulverulent, but which swells afterwards, and forms a slightly coherent mass. When this powder is treated with boiling alcohol, it assumes the consistence of a thick gluten, like crumbs of bread, but which does not stick to the fingers. Thus treated, it affords,

Resin soluble in cold alcohol - - -	31·42
Resin dissolved in boiling alcohol - - -	4·00
Resin insoluble in both - - - -	65·71
	100·83

The small excess is due to the adhesion of some of the menstruum to the resins.

Ether, boiling hot, dissolves 39·17 per cent. of copal.

Essence (spirits) of turpentine does not dissolve any of the copal, but it penetrates and combines with it at a heat of 212° Fah.

The property of swelling, becoming viscid and elastic, which Berzelius assigns to copal, belongs not to it, but to the American resin of courbaril, or the occidental animé; and the property of dissolving entirely in ether belongs to the aromatic *dammar*, a friable and tender resin.

2. Resin of courbaril of Rio Janeiro, the English gum-animé, and the semi-hard copal of the French. It is characterised by forming, in alcohol, a bulky, tenacious, elastic mass. It occurs in rounded tears, has a very pale glassy aspect, transparent within, covered with a thin white powder, which becomes glutinous with alcohol. Another variety is soft, and dissolves, for the most part, in alcohol; and a third resembles the oriental copal so much as to indicate that they may both be produced from the same tree. 100 parts of the oriental and the occidental animé yield respectively the following residua: —

	With alcohol.	With ether.	With essence.
Oriental	65·71	60.83	111
Occidental	43·53	27·50	75·76

The hard and soft copals possess the remarkable property in common of becoming soluble in alcohol, after being oxygenated in the air.

3. *Dammar puti, or dammar batu.* — This resin, soft at first, becomes eventually like amber, and as hard. It is little soluble in alcohol and ether, but more so in essence of turpentine.

4. *Aromatic dammar.*— This resin occurs in large orbicular masses. It is pretty soluble in alcohol. Only small samples have hitherto been obtained. Of 100 parts, 3 are insoluble in alcohol, none in ether, and 93 in essence of turpentine. M. Guibourt thinks that this resin comes from the Molucca isles. Its ready solubility in alcohol, and great hardness, render it valuable for varnish-making.

5. *Austral dammar.* —This resin is the product of the *Dammara australis*, one of the highest trees in New Zealand, where it is called *Kaurè*, or *Kouri*. It resembles elemi in some measure. It flows from the trunk and branches in the form of a resinous juice called *vare*, and gum-*cowdee* by the English settlers. The natives chew it continually, and with the soot obtained from its combustion they make the indelible black tattoo figures upon their faces. It comes home in lumps of considerable size. It possesses a certain toughness, which makes it difficult to break or to pulverise. It takes fire at a candle flame, and continues to burn by itself. It melts in water, heated below the boiling point. Alcohol boiled with it, leaves 43·3 per cent. of insoluble matter; ether leaves 36·66; and essence of turpentine 80 per cent. This resin, in fact, resembles very closely the resin of courbaril.

6. *Slightly aromatic dammar* leaves, after alcohol, 37 per cent.; after ether, 17 per cent.; and after essence, 87 per cent.

7. *Tender and friable dammar selan.* —This resin occurs in considerable quantity in commerce (at Paris). It is in round or oblong tears, vitreous, nearly colourless and transparent within, dull whitish on the surface. It exhales an agreeable odour of olibanum, or mastic, when it is heated. It crackles with the heat of the hand, like roll-sulphur. It becomes fluid in boiling water, but brittle when cooled again. It sparkles and burns at the flame of a candle; but this being the effect of a volatile oil, the combustion soon ceases.

Resin soluble in cold alcohol	75·28
Resin insoluble in boiling alcohol	20·86

It dissolves readily and completely in cold essence of turpentine, and forms a good varnish. M. Guibourt refers the origin of this resin to the *Dammara selanica* of Rumphius. Of the preceding resins, 100 parts have left respectively

	Alcohol of 0·830.	Insoluble in Ether.	Essence.
Hard copal, or animé	65·71	60·83	111
Tender copal	43·53	27·50	75·76
Dammar puti	—	—	—
Dammar aromatic	3·0	—	93
Dammar austral	43·33	36·66	80
Dammar slightly aromatic	37·00	17·00	87
Dammar friable	20·86	2·00	—

RETORTS OF CLAY are now extensively used in gas-making, and they are well manufactured at Newcastle. See the article Gas.

S.

SACCHAROMETER is the name of a hydrometer, adapted by its scale to point out the proportion of sugar, or the saccharine matter of malt, contained in a solution of any specific gravity. Brewers, distillers, and the Excise, sometimes denote by the term gravity, the excess of weight of 1000 parts of a liquid by volume above the weight of a like volume of distilled water; so that if the specific gravity be 1045, 1070, 1090, &c., the gravity is said to be 45, 70, or 90; at others, they thereby denote the weight of saccharine matter in a barrel (36 gallons) of worts; and again, they denote the excess in weight of a barrel of worts over a barrel of water, equal to 36 gallons, or 360 pounds. This and the first statement are identical, only 1000 is the standard in the first case, and 360 in the second.

The saccharometer now used by the Excise, and by the trade, is that constructed by Mr. R. B. Bate, well known for the accuracy of his philosophical and mathematical instruments. The tables published by him for ascertaining the values of wort or wash, and low wines, are preceded by explicit directions for their use. "The instrument is composed of brass; the ball or float being a circular spindle, in the opposite ends of which are fixed a stem and a loop. The stem bears a scale of divisions numbered downwards from the first to 30; these divisions, which are laid down in an original manner, observe a diminishing progression according to true principles; therefore each division correctly indicates the one thousandth part of the specific gravity of water; and further, by the alteration made in the bulk of the saccharometer at every change of poise, each of the same divisions continues to indicate correctly the said one thousandth part throughout."

In my own practice, I prefer to take specific gravities of all liquids whatever with a glass globe containing 500 or 1000 grains of distilled water at 60° Fahr., when it is closed with a capillary-bored glass stopper; and with the gravity so taken, I look into a table constructed to show the quantity per cent. of sugar, malt, extract, or of any other solid, proportional to the density of the solution. By bringing the liquid in the gravity bottle to the standard temperature, no correction on this account is needed. Mr Bate's elaborate table contains all these equations correctly for solutions of sugar of every successive specific gravity. When employed in such researches by the Molasses Committee of the House of Commons in the year 1830, I found that the specific gravities of solutions of the concrete extract of malt differed somewhat from those of solutions of sugar, as given by Mr. Bate. (*See page* 100. *of the Dictionary.*)

The following Table shows the Quantities of Sugar contained in Syrups of the annexed Specific Gravities. It was the result of experiments carefully made.

Experimental Spec. Gravity of Solution at 60° F.	Sugar in 100· by Weight.	Experimental Spec. Grav. of Solution, at 60° F.	Sugar in 100· by Weight.
1·3260	66·666	1·1045	25·000
1·2310	50·000	1·0905	21·740
1·1777	40·000	1·0820	20·000
1·4400	33·333	1·0635	16·666
1·1340	31·250	1·0500	12·500
1·1250	29·412	1·0395	10·000
1·1110	26·316		

N. B. The column in the opposite table, marked *Solid extract by weight*, is Mr. Bate's; it may be compared with this short table, and also with the table of malt infusions in page 100. of the Dictionary.

If the decimal part of the number denoting the specific gravity of syrup be multiplied by 26, the product will denote very nearly the quantity of sugar per gallon in pounds weight, at the given specific gravity.*

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* This rule was annexed to an extensive table, representing the quantities of sugar per gallon, corresponding to the specific gravities of the syrups constructed by the Author, for the Excise, in subserviency to the Beet-root bill.

Table exhibiting the Quantity of Sugar, in Pounds Avoirdupois which is contained in One Gallon of Syrup, at successive Degrees of Density, at 60° F.

Specific Gravity.	Lbs. per Gallon.	Extract by Weight in 100.	Specific Gravity.	Lbs. per Gallon.	Extract by Weight in 100.	Specific Gravity.	Lbs. per Gallon.	Specific Gravity.	Lbs. per Gallon.
1·000	0·0000	·0000	1·077	2·0197	·1851	1·154	4·0880	1·231	6·1474
1·001	0·0255	·0026	1·078	2·0465	·1873	1·155	4·1148	1·232	6·1743
1·002	0·0510	·0051	1·079	2·0734	·1896	1·156	4·1319	1·233	6·2012
1·003	0·0765	·0077	1·080	2·1006	·1918	1·157	4·1588	1·234	6·2280
1·004	0·1020	·0102	1·081	2·1275	·1941	1·158	4·1857	1·235	6·2551
1·005	0·1275	·0128	1·082	2·1543	·1963	1·159	4·2128	1·236	6·2822
1·006	0·1530	·0153	1·083	2·1811	·1985	1·160	4·2502	1·237	6·3093
1·007	0·1785	·0179	1·084	2·2080	·2007	1·161	4·2771	1·238	6·3362
1·008	0·2040	·0204	1·085	2·2359	·2029	1·162	4·3040	1·239	6·3631
1·009	0·2295	·0230	1·086	2·2627	·2051	1·163	4·3309	1·240	6·3903
1·010	0·2550	·0255	1·087	2·2894	·2073	1·164	4·3578	1·241	6·4152
1·011	0·2805	·0280	1·088	2·3161	·2095	1·165	4·3847	1·242	6·4401
1·012	0·3060	·0306	1·089	2·3438	·2117	1·166	4·4115	1·243	6·4650
1·013	0·3315	·0331	1·090	2·3710	·2139	1·167	4·4383	1·244	6·4902
1·014	0·3570	·0356	1·091	2·3987	·2161	1·168	4·4652	1·245	6·5153
1·015	0·3825	·0381	1·092	2·4256	·2183	1·169	4·4923	1·246	6·5402
1·016	0·4180	·0406	1·093	2·4524	·2205	1·170	4·5201	1·247	6·5651
1·017	0·4335	·0431	1·094	2·4792	·2227	1·171	4·5460	1·248	6·5903
1·018	0·4590	·0456	1·095	2·5061	·2249	1·172	4·5722	1·249	6·6152
1·019	0·4845	·0481	1·096	2·5329	·2270	1·173	4·5983	1·250	6·6402
1·020	0·5100	·0506	1·097	2·5598	·2292	1·174	4·6242	1·251	6·6681
1·021	0·5351	·0531	1·098	2·5866	·2314	1·175	4·6505	1·252	6·6960
1·022	0·5602	·0555	1·099	2·6130	·2335	1·176	4·6764	1·253	6·7240
1·023	0·5853	·0580	1·100	2·6404	·2357	1·177	4·7023	1·254	6·7521
1·024	0·6104	·0605	1·101	2·6663	·2378	1·178	4·7281	1·255	6·7800
1·025	0·6355	·0629	1·102	2·6921	·2400	1·179	4·7539	1·256	6·8081
1·026	0·6606	·0654	1·103	2·7188	·2421	1·180	4·7802	1·257	6·8362
1·027	0·6857	·0678	1·104	2·7446	·2443	1·181	4·8051	1·258	6·8643
1·028	0·7108	·0703	1·105	2·7704	·2464	1·182	4·8303	1·259	6·8921
1·029	0·7359	·0727	1·106	2·7961	·2486	1·183	4·8554	1·260	6·9201
1·030	0·7610	·0752	1·107	2·8227	·2507	1·184	4·8802	1·261	6·9510
1·031	0·7861	·0776	1·108	2·8485	·2529	1·185	4·9051	1·262	6·9822
1·032	0·8112	·0800	1·109	2·8740	·2550	1·186	4·9300	1·263	7·0133
1·033	0·8363	·0825	1·110	2·9001	·2571	1·187	4·9552	1·264	7·0444
1·034	0·8614	·0849	1·111	2·9263	·2593	1·188	4·9803	1·265	7·0751
1·035	0·8866	·0873	1·112	2·9522	·2614	1·189	5·0054	1·266	7·1060
1·036	0·9149	·0897	1·113	2·9780	·2635	1·190	5.0304	1·267	7·1369
1·037	0·9449	·0921	1·114	3·0045	·2656	1·191	5·0563	1·268	7·1678
1·038	0·9768	·0945	1·115	3·0304	·2677	1·192	5·0822	1·269	7·1988
1·039	1·0090	·0969	1·116	3·0563	·2698	1·193	5·1080	1·270	7·2300
1·040	1·0400	·0993	1·117	3·0821	·2719	1·194	5·1341	1·271	7·2601
1·041	1·0653	·1017	1·118	3·1080	·2740	1·195	5·1602	1·272	7·2902
1·042	1·0906	·1041	1·119	3·1343	·2761	1·196	5·1863	1·273	7·3204
1·043	1·1159	·1065	1·120	3·1610	·2782	1·197	5·2124	1·274	7·3506
1·044	1·1412	·1089	1·121	3·1871	·2803	1·198	5·2381	1·275	7·3807
1·045	1·1665	·1113	1·122	3·2130	·2824	1·199	5·2639	1·276	7·4109
1·046	1·1918	·1136	1·123	3·2399	·2845	1·200	5·2901	1·277	7·4409
1·047	1·2171	·1160	1·124	3·2658	·2865	1·201	5·3160	1·278	7·4708
1·048	1·2424	·1184	1·125	3·2916	·2886	1·202	5·3422	1·279	7·5007
1·049	1·2687	·1207	1·126	3·3174	·2907	1·203	5·3681	1·280	7·5307
1·050	1·2940	·1231	1·127	3·3431	·2927	1·204	5·3941	1·281	7·5600
1·051	1·3206	·1254	1·128	3·3690	·2948	1·205	5·4203	1·282	7·5891
1·052	1·3472	·1278	1·129	3·3949	·2969	1·206	5·4462	1·283	7·6180
1·053	1·3738	·1301	1·130	3·4211	·2989	1·207	5·4720	1·284	7·6469
1·054	1·4004	·1325	1·131	3·4490	·3010	1·208	5·4979	1·285	7·6758
1·055	1·4270	·1348	1·132	3·4769	·3030	1·209	5·5239	1·286	7·7048
1·056	1·4536	·1372	1·133	3·5048	·3051	1·210	5·5506	1·287	7·7331
1·057	1·4802	·1395	1·134	3·5326	·3071	1·211	5·5786	1·288	7·7620
1·058	1·5068	·1418	1·135	3·5605	·3092	1·212	5·6071	1·289	7·7910
1·059	1·5334	·1441	1·136	3·5882	·3112	1·213	5·6360	1·290	7·8201
1·060	1·5600	·1464	1·137	3·6160	·3132	1·214	5·6651	1·291	7·8482
1·061	1·5870	·1487	1·138	3·6437	·3153	1·215	5·6942	1·292	7·8763
1·062	1·6142	·1510	1·139	3·6716	·3173	1·216	5·7233	1·293	7·9042
1·063	1·6414	·1533	1·140	3·7000	·3193	1·217	5·7522	1·294	7·9321
1·064	1·6688	·1556	1·141	3·7281	·3214	1·218	5·7814	1·295	7·9600
1·065	1·6959	·1579	1·142	3·7562	·3234	1·219	5·8108	1·296	7·9879
1·066	1·7228	·1602	1·143	3·7840	·3254	1·220	5·8401	1·297	8·0158
1·067	1·7496	·1625	1·144	3·8119	·3274	1·221	5·8680	1·298	8·0448
1·068	1·7764	·1647	1·145	3·8398	·3294	1·222	5·8962	1·299	8·0719
1·069	1·8033	·1670	1·146	3·8677	·3314	1·223	5·9242	1·300	8·1001
1·070	1·8300	·1693	1·147	3·8955	·3334	1·224	5·9523		
1·071	1·8571	·1716	1·148	3·9235	·3354	1·225	5·9801		
1·072	1·8843	·1738	1·149	3·9516	·3374	1·226	6·0081		
1·073	1·9116	·1761	1·150	3·9801	·3394	1·227	6·0361		
1·074	1·9385	·1783	1·151	4·0070		1·228	6·0642		
1·075	1·9653	·1806	1·152	4·0342		1·229	6·0925		
1·076	1·9928	·1828	1·153	4·0611		1·230	6·1205		

SAFETY LAMP. During a visit which I paid to Newcastle some time ago, I took pains to learn the opinion of the best judges of coal mining, upon the merits of the patent invention of Upton and Roberts, described in the Dictionary, and I found from the concurring testimony of that very able engineer, Mr. Buddle, since lost to his friends and the world, and of Mr. Sopwith, well known for the geological study of the coal formation, that the said lamp could not be safely used on account of its glass case, which, being most liable to break, would be apt to cut or rupture the meshes of the wire gauze within it, and thus to lay the flame open for explosions. It is not therefore in use.

SAGO. See Pepper in this Supplement.

SAL AMMONIAC. A patent was obtained in 1840, for improvements in the manufacture of this article, by Mr. H. Waterton. Two modes of operating are described; the first consists in making a saturated solution of common salt in water, and mixing with it a quantity of finely pulverised carbonate of ammonia, about equal in weight to the salt contained in the solution. The mixture is agitated in a close vessel for six or eight hours, and as much carbonic acid gas is infused therein as it will absorb (but the introduction of the gas is not absolutely necessary, although the patentee prefers it); the liquid is then separated from the solid matter, by filtration and pressure. The solid matter is chiefly bi-carbonate of soda, and the liquid holds in solution muriate and carbonate of ammonia, and common salt, and sometimes a small portion of the bi-carbonate of soda.

The liquid is now placed in a distilling vessel, and the carbonate of ammonia being distilled over into a suitable receiver, a solution of muriate of ammonia and common salt remains in the still. This solution is evaporated, by heat, to such a consistency as will cause the separation of the common salt, by crystallisation, and the salt, thus crystallised, is evaporated from the liquid by any convenient method. The liquid is then evaporated until it attains the proper specific gravity for crystallising, and it is transferred into suitable utensils for that purpose. The crystals, produced by these means, are nearly pure muriate of ammonia, and, when pressed and dried, may be brought to market without further preparation, or they may be sublimed into cake sal ammoniac.

The other mode of manufacturing sal ammoniac consists in taking a quantity of liquid, containing ammonia, either in the caustic state, or combined with carbonic, hydrosulphuric, or hydrocyanic acid (such as gas ammoniacal liquor, or bone ammoniacal liquor), and rectifying it, by distillation, until the distilled portion contains from twenty to twenty-five per cent. of carbonate of ammonia. If the liquid contains any other acids than those above mentioned, a sufficient quantity of lime is used in the distillation to decompose the ammoniacal salt.

The distilled liquid being now mixed with as large a quantity of powdered common salt as it will dissolve, is agitated for several hours, and as much carbonic acid gas is infused into it as it will absorb. The remainder of the operation is the same as before described in the first method of manufacturing sal ammoniac. — *Newton's Journal*, C. S. xxii. 35.

SEMOULE. The name given in France, and used in this country, to denote the large hard grains of wheat flour retained in the bolting machine after the fine flour has been passed through its meshes. The best sémoule is obtained from the wheat of the southern parts of Europe. With the sémoule, the fine white Parisian bread called *gruau* is baked. Skilful millers contrive to produce a great proportion of sémoule from the large-grained wheat of Naples and Odessa.

SILK. Several pieces of silk were put into my hands, for analysis, on the 18th of February, after I had, on the preceding 12th of the month, visited the St. Katharine's Dock Warehouses, in New Street, Bishopsgate Street, for the purpose of inspecting a large package of the Corahs, per Colonist. I was convinced, by this inspection, that, notwithstanding the apparent pains bestowed upon the tin plate and teak wood packing-cases, certain fissures existed in them, through which the atmospheric air had found access, and had caused iron-mould spots upon the gunny wrapper, from the rusting or oxidizement of the tinned iron.

I commenced my course of analysis upon some of the pieces which were most damaged, as I thought they were most likely to lead me to an exact appreciation of the cause of the mischief; and I pursued the following general train of research: —

1. The piece of silk, measuring from 6 to 7 yards, was freely exposed to the air, then weighed, afterwards dried near a fire, and weighed again, in order to determine its hygrometric property, or its quality of becoming damp by absorbing atmospheric vapour. Many of the pieces absorbed, in this way, from one-tenth to one-eighth of their whole weight; that is, from 1 oz to 1½ oz. upon 13 oz. This fact is very instructive, and shows that the goods had been dressed in the loom, or imbued subsequently, with some very deliquescent pasty matter.

2. I next subjected the piece to the action of distilled water, at a boiling tempera-

ture, till the whole glutinous matter was extracted; five pints of water were employed for this purpose, the fifth being used in rinsing out the residuum. The liquid wrung out from the silk was evaporated first over the fire, but towards the end over a steam bath, till it became a dry extract; which in the damaged pieces was black, like extract of liquorice, but in the sound pieces was brown. In all cases, the extract so obtained absorbed moisture with great avidity. The extract was weighed in its driest state, and the weight noted, which showed the addition made, by the dressing, to the weight of the silk. The piece of silk was occasionally weighed in its cleansed state, when dry, as a check upon the preceding experiment.

3. The dry extract was now subjected to a regular chemical analysis, which was modified according to circumstances, as follows: — 100 parts of it were carefully ignited in a platinum capsule; during which a considerable flame and fetid smoke were disengaged. The ashes or incombustible residuum were examined by the action of distilled water, filtration, as also by that of acids, and other chemical tests, whereby the constituents of these ashes were ascertained. In the course of the incineration or calcination of the extract from the several samples, I never observed any sparkling or scintillation; whence I inferred that no nitre had been used in the dressing of the goods, as some persons suggested.

4. Having, in the course of boiling some of the extract from two of the damaged pieces, in a little distilled water, felt a urinous odour, I was induced to institute the following minute course of researches, in order to discover whether the urine of man had been introduced into the dressing paste of the silk webs. I digested a certain portion of the said extract in alcohol, 60 per cent. over proof, which is incapable of dissolving the rice water, or other starchy matter, which might be properly applied to the silk in the loom. The alcohol, however, especially when aided by a moderate heat, readily dissolves urea, a substance of a peculiar nature, which is the characteristic constituent of human urine. The alcohol took a yellow tint, and, being after subsidence of the sediment, decanted clear off into a glass retort, and exposed to the gentle heat of a water bath, it distilled over clear into the receiver, and left a residuum in the retort, which possessed the properties of urea. This substance was solid when cold, but melted at a heat of 220° F.; and at a heat of about 245° it decomposed with the production of water and carbonate of ammonia — the well-known products of urea at that temperature. The exhalation of the ammonia was very sensible to the smell, and was made peculiarly manifest by its browning yellow turmeric paper, exposed in a moist state to the fumes, as they issued from the orifice of the glass tube, in which the decomposition was usually effected. I thus obtained perfect evidence that urine had been employed in India in preparing the paste with which a great many of the pieces had been dressed. It is known to every experienced chemist, that one of the most fermentative or putrefactive compositions which can be made, results from the mixture of human urine with starchy or gummy matter, such as rice water; a substance which, by the test of iodine water, these Corahs also contained, as I showed to the gentlemen present, at my visit to the Bonding Warehouse.

5. On incinerating the extract of the Corahs, I obtained, in the residuum, a notable quantity of free alkali; which, by the test of chloride of platinum, proved to be potassa. But, as the extract itself was neutral to the tests of litmus and turmeric paper, I was consequently led to infer, that the said extract contained some vegetable acid, probably produced by the fermentation of the weaver's dressing, in the hot climate of Hindostan. I, accordingly, examined the nature of this acid, by distilling a portion of the extract along with some very dilute sulphuric acid, and obtained, in the receiver, a notable quantity of the volatilised acid condensed. This acid might be the acetic (vinegar), the result of fermentation, or it might be the formic or acid of ants, the result of the action of sulphuric acid upon starchy matter. To decide this point, I saturated the said distilled acid with magnesia, and obtained on evaporation the characteristic gummy mass of acetate of magnesia, soluble in alcohol, but none of the crystals of formiate of magnesia, insoluble in alcohol. From the quantity of alkali (potassa) which I obtained from the incineration of the extract of one piece of the damaged silk, and which amounted to six grains at least, I was convinced that wood ashes had been added, in India, to the mixture of sour rice water and urine, which would therefore constitute a compound remarkably hygrometric, and well qualified to keep the warp of the web damp, even in that arid atmosphere, during the time that the Tanty or weaver was working upon it. The acetate of potassa, present in the said Corahs, is one of the most deliquescent salts known to the chemist: and, when mixed with fermented urine, forms a most active hygrometric dressing, — one, likewise, which will readily generate mildew upon woven goods, with the aid of heat and the smallest portion of atmospheric oxygen. By the above-mentioned fermentative action, the carbon, which is one of the chemical constituents of the rice or starchy matter, had been eliminated, so as to occa-

sion the dark stains upon the silk, and the blackness of the extract taken out of it by distilled water.

6. That the dressing applied to the webs is not simply a decoction of rice, becomes very manifest, by comparing the incinerated residuum of rice with the incinerated residuum of the extract of the said Corahs. I find that 100 grains of rice, incinerated in a platinum capsule, leave only about one fifth of a grain, or 1 in 500 of incombustible matter, which is chiefly silicious sand; whereas, when 100 grains of an average extract of several of these Corahs were similarly incinerated, they left fully 17 parts of incombustible matter. This consisted chiefly of alumina or earth of clay, with silica, potassa, and a little common or culinary salt. (Has the clay been added, as is done in Manchester, to give apparent substance to the thin silk web?)

From the above elaborate course of experiments, which occupied me almost constantly during a period of four weeks, I was fully warranted to conclude that the damage of the said goods had been occasioned by the vile dressing which had been put into them in India; which, as I have said, under the influence of heat and air, had caused them to become more or less mildewed, in proportion to their original dampness when packed at Calcutta, and to the accidental ingress of atmospheric air into the cases during the voyage from Calcutta to London.

The following is the list of Corahs which I chemically examined: —

1 and 2, per Colonist, from Calcutta, 2 pieces, sound. — These two pieces had been dressed with a sweet viscid matter, like jaggery or goor (molassy sugar), mixed with the rice water. This extract contained no urine, but emitted a smell of caramel or burned sugar, when ignited. It amounted to 270 grains in the one, and 370 in the other.

3, ditto, 1 piece, mildewed, 1st degree. — This piece had been dressed like No. 5, and contained no trace of urine. It afforded 400 grains of a most deliquescent sweetish glutinous matter.

4, ditto, 1 piece, mildewed, 1st degree, as No. 3.

5, ditto, 1 piece, mildewed, 3d degree. — This piece contained no trace of urine, but it afforded 210 grains of a light brown extract, being rice water, mixed with something like jaggery.

6, ditto, 1 piece, 3d degree, mildewed.—This piece afforded evidence of urine in it, by test of carbonate of ammonia. The extract amounted to 320 grains.

8, ditto, 2 pieces, damaged in the 3d degree. — The total weight of one of these pieces, after exposure to air, was 4610 grains, and it lost 440 grains by drying. The total weight of the other was 4950 grains, and it lost 320 grains by drying. The weight of extract was, in one piece, 210 grains; and both pieces contained abundant traces of urine, as well as of potash. These constituents, along with the rice water, accounted sufficiently for the great damage of these two pieces by mildew.

10, ditto, 2 pieces, sound. — These contained no urea. Each afforded from 300 to 500 grains, of a light brown vegetable extract.

12, ditto, 2 pieces. — The extract in the one amounted to 222 grains, and in the other to 330. Both contained urea, and had, therefore, been imbued with urine.

14, ditto, 2 pieces, mildewed, 3d degree. — There was no urea in the extracts from these two pieces; but they afforded, the one 300 grains of extract, and the other 750. But this extract was a saccharine molassy matter, impossible to dry over a steam heat. The same quantity as the last, if dried by stronger means, would have weighed probably 600 grains. Its extraordinary deliquescence kept the pieces very moist, and thereby caused the mildewing of them. With the saccharine matter, four per cent. of culinary salt was mixed in one of these extracts.

16, ditto, 2 pieces, 3d degree of mildew. — The extract, about 200 grains, contained abundant evidence of urea, and consequently, of urine.

18, ditto, 2 pieces, sound. — Both these contained some traces of urea; but the one yielded only 102 grains of extract, and the other 370 grains. They must have been well screened from the air to have resisted the action of the urine.

20, ditto, 2 pieces, damaged, 1st degree. — No urea. The extract of the one was 320 grains; of the other piece 380; and it had a light brown colour, being a saccharine mucilage.

22, ditto, 2 pieces, 3d degree mildew. — 200 grains of extract in the one, and 210 in the other: they contained urea.

24, 2 pieces, 3d degree of mildew. — 310 grains of extract in the one, and 180 grains in the other. Both were impregnated with urea, and consequently with urine.

Having in the preceding report demonstrated, by the clearest processes of chemical research, that the above mildewed Corahs had been damaged by the fermentative decomposition of the dressing paste with which they had been so abundantly impregnated, I would recommend the importers of such goods to cause the whole of the dressing to be washed out of them, and the pieces to be thoroughly dried before being packed up.

I believe that clean silk may be kept and transported, even in the most humid atmosphere, without undergoing any change, if it be not imbued with fermentative paste.

I examined eight other pieces of a different mark, imported by another mercantile house, per Colonist, and they afforded results similar to the above.

SILVER, *Extraction of from Lead; Pattinson's process.*—The desilverizing apparatus of Locke, Blackett and Co., consists of seven crystallizing pots, and one smaller pot for receiving the desilverized lead. They are all made of cast iron, and arranged in a straight line.

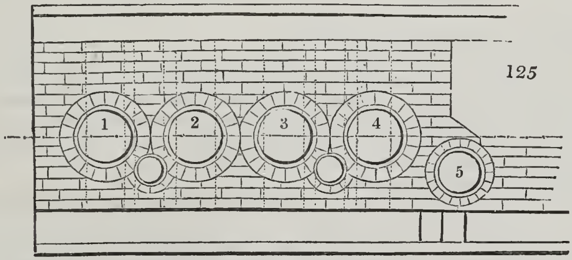
The lead in each pot varies in its contents of silver.

	oz.	oz.
The first containing 85 cwt. lead at about 60 oz. of silver, or $\frac{1}{544}$, per ton -		255
Is divided into 55 cwt. crystals carried to second pot, at 35 oz. per ton -	96	
18 cwt. do. to be put in first pot again, at 64 oz. per ton -	57	
and 12 cwt. rich lead to be cupelled, at 170 oz. per ton - -	102	
		255
The second pot containing 90 cwt. lead, at about 35 oz. silver per ton -		157
Is divided into 60 cwt. crystals carried to third pot, at 20 oz. per ton -	60	
and 30 cwt. lead put into first pot, at 65 oz. per ton - -	97	
		157
The third pot containing 90 cwt. of lead, at about 20 oz. per ton - -		90
Is divided into 55 cwt. crystals carried to fourth pot, at 10 oz. per ton -	27	
and 25 cwt. lead put into second pot, at 36 oz. per ton - -	63	
		90
The fourth pot containing 80 cwt. lead, at about 10 oz. per ton - -		40
Is divided into 55 cwt. crystals, carried to fifth pot, at 5½ oz. per ton -	15	
and 25 cwt. lead put into third pot, at 20 oz. per ton - -	25	
		40
The fifth pot containing 80 cwt. lead, at about 5½ oz. silver per ton - -		22
Is divided into 55 cwt. crystals, put into sixth pot, at 3 oz. per ton - -	8¼	
and 25 cwt. lead, put into fourth pot, at 11 oz. per ton - -	13¾	
		22
The sixth pot containing 80 cwt. lead, at about 3 oz. per ton - -		12
Is divided into 55 cwt. crystals, carried to seventh pot, at 1½ oz. per ton -	4½	
and 25 cwt. lead, put into fifth pot, at 6 oz. per ton - -	7½	
		12
The seventh pot containing 55 cwt. lead, at about 1½ oz. per ton - -		4
Is divided into 25 cwt. crystals, carried to small pot, at ½ oz. per ton -	½	
and 30 cwt. lead, put into sixth pot, at 2½ oz. per ton - -	3½	
		4

The above 25 cwt. of crystals are melted and cast into pigs and sent to the market.

In operating upon lead containing about 10 oz. per ton, the fourth pot is filled with it; if it should contain 20 oz., or thereabouts, it is put into the third pot; and so of any other.

Fig. 125. represents the arrangement of the iron pots or cauldrons, in their order.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The desilvering apparatus represented in *fig.* 125. is composed of five cauldrons of cast iron, each heated by its own fire, besides two smaller pots, similarly heated. The cauldrons rest by their upper flange and surface upon bricks properly formed and arranged. Their shape is not hemispherical; their mouth is 40 inches in length, but only 26 inches in width. Over the door of the fireplace, the mouth stands 8 feet 4 inches above the ground or bottom of the ash-pit, of which space, 18 inches intervene between the grate and the brim. The grate is 2 feet long and 8¾ inches wide. All the cauldrons have the same elliptic form, with a bottom like the small end of an egg. The fifth alone is smaller, but this one serves merely to melt the lead which has been stript of its silver, in order to be cast into salmons or blocks.

The charge consists of 64 or 65 salmons, each weighing from 120 to 140 lbs. When they are well melted, the fire is removed from the grate, as well as the small film of litharge from the surface of the metal; and one or two salmons are added to accelerate the cooling, or sometimes, instead, a little soapy water is sprinkled into the cauldron, whereby a crust of lead is formed, which being pushed down into the mass, melts with ebullition. This is repeated till the whole becomes sufficiently cool, that is, when crystals begin to form. The lead concreted round the sides being now detached, the whole is stirred with an iron bar, by a motion in a vertical plane, and varying its posture in this plane. During this operation, intended to establish a uniform temperature throughout the mass, a second workman heats in the smaller pot adjoining to No. 1. a large skimmer at the end of a long wooden handle, and next proceeds to fish out the crystals, taking care to let them drain off for a few seconds all the liquid lead among them, and then turns out the crystals slowly into the next cauldron, No. 2.; the second workman meanwhile adds the metal solidified round the sides, and stirs all together to equalise the temperature. These two-fold operations occupy about fifty minutes; by which time, there remains in the cauldron about 16 salmons. The workman now lifts out the crystals, as before, with the drainer, and throws them upon the ground in two heaps. His assistant takes them up a little while afterwards, and puts them away to make room for fresh crystals, which the first workman continues to throw down. This process goes on till only 8 salmons remain in the cauldron, a point ascertained by gauging the height to the bath. The fire being at this time removed from cauldron No. 2. into the grate of No. 1. the 8 salmons of lead enriched with silver, which remain at the bottom of the cauldron, are run out into movable moulds; and the 8 salmons which were thrown upon the ground are put into it; the full charge being then made up with salmons of the same richness as those previously used.

While this mass is melting in No. 1. the process just finished in it is repeated in No. 2. About three-fourths of the metallic mass is next separated in the state of crystals, which are transferred to No. 3. and also one-eighth of crystals thrown on the ground, after pouring the remaining one-eighth at the bottom of cauldron No. 2. not into moulds, but into No. 1.

A like process is performed in cauldrons 3. and 4.; and the poor lead taken out of 4. is transferred to 5. to be melted, and run into salmons, which are submitted afresh to the preceding series of crystallizations, provided the lead still contains a sufficient proportion of silver.

The following Table will place the results of the above successive operations in a clear light:—

		Silver in 1 Ton of Lead.
Original lead	- - - -	0·001153
1. Rich crystals	- - - -	0·003324
2. Poor ditto	- - - -	0·000933
—Rich ditto	proceeding from the treatment of the preceding No. 2. poor crystals - -	0·0020802
3 Poor ditto.		0·0007021
4. Rich	proceeding from the treatment of No. 3. poor crystals - - - -	0·001399
—Poor		0·0004569
—Rich	as above from No. 4. - -	0·0008135
(Lead) poor		0·0001128

We thus see, that four crystallizations, repeated upon the original lead from the smelting furnace, of the above richness, will afford a lead ten times poorer. With a lead originally containing only 0·0002248 in silver, three crystallizations would suffice to make it ten times poorer. In general, the poorer the lead, within certain limits, the better adapted is it to this process.

SILVERING. See Electrotype.

SLIDES. The name given by the Cornish miners to clay veins of more modern formation.

SMELTING IRON FURNACES, commonly called BLAST FURNACES. Several of these furnaces, as mounted near Glasgow, deserve to be made known, on account of the economy of their construction, the advantage of their form, and the amount of their performance.

Fig. 126. represents one of the smallest of these, which measures from the line at the bottom to the top 48 feet, from which all the other dimensions may be estimated. It produces a soft cast-iron for casting into moulds and for melting in the cupola. *Figs.* 127. and 128. represent a much larger furnace, being from the top, to the line A, B, C, D, 60 feet high. A few have been built still larger. This furnace has a double case, each of which consists of fire-bricks. This case is enclosed by common bricks, and these by a wall of stone masonry. The successive rows of bricks are laid stair-wise, having the angular retreat filled up with fire-clay. *Fig.* 131. is a modern furnace of very large dimensions, as the numbers upon it show.

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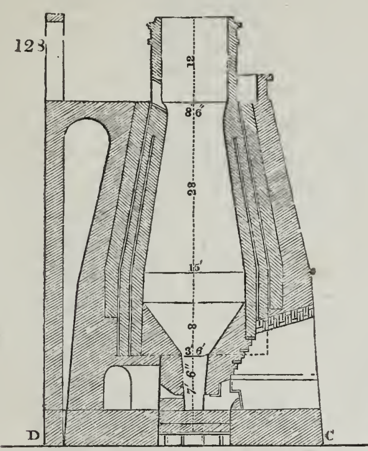

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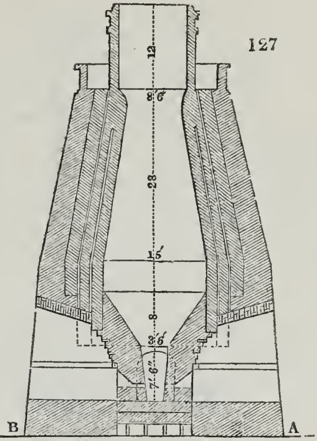

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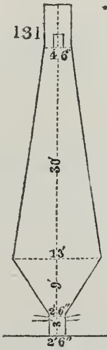

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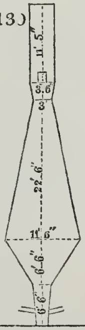

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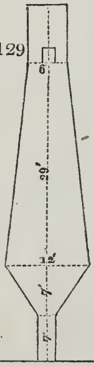

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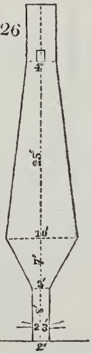

William Jessop, Esq., proprietor of the great iron works of Butterley and Codner Park in Derbyshire, has invented a very elegant and effective apparatus for feeding his blast furnaces with fuel, *mine* (calcined ironstone), and limestone in due proportions, and equally distributed round the inside of the furnace. *Figs.* 132, 133. represent this feed-apparatus. *Fig.* 132. shows at A, an outline of the furnace, and at B, the line of entrance into its throat. C, is the feed mechanism. It consists of a long balance lever barrow, D, E; D, being an iron cylinder, open at top and bottom, 4 feet in diameter and 2½ feet in height, in the inside of which a hollow cone of iron is suspended, with its apex uppermost, so that while the base of the cone is kept above the level of the bottom of the cylinder it shuts it; but on the cone being lowered below that level, it allows the charge of materials resting all round on the slant surface of the cone to fall down equally round the side of the cylinder into the furnace. In *fig.* 133. the barrow lever, D, E, is seen in profile or vertical section; *a*, is the fulcrum wheel, upon which the lever is in equilibrio when 9 cwt. of coals are put into the cylinder; then a weight is hung on, near the end, E, of the lever, as an equipoise either to 9 or 12 cwt. of mine, according to circumstances; and next, a weight to balance one-third of that weight of limestone. These weights of materials being introduced into the cylinder, while the barrow rests upon a level with the line E D, it is then rolled forward into its place, as shown in the figure, upon the wheels, *b b*, upon a platform sustained on the top of an inverted cylinder within the cast-iron column, into which cylinder air is admitted (through a valve opened by the workman) from the furnace blast, the air passing up the

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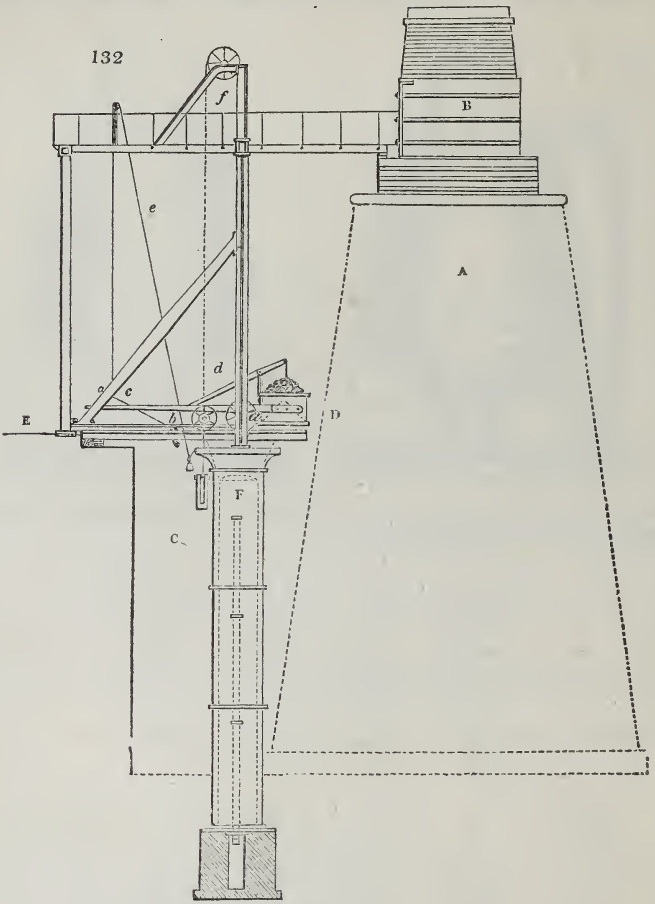

tube seen in the axis of F. The inverted air-cylinder is 3½ feet in diameter, 36 feet long, and rises 25 feet; being made air-tight with water, it ascends in its columnar case,

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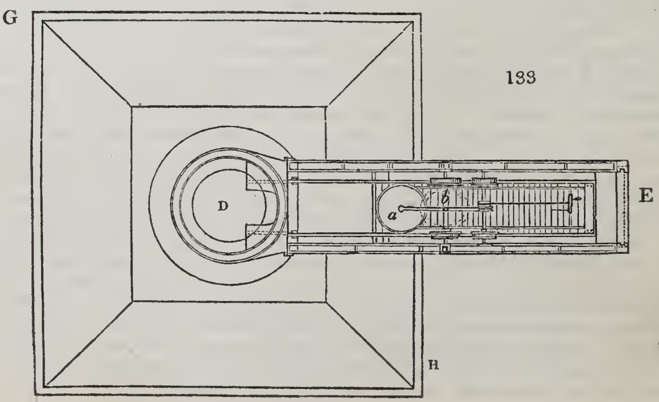

which is 4 feet in diameter, without friction. The space, G H, *fig.* 133., is 36 feet square.

The iron cone, which serves as a valve to the charging-drum or cylinder, is raised and lowered by means of a chain passing round a worm-wheel, which is turned round by an endless screw, acted upon by the long rod at *c*, which the workman can move by hand at pleasure, thereby lowering or raising the end of the short lever, *d*, to which the valve cone is suspended. The cord by which the workman opens or shuts the air piston-valve is seen at *e*, *f*. I have viewed with much pleasure the precise and easy movements of this feed-apparatus, at an excellent blast furnace in Codner Park iron works.

SMOKE PREVENTION. Among the fifty several inventions which have been patented for effecting this purpose, with regard to steam boiler and other large furnaces, very few are sufficiently economical or effective. The first person who investigated this subject in a truly philosophical manner was Mr. Charles Wye Williams, managing director of the Dublin and Liverpool Steam Navigation Company, and he also has had the merit of constructing many furnaces both for marine and land steam-engines, which thoroughly prevent the production of smoke, with increased energy of combustion, and a more or less considerable saving of fuel, according to the care of the stoker. The specific invention, for which he obtained a patent in 1840, consists in the introduction of a proper quantity of atmospheric air to the bridges and flame-beds of the furnaces, through a great number of small orifices, connected with a common pipe or canal, whose area can be increased or diminished, according as the circumstances of complete combustion may require, by means of an external valve. The operation of air thus entering in small jets into the half-burned hydro-carburetted gases over the fires, and in the first flue, is their perfect oxygenation, the development of all the heat which that can produce, and the entire prevention of smoke. One of the many ingenious methods in which Mr. Williams has carried out the principle of what he justly calls his Argand furnace, is represented in *fig.* 134., where *a* is the ash-pit of a steam boiler furnace; *b*, is the mouth of a tube which admits the external air into the chamber or iron box of distribution, *c*, placed immediately beyond the fire-bridge, *g*, and before the diffusion or mixing chamber, *f*. The front of the box is perforated either with round or oblong orifices, as shown in the two small figures *e*, *e* beneath *fig.* 134.; *d*, is the fire-door, which may have its fire-brick lining also perforated. In some cases, the fire-door projects in front, and it, as well as the sides and arched top of the fireplace, are constructed of perforated fire-tiles, enclosed in common brickwork, with an intermediate space, into which the air may be admitted in regulated quantity through a moveable valve in the door. I have seen a fireplace of this latter construction performing admirably, without smoke, with an economy of one-seventh of the coals formerly consumed in producing a like amount of steam from an ordinary furnace; *h* is the steam boiler.

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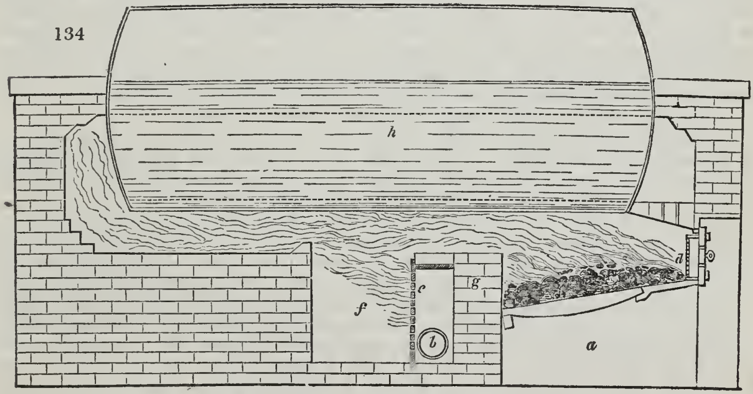

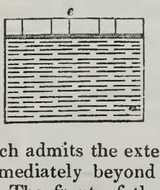

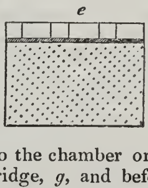

Very ample evidence was presented last session to the Smoke Prevention Committee of the House of Commons of the successful application of Mr. Williams's patent invention to many furnaces of the largest dimensions, more especially by Mr. Henry Houldsworth, of Manchester, who, mounting in the first flue a pyrometrical rod, which acted on an external dial index, succeeded in observing every variation of temperature, produced by varying the introduction of the air-jets into the mass of ignited gases passing out of the furnace. He thereby demonstrated, that 20 per cent. more heat could be easily obtained from the fuel, when Mr. Williams's plan was in operation, than when the fire was left to burn in the usual way, and with the production of the usual volumes of smoke. It is to be hoped, that a law will be enacted in the next session of parliament for the suppression, or at least abatement, of this nuisance, which so greatly disfigures and pollutes many parts of London, as well as all our manufacturing towns, while it acts injuriously on animal and vegetable life. Much praise is due to Mr. Williams for his indefatigable and disinterested labours in this difficult enterprise, and for his forbearance under much unmerited obloquy from narrow-minded prejudice and indocile ignorance.

SOAP. Several contrivances upon this subject have bustled over the patent stage within these few years; such as Mr. Dunn's for making soap rapidly at a temperature of 310° Fahr. under high steam pressure, by which many credulous shareholders were gulled into a belief that they would realise by this joint-stock project 200,000*l.* per annum. The soap so made was merely swelled in size and weight, by being surcharged with water, so that in a few weeks, the bars of it shrunk, rent, and twisted into mere skeletons; and being in this plight, returned to the company by their customers, caused that large soap bubble to burst.

Mr. Sheridan's silica soap had a somewhat longer career, but is now also nearly consigned to oblivion. Causticity and abrasiveness were the chief characteristics, resulting from the mixture of a strong solution of silicate of soda, or liquor of flints, with soap made in the common way.

The invention for which Dr. Normandy obtained a patent merits a better fate. When yellow soap is made with the cheaper kinds of fat, it will hardly acquire a sufficient degree or firmness or hardness to satisfy the thrifty washerwoman. It melts away too rapidly in the hot water; a defect which may be well remedied by the introduction into the soap of a little fused sulphate of soda; and the salt concreting gives the soap a desirable hardness, while it improves its colour, and renders it a more economical article for the washing-tub. In a trial recently before the Court of Common Pleas, it was proved that the soap made according to Dr. Normandy's patent was worth fully 2*l.* a ton more than the original soap, without the sulphate of soda.

Mr. Dunn has recently obtained a patent for accelerating the process of soap-making; he promotes the combination of the alkali, fat, and water, by pumping streams of atmospheric air through the saponaceous materials, while exposed to the usual heat in the pan. This scheme is said to effect its purpose, and to save much time.

SODA. On the 30th of June, 1838, Messrs. Dyar and Hemmings obtained a patent for manufacturing soda by the decomposition of sea salt with sesqui-carbonate or bicarbonate of ammonia. Equal parts of the chloride of sodium and sesqui-carbonate are prescribed, being very nearly the equivalent decomposing proportions, and the ammonia salt is recommended to be added in powder to a saturated solution of the sea salt, and the mixture to be stirred and then set aside till the mutual action and decomposition be effected. Having been employed to examine this process for a gentleman who wished to adopt it upon a manufacturing scale, I obtained the following results. On making the prescribed mixture in the cold, brisk effervescence takes place, because the quantity of carbonic acid combined with the ammonia is greater than the resulting soda can readily absorb, even to form its bicarbonate, and this extrication of gas carries off with it more or less ammonia, amounting, in carefully conducted experiments, to no less than 27 per cent. of the sesqui-carbonate employed; though the magma deposited from the mixture was drained in vessels nearly close, and though the ammonia which adhered to it, as well as that in the drained mother liquors, was recovered by distillation in vessels connected with a Woulfe's apparatus. Moreover, the utmost amount of soda-ash (not pure carbonate) which was obtained, was only 37·5 for 100 of sea salt used, whereas 90 of carbonate should result from 100 of the sea salt, with the above equivalent dose of sesqui-carbonate of ammonia. This latter salt contains about one-half more carbonic acid than is required by the soda to become a carbonate. A good illustration of the loss of ammonia in a similar case is afforded by the decomposition of chloride of calcium in solution, by adding to it the equivalent dose of pulverized ammonia carbonate; viz. 56 of the former and 59 of the latter. The rapid extrication of the carbonic acid on making this mixture, causes such a waste of ammonia. that more of the sesqui-carbonate must be afterwards introduced, to complete the decomposition of the chloride; the stronger the solution of the chloride the greater is the loss of ammonia.

In one of my experiments, where were employed 3500 grains = half a pound avoirdupois, of each ingredient, the following were the products:—

	Grains.
1. Ammonia recovered by distillation from the drained magma, equivalent in sesqui-carbonate to - - - -	257
2. Ammonia as carbonate, from the remaining liquid, sucked into a vacuous apparatus and distilled - - - -	1509
3. Additional ammonia as carbonate, obtained from the cold mother liquors, by distillation with quick lime, and out of the sal ammoniac formed - - - - -	775
	2541
Sesqui carbonate employed - - - - -	3500
Loss - - - -	959

or 27·4 per cent.

The product from this experiment in dry soda ash was only 1500 grains, which were

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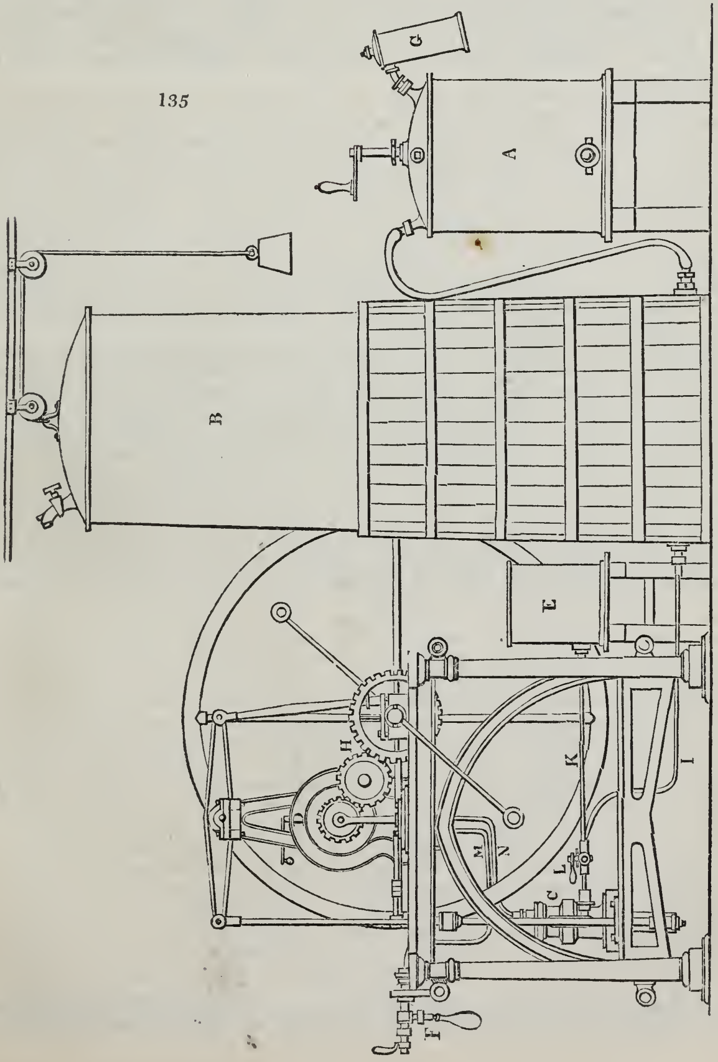

found to contain only 1312 of pure carbonate, or 87·5 per cent. of the whole. Here is a deficiency of soda carbonate, upon the quantity of the chloride used, of no less than 58⅓ per cent., for only 1312 grains are obtained instead of 3150.

Subsequently a method occurred to me, whereby this process, elegant in a scientific point of view, might possibly be executed with advantage upon the commercial scale; but it would require a very peculiar apparatus, though not nearly so costly as what was erected by Mr. Cooper under the direction of the patentees at Battersea, and in Brussels.

SODA WATER. At page 21. of vol. x. of the conjoined series of Newton's Journal, the patent apparatus of Mr. F. C. Bakewell, of Hampstead, for making Soda Water, is well described with illustrative figures. The patent was obtained in March 1832, but how far it has been introduced into practice I have not heard. Its arrangement discovers ingenuity, but it seems less likely to prove durable than the patent apparatus of Mr. Tyler, which *fig.* 135. in the preceding page represents according to his latest specification. A, is the gas generator, where the chalk and sulphuric acid are mixed; B, the gasometer; C, the soda-water pump, for forcing in the gas; D, the condenser; E, the solution (of soda) pan; F, the bottling cork; G, the acid bottle, at the right hand shoulder of A; H, the wheels, for working the agitator in the condenser; I, the pipe, for conveying the gas to the pump; K, pipe for conveying the solution to the pump; L, cocks for regulating the admission of the gas into the solution; M, drawing-off pipe leading to the bottling cork; N, the forcing pipe from the pump to the condenser.

The vessel in which the soda water is condensed is lined with silver in order to resist corrosion.

SOLDERING OF LEAD, *and other metals*, is called by its inventor M. de Richemont, *autogenous*, because it takes place by the fusion of the two edges of the metals themselves, without interposing another metallic alloy, as a bond of union. He effects this purpose, by directing a jet of burning hydrogen gas, from a small movable beak, upon the two surfaces or edges to be soldered together. Metals thus joined are much less apt to crack asunder at the line of union, by differences of temperature, flexure, &c., than when the common soldering processes are employed. The fusing together the edges of lead sheets, for making sulphuric acid chambers, has been long practised in this country, but it was performed by pouring some of the melted metal along the line of junction, and afterwards removing its excess by means of a plumber's soldering iron. The method of M. Richemont is a great improvement upon that old practice. It is much quicker and more convenient.

SPINNING. The greatest improvement hitherto made in forming textile fabrics, since the era of Arkwright, is due to Mr. G. Bodmer, of Manchester. By his patent inventions the several organs of a spinning factory are united in one self-acting and self-supplying body — a system most truly *automatic*. His most comprehensive patent was obtained in 1824, and was prolonged by the Judicial Committee of the Privy Council, for 7 years after the period of 14 years was expired. It contained the first developement of a plan by which fibres of cotton, flax, &c. were lapped and unlapped through all the operations of cleaning and blowing, carding, drawing, roving, and spinning; in the latter, however, only as far as the operation of feeding is concerned. The lapping from the blower was then not new, but the lapping directly and in connection with the carding engines was his invention, and was brought by him into operation at St. Blaise in the Black Forest, several years before he took out his patent in England. The method applied through all the following operations was then new. Mr. Dyer's and several other patents granted subsequently were decided and

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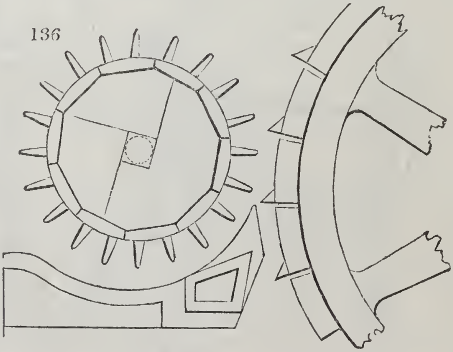

Patent of 1835.

acknowledged infringements. The patent of 1824 was the beginning; the result of which was the several patents for improvements in 1835, 1837, 1838, and 1842, of Mr. Bodmer.

By a machine generally called a Devil or Opener ("Wolf," in German), which consists of a feeding-plate set with teeth and a roller covered with spikes (see *fig.* 136.), the cotton is cleared from its heaviest dirt and opened. This machine delivers the cotton into a room or on to a travelling cloth, from which it is taken, weighed in certain portions, and spread upon cloth in equal portions: this is then rolled up, and placed behind the first blower.

The first blower has a feeding-plate like *fig.* 137., without teeth, and over this plate the cotton is delivered to the operation of the common beaters, from which it is received into a narrow compartment of 4½ or 5 inches broad, and wound, by means of his lap-machines, upon rollers in beautifully level and well-cleaned laps. Eight of these narrow laps are then placed behind a second blower, of a similar construction to the first. Instead of the common beater, however, a drum with toothed straight edges is used (see *fig.* 138.), which opens the cotton still more, and separates the fibres from one another. The cotton is again formed into similar narrow laps, which are still more equal than the preceding ones, and eight of these laps are then placed behind the carding engines. It was only by applying his lap-machine, patented in 1842, that he succeeded in forming small laps on the blower; without this he could not perform the doffing of the laps without stopping the wire-cloth, and in doing this, an irregular lap would be formed because of the accumulating of the falling cotton in one place while the wire-cloth was standing.

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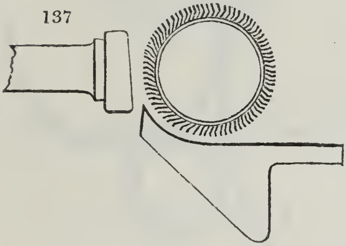

Patent of 1835.

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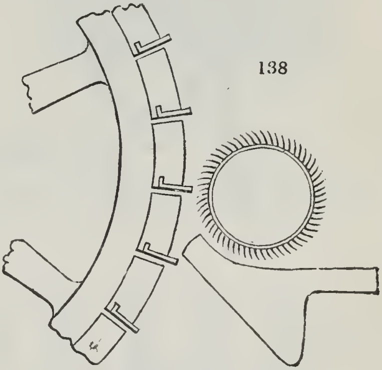


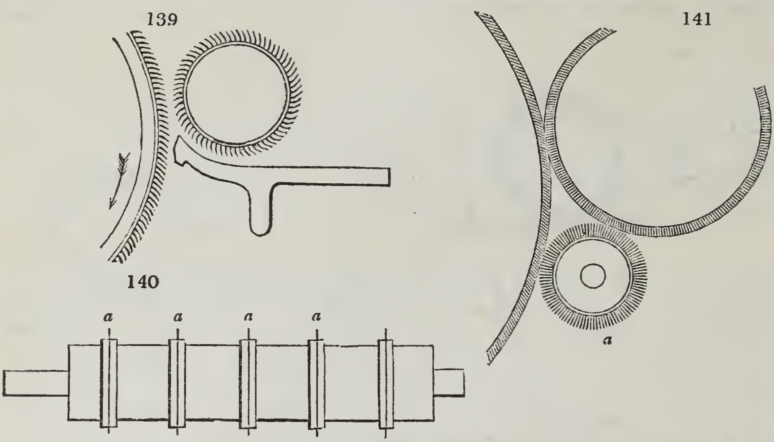
Patents of 1824 *and* 1835.

Carding Engine. — His patent of 1824 showed a mode of coupling a number of carding engines, the product of which was delivered upon an endless belt or a trough, and at the end of this trough was wound upon a roller. This arrangement wants no description, as it is generally known. I have seen it in use on the Continent.

When a set of cards work together, any interruption or stoppage of a single carding engine causes a defect in the produce of the whole lap. Interruptions occurred several times a day by the stripping of the main cylinder, and during this operation the missing band or sliver was supplied out of a can, being the produce of a single carding engine working into cans (a spare card). The more objectionable defect was, however, the difference of the product of the carding engine after the main cylinder had been stripped; the band or sliver from it will be thin and light until the cards of the main cylinder are again sufficiently filled with cotton, when the band will again assume its proper thickness. Another irregularity was caused by the stripping of the flats or top cards, but was not so fatal as the first one. These defects were of course a serious drawback in his system of working, the latter of which he provided against in his first patent by stripping the top cards by mechanism; the former, however, was only conquered by his invention of the self-strippers for the main cylinders; thus the carding engine may now work from Monday morning till Saturday night without interruption, the cylinders requiring only to be brushed out every evening; the consequence is, that much time is gained, and a very equal, clean, and clear product is obtained. Old carding engines to which he applied his feeders (see *fig.* 139.) and main cylinder-clearers produce much superior work, and increase the production from 18 to 24 per cent.

The main cylinder-clearer consists of a very light cast iron cylinder upon which five, six, or more sets of wire brushes are fixed, which are caused to travel to and fro across the main cylinder; the surface or periphery of the brushes overrunning the surface or periphery of the main cylinder by 8 or 10 per cent., the brushes thus lifting the cotton out of the teeth of the cards of the main cylinder, and causing the dirt and lumps to fall.

As the brushes are not above a quarter-inch in breadth and travel to and fro, it is clear that no irregularity can take place in the fleece which comes from the doffer; not more than 1-40th part of the breadth of the cylinder being acted upon at the same time. *Figs.* 140. and 141. give an idea of the clearer: the mechanism within the clearer and by which the brushes, *a*, are caused to travel is simple and solid. The main cylinders for the carding engines are made of cast iron, the two sets of arms and rim are cast in the same piece; when complete, they weigh 50 lbs. less than those made of wood.



Patents of 1838 *and* 1842.

The new lap machine connected with these engines is almost self-acting; a girl has only to turn a crank when the lap is full; by this turn, the full lap is removed and an empty roller put in its place, the band of cotton is cut, and no waste is made.

Drawing Frame. — The drawing frame of 1824 was improved, and the improvements patented, in 1835, and others again in 1842. That of 1824 is known in Germany and France, and generally in use. The laps from the carding engine lap-machine are put upon delivering rollers, behind a set of drawing rollers, and from them delivered upon a belt or trough, and again formed into laps similar to those from the carding engines. The next operation formed the laps into untwisted rovings, and the next again into smaller untwisted rovings, or rovings with false twist in them, as infringed upon by Dyer. The false twist was rather objectionable, and in his patent of 1835 he put a number of rovings on the same bobbin, with left and right permanent twist in them. This does very well; there is, however, a little objection to that place in which the twist changes from right to left when it comes to the last operation before spinning. In his patent of 1838, and particularly in that of 1842, he confined the left and right-hand twist to the drawing frame, when he converts two laps into one roving, and forms a roller or bobbin of 14 inches diameter and 15 inches broad, with six separate and twisted rovings wound upon it. (See *figs.* 142. and 143.) The twist is given by tubes in two directions, so that it remains in it (see *fig.* 143.), the tube turns in the same direction, while the roving advances 4 or 5 inches, and then turns in the other direction. These laps or bobbins are then placed behind a machine, which he calls a Coil-frame, the most important arrangement of which he claimed already in his patent of 1835. It consists of a slot with a travelling spout, without which the coils cannot be formed under pressure. Coiling in cotton cannot be claimed, as it was done in the first system of cotton spinning.

Coil Frame. — The bobbins (*fig.* 142.) are placed behind this machine, and two ends from the bobbin are passed through the drawing rollers and formed into one untwisted sliver or roving in the following manner: — When the cotton has passed through the drawing rollers (see *fig.* 144.) and calender rollers, A, it is passed through the tube, B, and the finger, C; the spindle with its disc, D, revolves in such a proportion as to take up the cotton which proceeds from the calender rollers, A, and cause the rovings to be laid down in a spiral line closely one by one, and as the rollers, A, work at a regular speed, it is evident that the motion of the finger, C, and the speed of the tube, B, must vary accordingly. The coil, E, is stationary, and is pressed by the lid or top, F, which

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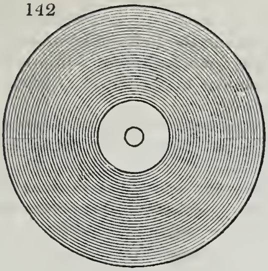

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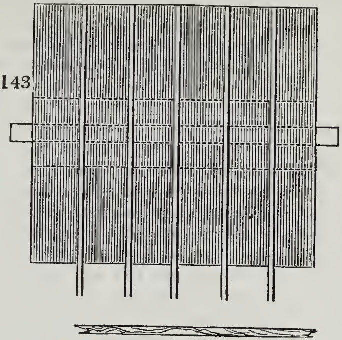
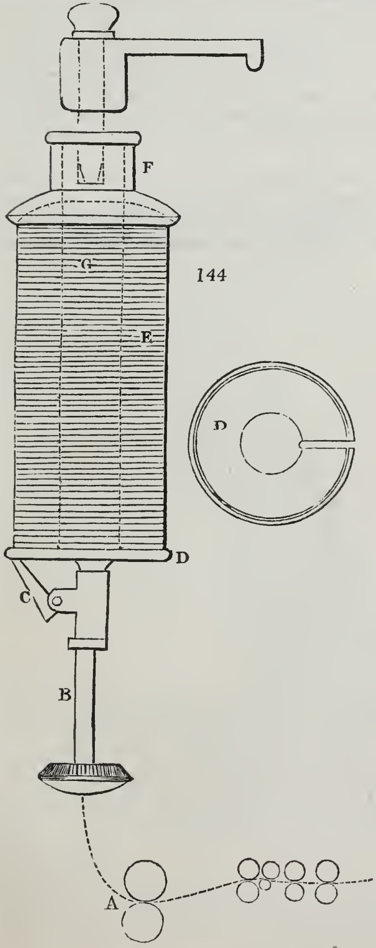


Patents of 1835, 1838, *and* 1842.

144



Patents of 1838 *and* 1842.

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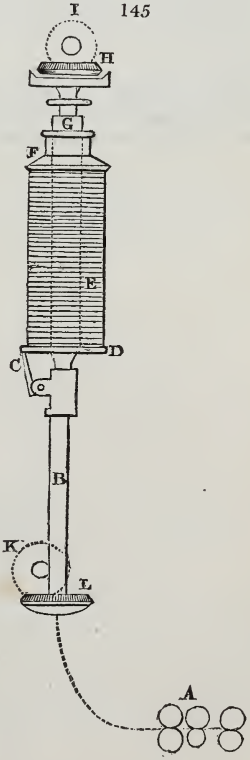

Patents of 1838 *and* 1842.

slides up the spindle, G, made of tin-plate. The cotton enters through the slot, X, in *fig.* D. It is quite evident that the finger, C, and spindle, G, only perform one and the same varying motion, which is repeated at every fresh layer, and the coil is thus built from below; it is about 8 inches in diameter and 18 inches high when compressed, and contains 4½ lbs. of cotton. Mr. Bodmer has several modes of forming these coils, but one only is shown here. These coils are placed behind the twist coil frames in half cans or partly open ones or troughs, or behind a winding machine, where they are wound upon rollers side by side, like the lap or bobbin shown in the drawing frame, and placed behind the twist coil frame in this state.

Twist Coil Frame. — This frame forms rovings into coils similar to those above explained, with this difference, that the rovings are fine, say, from 1 to 10 hanks per pound, and regularly twisted: their diameter varies from 2½ to 5 inches. The same machine produces rovings more or less fine, but the diameter of the coils does not differ. The difference of this machine from that above described consists in the dimensions of their parts, and in its having the spindle, G, and the lid or top, F, revolving, as well as the tube, B. (See *fig.* 145.) In this machine the motion of the spindle, B, is uniform; the spindle, G, however, is connected by the bevel wheels, H and I, with a differential motion at the end of the frame, with which the motion of the finger, C, corresponds. The skew wheels, K and L, are connected with the drawing rollers, A. The speeds of the tube, B, and the spindle, G, are so proportioned, that while the spindle, G, performs one revolution, and therefore puts one twist into the roving, the tube, B, also performs one revolution, missing so much as will be required to pass through the slot in the cap or disc, D, and lay on it as much of the roving as proceeds from the rollers, A, and in which one twist is contained. Of course the twist of these rovings can be adapted to their fineness and varied; but it is evident that, on account of the regularity of the machine and its simplicity of movement, the rovings can never be stretched, and much less twist can be put into them than can be put in the common fly frames. These coils are put behind the spinning machines on shelves or in small cans, open in front; or they are wound from 24 to 72 ends upon bobbins, and placed upon unlap rollers behind the spinning frames.

Coiling Machine for Carding Engines and Drawing Frames. — These are simple machines, which may be applied to carding engines or drawing frames of any description. They form large coils, 9 inches in diameter and 22 inches long, when on the machine. There are two spindles, *a*, (see *fig.* 146.) on each machine, for the purpose of

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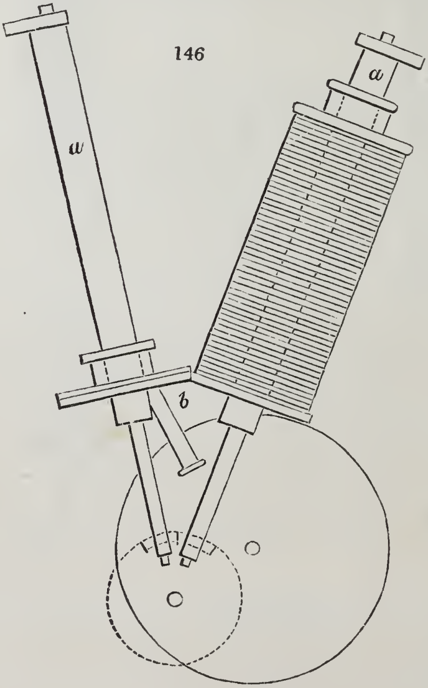

Patents of 1842.

doffing without stopping the drawing frame or carding engines. When one coil is filled, the finger, *b*, is just brought over to the other spindle, so that the full coil is stopped, and the new one begins to be formed without the slightest interruption of the machine.

Mr. B. form coils in various ways, also in cans; but this description is sufficient to show the application of this mode of winding up bands or rovings. Several of the above-described machines are adopted with equal success to wool and flax. In his patents of 1835, 1837, and 1838, he shows several modes of applying his system to cotton and other machinery. He winds directly from the carding engines the slivers separately upon long bobbins, and he gives them twist in two directions, for the purpose of uniting the fibres to some extent, so that they not only come off the bobbins without sticking to one another, but also that they may draw smoother. He also showed a machine, by which several rovings, say 4 or more, are put upon the same bobbin with conical ends; these bobbins are placed behind the mules or throstles, and are unwound by a belt or strap running parallel with the fluted rollers of the spinning machine, as seen in *fig.* 147. The belt or band, A, is worked in a similar way to that described in his former patent, and the bobbins, B, rest upon and revolve upon their surface, exactly according to the speed of the belt. It is quite evident that the whole set of rovings must be unwound exactly at the same speed, and that no stretching can take place. He can put real and reversed twist in these rovings as well as false twist only. The most important feature in the roving machine is a metal plate, in which a slot is formed through which the rovings pass; this slot is seen in *figs.* 148, 149, and 150. The cotton, when coming from the drawing rollers, is passed through the twisters, C, and through the slot in the plate, D. Thus he is enabled to put any convenient number of neatly formed and perfectly separate coils upon the wooden barrel or bobbin. The bobbin formed upon these machines is represented in *fig.* 151., and the conical ends are formed by a mechanism, by which the twisters, C, are caused to approach a little more to one another, after each layer of rovings has been coiled round the barrel: the section of the bobbin is therefore like that shown in *fig.* 151. He makes use of exactly the same arrangement, viz. a finger travelling along a slot in a plate, for the purpose of forming the coils, which has been already described.

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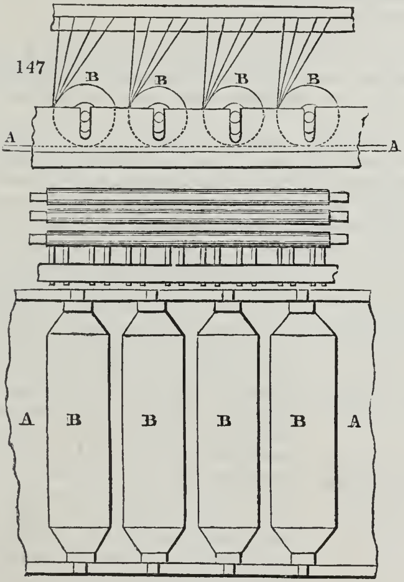

Patent of 1835.

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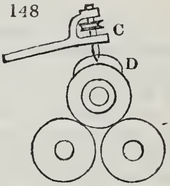

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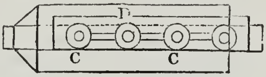

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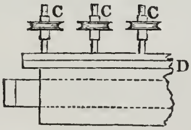

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Rovings wound upon bobbins by means of tubes revolving in one direction, are certainly not so fit for spinning as rovings into which a small degree of twist is put. The tube by which a twist is put in on one side and taken out at the other curls or ruffles the cotton, and causes it to spread out as it passes between the rollers, while rovings with a little permanent twist in them are held together in the process of drawing, and thus produce smooth yarn. To remedy the evil above described, when untwisted rovings are used, he causes the spouts or guides, through which the rovings pass into or between the drawing rollers, to revolve slowly first in one, and then in the other direction, and thus puts a certain quantity of twist into the rovings while they are being prepared for spinning. Two modes of performing this operation are clearly described in his patent of 1835.

There is a little defect in the working of the rovings with reversed twist when too much or too little twist is put in them, or when the winding machine is not kept in good order. This defect proceeds from the change in the twist of the roving seen at A, *fig.* 152.; in this place the twist is not like that at B, and it would, in some parts of the yarn, be detected under circumstances just described. In cases where double rovings are used, the twisters are so arranged as to put the twist in the rovings, as shown in *fig.* 153.: in this case the reversing place of one roving meets the twisted place of the other, and the fault is completely rectified.

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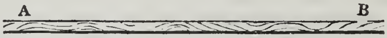

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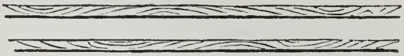

The preceding description gives an idea of Mr. Bodmer's admirable system of preparing and spinning cotton, wool, flax, &c., and of the several processes; it would be superfluous to describe the several machines, or the details of the same, as exhibited in his patents.

In his patent of 1838, he specifies a self-actor, namely, a machine in itself, which can be attached to 2, 3, or even 4 mules of almost any convenient number of spindles. The mules are previously stripped of all their mechanism except the rollers and their wheels, the carriage and spindles; all the other movements ordinarily combined with the mule are contained in the machine, which is placed between a set of mules, as seen in *fig.* 154.; *a* and *b*, the self-actors, to each of which 3 mules are yoked, and which are connected by bands and shafts with the self-actor, or rather partly self-actor. A girl of fifteen or sixteen years old stands at × between *a* and *b*, and never leaves her place except, perhaps, for aiding in doffing or in banding the spindles. The geering of the room acts by means of straps upon the machines *a* and *b*, and from these machines all the movements are given to the six mules, namely, the motion of the rollers, the spindles, the drawing out of the carriage, the after draft, &c. When the carriages are to be put up, the girl takes hold of two levers of the machine *a*, and by moving them in certain proportions, acts upon two cones and pulleys, and thus causes, in the most easy and certain manner, the carriages to run in and the yarn to be wound on the spindles. The first machine Mr. B. made for this purpose was completely self-acting, but he found very soon that the mechanism was more complicated and apt to go out of order than that of the above-described machine; and as it is necessary to have a girl of a certain age to watch over the piecers for a certain number of mules, he preferred the simplified machine; placing the girl near these machines, from whence the whole set of mules attached to the same can be overlooked;

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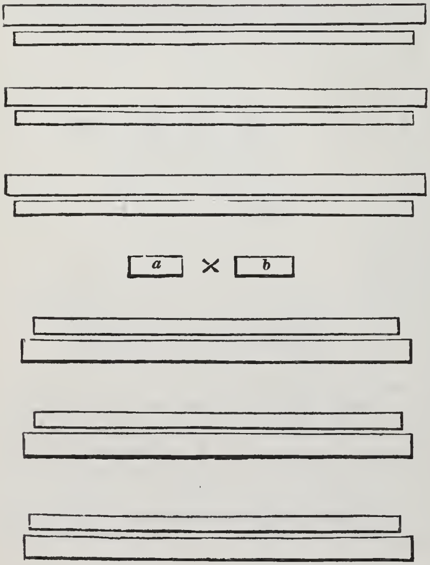

as the creels behind the mules are not wanted in his system, this impediment to the sight of the girl would be removed. He schemed these machines for the purpose of altering, at a trifling expense, the common mules into self-actors; they are equally good for any numbers of yarn.

Bastard Frame. — In his patent of 1838 and 1842, we find the description of a very simple bastard frame, namely, a throstle with mule spindles, forming cops, as seen in *fig.* 155., and wound so hard that they can be handled about without any danger of spoiling them; in the same dimensions they contain one third more yarn than the best cops of self-actors. The machine is extremely simple; but owing to some circumstances in the construction of the winders and plates, he has not been able to spin advantageously upon large machines above No. 20's. He has spun on it No. 56, and most beautiful yarn. The quantity this machinery produces is nearly one third more than the best self-actor, on an equal number of spindles, and the yarn and cops are much superior. Of course there is a copping motion connected with the machine: the winding, however, is continuous, as well as the twisting, and *figs.* 156. and 157. will give the reader an idea of the frame. The yarn coming from the rollers, A, goes through an eye, B, to the wire, C, fixed in the flyer, D, and from thence on to the mule spindle, E: as the spindle revolves the flyer is dragged along, and by its centrifugal power winds the yarn tight upon the spindles.

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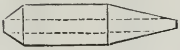

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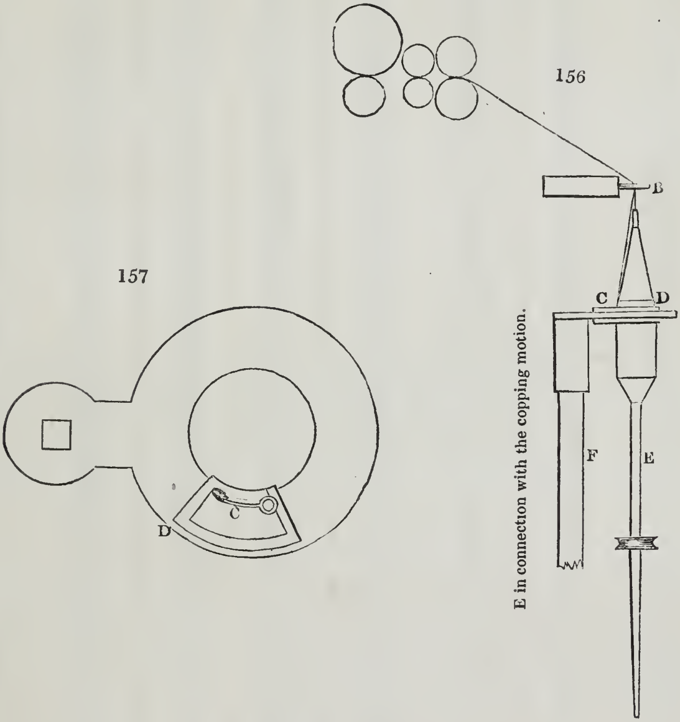

Patents of 1838 *and* 1842.

SPIRITS.

Correspondence between Specific Gravity and Per Cents. over Proof at 60° F.

Specific Gravity.	Per Cent. Over Proof.	Specific Gravity.	Per Cent. Over Proof.	Specific Gravity.	Per Cent. Over Proof.	Specific Gravity.	Per Cent. Over Proof.
0·8156	67·0	·8455	51·7	·8748	33·4	·9056	11·4
·8160	66·8	·8459	51·5	·8751	33·2	·9060	11·1
·8163	66·6	·8462	51·3	·8755	32·9	·9064	10·8
·8167	66·5	·8465	51·1	·8758	32·7	·9067	10·6
·8170	66·3	·8469	50·9	·8762	32·4	·9071	10·3
·8174	66·1	·8472	50·7	·8765	32·2	·9075	10·0
·8178	65·6	·8476	50·5	·8769	32·0	·9079	9·7
·8181	65·8	·8480	50·3	·8772	31·7	·9082	9·4
·8185	65·6	·8482	50·1	·8776	31·5	·9085	9·2
·8188	65·5	·8486	49·9	·8779	31·2	·9089	8·9
·8192	65·3	·8490	49·7	·8783	31·0	·9093	8·6
·8196	65·1	·8493	49·5	·8786	30·8	·9697	8·3
·8199	65·0	·8496	49·3	·8790	30·5	·9100	8·0
·8203	64·8	·8499	49·1	·8793	30·3	·9104	7·7
·8206	64·7	·8503	48·9	·8797	30·0	·9107	7·4
·8210	64·5	·8506	48·7	·8800	29·8	·9111	7·1
·8214	64·3	·8510	48·5	·8804	29·5	·9115	6·8
·8218	64·1	·8513	48·3	·8807	29·3	·9118	6·5
·8221	64·0	·8516	48·0	·8811	29·0	·9122	6·2
·8224	63·8	·8520	47·8	·8814	28 8	·9126	5·9
·8227	63·6	·8523	47·6	·8818	28·5	·9130	5·6
·8231	63·4	·8527	47·4	·8822	28·3	·9134	5·3
·8234	63·2	·8530	47·2	·8825	28·0	·9137	5·0
·8238	63·1	·8533	47·0	·8829	27·8	·9141	4·8
·8242	62·9	·8537	46·8	·8832	27·5	·9145	4·5
·8245	62·7	·8540	46·6	·8836	27·3	·9148	4·2
·8249	62·5	·8543	46·4	·8840	27·0	·9152	3·9
·8252	62·3	·8547	46·2	·8843	26·8	·9156	3·6
·8256	62·2	·8550	46·0	·8847	26·5	·9159	3·3
·8259	62·0	·8553	45·8	·8850	26·3	·9163	3·0
·8263	61·8	·8556	45·6	·8854	26·0	·9167	2·7
·8266	61·6	·8560	45·4	·8858	25·8	·9170	2·4
·8270	61·4	·8563	45·2	·8861	25·5	·9174	2·1
·8273	61·3	·8566	45·0	·8865	25·3	·9178	1·9
·8277	61·1	·8570	44·8	·8869	25·0	·9182	1·6
·8280	60·9	·8573	44·6	·8872	24·8	·9185	1·3
·8284	60·7	·8577	44·4	·8876	24·5	·9189	1·0
·8287	60·5	·8581	44·2	·8879	24·3	·9192	0·7
·8291	60·4	·8583	43·9	·8883	24·0	·9196	0·3
·8294	60·2	·8587	43·7	·8886	23·8	·9200	Proof.
·8298	60·0	·8590	43·5	·8890	23·5	Under	Proof.
·8301	59·8	·8594	43·3	·8894	23·2	·9204	0·3
·8305	59·6	·8597	43·1	·8897	23·0	·9207	0·6
·8308	59·5	·8601	42·8	·8901	22·7	·9210	0·9
·8312	59·3	·8604	42·6	·8904	22·5	·9214	1·3
·8315	59·1	·8608	42·4	·8908	22·2	·9218	1·6
·8319	58·9	·8611	42·2	·8912	21·9	·9222	1·9
·8322	58·7	·8615	42·0	·8915	21·7	·9226	2·2
·8326	58·6	·8618	41·7	·8919	21·4	·9229	2·5
·8329	58·4	·8622	41·5	·8922	21·2	·9233	2·8
·8333	58·2	·8625	41·3	·8926	20·9	·9237	3·1
·8336	58·0	·8629	41·1	·8930	20·6	·9241	3·4
·8340	57·8	·8632	40·9	·8933	20·4	·9244	3·7
·8344	57·7	·8636	40·6	·8937	20·1	·9248	4·0
·8347	57·5	·8639	40·4	·8940	19·9	·9252	4·4
·8351	57·3	·8643	40·2	·8944	19·6	·9255	4·7
·8354	57·1	·8646	40·0	·8948	19·3	·9259	5·0
·8358	56·9	·8650	39·8	·8951	19·1	·9263	5·3
·8362	56·8	·8653	39·5	·8955	18·8	·9267	5·7
·8365	56·6	·8657	39·3	·8959	18·6	·9270	6·0
·8369	56·4	·8660	39·1	·8962	18·3	·9274	6·4
·8372	56·2	·8664	38·9	·8966	18·0	·9278	6·7
·8376	56·0	·8667	38·7	·8970	17·7	·9282	7·0
·8379	55·9	·8671	38·4	·8974	17·5	·9286	7·3
·8383	55·7	·8674	38·2	·8977	17·2	·9291	7·7
·8386	55·5	·8678	38·0	·8981	16·9	·9295	8·0
·8390	55·3	·8681	37·8	·8985	16·6	·9299	8·3
·8393	55·1	·8685	37·6	·8989	16·4	·9302	8·6
·8396	55·0	·8688	37·3	·8992	16·1	·9306	9·0
·8400	54·8	·8692	37·1	·8996	15·9	·9310	9·3
·8403	54·6	·8695	36·9	·9000	15·6	·9314	9·7
·8407	54·4	·8699	36·7	·9004	15·3	·9318	10·0
·8410	54·2	·8702	36·4	·9008	15·0	·9322	10·3
·8413	54·1	·8706	36·2	·9011	14·8	·9326	10·7
·8417	53·9	·8709	35·9	·9015	14·5	·9329	11·0
·8420	53·7	·8713	35·7	·9019	14·2	·9332	11·4
·8424	53·5	·8716	35·5	·9023	13·9	·9337	11·7
·8427	53·3	·8720	35·2	·9026	13·6	·9341	12·1
·8431	53·1	·8723	35·0	·9030	13·4	·9345	12·4
·8434	52·9	·8727	34·7	·9034	13·1	·9349	12·8
·8438	52·7	·8730	34·5	·9038	12·8	·9353	13·1
·8441	52·5	·8734	34·3	·9041	12·5	·9357	13·5
·8445	52·3	·8737	34·1	·9045	12·2	·9360	13·9
·8448	52·1	·8741	33·8	·9049	12·0	·9364	14·2
·8452	51·9	·8744	33·6	·9052	11·7	·9368	14·6

Table — *continued.*

Specific Gravity.	Per Cent. Under Prf.	Specific Gravity.	Per Cent. Under Prf.	Specific Gravity.	Per Cent. Under Prf.	Specific Gravity.	Per Cent. Under Prf.
·9372	14·9	·9530	31·0	·9685	52·2	·9846	79·2
·9376	15·3	·9534	31·4	·9689	52·9	·9850	79·8
·9380	15·7	·9539	31·1	·9693	53·3	·9854	80·4
·9384	16·0	·9542	32·3	·9697	54·2	·9858	81·1
·9388	16·4	·9546	32·8	·9701	54·8	·9862	81·7
·9392	16·7	·9550	33·2	·9705	55·5	·9866	82·3
·9396	17·1	·9553	33·7	·9709	56·2	·9870	82·9
·9399	17·5	·9557	34·2	·9713	56·9	·9874	83·5
·9403	17·8	·9561	34·6	·9718	57·6	·9878	84·0
·9407	18·2	·9565	35·1	·9722	58·3	·9882	84·6
·9411	18·5	·9569	35·6	·9726	59·0	·9886	85·2
·9415	18·9	·9573	36·1	·9730	59·7	·9890	85·8
·9419	19·3	·9577	36·6	·9734	60·4	·9894	86·3
·9422	19·7	·9580	37·1	·9738	61·1	·9898	86·9
·9426	20·0	·9584	37·6	·9742	61·8	·9902	87·4
·9430	20·4	·9588	38·1	·9746	62·5	·9906	88·0
·9434	20·8	·9592	38·6	·9750	63·2	·9910	88·5
·9437	21·2	·9596	39·1	·9754	63·9	·9914	89·1
·9441	21·6	·9599	39·6	·9758	64·6	·9918	89·6
·9445	21·9	·9603	40·1	·9762	65·3	·9922	90·2
·9448	22·2	·9607	40·6	·9766	66·0	·9926	90·7
·9452	22·7	·9611	41·1	·9770	66·7	·9930	91·2
·9456	23·1	·9615	41·7	·9774	67·4	·9934	91·7
·9460	23·5	·9619	42·2	·9778	68·0	·9938	92·3
·9464	23·9	·9623	42·8	·9782	68·7	·9942	92·8
·9468	24·3	·9627	43·3	·9786	69·4	·9946	93·3
·9472	24·7	·9631	43·9	·9790	70·1	·9950	93·8
·9476	25·1	·9635	44·4	·9794	70·8	·9954	94·3
·9480	25·5	·9638	45·0	·9798	71·4	·9958	94·9
·9484	25·9	·9642	45·5	·9802	72·1	·9962	94·4
·9488	26·3	·9646	46·1	·9806	72·8	·9966	95·9
·9492	26·7	·9650	46·7	·9810	73·5	·9970	96·4
·9496	27·1	·9654	47·3	·9814	74·1	·9974	96·8
·9499	27·5	·9657	47·9	·9816	74·8	·9978	97 3
·9503	28·0	·9661	48·5	·9822	75·4	·9982	97·7
·9507	28·4	·9665	49·1	·9826	76·1	·9986	98·2
·9511	28·8	·9669	49·7	·9830	76·7	·9990	98·7
·9515	29·2	·9674	50·3	·9834	77·3	·9993	99·1
·9519	29·7	·9677	51·0	·9838	78·0	·9997	99·6
·9522	30·1	·9681	51·6	·9842	78·6	1·0000	100·0
·9526	30·6						

STAINED GLASS. The blues of vitrified colours are all obtained from the oxide of cobalt. Cobalt ore (sulphuret) being well roasted at a dull red heat, to dissipate all the sulphur and arsenic, is dissolved in somewhat dilute nitric acid, and after the addition of much water to the saturated solution, the oxide is precipitated by carbonate of soda, then washed upon a filter and dried. The powder is to be mixed with thrice its weight of saltpetre; the mixture is to be deflagrated in a crucible, by applying a red hot cinder to it, then exposed to the heat of ignition, washed and dried. Three parts of this oxide are to be mixed with a flux, consisting of white sand, borax, nitre, and a little chalk, subjected to fusion for an hour, and then ground down into an enamel powder for use. Blues of any shade or intensity may be obtained from the above, by mixing it with more or less flux.

The beautiful greenish-yellow, of which colour so many ornamental glass vessels have been lately imported from Germany, is made in Bohemia by the following process. Ore of uranium, Uran-ochre, or Uran-glimmer, in fine powder, being roasted and dissolved in nitric acid; the filtered solution is to be freed from any lead present in it, by the cautious addition of dilute sulphuric acid. The clear green solution is to be evaporated to dryness, and the mass ignited till it becomes yellow. One part of this oxide is to be mixed with 3 or more parts of a flux, consisting of 4 parts of red lead and 1 of ground flints; the whole fused together and then reduced to powder.

Chrome Green. Triturate together in a mortar equal parts of chromate of potash and flowers of sulphur: put the mixture into a crucible and fuse. Pour out the fluid mass; when cool, grind and wash well with water to remove the sulphuret of potash and to leave the beautiful green oxide of chrome. This is to be collected upon a filter, dried, rubbed down along with thrice its weight of a flux, consisting of 4 parts of red lead and 1 part of ground flints fused into a transparent glass; the whole is now to be melted and afterwards reduced to a fine powder.

Violet. One part of calcined black oxide of manganese, one of zaffre, ten parts of white glass pounded, and one of red lead, mixed, fused, and ground. Or gold purple (Cassius's purple precipitate) with chlorsilver previously fused, with ten times its weight of a flux, consisting of ground quartz, borax, and red lead, all melted together; or, solution of tin being dropped into a large quantity of water, solution of nitrate of silver may be first added, and then solution of gold in *aqua regia*, in proper proportions. The precipitate to be mixed with flux and fused.

STARCH. In January 1839, M. Pierre Isidore Verdure obtained a patent for making starch, the chief object of which was to obtain the gluten of the wheat in a pure state, as a suitable ingredient in making bread, biscuits, &c. He works wheat flour into dough by a machine, kneads it, washes out the starch by streams of cold water, a process long known to the chemist, and purifies the starch by fermentation of the superjacent water. I can see nothing new in his specification.

Mr. Jones's patent, of date April 1840, is based upon the purification of the starch of rice and other farinaceous matters, by means of caustic alkali. He macerates 100 lbs. of ground rice in 100 gallons of a solution composed of 200 grains of caustic soda or potash to a gallon of water, stirs it gradually, till the whole be well mixed; after 24 hours, draws off the superjacent liquid solution of gluten in alkali, treats the starchy deposit with a fresh quantity of weak caustic lye, and thus repeatedly, till the starch becomes white and pure. The rice before being ground is steeped for some time in a like caustic lye, drained, dried, and sent to the mill.

Starch is made from wheat flour in a like way. The gluten may be recovered for use, by saturating the alkaline solution with sulphuric acid, washing and drying the precipitate.

In June 1841, Mr. W. T. Berger obtained a patent for manufacturing starch by the agency of an alkaline salt upon rice. He prefers the carbonates of potash and soda.

Mr. James Colman, by his patent invention of December 1841, makes starch from ground maize or Indian corn, by the agency either of the ordinary process of steeping and fermenting, or of caustic or carbonated alkaline lyes. He also proposes to employ dilute muriatic acid to purify the starchy matter from gluten, &c. — *See Newton's Journal, C. S.* xix. 246.; xx. 184. 188.; and xxi. 173.

The manufacture of potato flour (*fecule*) or starch in France and Holland has been economised to such a degree that they supply this country with it, at the rate of 8*s.* or 10*s.* a hundredweight. *Fig.* 158. represents in section the powerful and ingenious mechanical grater, or rasp (*râpe*), now used in France. *a a*, is the canal, or spout, along which the previously well-washed potatoes descend; *b b*, is the grater, composed of a wooden cylinder, on whose round surface circular saw rings of steel, with short sharp teeth, are planted pretty close together. The greater the velocity of the cylinder the finer is the pulp. A cylinder 20 inches in diameter revolves at the rate of from 600 to 900 times in a minute, and it will convert into pulp from 14 to 15 hecto-

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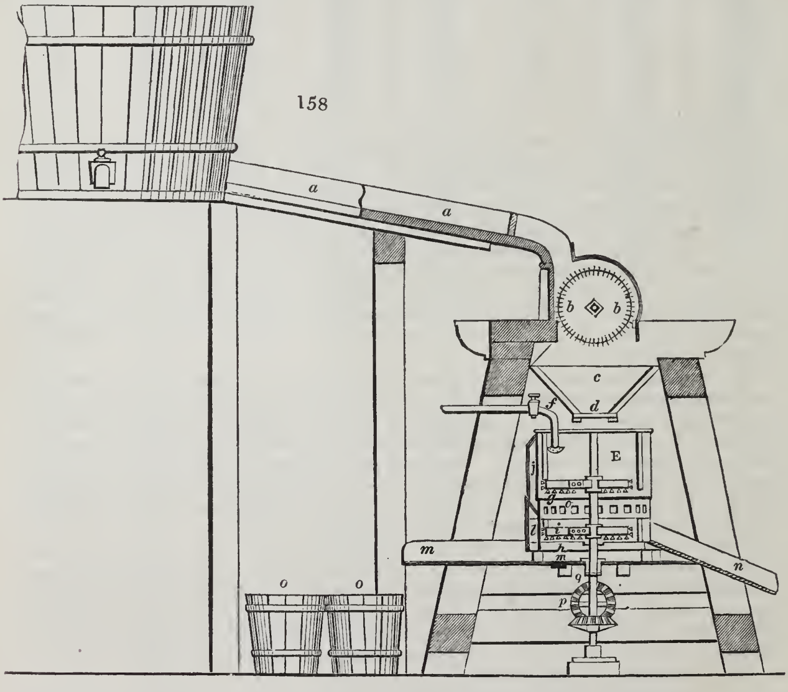

litres (about 300 imperial gallons) of potatoes in an hour. Potatoes contain from 15 to 22 per cent. of dry fecula. The pulp, after leaving the rasp, passes directly into the apparatus for the preparation of the starch. *c c*, is a wooden hopper for receiving the falling pulp, with a trap door, *d*, at bottom. E, is the cylinder-sieve of M. Etienne; *f*, a pipe ending in a rose spout, which delivers the water requisite for washing the pulp, and extracting the starch from it; *g g*, a diaphragm of wire cloth, with small meshes, on which the pulp is exposed to the action of the brushes *i i*, moving with great speed, whereby it gives out its starchy matter, which is thrown out by a side aperture into the spout *n*. The fecula now falls upon a second web of fine wire-cloth, and leaves upon it merely some fragments of the parenchyma or cellular matter of the potato, to be turned out by a side opening in the spout *n*. The sifting or straining of the starch likewise takes place through the sides of the cylinder, which consist also of wire-cloth; it is collected into a wooden spout, *m*, and is thence conducted into the tubes *o o*, to be deposited and washed. *p*, is a metre-toothed wheel-work placed on the driving-shaft, and gives motion to the upright axis or spindle, *q q*, which turns the brushes, *i i*.

STEARINE. *Fig.* 159. is a view of both the exterior and interior of the saponifying tun of a stearine factory; where the constituents of the tallow are combined with quicklime, by the intervention of water and steam: *a*, is the upright shaft of iron, turned by the bevel wheel above, in gear with another bevel wheel on the moving shaft, not shown in this figure. This upright shaft bears several arms *d*, furnished with large teeth. The tun is bound with strong hoops of iron, and its contents are heated by means of a spiral tube laid on the bottom, perforated with numerous holes, and connected by a pipe with a high-pressure steam-boiler.

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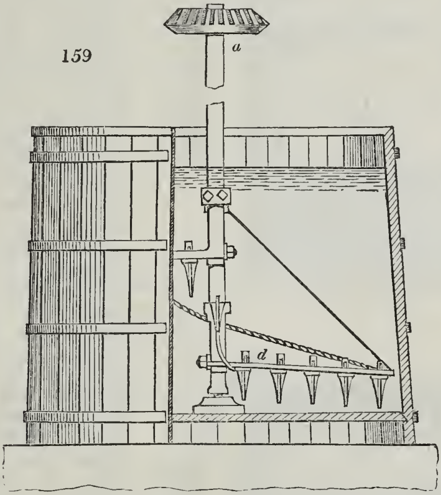

Fig. 160. represents a longitudinal section of the horizontal hydraulic press for depriving stearic acid, as also spermaceti, of all their fluid oily impurities. *a*, is the cylinder of the press; *b*, the ram or piston; *i*, *i*, *i*, *i*, hair and flannel bags inclosing the impure cakes to be exposed to pressure; *d*, *d*, *d*, *d*, iron plates previously heated, and placed between every two cakes to facilitate the discharge of their oily matter; *e*, *e*,

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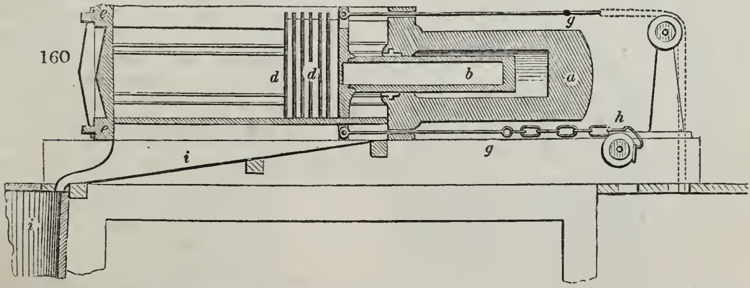

solid iron end of the press, made to resist great pressure; it is strongly bolted to the cylinder *a*, so as to resist the force of the ram; *g*, *g*, iron rods, for bringing back the ram *b*, into its place after the pressure is over, by means of counter weights suspended to a chain, which passes over the pulleys *h*, *h*; *i*, *i*, a spout and a sheet-iron pan for receiving the oily fluid.

STEEL. One of the greatest improvements which this valuable modification of iron has ever received is due to Mr. Josiah M. Heath, who, after many elaborate and costly researches, upon both the small and the great scale, discovered that by the introduction of a small portion, 1 per cent., and even less, of carburet of manganese into the melting-pot along with the usual broken bars of blistered steel, a cast steel was obtained, after fusion, of a quality very superior to what the bar steel would have yielded without the manganese, and moreover possessed of the new and peculiar property of being weldable either to itself or to wrought iron. He also found that a common bar-steel, made from an inferior mark or quality of Swedish or Russian iron, would, when so treated, produce an excellent cast steel. One immediate consequence of this discovery has been the reduction of the price of good steel in the Sheffield market by from 30 to 40 per cent., and likewise the manufacture of table-knives of cast steel with iron tangs welded to them; whereas, till Mr. Heath's invention, table-knives were necessarily made of shear steel, with unseemly wavy lines in them, because *cast* steel could not be welded to the tangs. Mr. Heath obtained a patent for this and other kindred meritorious inventions on the 5th of April 1839; but, strange and melancholy to say, he has never derived any thing from his acknowledged improvement but vexation and loss, in consequence of a numerous body of Sheffield steel manufacturers having banded together to pirate his patent, and to baffle him in our complex law courts. I hope, however, that eventually justice will have its own, and the ridiculously unfounded pretences of the pirates to the prior use of carburet of manganese will be set finally at rest. It is supposed that fifty persons at least are embarked in this pilfering conspiracy.

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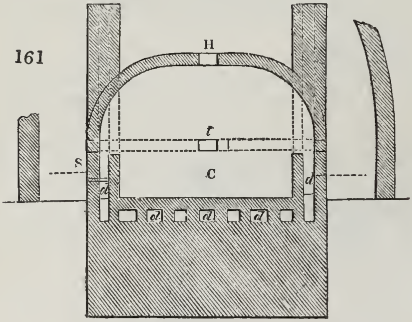

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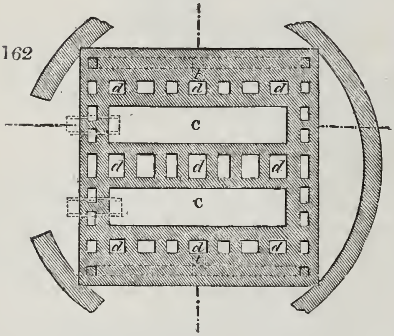

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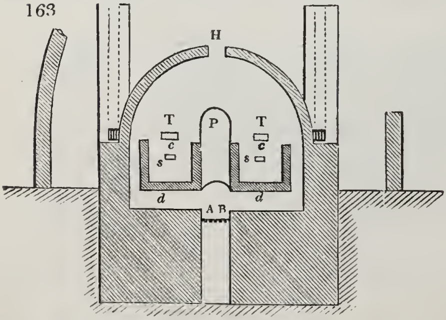

The furnace of cementation in which bar-iron is converted into bar or blistered steel is represented in *figs.* 161, 162, 163. It is rectangular and covered in by a groined or *cloister* arch: it contains two cementing chests, or sarcophaguses, C, C, made either of fire-stone or fire-bricks: each is $2\frac{1}{2}$ feet wide, 3 feet deep, and 12 long; the one being placed on the one side, and the other on the other of the grate, A B, which occupies the whole length of the furnace, and is from 13 to 14 feet long. The grate is 14 inches broad, and rests from 10 to 12 inches below the inferior plane or bottom level of the chests; the height of the top of the arch above the chests is $5\frac{1}{2}$ feet; the bottom of the chests is nearly on a level with the ground, so that the bars do not need to be lifted high in charging the furnace. The flame rises between the two chests, passes also below and round them through horizontal and vertical flues, *d*, and issues from the furnace by an opening, H, in the top of the vault, and by orifices, *t*, which communicate with the chimneys placed in the angles. The whole is placed within a large cone of bricks, 25 or 30 feet high, and open at top: this cone increases the draught, makes it more regular, and carries off the smoke away from the establishment. The furnace has three doors; two, T (*fig.* 162.), above the chests, serve to admit and to remove the bars; they are about 7 or 8 inches square: in each of them a piece of sheet-iron is put, folded back on its edges; upon which the bars are made to slide, so as to save the wall. A workman enters by the middle door, P, to arrange the bars; the trial bars are taken out from time to time by the apertures, S, (*fig.* 161.) left in the sides of the chests. The bars are laid in strata, along with wood charcoal in powder, in the said chests; they are about 3 inches broad, and one-third of an inch thick; they must not be placed too near each other, lest they should get welded together; the last or uppermost layer is covered with a stratum of loamy matter from 4 to 5 inches thick. The furnace must be gradually heated, not reaching its maximum temperature before 8 or 9 days, and the cooling lasts 5 or 6 days; the whole operation 18 or 20 days, and sometimes more, according to the quality of the steel to be cemented. About 13 tons of coals are consumed in this period. It is of consequence that the refrigeration be slow, to favour the crystallisation of the metal. The grain of the steel varies with the rate of cooling, the largest and whitest grain denoting the most fusible steel.

STILL. The continuous system of distillation has been carried in France to a great pitch of perfection, by the ingenuity chiefly of M. Cellier Blumenthal, and M. Ch. Derosne. *Fig.* 164. is a general view of their apparatus; A and B are boilers or alembics encased in brickwork, and receiving directly the action of the flame playing beneath them; in the copper, A, the *vinasse*, or spent wine, is finally exhausted of all its alcohol. C is the column of distillation; D, the column of rectification; E, the wine-heating condenser; F, the refrigerator; G, a vessel supplying *vinasse* to the cooler F, and feeding itself at the same time by means of a ball stop-cock placed in the vessel H; H, reservoir of vinasse; I, tube of communication conducting the alcoholic vapours of the rectifying column, D, up into the flat worm of the wine-heater, E; *a*, stop-cock of discharge of the alembic, A; when the operation goes on, the spent *vinasse* runs off continually by this stop-cock; *b*, a glass tube to show the height of the liquor in A; *c*, a safety-valve; *d*, a stop-cock for passing the vinasse from the alembic, B, into the bottom of the alembic, A; *e*, a tube to lead the alcoholic vapours, generated in A, into the bottom of B, which vapours, in passing through the liquor in B, heat it, and are partially condensed; *f*, glass tube to mark the level of the liquor in B; *g*, and *g*, level indicators; *h*, pipe conducting the vinasse from the lower part of the wine-heater, E, upon the uppermost of the series of horizontal discs, mounted within the column of distillation; *i*, a stop-cock for emptying the wine-heater at the end of an operation; *l*, *l*, two tubes fitted to the wine-heater, E, of which the first descends into the last compartment of the rectifier, whence it rises

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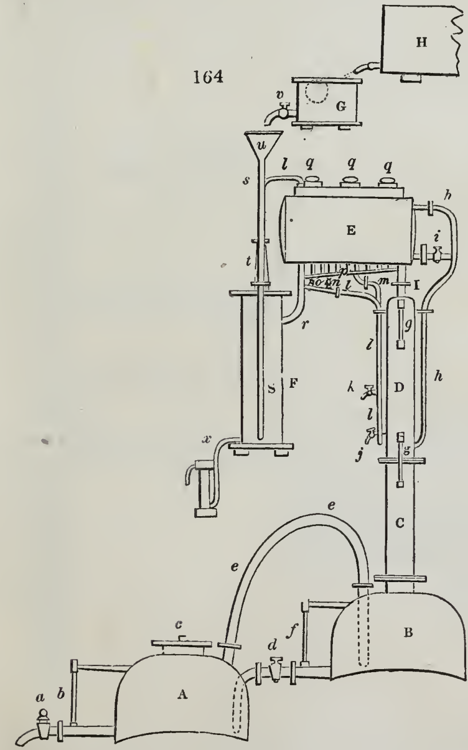

to the fifth; and the second tube descends to the third compartment, whence it rises above the second. At the curvature of each of these two tubes a stop-cock, *l*, and *k*, is placed on them, for drawing at pleasure a sample of the liquor returned to the rectifier; *m*, *n*, and *o*, are tubes communicating on one side with the slanting tube, *p*, and on the other with the tube, *l*. These three communications serve to furnish a spirit of greater or less strength. Thus if it be wished to obtain a very strong spirit, the alcoholic vapours which condense in the worm enclosed in E, are all to be led back into the rectifier, D, to effect which purpose, it is requisite merely to open the stop-cocks, *n* and *o*; again, weaker spirits may be had by closing the stop-cock, *o*, and still weaker by closing the stop-cock, *n*; for in this case, the alcoholic vapours condensed in the worm within E, will flow off into the worm within the upright cooler, F, and will get mixed with the richer vapours condensed in this refrigeratory. The interior of the column, C, contains a series of movable concave scale pans (like those of balances), with spaces between, each alternate pan having the convex side turned reversely of the preceding one, for the purpose of prolonging the cascade descent of the vinasse through C, and exposing it more to the heating action of the ascending vapours; the edges of these pans are, moreover, furnished with projecting spiculæ of copper wires, to lead off the liquor from their surfaces in a fine shower. The interior of the rectifier column, D, is mounted with a series of shelves, or floors, the passage from one compartment to that above it being through a short tube, bent at right angles, and open at either end; *p*, *p*, *p*, is a general tube, for receiving the vapours condensed in each of the turns of the large serpentine within E. The axis of this worm is horizontal; *q*, *q*, *q*, peep-holes in the top of the wine heater; *r*, a tube to conduct the alcoholic vapours not condensed in the worm of E, and also, if desired, those which have been condensed there, into the worm of the refrigeratory, F; *s*, a tube to bring the vinasse from the reservoir, G, into the lower part of the cooler, F; *t*, a tube to lead the vinasse from the upper part of the cooler, F, into the upper part of the wine-heater, E; *u*, a funnel; *v*, a stop-cock to feed the tube, *t*, with vinasse; *x*, a tube of outlet for the spirits produced; it ends, as shown in the figure, in a test tube containing an hydrometer.

The still of Laugier is represented by a general view in *fig.* 165. A and B are alembics exposed to the direct action of the fire, and serve a like purpose to those of *fig.* 164; C, is a cylinder containing the rectifier, and serving as a wine-heater; D, is the condensing cylinder; *a*, a stop-cock communicating with the wine tun; *b*, a plunger-tube, furnished with a funnel, through which wine runs constantly into the condenser, D; *c*, an overflow pipe of D, between C and D, communicating by a tube, dipping in the cylinder, C; *d*, a plunger equilibrium tube, supplying the alembics with hot wine; *e*, a tube leading the vapours of the first alembic, A, into the second one, B, into which it dips;

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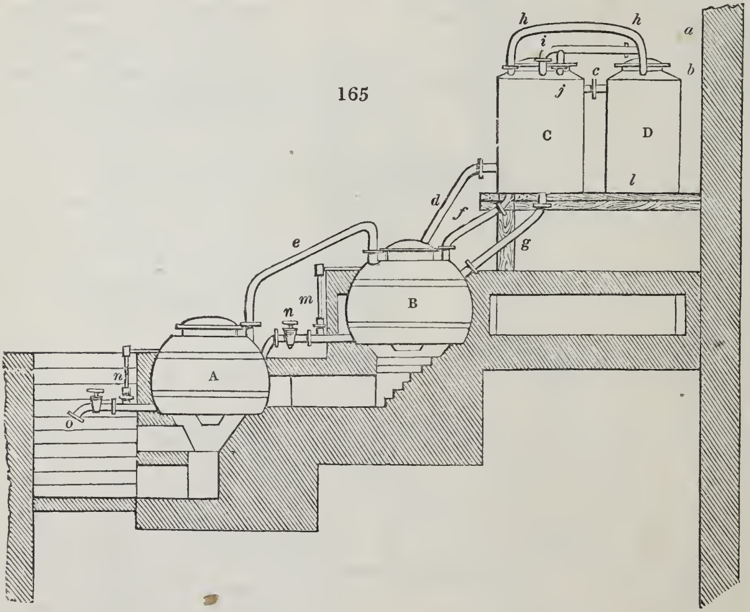

f, a tube conducting the vapours of alcohol from the alembic, B, into the circles of the rectifier; *g*, a tube bringing back into the alembic, B, the vapours condensed in the circles of the rectifier; *h*, a tube conducting the vapours not condensed into the worm of the condenser; *i*, a tube serving for the expulsion of the air when the wine comes into the vessel, *c*; it communicates with the tube, *h*, so as not to lose alcohol. *j*, is a prolongation of the tube D, communicating with the tube *h*, so that it may be in contact with the external air; *l*, a stop-cock through which the alcohol condensed runs off into the serpentine; *m*, levels, indicating the height of the liquor in the alembics, A and B; *n*, tube with a stop-cock, for feeding the alembic, A; *o*, discharge stop-cock of the spent vinasse (wash).

A description of the operation of the first still will render that of the second intelligible.

The alembic, A, being filled three-fourths with vinasse, and B having only 4 or 5 inches of vinasse over its bottom, the liquor in A is made to boil, and the stopcock, *r*, being at the same time opened, some of the wine to be distilled is allowed to fall into the funnel, *u*; this cold liquor runs to the bottom of the cooler, F, fills it, passes into the wine-heater by the tube, *l*, spreads into a perforated conduit along the top of E, thence trickles down into this vessel till it fills it to the level of the tube, *h*, by which it is conducted into the column, C, and, flowing down through all its compartments, it falls at last into the second alembic, B.

During this progress, the liquor of A having begun to boil, the alcoholic vapour passes, by means of the tube *e*, *e*, into the second alembic B, which, being heated by these vapours, and by the products of combustion issuing from the fire-place under the first alembic, is also soon made to boil. The vapour which it produces is disengaged into the column of distillation C, meets there the wine which trickles through all its compartments, transfers to it a portion of its heat, and deprives it of alcohol, goes into the column D, where it is alcoholized afresh, then enters into the worm within the wine-heater E, glides through all its windings, gets stripped in part of the aqueous vapours which accompanied the alcohol, and which return first by the tube *p*, *p*, then by *l*, *l*, into the column of rectification; afterwards the spirituous vapour passes into the worm enclosed in the cooler F, to issue finally condensed and deprived of all the water, wished to be taken from it, by the tube *x*, into the guage receiver.

When the indicator *f*, of the alembic B, shows it to be nearly full, the stop cock *a* of the alembic A is opened, and the vinasse is allowed to run out entirely exhausted of spirit; but as soon as there are only seven inches of liquor above the discharge pipe, the cock *a* is shut, and *d* is opened to run off seven inches of liquor from B.

It appears, therefore, that in reference to the discharge, the operation is not quite continuous; but this slight interruption is a real improvement introduced by M. Derosne into the working of M. Blumenthal's apparatus. It is impossible for any distiller, however expert, to exhaust entirely the liquor of the last alembic, if the discharge be not stopped for a short time. The above distilling apparatus requires from two to three hours to put it in full action. From 10 to 15 per cent. of spirit of $\frac{3}{6}$ are obtained from the average of French wine! and 600 litres of such spirit are run off with 150 kilogrammes of coals; or about two old English quarts of spirit for each pound of coals.

STONES, for building, and bricks, may be proved as to their power of resisting the action of frost, by the following method, first practised by M. Brard, and afterwards by MM. Vicat, Billaudel, and Coarad, engineers of the bridges and highways in France. The operation of water in congealing within the pores of a stone may be imitated by the action of a salt, which can increase in bulk by a cause easily produced; such as efflorescence or crystallisation, for example. Sulphate of soda or Glauber's salt answers the purpose perfectly, and it should be applied as follows:—

Average samples of the stones in their sound state, free from shakes, should be sawed into pieces 2 or 3 inches cube, and numbered with China ink or a graving tool. A large quantity of Glauber's salt should be dissolved in hot water, and the solution should be left to cool. The clear saturated solution being heated to the boiling point in a saucepan, the several pieces of stone are to be suspended by a thread in the liquid for exactly one half-hour. They are then removed and hung up each by itself over a vessel containing some of the above cold saturated solution. In the course of 24 hours, if the air be not very damp or cold, a white efflorescence will appear upon the stones. Each piece must be then immersed in the liquor in the subjacent vessel, so as to cause the crystals to disappear, be once more hung up — and dipped again whenever the dry efflorescence forms. The temperature of the apartment should be kept as uniform as possible during the progress of the trials. According to their tendency to exfoliate by frost, the several stones will show, even in the course of the first day, alterations on the edges and angles of the cubes; and in 5 days after efflorescence begins, the result will be manifest, and may be estimated by the weight of disintegrated fragments, compared to the known weight of the piece in its original state, both taken equally dry.

STREAM-WORKS. The name given by the Cornish miners to alluvial deposits of tin ore, usually worked in the open air.

STRINGS. The name given by the Cornish miners to the small filamentous ramifications of a metallic vein.

SUGAR. The recent researches of the eminent French chemist, M. Casaseca, upon cane-juice, at Havanna in Cuba, have demonstrated clearly the enormous loss which sugar-planters suffer by the imperfection of their manufacturing processes. His results confirm those previously obtained by M. Peligot in Paris, and show that cane-juice evaporated in vacuo at the atmospheric temperature yields, in 100 parts,

Crystalline white sugar	20·94
Water	78·80
Mineral substances	0·14
Organic matter, different from sugar	0·12
	100·00

The cane from which the above juice was drawn is called *canade la tierra* in Cuba. The juice of the Otaheita cane is identical with the preceding. But the proportions of ligneous fibres in the two canes are very different; that of *la tierra* containing, according to M. Casaseca, 16·4 per cent., while that of Otaheita contains only 10. Other canes, however, differ in this respect considerably from these two varieties. The average quantity of grained sugar obtained from cane-juice in our colonial plantations is probably not more than one-third of the quantity of crystalline sugar in the juice which they boil.

The following analysis of cane-juice, performed by a French chemist, was given me by Mr. Forstall of New Orleans. In 10 English gallons, of 231 cubic inches each, of juice marking $8\frac{1}{2}$° Baumé, there are $5\frac{3}{4}$ ounces English of salts, which consist of—

Sulphate of potash	17·840 grammes = 15·44 grains each.
Phosphate of potash	16·028
Chlorure of potassium	8·355
Acetate of potash	63·750
Acetate of lime	36·010
Gelatinous silica	15·270
	157·253 = 5·57 ounces avoirdupois.

To the large proportion of deliquescent saline matter, of which one half, he says, remains in the sugar, the analyst ascribes very properly the deliquescence and deterioration of the sugar when kept for some time or transported. It was probably the juice of the cane grown in the rich alluvial soil of Louisiana, and therefore more abundant in saline matter than the average soil of our West India islands. The Demerara cane-juice has perhaps the above saline constitution, as it suffers much loss of weight by drainage in the home voyage.

SUGAR OF POTATOES, GRAPES, or STARCH. About two years ago a sample of sweet mucilaginous liquid was sent to me for analysis, by the Honourable the Commissioners of Customs. It was part of a quantity imported in casks at Hull, from Rotterdam. It was called by the importers, "Vegetable Juice." I found it to be imperfectly saccharified starch or fecula; and, on my reporting it as such, it was admitted at a moderate rate of duty.

Three months since I received a sample of a similar liquid from the importer at Hull, with a request that I would examine it chemically. He informed me, that an importation, just made by him of 30 casks of it, had been detained by orders of the Excise, till the sugar duty of 25*s*. per cwt. of solid matter it contained was paid upon it. It was of specific gravity 1·362, and contained 80 per cent. of ill-saccharified fecula.

In the interval between the first importation and the second, an Act of Parliament had been obtained for placing every kind of sugar, from whatever material it was formed, under the provisions of the "Beet-root Sugar Bill." As the saccharometer tables, subservient to the levying of the excise duties, under this Act, were constructed by me, at the request of the President of the Board of Trade, I well knew that 50 per cent. of the syrup of the beet-root was deducted as a waste product, because beet-root molasses is too crude an article for the use of man. Well saccharified starch paste, however, constitutes a syrup, poor indeed in sweetness when compared with cane syrup, or that of the beet-root; but then it does not spontaneously blacken into molasses, by evaporation, as solutions of ordinary sugar never fail to do when they are concentrated, even with great care. Hence the residuary syrups of saccharified fecula may be all worked up into a tolerably white granular mass, which, being crushed, is used by greedy grocers to mix with their dark-brown bastard sugars, to improve their colour.

It is only within two years that sugar has been in this country manufactured from potato starch to any extent, though it has been long an object of commercial enterprise in France, Belgium, and Holland, where the large coarse potatoes are used for this purpose. The raw material must be very cheap there, as well as the labour; for potato flour or starch, for conversion into sugar, has been imported from the continent into this country in large quantities, and sold in London at the low price of 10*s.* per cwt.

The process usually followed by the potato sugar makers, is to mix ·100 gallons of boiling water with every 112 lbs. of the fecula, and 2 lbs of the strongest sulphuric acid. This mixture is boiled about 12 hours in a large vat, made of white deal, having pipes laid along its bottom, which are connected with a high pressure steam-boiler. After being thus saccharified, the acid liquid is neutralized with chalk, filtered, and then evaporated to the density of about 1·300, at the boiling temperature, or exactly 1·342, when cooled to 60°. When syrup of this density is left in repose for some days, it concretes altogether into crystalline tufts, and forms an apparently dry solid, of specific gravity 1·39. When this is exposed to the heat of 220°, it fuses into a liquid nearly as thin as water; on cooling to 150°, it takes the consistence of honey, and at 100° F. it has that of a viscid varnish. It must be left a considerable time at rest before it recovers its granular state. When heated to 270°, it boils briskly, gives off one-tenth of its weight of water, and concretes, on cooling, into a bright yellow, brittle, but very deliquescent mass, like barley sugar. If the syrup be concentrated to a much greater density than 1·340, as to 1·362, or if it be left faintly acidulous, in either case it will not granulate, but will remain either a viscid magma or become a concrete mass, which may indeed be pulverized, though it is so deliquescent as to be unfit for the adulteration of raw sugar. The Hull juice is in this predicament, and is therefore, in my opinion, hardly amenable to the new sugar law, as it cannot by any means be worked up into even the semblance of sugar.

Good Muscovado sugar, from Jamaica, fuses only when heated to 280°, but it turns immediately dark-brown, from the disengagement of some of its carbon, at that temperature, and becomes, in fact, the substance called "caramel" by the French, which is used for colouring brandies, white wines, and liqueurs.

Thus we see that starch or grape sugar is well distinguished from cane sugar, by its fusibility, at a moderate heat, and its inalterability at a pretty high heat. Its sweetening power is only two-fifths of that of ordinary sugar. A good criterion of incompletely formed starch sugar is, its resisting the action of sulphuric acid, while perfectly saccharified starch or cane sugar is readily decomposed by it. If, to a strong solution of imperfectly saccharified grape sugar, nearly boiling hot, one drop of strong sulphuric acid be let fall, no perceptible change will ensue, but if the acid be dropped into solutions of either of the other two sugars, black carbonaceous particles will make their appearance.

The article which was lately detained by the Excise, for the high duties, at Hull, is not affected by sulphuric acid, like the solutions of cane sugar, and of the well-made potato sugar of London; and for this reason I gave my opinion in favour of admitting the so-called vegetable juice at a moderate rate of duty.

I subjected the solid matter, obtained by evaporating the Hull juice, to ultimate analysis, by peroxide of copper, in a combustion tube, with all the requisite precautions, and obtained, in one experiment, 37 per cent. of carbon; and in another 38 per cent., when the substance had been dried in an air-bath, heated to 275°. The difference to 100, is hydrogen and oxygen, in the proportion to form water. Now this is nearly the constitution of starch. Cane sugar contains about 5 per cent. more carbon, whereby it readily evolves this black element, by the action of heat or sulphuric acid.

An ingenious memoir, by Mr. Trommer, upon the distinguishing criteria of gum, dextrine, grape sugar, and cane sugar, has been published in the 39th volume of the "Annalen der Chemie und Pharmacie." I have repeated his experiments, and find them to give correct results, when modified in a certain way. His general plan is to expose the hydrate of copper to the action of solutions of the above-mentioned vegetable products. He first renders the solution alkaline, then adds solution of sulphate of copper to it, and either heats the mixture or leaves it for some time in the cold. By pursuing his directions, I encountered contradictory results; but by the following method, I have secured uniform success, in applying the criteria, and have even arrived at a method of determining, by a direct test, the quantity of sugar in diabetic urine.

I dissolve a weighed portion of sulphate of copper in a measured quantity of water, and make the solution *faintly* alkaline, as tested with turmeric paper, by the addition of potash lye, in the cold; for if the mixture be hot, a portion of the disengaged green hydrate of copper is converted into black oxide. This mixture being always agitated before applying it, forms the test liquor. If a few drops of it be introduced into a solution of gum, no change ensues on the hydrate of copper, even at a boiling heat, which shows that a gummate of copper is formed, which resists decomposition; but the cupreous mixture, without the gum, is rapidly blackened at the boiling temperature. I do not find that the gummate is re-dissolved by an excess of water, as Trommer affirms.

Starch and tragacanth comport like gum, in which respect I agree with Trommer. Starch, however, possesses already a perfect criterion, in iodine water. Mr. Trommer says, that solution of dextrine affords a deep blue coloured liquid, without a trace of precipitate; and that when his mixture is heated to 85° C., it deposits red grains of protoxide of copper, soluble in muriatic acid. I think these phenomena are dependent, in some measure, upon the degree of alkaline excess in the mixture. I find, that solution of dextrine, treated in my way, hardly changes in the cold; but when heated slightly, it becomes green, and by brisk boiling an olive tint is produced. It thus betrays its tendency of transition into sugar.

Solution of cane sugar, similarly treated, undergoes no change in the cold at the end of two days; and very little change of colour even at a boiling heat, if not too concentrated. Cane sugar, treated by Trommer in his way, becomes of a deep blue; it can be boiled with potash in excess, without any separation of orange-red oxide of copper.

Starch or grape sugar has a marvellous power of reducing the green hydrate of copper to the orange oxide. I find, however, that it will not act upon the pure blue hydrate, even when recently precipitated; it needs the addition, in every case, of a small portion of alkali. Yet ammonia does not seem to serve the purpose; for, in using the ammonia-sulphate of copper, in solution, I obtained unsatisfactory results with the above vegetable products.

The black oxide of copper is not affected by being boiled in solution of starch sugar.

"If solution of grape sugar," says Trommer, "and potash, be treated with a solution of sulphate of copper, till the separated hydrate is re-dissolved, a precipitate of red oxide will soon take place, at common temperatures, but it immediately forms, if the mixture is heated. A liquid containing $\frac{1}{100\,000}$ of grape sugar, even one-millionth part," says he, "gives a perceptible tinge (orange), if the light is let fall upon it." To obtain such a minute result, very great nicety must be used in the dose of alkali, which I have found it extremely difficult to hit. With my regulated alkaline mixture, however, I never fail in discovering an exceedingly small portion of starch sugar, even when mixed with Muscovado sugar; and thus an excellent method is afforded of detecting the frauds of the grocers.

I find, that manna deoxidizes the green hydrate of copper slowly when heated, but not nearly to the same extent as grape sugar, which reduces it rapidly to the orange oxide.

If an excess of the hydrate of copper test be used, there will be a deposit of green hydrate at the bottom of the vessel, under the orange oxide.

To apply these researches to the sugar of diabetic urine: — This should first be boiled briskly to decompose the urea, and to dissipate its elements in the form of ammonia, as well as to concentrate the saccharine matter, whereby the test becomes more efficacious. Then add to the boiling urine, in a few drops at a time, the cupreous mixture, containing a known quantity of sulphate of copper, till the whole assumes a greenish tint, and continue the heat until the colour becomes bright orange. Should it remain green, it is a proof that more hydrate of copper has been introduced than has been equivalent to the deoxidixing power of the starch sugar. I have found that one grain of sulphate of copper in solution, supersaturated very slightly with potash, is decomposed with the production of orange protoxide, by about 3 grains of potato sugar; or, more exactly, 30 parts of the said sulphate, in the state of an alkaline hydrate of copper, pass altogether into the state of orange oxide, by means of 100 parts of granular starch sugar. Thus, for every 3 grains of sulphate so changed, 10 grains of sugar may be estimated to exist in diabetic urine.

Acetate of copper may be used in the above experiments, but it is not so good as the sulphate. The chloride of copper does not answer.

Specific gravity is also an important criterion, applied to sugars; that of the cane and beet-root is 1·577; that of starch sugar, in crystalline tufts, is 1·39, or perhaps 1·40, as it varies a little with its state of dryness. At 1·342, syrup of the cane contains 70 per cent. of sugar; at the same density, syrup of starch sugar contains 75½ per cent. of concrete matter, dried at 260° F., and therefore freed from the 10 per cent. of water which it contains in the granular state. Thus, another distinction is obtained between the two sugars, in the relative densities of their solutions, at like saccharine contents per cent.

SULPHATE OF AMMONIA. This salt, now so extensively used in preparing artificial manures and imitations of guano, for farmers, is made of great purity, and at an economical rate, by the patent process of Mr. Croll, described under the article Gas. A mixture of 10 per cent. of this sulphate with 20 of bone-dust, some gypsum, and farmyard manure, will form a very fertilising compost, applicable to a great variety of soils.

SULPHURIC ACID. A valuable improvement of the process for manufacturing this fundamental chemical agent has been lately contrived by M. Gay Lussac, and made the subject of a patent in this country by his agent M. Sautter. It consists in causing the waste gas of the vitriol chamber to ascend through the *chemical cascade* of M. Clement Desormes, and to encounter there a stream of sulphuric acid of specific gravity 1·750. The nitrous acid gas, which is in a well regulated chamber always slightly redundant, is perfectly absorbed by the said sulphuric acid; which, thus impregnated, is made to trickle down through another cascade, up through which passes a current of sulphurous acid, from the combustion of sulphur in a little adjoining chamber. The condensed nitrous acid gas is thereby immediately transformed into nitrous gas (deutoxide of azote) which is transmitted from this second cascade into the large vitriol chamber, and there exercises its well known reaction upon its aeriform contents. The economy thus effected in the sulphuric acid manufacture is such that for 100 parts of sulphur 3 of nitrate of soda will suffice, instead of 9 or 10 as usually consumed.

Upon the formation of sulphated nitrous gas (NO^2, $3SO^3$, $2HO$), and its combination with oil of vitriol, the manufacture of hydrated-sulphuric acid is founded. Either sulphur is burned in mixture with about one-ninth of saltpetre; whence along with sulphurous acid gas, nitrous oxide gas is disengaged, while sulphate of potash remains; thus $KO, NO^5 + S = SO^3 + NO^2, KO$. 2. Or, nitric acid in the fluid or vaporous form may be present in the lead-chamber, into which the sulphurous acid gas passes, in consequence of placing in the flames of the sulphur a pan, charged with a mixture of sulphuric acid and nitre or nitrate of soda. This nitric acid being decomposed by a portion of the sulphurous acid, there will result sulphuric acid and nitrous gas. By the mutual re-action of the sulphurous and nitric acids, sulphuric acid and nitrous gas will be produced; $NO^5 + 3SO = NO^2 + 3SO^3$. 3. Or, by heating sugar or starch with nitric acid, the mixture of nitrous gas and nitrous acid vapour which results, may be thrown into the chamber among the sulphurous acid. In any one of these three cases, sulphurous acid gas, nitrous acid vapours (proceeding from the mixture of nitrous oxide and atmospherical oxygen) and steam are mingled together; whence arises the crystalline compound of sulphated nitrous oxide with sulphuric acid, which compound subsides in white clouds to the bottom of the chamber, and dissolves in the dilute oil of vitriol placed there, into sulphuric acid, with disengagement of nitrous gas. This gas now forms, with the remaining atmospherical oxygen, nitrous acid vapours once more, which condense a fresh portion of sulphurous acid gas into the above crystalline compound; and thus in perpetual alternation.

Sulphurous acid gas does not act upon nitrous gas, not even upon the nitrous acid vapour produced by the admission of oxygen, if water be absent; but the moment that a little steam is admitted the crystalline compound is condensed. The presence of much sulphuric acid favours the formation of the sulphated nitrous gas. These crystals are decomposed by tepid water with disengagement of nitrous gas, which seizes the oxygen present and becomes nitrous acid (hyponitric of many chemists).

T.

TEA. This well-known plant has recently acquired peculiar interest among men of science, both in a chemical and physiological point of view. In its composition it approaches by the quantity of azote it contains to animalized matter, and it seems thereby qualified, according to Liebig, to exercise an extraordinary action on some of the functions of animals, especially the secretion of bile. The chemical principle characteristic of tea, coffee, and cocoa beans, is one and the same when equally purified, from whichever of these substances it is extracted; and is called indifferently either Theine or Caffeine. Mulder takes it from tea, by treating the evaporated extract by hot water, with calcined magnesia, filtering the mixture, evaporating to dryness the liquor which passes through, and digesting the residuum in ether. This solution being distilled, the ether passes over, and the theine remains in the retort. This principle is extracted in the same way from ground raw coffee and from *guarana*, a preparation of the seeds of *Paullinia*, highly valued by the Brazilians. Theine, when pure, crystallises in fine glossy needles, like white silk, which lose, at the heat of boiling water, 8 per cent. of their weight, constituting its two atoms of water of crystallisation. These needles are bitter tasted. They melt at 350° F., and sublime at 543° without decomposing. The crystals dried at 250° dissolve in 98 parts of cold water, 97 of alcohol, and 194 parts of ether. In their ordinary state, they are but little more soluble in these menstrua. Theine is a feeble base, and is precipitable by tannin alone from its solutions.

Mr. Stenhouse prepares theine by precipitating a decoction of tea with solution of acetate of lead, evaporating the filtered liquor to a dry extract, and exposing this extract to a subliming heat in a shallow iron pan, whose mouth is covered flatly with porous paper luted round the edges, as a filter to the vapour, and surmounted with a cap of compact paper, as a receiver to the crystals. In this way he obtained, at a maximum, only 1·37 from 100·00 of tea. But M. Peligot, from the quantity of azote amounting to about 6 per cent., which he found in the tea leaves, being led to believe that much more theine existed in them than had hitherto been obtained, adopted the following improved process of extraction. To the hot infusion of tea, subacetate of lead and then ammonia were added; through the filtered liquor a current of sulphuretted hydrogen was passed to throw down all the lead, and the clear liquid being evaporated at a gentle heat afforded, on cooling, an abundant crop of crystals. By re-evaporation of the mother liquor, more crystals were procured, amounting altogether to from 5 to 6 out of 100 of tea.

The composition of theine may be represented by the chemical formula, C^8, H^5, N^2, O^2; whence it appears to contain no less than 29 per cent. of nitrogen or azote.

Peligot found, on an average, in 100 parts of—

	Parts soluble in boiling Water.
Dried black teas	43·2
——— green teas	47·1
Black teas, as sold	38·4
Green teas, ditto	43·4

Tea, by Mulder's general analysis, has a very complex constitution; 100 parts contain—

	Green.	Black.
Essential oil (to which the flavour is due)	0·79	0·60
Chlorophyle (leaf-green matter)	2·22	1·84
Wax	0·28	
Resin	2·22	3·64
Gum	8·56	7·28
Tannin	17·80	12·88
Theine	0·43*	0·46
Extractive matter	22·80	19·88
Do., dark-coloured	—	1·48
Colourable matter separable by muriatic acid	23·60	19·12
Albumine	3·00	2·80
Vegetable fibre	17·08	28·32
Ashes	5·56	5·24

Since the proportion of azote in theine and caffeine is so much greater than even in any animal compound, urea and uric acid excepted, and since so many different nations have been, as it were, instinctively led to the extensive use of tea, coffee, and chocolate or cocoa, as articles of food and enlivening beverage, which agree in no feature or property, but in the possession of one peculiar chemical principle, we must conclude that the constitution of these vegetable products is no random freak of nature, but that it has been ordained by Divine Wisdom for performing beneficial effects on the human race. Hitherto, indeed, medicine, a conjectural art, exercised too much by men superficially skilled in the science of nature, and the slaves or abettors of baseless hypotheses, has laid tea and coffee generally under its ban, equally infallible with the multitude, as that of the Pope in the older time, and has denounced their use, as causing a variety of nervous and other *nosological* maladies. But Chemistry, advancing with her unquenchable torch into the darkest domains of Nature, has now unveiled the mystery, and displayed those elemental transformations of the organic functions in the human body, to which tea and coffee contribute a salutary and powerful aid.

Liebig, in his admirable researches into the kingdoms of life, has been led to infer that the bile is one of the products resulting from the decomposition of the animal tissues, and that our animal food may be resolved by the action of oxygen, so amply applied to the lungs in respiration, into bile and urea, the characteristic constituent of urine.

When the consumption of tissue in man is small, as among mankind in the artificial state of life, with little exercise and consequently languid digestion, assimilation, and decomposition, the constant use of substances rich in azotised compounds, closely analogous to the chief principle of the bile, must assist powerfully in the production of this secretion, so essential to the healthy action of the bowels and other organs. Liebig has fully proved that the bile is not an excrementitious fluid, merely to be rejected, as

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* This constituent is obviously much underrated.

a prejudicial inmate of the system, but that it serves, after secretion, some important purpose in the animal economy, being, in particular, subservient to respiration.

I shall conclude these remarks, perhaps more appropriate to a work on chemistry than to the present, by stating the relation between *theine* and the animal product *taurine*, the characteristic constituent of bile.

$$\left.\begin{array}{lll} \text{One atom of theine} & - \ = & C_8,\ N_2,\ H_5,\ O_2 \\ \text{Nine atoms of water} & - \ = & \qquad\quad H_9,\ O_9 \\ \text{Nine atoms of oxygen} & - \ = & \qquad\qquad\quad O_9 \end{array}\right\} = \overset{\text{Two atoms of taurine.}}{C_8,\ N_2,\ H_{14},\ O_{20}}.$$

The letters C, N, H, O, denote carbon, nitrogen or azote, hydrogen, and oxygen; and the figures attached to each, the number of atoms; one atom of carbon being 6, one of azote 14, one of hydrogen 1, and one of oxygen 8; from which the composition of the bodies, theine and taurine, may be easily computed for 100 parts. Now, supposing one tenth of the bile to consist of solid matter, and this solid matter to be choleic acid (resolvable into taurine but different from it), which contains 3·87 of nitrogen, then 2·8 grains of theine would afford to 480 grains of bile (supposed solid, or 4,800 grains in its ordinary state) all the nitrogen required for the constitution of *taurine*, its peculiar crystalline principle.

It may be remarked here, however, with regard to tea and coffee, that while they agree in the main feature, they differ in some others, and especially in the large proportion of tannin in the former, and its non-existence, according to my experiments, in the latter, notwithstanding the statement of its presence in many chemical works. Hence, tea may act injuriously in persons of *Cretian* habits*, while coffee has no constipating power, however much it may cause excitement and heat under certain idiosyncrasies.

A pure, agreeable, and convenient concentrated preparation of tea and coffee has been recently made the subject of an ingenious patent by Mr. Staite, which I can recommend as being made from the best articles in the market, by a perfectly wholesome apparatus and process. The patentee has printed a little explanatory pamphlet on the object of his improvement, from which the following extracts are taken: —

" The quantity of tea grown and consumed in China cannot be ascertained, but the consumption of Europe and America may be taken as follows: —

Russia - - -	6,500,000 lbs.
United States of America	8,000,000
France - - -	2,000,000
Holland - - -	2,800,000
Other countries - -	2,000,000
Great Britain - -	50,000,000
	71,300,000 lbs. or 31,830 tons.

" The number of tea-dealers in the year 1839 was, in England, 82,794; in Scotland, 13,611; and in Ireland, 12,744; making a total of 109,179. It is presumed that in consequence of the increased population their number at present must exceed 120,000.

" The observations of Liebig afford a satisfactory explanation of the cause of the great partiality of the poor not only for tea, but for tea of an expensive and superior kind. He says, ' We shall never certainly be able to discover how men were first led to the use of the hot infusion of the leaves of a certain shrub (tea), or of a decoction of certain roasted seeds (coffee). Some cause there must be, which will explain how the practice has become a necessary of life to all nations. But it is still more remarkable, that the beneficial effects of both plants on the health must be ascribed to one and the same substance (*théine* or *caffeine*), the presence of which in two vegetables, belonging to natural families, the products of different quarters of the globe, could hardly have presented itself to the boldest imagination. Yet recent researches have shown, in such a manner as to exclude all doubt, that *théine* and *caffeine* are in all respects identical.' And he adds, ' That we may consider these vegetable compounds, so remarkable for their action on the brain, and the substance of the organs of motion, as elements of food for organs as yet unknown, which are destined to convert the blood into nervous substance, and thus recruit the energy of the moving and thinking faculties.' Such a discovery gives great importance to tea and coffee, in a physiological and medical point of view.

" At a meeting of the Academy of Sciences, in Paris, lately held, M. Peligot read a paper on the Chemical Combinations of Tea. He stated, that tea contained essential principles of nutrition, far exceeding in importance its stimulating properties; and showed that tea is, in every respect, one of the most desirable articles of general use.

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* Titus, chap. i. v. 12.

One of his experiments on the nutritious qualities of tea, as compared with those of soup, was decidedly in favour of the former.

"Coffee is grown in Brazil, Cuba, Hayti, Java, British West Indies, Dutch Guiana, States of South America, French West India Colonies, Porto Rico, Sumatra, Ceylon, Bourbon, Manilla and Mocha. Brazil produces the largest quantity, 72,000,000 pounds weight; and the other states and colonies according to the order in which they are enumerated, down to Mocha, which produces the least, or 1,000,000 pounds; making a total of 346,000,000 pounds, equal to the consumption of the enormous quantity of 2,900 tons weekly, or 150,800 tons per annum.

"From the official returns, the quantities of coffee exported in one year from the different places of production were 154,550 tons: —

	TONS.		TONS.
To France	29,650	Denmark	1,400
U. S. of America	46,070	Spain	1,000
Trieste	9,000	Prussia	930
Hamburg	20,620	Naples and Sicily	640
Antwerp	10,000	Venice	320
Amsterdam	8,530	Fiume	170
Bremen	4,500	Great Britain (average of 10 yrs.)	18,250
St. Petersburg	2,000		
Norway and Sweden	1,470		154,550

"Every reflecting man will admit, that articles of such vast consumption as tea and coffee (amounting together to more than 185,000 tons annually), forming the chief liquid food of a whole nation, must exercise a great influence upon the health of the people, and that any discovery which tends to the purification of these alimentary drinks, rendering them more wholesome, without rendering them less agreeable, is a great boon conferred upon society.

"The inventor and manufacturers of the 'Pure Concentrated Fluid Essence of Tea and Coffee,' hope that the convenient and portable form in which they are enabled to offer them to the public (in 'Rand's Patent Collapsible Tubes,' made of pure tin, whereby all the usual trouble and inconvenience of making tea and coffee are avoided), affords rational grounds (in addition to more important considerations) for anticipating an extensive sale."

TOBACCO. This important subject of our national revenue has been, during the last session of parliament, very fully investigated, in reference to the smuggling and adulteration carried to an enormous extent, and hitherto but little checked by all the efforts of the officers of the customs and excise. Mr. Joseph Hume, M. P., who moved the appointment of the committee of the House of Commons, and of which he was chairman, proposed a reduction of duty from 3*s.* 2*d.* a pound to 1*s.*, as the only effectual remedy against these joint evils; but he was counteracted by Mr. Goulbourn, chancellor of the exchequer, and a majority of the members of the committee, on the score that the state of the national finances did not permit such a defalcation of income as that reduction would occasion. It would appear, from a great mass of evidence, that much more tobacco is introduced illicitly than what duty is paid upon, and that very great adulterations are practised. The following statement shows the temptations: —

Virginia leaf costs	in bond	3½*d.*	per lib., the duty is	1,100	per cent.
Ditto strips	„	5½*d.*	„	700	„
Kentucky leaf	„	3¼*d.*	„	1,200	„
Ditto strips	„	4¾*d.*	„	800	„
Havannah cigars	„	8*s.*	„	112	„
Manilla cheroots	„	6*s.*	„	150	„
East India cheroots	„	1*s.*	„	900	„
Negrohead and Cavendish		6*d.*	„	1,800	„

Rates of duty on tobacco in foreign countries: —

		Per English Pound.			Per English Pound.
Austria	— leaf tobacco	3*d.*	Other German States		½*d.*
Belgium	ditto	¼*d.*	Hamburgh	⅔ per cent. ad valorem.	
Bremen	ditto, ½ per cent. ad valorem.		Holland	2 per cent. ad valorem.	
Denmark	leaves and stems	¼*d.*	Ditto, cigars		2*d.*
Prussia	Zoll-Verein States	2*d.*	Ionian islands,	leaf stems	2*d.*
Saxony			Ditto,	manufactured	3*d.*
Bavaria			Russia	30 per cent. ad valorem on foreign.	
Brunswick			Sweden and Norway		about 1*d.*
Würtemberg					
Frankfort on the Maine					

A strict royal monopoly (*régie*) exists in Austria Proper, France, Sardinia, the Duchies of Parma and Lucca, and the Grand Duchy of Tuscany; and in Portugal, Spain, Naples, and the States of the Church, the licence to manufacture is periodically sold to companies, which regulate the prices of tobacco as they please. It will be found that the situation of all these countries where the monopolies and high prices are kept up, is nearly the same, as to illicit trade in tobacco, as in England.

In the years 1841, 1842, and 1843, the average revenue in this country on tobacco, at 3*s.* 2*d.* per lb., was 3,635,105*l.*

The greater part of the committee's report is occupied with the examination of witnesses as to the extent, modes, facilities, and chief localities of the illicit trade. It exhibits a great body of very curious and useful information, and demonstrates, beyond a doubt, that no measure short of a reduction of the duty to 1*s.* per lb. can put a stop to it.

The portion of the Report most interesting to the readers of the present work will probably be found to be the scientific evidence as to the means of detecting adulteration.

The society of tobacco manufacturers in London, desirous of ascertaining how far chemistry could detect adulteration in tobacco, mixed four samples with different materials. No. 1. contained 5 per cent. of refined sugar; No. 2. 10 per cent. of extraneous matter, viz. sugar and common salt; No. 3. 15 per cent. of extraneous matter. the one half of it sugar, and the other half a certain powder used by the trade; No. 4. 15 per cent. also, consisting of about 3 parts sugar, and 1 part *terra japonica* (catechu). These four samples were placed in the hands of Mr. A. Garden, chemist, of Oxford Street, for analysis, who made the following report upon their composition: —

> "The leaves of the tobacco-plant, in addition to the vegetable principles of which they are chiefly composed, are known to contain a considerable number of saline and earthy substances, and which no doubt ought to be regarded as legitimate constituents of the plant. The proportion which these saline substances bear to the whole vegetable mass is, it is true, but small, yet it becomes a question how far the presence of these salts, in quantities somewhat larger than those in which they are generally found to exist, can fairly be referred to a process of adulteration. The five samples of tobacco sent to me for examination do not appear to differ very widely from one another. After the removal of all the vegetable matter, they have, on an average, yielded 14 per cent. of solid substances, consisting of soluble and insoluble saline and earthy compounds, the principal of which are as follow: sulphate and phosphate of lime, carbonate of potash, muriate of ammonia and soda, sulphate of iron, malate of lime, and siliceous earth. The specimens marked 1, 2, and 4*, are exceedingly similar; that marked genuine contains about 2 per cent. less than the others, and the specimen No. 4. (3. as stated above) is remarkable for having yielded a proportion of oxide of iron, which would almost lead to the supposition that sulphate of iron had been introduced. The other samples, it is true, also afforded evidence of the presence of iron, but in such minute quantity as might easily be accounted for by the contact of iron vessels or instruments, in the transports or manipulations to which the articles may have been exposed.
>
> (Signed) "A. GARDEN."

Mr. Rogers, chairman of the Tobacconists' Society, who superintended the adulteration, states that no iron or copperas was put into any of them; that Mr. Garden had them some time under process, having received them in May or June, and having made his report on the 26th of August, 1843. "The manufacturers, in consequence of that report, came to the conclusion that the analysation was not satisfactory, and could not be done, so far as that process was concerned."

Mr. Joseph Hume, M.P., under instructions from the committee, requested two chemists, Mr. Heathfield and Mr. Edward Solly, jun., each to prepare six samples in the presence of two members of the committee. That was done, and the samples were sent to the Excise Board, and during ten or twelve days were carefully analysed by the three chemists employed by the board to detect adulteration. The evidence of these three gentlemen, viz. Professor Graham, Mr. Richard, and Mr. George Phillips, will explain the course they took to carry on the analysis; and the following are the results: —

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* 6 in the original, but altered by me to 4, as denoting the fourth of the adulterated samples. The fifth was genuine tobacco.

Particulars of Six Samples of Tobacco, prepared as above, in the presence of Sir Charles Douglas, M.P., and Mr. Ewart, M.P., Members of the Committee.

No. I., marked X.

9 lbs. 8 oz. of tobacco, with 1 lib. 8 oz. of garden rhubarb leaves, about 16 per cent., or 12½ per cent. in 100 parts.

No. II., marked K.

9 lbs. 6 oz. of tobacco, with 1 lib. foxglove leaves. About 10 per cent. added, or $9\frac{52}{100}$ in 100 parts.

No. III., marked N.

11 lbs. 11 oz. tobacco, mixed with 8 oz. brown paper, soaked in decoction of sarsaparilla. 10½ oz. syrup of sugar, combining solid sugar, 7 or 8 dwts.; 1 oz. of saltpetre, and ½ oz. of alum; in all, 18½ oz. About 8 per cent. added, or 7·54 in 100 parts.

No. IV., marked F.

11 libs. 14 oz. of tobacco, mixed with chicory root, dried and powdered, Irish moss glutenised, carbonate of potash, sulphate of potash, carbonate of magnesia, and carbonate of lime, about 9 oz., or about 5¼ per cent., or 4 in 100 parts.

No. V., marked O.

13 lbs. 9 oz. of tobacco, mixed with 12 oz. of ground tobacco stalks.

No. VI., marked R.

11 libs. 4 oz. No adulteration.

Report of the Analysis of the first Series of Six Samples, by Messrs. Richard Phillips, Graham, and George Phillips, 7th June, 1844.

No. I., marked X.

Adulterated with the leaves of garden rhubarb; the amount of the adulteration is estimated at 3·3 per cent.

No. II., marked K.

Adulterated by a green leaf, not tobacco, which appears to belong to a plant of the same natural family, probably the potato; the amount of the adulteration estimated at 3·9 per cent.

No. III., marked N.

Adulterated with brown paper or millboard, and also with sugar; the amount of the first adulteration is estimated at 6 per cent., of the second 1½ or two per cent.

No. IV., marked F.

Adulterated with a vegetable matter, not tobacco, the nature of which we are not agreed upon. The amount of this adulteration is estimated at 1·2 per cent. There is reason to suspect the addition to this tobacco of both sand and sugar, in small quantity.

No. V., marked O.

Adulterated with sand and sugar; the amount of the first adulteration is estimated at 2 per cent.; of the second at 3 per cent.

No. VI., marked R.

Genuine, but with a proportion of sand unusually high.

Particulars of Six Samples of Tobacco, mixed and sealed up at Mr. Rogers's, 392. Oxford Street, in the presence of Sir Charles Douglas and Mr. Ewart, by Edward Solly, jun. Esq.

No. I., marked C.

Adulterated with sugar of milk	5
Terra japonica	1
Nitrate of potash	1
Alum	1
Total per cent.	8

No. II., marked L.

Adulterated with refined sugar	3
Terra japonica	1
Carbonate of potash	1
Common salt	1
Total per cent.	6

No. III., marked Q.

Adulterated with refined sugar	2
Crude nitrate of ammonia	4
Common salt	1
Muriate of potash	0·5
Nitrate of potash	0·5
Alum	1·0
Total per cent.	9

No. IV., marked P.

Adulterated with sugar of milk	5
Refined sugar	3
Common salt	1
Carbonate of potash	1
Total per cent.	10

No. V., marked B.

Not adulterated at all.

No. VI., marked M.

Not adulterated at all.

Second Series of Six Samples, signed Rogers and Son, marked as under, analysed by Messrs. Richard and George Phillips, and Thomas Graham.

No. I., marked C.

Adulterated with sugar, the adulteration estimated at 1 per cent.

No. II., marked L.

Adulterated with sugar, the adulteration estimated at 3 per cent.

No. III., marked Q.

Adulterated with sugar, the adulteration estimated at 2 per cent.

No. IV., marked P.

Adulterated with sugar, the adulteration estimated at 4 per cent.

No. V., marked B.

Genuine; grains of sugar were, however, found in it and picked out, but the quantity so small, that we allow their introduction to be accidental.

No. VI., marked M.

Adulterated with loaf-bread, which has been cut up in the same manner as the tobacco; the amount of this adulteration was not estimated, but is small; the sample contains also a little sugar.

It appears from the preceding statement, that the chemists made no attempt at a true chemical analysis, but contented themselves with a physical examination of the appearances, and with the single process of fermentation to detect sugar, by the production of alcohol; and yet they declare the presence of sugar in the tobacco which contained none; as in samples F, O, and B. They did not search for saline matter, such as nitrate of potash, alum, common salt, nitrate of ammonia, muriate of potash, or carbonate of potash, and in fact do not seem to have made any analytical research for any such foreign bodies; so that if the sugar had been left out (as a skilful adulterator would have done), and if the foxglove leaves had been well browned by tobacco juice, none of the adulterations would have been detected.

Mr. R. Phillips says, in his examination before the Committee, "generally speaking we did not employ chemical tests," but it was principally by mechanical analysis and examination of the plant that they judged. When asked if he could obtain alcohol from sugar of milk, Mr. R. Phillips replies, "I think not." Question 7555.

"7597. *Chairman.*— Will you (Mr. R. Phillips) look at your report, letter C, adulterated with sugar estimated at 1 per cent.; I asked you the question, whether you could discover the adulteration, if made with sugar of milk? and your answer was No, I believe not, for I think it would not ferment.

"7598. That specimen was mixed with 5 per cent. of sugar of milk, and 3 per cent. of other articles, earthy matters, making altogether 8 per cent.; your report is, 'adulterated with sugar, estimated at 1 per cent.;' how do you reconcile your detecting sugar there, when you said that you could not detect sugar of milk?—I said that I spoke from the best of my recollection, and that is my recollection."

"7632. Letter O, you (Mr. R. Phillips) report as being 'adulterated with sand and sugar; the amount of the first estimated at 2, and the second at 3 per cent.,' therefore that is reported as adulterated to the extent of 5 per cent.?—Yes.

"7633. That specimen is stated to be '13 pounds 9 ounces of tobacco mixed with 12 ounces of ground stalk;' what should you say to that? Are you perfectly satisfied that the sugar in this specimen was foreign matter?—I have no doubt of it; and with respect to the increased quantity of sand, that might come in with the increased quantity of stalks, which always contain a larger quantity than leaf tobacco.

"7637. But are you the least shaken in your opinion as to this analysis, by its being stated to you, that that which was presented to you was tobacco mixed with 12 ounces of stalk? *Not the least, neither with respect to sugar nor sand; confirmed with respect to sand, and not shaken with regard to sugar.*"

"7640. Here is an addition of *eight* per cent. of stalk; do you imagine that that would give *two* per cent. of sand upon the whole amount?—It seems a large amount, but I cannot account for it in any other way; it would increase it, but I cannot say to what amount."

"7645. Taking the specimen letter Q, on which you were before examined, in which you have stated, 'adulteration at 2 per cent.;' if informed that eight per cent. of muriate of potash, and other soluble matters were mixed, do you not consider that tobacco might be adulterated by those matters, which you could not discover as adulterations, to the extent of 5 or 6 per cent., without the possibility of detection?—I think they might, with such matter as that, without the possibility of detection."

Mr. R. Phillips says, in answer to Question 7673, that he never saw nicotine, and "never saw any body that saw it." Now he has seen me often, and I have a specimen of pure nicotine, which I showed to the Committee in my examination, and which I shall be happy to show him at any time.

"Mr. George Phillips called in and examined.

"7767. What situation do you hold in the excise?—That of an examiner.

"7768. What are the duties of an examiner?—They are various, but I have been employed chemically.

"7769. How long have you been in that situation?—About two years.

"7773. Have you been educated as a chemist?—No, I am self-educated.

"7775. Have you examined all those specimens which have been suspected to be adulterated tobacco?—Yes, I have examined the whole of them.

"7776. And you were employed at Gainsborough, Liverpool, and Manchester, in those different seizures and trials which took place?—Yes, I was present at the whole of them.

"7777. You were also associated with Mr. Richard Phillips and Professor Graham, in making inquiries into the 12 samples submitted to you?—Yes.

"7780. What time did you take in making these experiments?—I think we were about 12 days.

"7781. In examining the 12 specimens?—Yes.

"7782. Did you sign the report?—Yes."

His process of examination consists in drying the tobacco thoroughly by a heat of from 176° to 182°, in then weighing out 100 grains of it, in digesting that weight in 2½ pints of water of the above temperature, stirring the mixture with a glass rod, leaving it to infuse for 50 minutes, and then separating the liquid from the insoluble matter by a fine strainer or filter. The insoluble part is gently pressed, dried at the above heat, and weighed. In this way Mr. Phillips found, that

	Ligneous.	Extractive.
Virginia hand, the entire leaf and stem gave	46	54
Virginia, stripped, the stem being taken out	49	51
Do. do.	47	53
Kentucky hand	50	50
Do. do.	55·8	44·2
Do. stripped	54·8	45·2
Do. do.	53·3	46·7
Maryland, not stripped	56·9	43·1
Do. do.	57·7	42·3
Mean of Virginia hand experiments	46	54
Do. do. stripped do.	48	52
Do. Kentucky hand	52·9	47·1
Do. do. stripped	54·05	49·95
Do. do. do.	57·3	42·7

After experimenting upon between 500 and 600 different samples, he has never found any to exceed the highest of the above which is 54; though he calls it, in his subsequent examination, 55 of extract.

	Ligneous.	Extractive.
Porto-Rico tobacco-leaf gave	70	30
Columbia do.	61·5	38·5
Do. do.	60·8	39·2
Virginia stalks	48·5	51·5
Kentucky do.	64·1	35·9
Do. do.	66·4	33·6
Turkey	46·8	53·2

"7865. Do you know to what natural family tobacco belongs?—Mr. G. Phillips. I am not a botanist.

"7867. Take the foxglove for instance?—I cannot say whether it belongs to the same family. I know it has not the same character; it is essentially different in character."

Yet the sample marked K, which contained foxglove, maladroitly introduced in the green state, and thus easily distinguishable by the least experienced eye from tobacco, was pronounced by the three chemists to be "adulterated by a green leaf, not tobacco, which appears to belong to a plant of the same natural family, possibly the potatoe." Digitalis belongs to the family Scrophulariæ, not the Solaneæ, like tobacco.

By selecting such tobaccos from the above tables as abound in ligneous matter, imbuing them with a quantity of some cheap vegetable extracts not fermentable into alcohol, drying and pressing them properly, it would be easy to adulterate tobaccos to the amount of 10 or more per cent., and set at defiance this scheme of Mr. G. Phillips. The manufacturer has of course a stock of Virginia tobacco at hand, capable of yielding a like proportion of extract, to cover his deception, which he puts into their hands, *pour leur donner le change*.

"7869. What is the power of microscope you employ?—About 60,000."

Does Mr. G. Phillips mean to say that the linear magnifying power of his microscope is 60,000? There is no such instrument in existence. If he means the area is enlarged by his microscope 60,000 times, he ought to have said so, and the linear power in that case would be about 245 times.

"7877. In what manner do you obtain saline matter from the tobacco?—I first ascertained the amount of ashes: I took 100 grains of Virginia leaf; I burned it to a red heat, not sufficiently high to drive off any thing beyond the carbonaceous matter; those 100 grains of Virginia leaf produced 10·5 of ashes, and it contained 1·3 of sand or silica. The next experiment upon the same leaf gave ashes 11·2, and precisely the same amount of sand as the other 1·3. The next was upon stalk alone, 100 grains of the same tobacco stalk; it gave ashes 16·5, and ·4 of sand. The next, stalk and leaf, was upon 62 grains, which gave ashes 8·2, and ·5 of sand (13·2 and 0·8 per cent.). Now we come to the Kentucky; 100 grains of the Kentucky leaf gave ashes 19·5, sand 1·4; ditto 18·4 and 1·4; 47 grains of stalk and leaf gave ashes 9·5 and sand ·8; (20 and 1·7 per cent.); 100 grains of stalk gave 20·4 and ·9. Another experiment gave the same." Here we have nearly double the proportion of sand from leaf that there is from stalks.

Let us compare these experiments of Mr. G. Phillips with the unlucky counter-statement of Mr. R. Phillips. The former actually finds in the one set of stalks only $\frac{4}{10}$ of 1 per cent. of sand, and $1\frac{3}{10}$, or upwards of three times as much in the leaf; while, in the other set, he finds about one half of sand in the stalks of what was in the leaf. Now Mr. R. Phillips defers to Mr. G. P. as his standard authority on this point. Thus,

" Question 7580. You (Mr. R. Phillips) are not able to state the exact amount of those saline matters which exist in the different kinds of tobacco? — No, I have never tried.

" 7582. You have not, up to this time, made that experiment in the various inquiries you have made? — No, I have not. I have not thought it necessary."

" 7583. You state that the earthy matter found " (in the ashes) " is silica; do you mean sand? —Yes.

" 7584. What is the greatest or the smallest quantity you have found in the genuine tobacco? — I have not got the proportion; I *perhaps* could find it, but I have it not with me.

" 7585. You do not know the *minimum* or the *maximum?* — No, but I believe that can be stated by Mr. George Phillips very accurately."

" 7633. ———. — (Answer of Mr. R. Phillips.) " With respect to the increased quantity of sand, that might come in with the increased quantity of stalks, *which always contain a larger quantity than leaf tobacco.*"

" 7634. Would the proportion of sand be accounted for, in your opinion, by the introduction of 12 oz. of stalks? — I think it would."

Why did not the two Messrs. Phillips compare notes beforehand?

" 7878. Besides silica, what did you (Mr. G. Phillips) find? — Number 36., which produced 19·5; gave carbonate of lime 7·3 grains, silica 1·4, carbonate of potash, and a trace of iron 9·7 grains[*]; that is, it showed the presence of iron, but there was no appreciable quantity. The object of separating it into lime and potash was, that if there had been an introduction of 5 per cent. of potash, I should have had an increased amount of extractive matter " (soluble, he should say) "and an increased amount of ashes; in genuine tobacco, where the extractive proportion is high, the ashes are low."[†]

" 7885. Are there any other articles found, besides the silica and carbonate of lime and potash? — Not by my mode: both lime and potash exist in tobacco, in various quantities, malate and nitrate, and so on; but the amount of each has never been found by any one.[‡]

" 7918. ———. — *Ans.* The only two kinds of tobacco manufactured worth speaking of are Virginia and Kentucky, and they come in strips principally. Now the tobacco-manufacturer might endeavour to defeat us in this way; suppose we endeavour to tie him down, he might mix his tobacco not in the proportion that we expect."

The Excise, though it has no power to tie the manufacturers *down* so hard and fast that they may not use any duty-paid tobacco which they please, yet it is too apt to give rise to a spirit of evasion. When a low-priced Kentucky, poor in extract is laid down, it may be easily enriched with 10 per cent. of some vegetable extract to bring it up to Mr. G. Phillips' standard Virginia pitch of 55.

" 7924. Have you subjected the extract to the process of combustion, in order to ascertain its amount of saline matter?—Not the extract; I make a point of preserving part, in order to experiment upon."

Yet he immediately afterwards declares he makes no experiments upon it.

" 7928. What do the ashes of C consist of?—We did not try that beyond the sand.

" 7929. You have got the ashes 16 by combustion?—Yes we suspected this sample to contain sugar, and also tried for sand."

" 7934. Could you not find alum?—Yes, but it would be impossible to try for the various salts that might be put in tobacco; you might be experimenting for years on one sample."

Relatively to Mr. R. Phillips' explanation of the *rationale* of the production of sand, question 7961 to Mr. G. Phillips affords a flat contradiction. " Could the introduction of 12 ounces of ground stalk into 13 pounds 9 ounces of tobacco, give an adulteration of 3 per cent. of sand?—*It is perfectly* impossible; the stalk contains less sand than the leaf.

" 8032. In any of those 12 specimens that you examined, were you able to distin-

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[*] An extraordinary quantity.

[†] How easy to give this character to tobacco by adding extractive matter from different plants!

[‡] What a rash assertion! He missed an uniform and main constituent, the phosphate of lime.

guish any vegetable mixture besides the tobacco?—We readily distinguished in K, the mixture of foxglove and rhubarb."

There was no rhubarb in K; the foxglove was unluckily conspicuous by its light green colour, and easily picked out. Answer to Question 7858. "So also as regards the rhubarb, the rhubarb is very full of massy strong hairs, which are something like bodkins rather round; they are larger at the end; in fact, where the points of the hairs of tobacco are small, the rhubarb swell out and increase and cross each other in various directions, while those of the tobacco are flattened at the top."

Has the foxglove the same massy hairs as the rhubarb?

With regard to the production of alcohol from the samples of adulterated tobacco, Mr. E. Solly, in his examination before the Committee, makes the following observations in answers to Questions 8350. 8352. "Then you do not consider the mode by which saccharine matter is said to be detected at present to be a good and sufficient test?—I should receive it with very great caution.

"8352.—*Ans.* "I believe that tobacco contains substances that may give rise to the formation of spirit; therefore I think it possible, until the contrary has been proved, that spirit may be formed from fermenting pure tobacco."

Seven samples of tobacco, mixed under the superintendence of the Committee, as above described, were sent to me on the 18th of June last, for analysis, marked B B, C C, F F, M M, O O, Q Q, X X, which I now presume were of like composition to the parcels marked B, C, F, M, O, Q, X, in those sent to the Excise. As I operate always alone in my laboratory, I required naturally a considerable time to perform the several sets of experiments which I deemed requisite *in trying* to detect adulterations in so heterogeneous a compound as tobacco. In my first examination before the Committee, on the 15th July, I stated that my first line of research had been to determine the proportion of azote in each of the above specimens, and compare it with that in genuine tobacco, with the view of ascertaining into which of the parcels, non-azotised plants, such as rhubarb and other indigenous leaves, might have been introduced. For this purpose I took a weighed portion of each tobacco, dried it thoroughly by a gentle steam heat, and found thereby how much moisture it contained.—*See 2d table below.*

	Ammonia.		Azote. in 100 grains.
B B when dry afforded, by ignition with hydrate of soda and quicklime, in an appropriate apparatus	2·55	=	2·1
C C afforded	2·49	=	1·89
F F „	2·38	=	1·96
M M „	3·06	=	2·52
O O „	2·72	=	2·24
Q Q „	3·6	=	2·97
X X „	2·72	=	2·24
Virginia (genuine)	2·6	=	2·14

I was now convinced that no good purpose could be served by this process of analysis, since it appeared that the differences in the proportions of azote resulting from the different proportions of nicotine, albumen, gluten, &c., in the tobacco, were too slight, and most probably too variable, from soil, climate, and mode of culture, to be relied on as tests of purity; and more especially when I found, on trial, that the dried leaves of foxglove afforded 1·96, or nearly 2 per cent. of azote, and that this plant was one likely to be used in making the adulterations. Besides, it appears that X X, which I now perceive to have contained 16 per cent. of rhubarb leaves, afforded as much azote as O O, which was altogether tobacco. Practical chemists are aware that each of the above experiments requires no little time, as well as nicety of manipulation, The results may, I believe, be depended on; they were derived in each case from the decomposition of 50 grains of the dried tobacco. I next dried by a gentle heat, continued for several hours, as long as weight was lost, 200 grains of each sample.

		Dry.	Water at 70° F.	Spec. Grav. of Infusion.	Residuum dried.	Soluble Matter or Extract.
B B lost	11·75 per cent. and	100 gr.	+ 1000	= 1·017	59·5	40·5
C C „	14·5	„	„	= 1·0184	54	46·0
F F „	15	„	„	= 1·017	60	40
M M „	14·75	„	„	= 1·015	71	29
O O „	15·5	„	„	= 1·018	62	38
Q Q „	17·5	„	„	= 1·021	72	28
X X „	17·75	„	„	= 1·019	67	33
Virginia leaf	6·5	„	„	= 1·015	53	47

In a second series of experiments, where 100 grains of each of the dried tobaccos, as under, were digested for two hours in 4000 grains of distilled water, at the temperature of 176° F., the following results were obtained :

	Dried Residuum.	Soluble or Extract.
B B - -	56·7	43·3
C C - -	56·0	44·0
F F - -	54·7	45·3
M M - -	63·7	36·3
O O - -	58·2	41·8
Q Q - -	54·0	46·0
X X - -	57·7	42·3

Thus, by a longer digestion with heat, and a larger quantity of water, more soluble matter or extract is obtained, and also in different proportions, from the same samples.

	Dried Residuum.	Soluble or Extract.
Havannah tobacco -	60·1	39·9
Cuba - - -	62·1	37·9
Virginia - -	53·9	46·1
Kentucky - -	57·2	42·8

It may, moreover, be remarked that none of the tobaccos, either adulterated or genuine, yielded so great a proportion of extract as Mr. G. Phillips asserts.

It will be observed from the table of the specific gravity of the infusions of 100 grains of the respective tobaccos, in 1000 grains of water, at 70° F. (with trituration in a mortar), that Q Q afforded the densest liquor, having a specific gravity of 1·021. I was hence led to imagine that this sample was adulterated with some soluble substances, and possibly with sugar, of which such a handle had been made in the Excise prosecutions. I therefore boiled 1000 grains of that sample with 5000 grains of distilled water, and evaporated the soluble matter to a solid extract, which weighed 400 grains. These were next digested in 3000 grain-measures of alcohol of 0·834, and they left 330 grains insoluble in this menstruum. The matter insoluble in alcohol should have contained the sugar if any were present; but when it was treated with nitric acid of proper density and temperature, it afforded no oxalic acid whatever; even by the test of chloride of calcium. Hence I inferred that if sugar had been mixed with that tobacco, it could not be discovered by probably the best test of sugar in common circumstances; and indeed, on looking now into the actual composition of sample Q, we find it to contain only 2 per cent. of sugar, mixed with 4 of nitrate of ammonia, 1 of common salt, 1 of the mixed nitrates of potash and muriate of potash, and one of alum. As the infusion of 100 grains of X X in 1000 of water was next in density, being 1·019 I treated 1000 grains of it as I had done with Q Q, and obtained 600 grains of watery extract, which, being digested in alcohol, left 330 grains like the preceding. When this also was treated with nitric acid, it afforded no oxalic. I therefore abandoned this line of research as unprofitable.

It occurred to me that muriate or nitrate of ammonia might have been employed in adulterating some of the samples of tobacco. To ascertain this point I distilled 100 grains of each sample along with water and quick-lime, condensing the vapours, and testing the distilled liquid for ammonia : —

B B afforded - - - -	0·68	of ammonia.
C C „ - - - -	0·34	„
F F „ - - - -	0·347	„
M M „ - - - -	0·51	„
O O „ - - - -	0·238	„
Q Q „ - - - -	0·765	„
X X „ - - - -	0·68	„
Kentucky - - - - -	0·58	„
Virginia - - - - -	0·64	„

Ammonia exists in the saline state in all tobaccos, but here in Q Q in notable excess, corresponding to the 4 per cent. of crude nitrate of ammonia, which had been introduced by the mixers. So far this experiment has a positive result.

The filtered cold infusions of 100 grains of each dried sample in 1000 grains of distilled water were examined by many chemical tests, as follows : —

1. Virginia taken as a standard :

Infusion pale brown; acid reaction with litmus paper; nitrate of barytes, O; nitrate of silver, a faint opalescence, but no curdy precipitate; oxalate of ammonia, a faint cloud of calcareous matter; water of ammonia, O; chlorure of tin, a faint white precipitate — hence no sulphuretted hydrogen present; chloride of platinum, a copious white precipitate, from the ammoniacal salt present; acetate of lead, an abundant whitish precipitate, soluble in nitric acid; chloride of iron caused a green tint, and sulphate of copper an olive brown, both resulting from the yellow of the iron and blue of the copper solutions with the brown of the tobacco.

B B afforded the same results with the above tests as the Virginia tobacco: hence it might be inferred to be free from soluble sulphates, muriates, carbonates, &c.

C C, acid reaction like the preceding; nitrate of barytes, a precipitate which, being drained on a filter, washed, dried, and ignited, weighed 2·2 grains; resulting, as it now appears, from the 1 per cent. of alum introduced into that sample.

F F afforded 2·6 sulphate of barytes, resulting from the sulphate of potash introduced into this sample.

M M afforded 0·6 of sulphate of barytes, a quantity belonging to this description of tobacco, derived, no doubt, from the soil — indicating possibly the proportion that should be deducted from that afforded by C C and F F.

O O afforded 0·5 of sulphate of barytes, indicating freedom from any added sulphate.

Q Q, 1 grain of sulphate of barytes, corresponding to the 1 per cent. of alum, which was possibly not uniformly diffused through the parcel; so that probably more of it existed in the portion taken for experiment of C C, than in that taken of Q Q.

X X, sulphate of barytes, 0·8; the small excess here over pure tobacco due to the admixture of rhubarb leaves. It is to be observed, that all these barytic precipitates were insoluble in nitric acid.

After separation by the filter of the barytic precipitates, from the infusions made *with heat*, a definite quantity of solution of nitrate of silver was added to each at once, because it was found impossible to define the point at which that test ceased to produce a change. The phenomena here were singular and puzzling. The phials containing the infusions of B B, C C, F F, O O, had their sides coated with a lively green film, that with X X slightly; those containing M M and Q Q, with a brown film; as also those from the Virginia, Kentucky, Havannah, and Cuba tobaccos; while the contents of F F remained turbid after many days. From these phenomena, it appears that nitrate of silver cannot be advantageously used as a test upon infusions of tobacco made with hot water.

When the infusions of the tobaccos are made in the cold, those hydrogenated principles, which seem to reduce a portion of the oxide of the nitrate of silver, and render its precipitate insoluble in ammonia, are not apparently generated. The nitrate of silver in this case gave the following results.

B B	out of 100 grains infused, yielded - -	1·8 chlorsilver.
C C	- - - - - - -	1·0 „
M M	- - - - - -	1·3 „

These quantities belong to genuine tobacco, as I found on trying the Virginia. The precipitates were insoluble in nitric acid.

My next series of experiments was instituted to determine, by fermentative action, with the addition of good yeast to the infusions of the respective samples, whether sugar could be detected in any of them by the production of alcohol. Accordingly, I infused half a pound avoirdupois, = 3500 grains, of each in 4000 grains of boiling water, strained off the liquor into wide-mouthed phials, introduced into each 800 grains by weight of the best fresh porter-yeast from Messrs. Meux's brewery in my neighbourhood, and enclosed them all in a space, kept at the temperature of 80° F. The specific gravity of each, before the yeast, was very nearly 1·08. After 40 hours, the specific gravities were found to be (at 80°) of: —

B B - - -	1·055	O O - - -	1·049
C C - - -	1·062	Q Q - - -	1·0645
F F - - -	1·055	X X - - -	1·0575
M M - - -	1·056		

The contents of F F being distilled carefully in glass vessels, 700 water-grain measures of liquid were drawn off, which, at 70° F., had the specific gravity, 0·9921.

The contents of O O afforded 700 grain measures of specific gravity, 0·9876; besides 500 grain measures —— of 0·9974.

Contents of B B afforded 700 grain measures of 0·9946, and 240 grain measures of 0·998.

From 2400 grains by weight of the yeast, 700 grain measures of liquor were distilled off, at specific gravity, 0·983.

On the hypothesis that the liquor distilled from the infusions of the three samples of tobacco were alcoholic, the 700 grains of F F would contain about 10 per cent. of proof spirit, or nearly 70 grains.

Alcoholic spirits of 0·983 specific gravity contain 23·3 per cent. of proof spirit; hence 7 × 23·3 = 163·1 grains, of which one third = 54·4 grains, being the product of 800 grains of yeast, had been introduced into each of the tobacco worts. The product of F F is therefore 70—54·4 = 15·6 grains of proof spirit, containing about 7 grains of alcohol—a paltry result, and much too fallacious, whereon to found a fiscal persecution, as we shall presently show.

O O, yielded 700 grain measures of 0·9876, equivalent to 16 per cent. of proof spirit = 112 grains, besides 500 grains of 0·9974, equivalent to 3·2 per cent. of proof = 16 grains of proof; together = 128 grains, from which 54·4 being deducted on account of the yeast spirit, there remain 73·6 of apparent spirit, as the product of the tobacco wash of half a pound of O O.

B B, afforded 760 grains at 0·9946, representing 6·7 per cent. of proof = 50 grains of proof; to which 8½ grains for 240, at 0·998, the sum 58½ represents the whole obtained for this wash, and 54½ being deducted for the yeast spirit, there will remain 4 grains of proof spirit, corresponding to 2 grains of alcohol and 4 grains of sugar in 3500 grains of the tobacco.*

The only inference that can be drawn from these results of experiments carefully conducted on the principles assumed as certain by Professor Graham and the Messrs. Phillips, is that the sample O O contained 73·4 grains or thereby of sugar mixed in the half pound of tobacco; that F F sample contained about 15·6 grains, and B B, 4; whereas, as it appears in the published report that there was no sugar in any one of the three samples, the fallacy of the excise process is manifest.

It would therefore seem, that infusions of tobacco without sugar, when mixed with brisk yeast, and placed for 40 hours in a temperature of about 80°, undergo a certain degree of decomposition; attended with a diminution of their specific gravity, or, in the vulgar language of the Excise, they suffer attenuation. This phenomenon offers no difficulty to any one conversant with organic chemistry. He knows that there are no fewer than twelve different species of fermentation, all involving a specific series of decompositions and recompositions, each occupied with its appropriate subject, and generating peculiar products. See FERMENTATION in this Supplement. I shall advert, in this place, merely to that marvellous metamorphosis which bitter almonds experience by contact of pure water; during which, aided by heat alone, the solid inert matter of the kernel is converted into a volatile, pungent, poisonous, ethereal oil, mixed with hydrocyanic or prussic acid, a fluid lighter than water. Such remarkable changes must be well known to Mr. R. Phillips and Professor Graham, and ought to have made them hesitate before they pronounced a distilled fluid, which is destitute of the smell and taste of alcohol, and which they do not say they had submitted to the requisite ordeal, to be this substance.

If by fermenting the infusion of 3500 grains of tobacco, my distilled products were so slight and fallacious, what could the chemist get from 1000 grains? or, as Mr. Graham is wont to operate, from 200 grains, or less than half an ounce? See Question 7548. Have they ever converted their supposed alcohol into ether, have they made fulminating mercury by its means, or have they extracted olefiant gas out of it? If not, their testimony would have been scouted in any of our great courts of judicature.

If sugar be present in any notable proportion, I think that it should be found by evaporating the watery extract to dryness, digesting the extract in alcohol, and then treating the residuum properly with nitric acid. From the quantity of oxalic acid formed, the proportion of sugar might possibly be approximately estimated. I am not aware that there are any principles in tobacco itself which would give rise to the formation of oxalic acid; but this point could be easily set at rest by preliminary experiments. I tried this method, and obtained, as I have stated, no oxalic acid from the samples subjected to the process.

The last series of experiments which I made upon the samples of tobacco sent to me by the Committee, was the incineration of 500 grains of each in a platinum basin, and the analysis of the ashes. The results per cent. were as follows:—

	Total ashes in 100.	Carbonate of potash.	Silica.	Phosphate of lime.	Carbonate of lime.	Sulphate of barytes.	Chloride of silver.
B B - -	15	1·6	2·4	2·8	7·1	1·4	2·6
C C - -	15·6	2·166	2·0	3·8	5·2	3·0	0·7
F F - -	16·3	1·82	2·9	2·4	8·1	1·5	0·5
M M - -	16·4	1·75	3·1	4·2	6·3	1·66	5·0
O O - -	13·2	1·82	2·6	1·6	5·4	1·35	0·6
Q Q - -	16·0	2·4	1·6	3·7	4·9	3·2	3·7
X X - -	14·2	2·66	1·1	2·1	6·4	1·6	0·4
Virginico leaf	12·6	1·65	1 0·6 2 0·7	2·1	6·8	1·1	0·95
Kentucky -	13·25	3·00	0·6	2·2	lost	1·25	lost

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* I have not deemed it necessary to convert water-grain measures into weights, or *vice versâ*, in this frivolous speculation.

The results here stated may be relied on, as they were the mean of many very deliberate experiments. They show that there are great variations in the proportions of the constituents, even in the five genuine tobaccos; B B, M M, O O, Virginia and Kentucky. But the alum in C C and Q Q, is indicated by the larger proportion of sulphate of barytes, obtained by precipitating the matter soluble in water, and acidulated with nitric acid, by means of nitrate of barytes. The sulphate of potash in F F had been probably decomposed into carbonate during the ignition, along with carbonate of lime and carbonaceous matter; and has thereby escaped notice in the column of sulphate of barytes.

I tried each of the aqueous infusions of the fresh samples with solution of gelatine, but obtained no indication of tannin, as should have happened with C C, in consequence of the introduction into it, of 1 per cent. of terra japonica or catechu.

Finally, I regret exceedingly, that so short a space of time was allowed me for making and digesting all these various researches, prior to my examinations before the Committee. Even my report supplementary to my oral evidence, was given in before I had finished my experiments on the action of nitric acid upon the tobacco extracts, and hence I mention there my having obtained crystals of oxalic acid, which turned out upon further examination to be no such thing.

The following analysis of 10,000 parts of fresh tobacco, by Posselt and Reimann, will show the exceeding complexity of this substance: —

Nicotine	6
Nicotianine	1
Extractive matter, slightly bitter	287
Gum with a little malate of lime	174
Green resin	26·7
Vegetable albumen	26·0
Substance analogous to gluten	104·8
Malic acid	51·0
Malate of amonia	12·0
Sulphate of potash	4·8
Chloride of potassium	6·3
Potash combined with malic and nitric acids	9·5
Phosphate of lime	16·6
Lime in union with malic acid	24·2
Silica	8·8
Woody fibre	496·9
Water (traces of starch)	8828·0
	10000·0

In *Silliman's Journal*, vol. vii. p. 2., a chemical examination of tobacco is given by Dr. Covell, which shows its components to have been but imperfectly represented in the above German analysis. He found, 1. gum; 2. a viscid slime, equally soluble in water and alcohol, and precipitable from both by subacetate of lead; 3. tannin; 4. gallic acid; 5. chlorophyle (leaf-green); 6. a green pulverulent matter, which dissolves in boiling water, but falls down again when the water cools; 7. a yellow oil, possessing the smell, taste, and poisonous qualities of tobacco; 8. a large quantity of a pale yellow resin; 9. nicotine; 10. a white substance, analogous to morphia, soluble in hot, but hardly in cold, alcohol; 11. a beautiful orange-red dye stuff, soluble only in acids: it deflagrates in the fire, and seems to possess neutral properties; 12. nicotianine. In the infusion and decoction of the leaves of tobacco, little of this substance is found; but after they are exhausted with ether, alcohol, and water, if they be treated with sulphuric acid, and evaporated nearly to dryness, crystals of sulphate of nicotianine are obtained. Ammonia precipitates the nicotianine from the solution in the state of a yellowish white, soft powdering matter, which may be kneaded into a lump, and is void of taste and smell, as all its neutral saline combinations also are: its most characteristic property is that of forming soluble and uncrystallisable compounds with vegetable acids.

According to Buchner, the seeds of tobacco yield a pale yellow extract to alcohol, which contains a compound of nicotine and sugar. *Repertorium für die Pharmacie*, vol. xxxii.

MM. Henry and Boutron Charlard found in
1000 parts of Cuba tobacco - 8·64 of nicotine;
Maryland - - 5·28
Virginia - - 10·00
Ile et Vilaine - 11·20
Lot et Garonne - 8·20; quantities from 12 to 19
times more than were obtained by Posselt and Reimann.

I shall conclude this examination of the Tobacco Report with a few remarks upon the pretences of the Messrs. Phillips and Graham to botanical and microscopic skill in distinguishing the minutest filaments of shag tobacco from those of other plants. Having applied a good achromatic microscope to this object along with my son, who is familiar with the use of that instrument, I must acknowledge that I would place exceedingly little reliance on the possibility of distinguishing such vegetable leaves as I could easily select for the adulteration of tobacco; and I will engage to set at fault even the superior accomplishments of Professor Lindley.

"6999. When a vegetable fibrous addition is made to the ordinary tobacco, and so ground and minutely divided as not to allow an examination by the glass, could you distinguish it from tobacco?" — Mr. Graham's answer: "It would be extremely difficult to divide it so finely as not to present a sensible magnitude to the microscope. I have never met with tobacco manufactured for sale as shag tobacco, in which I could not distinguish it."

Mr. R. Phillips, in reply to question 7511., "Generally speaking, we did not employ any chemical tests."

"7512. Then it was principally by mechanical analysis, and examination of the fibre of the plant, that you judged? — Yes, certainly."

Answer to question 7523: "You may distinguish it (tobacco) not by the naked eye, but by the microscope."

"7857. Can you (Mr. G. Phillips) distinguish the fibre of tobacco from the fibre of dock, or any other vegetable of the same family? — Yes."

"7856. In how small a quantity can you detect it? — However small the quantity, if you take pains, you can discover it: nothing can be finer than the sample K, in which there was foxglove."

Professor Lindley and Mr. George Phillips distinguish tobacco from other plants chiefly by the structure of its hairs. But in Geiger's *Pharmaceutische Botanik*, the second edition, improved by Nees von Esenbeck, and Heinrich Dierbach, a book of standard authority, the *Nicotiana tabacum* of Linnæus, which is the Florida tobacco of the French botanists, is described as having smooth (*glabra*) somewhat glutinous leaves. Several varieties of this plant are said to be cultivated under peculiar provincial names, to which the *Nicotiana petiolata*, *Nicotiana decurrens*, &c., belong; all with *smooth* and blistery leaves.

In my examination before the Committee on the 15th of July, in answer to Question 8569., I said, — "The conclusion to which I am led is this, that when the tobacco is brought in this shag state, it is next to impossible, by chemical means in most cases, or by physiological means, to determine the adulteration; the only case in which adulteration can be detected, in my opinion, is when sugar is mixed.

"8570. Does the presence of alcohol, by distillation from a fermented solution, give you an invariable test that sugar is present? — If sugar is present in any quantity above 5 per cent., I think alcohol may be produced from it."

But I would never content myself with the deceptious test of the specific gravity of a minute portion of the distilled liquid. I would take at least seven pounds of the suspected tobacco, rinse it rapidly in cold water, in order to dissolve out the saccharine matter, with as little as possible of the tobacco extract; mix it with a certain quantity of yeast; take the specific gravity of the mixture; set it in a chamber heated to 80° Fah., and watch the phenomena of fermentation, if any occur. At the end of 40 hours, or whenever the density of the mixture had sunk to the lowest point, I would note it; then distil, rectify the distilled liquor, and expose it to the appropriate tests of alcohol, as stated above. I am quite convinced that no certainty could be obtained by operating upon the infusion of 200 grains of a tobacco containing 5 or 10 per cent. of sugar, as Professor Graham, in his evidence before the magistrates in the Gainsborough prosecution, said he had done with the tobacco then in question. The total quantity of sugar that could be present was under 20 grains, and this being mixed with tobacco juice, which counteracts the fermentative process, would afford a most unsatisfactory quantity of alcohol—a quantity most difficult of verification; one on which, in my humble apprehension, knowing, as I do, the fallacy of chemical experiments and experimenters, no person should ever venture to seek a verdict, or to levy a heavy fine.

"8589. Then you are of opinion that it will be impossible, if care be taken, such as you state, by chemists, for detection to be within the power of the government? — Quite impossible. I will pledge my chemical character to make such specimens as the Excise cannot detect.

"8590. Then to continue the system of alleged detection by analysis might subject individuals to punishment most unjustly.

"8591. Have any cases come under your knowledge of errors in judgment upon that point? — There is a case which has lately occurred to me of a very unjustifiable kind on the part of the Excise, and I think I might mention it. It is a case of pepper.

"8592. Will you describe the case? — About a year ago the Excise officers entered the premises of Messrs. Mayor and Dove, large spice merchants in Little Distaff Lane, and seized a quantity of ground white pepper, alleging it to be adulterated, and carried it off. I attended the Court of Excise. Professor Graham and Mr. George Phillips, the two witnesses as to the adulteration on the part of the Excise, were first examined, and they swore that the seized pepper contained sago to the amount of 10 or 12 per cent., and they produced a few particles like sago in a very small pill-box." [For the other details, see the article Pepper in this Supplement.]

"8596. From the advance of chemical science, supposing the Excise Office to have your assistance, or the assistance of other experienced chemists, do you think that, with all that assistance, they could detect an adulteration that might, with perfect facility, be introduced by chemists?—I would say that adulteration may be made upon tobacco which may defy all the chemists in Europe to find out.

"8597. And not only chemists, but physiologists? — Yes, and botanists."

It will be seen, from the vagueness of the results of the several series of experiments which I made on the seven samples of tobacco sent to me by the committee, with every possible attention in the short period allowed me, that it is no easy matter to detect adulterations in tobacco; and a chemist should be extremely cautious in pronouncing a decided opinion upon such slender grounds as the professional gentlemen employed by the Excise Board have in many cases done. Supposing a tobacco poor in extractive matter, like the Kentucky, were skilfully imbued with juice of liquorice till it came to the standard of the Virginia, neither Mr. G. Phillips, by his plan of infusion, nor Professor Graham, by that of fermentation, could detect the adulteration. The liquorice juice assimilates with tobacco better even than sugar, but "it is incapable of undergoing the spirituous fermentation." *

I offer this one example, out of many, merely as a hint to my brother chemists to be somewhat less confident and dogmatical in their decisions. Were the questions of tobacco adulteration referred to one of our law courts in Westminster or Guildhall, the evidence of the chemists for the prosecution would be weighed in a more ticklish balance than that of a provincial justice of the peace, or even of the Honourable Commissioners of Excise, and it might possibly be found *wanting.*

How vexatiously inquisitorial, and how abhorrent from the genius of the British constitution, must the practice of the Excise Board be, when the following regulations are recommended by its most influential functionary! To question 8005, Mr. George Phillips replies: "I would make the manufacturers responsible for the samples which they gave; for instance, we know very well there are only two tobaccos used for general cutting tobaccos, that is, Kentucky and Virginia; we know the nature of those, and we very well know what description of tobacco the manufacturer must use to make it answer his purpose. A tobacco which will not yield 45 per cent. of extractive is not fit for him to use. If he sent a sample which should be 35, such as Porto Rico, or got some rubbishing stuff from the sales at the tobacco warehouse, *I would not allow that sample to be used,* or at any rate to be mixed with any other; if he used that, he should use that alone; he should be confined within a range, which experience has proved to be the general range." No choice for taste is to be allowed. Again, to question 8023, he answers: "Sometimes the seizures are made before the tobacco is examined; sometimes seizures are made afterwards, upon *my* report that it is adulterated. The officers send a sample up unknown to the manufacturer; they *take a sample unknown* to the manufacturer, and then, after I have examined it, instructions are sent to the supervisor, that any tobacco of that sort that he can find on the manufacturer's premises he should seize. If the tobacco is seized merely upon the examination of the sample, samples taken from the bulk of the seizure are then sent up and examined. I could mention cases where samples have been sent up by the supervisor or other officer, and have been examined; they have gone and seized, after the lapse of a fortnight, and it has turned out that the tobacco has been pure when it has been examined; of course that has been returned again." Question 8024. "How small an amount would you report to be adulterated? — *Two per cent.*"

Every intelligent reader of the experimental and other evidence detailed in the present article, must perceive the precariousness of decisions based upon an adulteration of only 2 per cent., in so complex a substance as tobacco, that adulteration being sworn to in consequence of such unsatisfactory microscopic and chemical researches. What a servile spirit must be engendered among the tributaries to the Excise, when thirteen eminent tobacconists of London could recently petition the House of Commons to aggravate the stringent administration of that tribunal, *praying* that adulterations detected by its officers should be prosecuted more rigorously; and the efficiency of the law be "further secured by the abolition of compromise, publicity by prosecution in the local courts or otherwise, and the substitution of *personal* for pecuniary penalties."

What powerful inducements are held out to Mr. George Phillips and his coadjutors to obtain convictions for adulterations of tobacco, may be inferred from the fact, that "all penalties and seizures are by law divisible in equal parts, between the Crown and the informer;" 1st, to the person by whom the information was communicated; 2dly, to the officers by whose instrumentality, and *subsequent aid,* proceedings for penalties are brought to a successful termination. In all other cases, liberal means of remuneration are placed at the disposal of the Board of Excise. See *Memorandum as to rewards for information given to the Excise,* p. 584., *Tobacco Report.*

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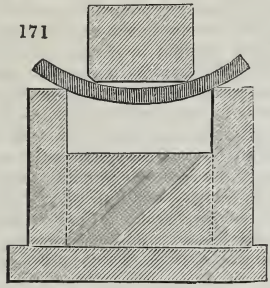
* Liebig, Chimie Organique, iii. 43.

TORTOISE-SHELL is manufactured into various objects, partly by cutting out the shapes, and partly by agglutinating portions of the shell by heat. When the shell has become soft by dipping it in hot water, the edges are in the cleanest possible state, without grease, pressed together with hot flat tongs, and then plunged into cold water, to fix them in their position. The teeth of the larger combs are parted in their heated state, or cut out with a thin frame saw, while the shell, equal in size to two combs, with their teeth interlaced, as in *fig.* 166., is bent like an arch in the direction of the length of the teeth, as in *fig.* 167. The shell is then flattened, the points are separated with a narrow chisel or *pricker*, and the two combs are finished, while flat, with coarse single-cut files and triangular scrapers. They are finally warmed, and bent on the knee over a wooden mould, by means of a strap passed round the foot, just as a shoemaker fixes his last. Smaller combs of horn and tortoise-shell are parted, while flat, by an ingenious machine, with two chisel-formed cutters placed obliquely, so that each cut produces one tooth. See Rogers' comb-cutting machine, *Trans. Soc. Arts*, vol. xlix. part 2., since improved by Mr. Kelly. In making the frames for eye-glasses, spectacles, &c. the apertures for the glasses were formerly cut out to the circular form, with a tool something like a carpenter's centre-bit, or with a crown saw in the lathe. The discs so cut out were used for inlaying in the tops of boxes, &c. This required a piece of shell as large as the front of the spectacle; but a piece one third of the size will now suffice, as the eyes are *strained* or *pulled*. A long narrow piece is cut out, and two slits are made in it with a saw. The shell is then warmed, the apertures are pulled open, and fastened upon a taper triblet of the appropriate shape; as illustrated by *figs.* 168, 169, and 170. The groove for the edge of the glass is cut with a small circular cutter, or sharp-edged saw, about three eighths or half an inch in diameter; and the glass is sprung in when the frame is expanded by heat.

171



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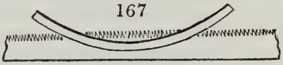

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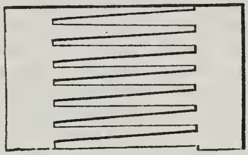

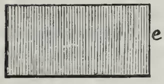

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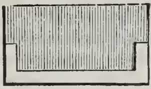

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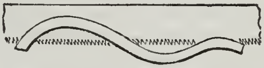

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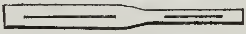

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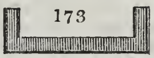

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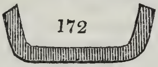

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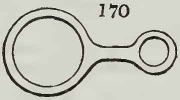

In making tortoise-shell boxes, the round plate of shell is first placed centrally over the edge of the ring, as in *fig.* 171.: it is slightly squeezed with the small round edge-block *g*, and the whole press is then lowered into the boiling water; after immersion for about half an hour, it is transferred to the bench, and *g* is pressed entirely down, so as to bend the shell into the shape of a saucer, as at *fig.* 172., without cutting or injuring the material; and the press is then cooled in a water-trough. The same processes are repeated with the die *d*, which has a rebate turned away to the thickness of the shell, and completes the angle of the box to the section *fig.* 173., ready for finishing in the lathe. It is always safer to perform each of these processes at two successive boilings and coolings. Two thin pieces are cemented together by pressure with the die *e*, and a device may be given by the engraved die *f*. See *Holtzapffel's Turning and Mechanical Manipulation*, vol. i. p. 129.

TURPENTINE, SPIRITS, ESSENCE, OR OIL OF. Camphen is the new name given by the continental chemists to every ethereous or volatile oil, which is composed of 5 atoms of carbon and 8 of hydrogen, and which combines directly with hydrochloric acid, either into a solid or a liquid compound, resembling camphor. Under this title the following oils are included :—turpentine, citron, or lemon, orange-flower, copaiva, balsam-oil, juniper, cubebs, and pepper. Some add to this last,—the oils of cloves, valerian, and bergamot. As the new patent lamps burn spirits of turpentine, they have been called Camphine. (*See* Lamps.) Since that article was printed I have had occasion to test a variety of Camphine lamps during the preceding three months, and I am convinced the patent Vesta lamp of Mr. Young is not merely the best, but it is the only one hitherto made public, which can be used with comfort in closed apartments. It was the first spirit lamp constructed on right principles, keeping in view the peculiar nature of Camphine spirits, and being secured by a correct specification, leaves no room to expect another equally good. In this lamp the burner is completely insulated from the reservoir by a ring of wood, or other non-conducting material, placed between them, and as no metallic tube passes down from the flame into the volatile spirits, they remain cold; whereas, when such a tube passes down through the reservoir, for the admission of air to the inside of the flame (as in all other Argand lamps), without being insulated from the flame, the spirits become 20 or 30 degrees hotter, so as to emit acrid and offensive fumes. The wick also, which embraces the heated tube becomes dry and resinous, loses its capillary power, coals at the flame, and then sends up smoke with a shower of lamp black.

The Vesta lamp is free from these defects, and when used with properly rectified spirits, never smokes nor smells; it may be easily distinguished by the above characters, and by the circumstance of the air passing between the wicks to the interior of the flame. It affords, undoubtedly, the brightest, cleanliest, and most economical light hitherto invented, when supplied with pure spirits free from rosin. I have lighted my drawing-rooms with the Vesta lamp for several evenings successively, without having its wick trimmed or its occasioning the slightest inconvenience. I therefore deem it due to the patentee's ingenuity, as well as to the public welfare, to give this deliberate opinion at a time when the volatile spirits of turpentine are getting into general use, and when, if burned in lamps on the Argand plan, they must create danger.

Great care must be taken in the choice of the spirits of turpentine as the combustible. As those very generally sold in London contain rosin and other impurities, they are quite unfit for that purpose; but the spirits manufactured by Messrs. John Tall and Co. of Hull, to be had of their agents, Ratcliffe and Co., 103. Hatton Garden, London, answer perfectly. I have subjected these spirits to careful chemical examination, and I find them to be quite pure, and very different indeed from those on common sale here. Their specific gravity is only 0·864 at 62° Fahr., while that of the average London article is from 0·874 to 0·882, the greater density being due to rosin. Messrs. Tall's spirits may be boiled off in a retort without leaving any sensible residuum, and they also boil at a lower degree of heat; but the best proof of their excellence, in the present point of view, is exhibited in the preceding notice of the Vesta lamp, for it was Messrs. Tall's spirits which were used on that occasion.

V.

VENTILATION. There are two general plans in use for at once diffusing heat and renewing the air in extensive buildings, which plans differ essentially in their principles, modes of action, and effects. The oldest, and what may be called, the *vulgar* method, consists in planting stoves in the passages or rooms, to give warmth in cold weather, and in constructing large and lofty chimney-stalks, to draw air in hot weather out of the house, by suction, so to speak, whereby fresh air flows in, to maintain, though imperfectly, an equilibrium of pressure. In apartments, thus warmed and ventilated, the atmosphere is necessarily rarer than it is out of doors, while, in cold weather, the external air rushes in at every opening and crevice of door, window, or chimney — the fruitful source of indisposition to the inmates.

The evils resulting from the stove-heating and air-rarefying system were, a few years ago, investigated by me, in a Paper read before the Royal Society*, and afterwards

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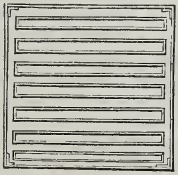
* I had been professionally employed by a Committee of the Officers of the Custom House, to examine the nature of the malaria which prevailed there, but I had no concern in erecting the stoves which caused it.

published in several scientific and technological journals. It is there said that the observations of Saussure, and other scientific travellers in mountainous regions, demonstrate how difficult and painful it is to make muscular or mental exertions in rarefied air. Even the slight rarefaction of the atmosphere, corresponding to a low state of the barometer, at the level of the sea, is sufficient to occasion languor, lassitude, and uneasiness in persons of delicate nerves; while the opposite condition of increased pressure as indicated by a high state of the barometer, has a bracing effect upon both body and mind. Thus, we see how ventilation, by the powerful draught of a high chimney-stalk, as it operates by pumping out, exhausting, and attenuating the air, may prove detrimental to vivacity and health; and how ventilation, by forcing in air with a fan or a pump, is greatly to be preferred, not only for the reason above assigned, but because it prevents all regurgitation of foul air down the chimneys, an accident sure to happen in the former method. Genial air thrown in by a fan, in the basement story of a building, also prevents the stagnation of vapours from damp and miasmata, which lurk about the foundation of buildings and in sewers, and which are sucked in by the rarefying plan. Many a lordly mansion is rendered hardly tenantable from such a cause, during certain vicissitudes of wind and weather.

The condensing plan, as executed by the engineers, Messrs. Easton and Amos, at the Reform Club House, consists of a large fan, revolving rapidly in a cylindrical case, and is capable of throwing 11,000 cubic feet of air per minute into a spacious subterranean tunnel, under the basement story. The fan is driven by an elegant steam-engine, worked on the expansion principle, of five horses' power. It is placed in a vault, under the flag-pavement, in front of the building; and as it moves very smoothly, and burns merely cinders from the house fires, along with some anthracite, it occasions no nuisance of any kind. The steam of condensation of the engine supplies 3 cast-iron chests with the requisite heat for warming the whole of the building. Each of these chests is a cube of 3 feet externally, and is distributed internally into 7 parallel cast-iron cases, each about 3 inches wide, which are separated by parallel alternate spaces, of the same width, for the passage of the air transversely, as it is impelled by the fan.

Fig. 174. is a transverse vertical section of the steam chest, for heating the air; *fig.* 175. is a plan of the same; and *fig.* 176. is a perspective view, showing the outside casing, also the pipe *a*, for admitting the steam, and the stop-cock *b*, for allowing the condensed water to escape.

174



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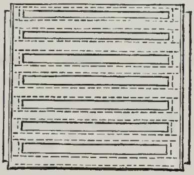

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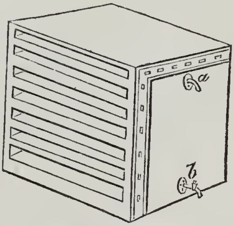

This arrangement is most judicious, economising fuel to the utmost degree; because the steam of condensation which, in a Watt's engine, would be absorbed and carried off by the air-pump, is here turned to good account, in warming the air of ventilation during the winter months. Two hundred weight of fuel suffice for working this steam-engine during twelve hours. It pumps water for household purposes, raises the coals to the several apartments on the upper floors, and drives the fan ventilator. The air, in flowing rapidly through the series of cells, placed alternately between the steam-cases, cannot be scorched, as it is generally with air stoves; but it is heated only to the genial temperature of from 75° to 85° Fahr., and it thence enters a common chamber of brick-work in the basement story, from which it is let off into a series of distinct flues, governed by dialled valves or registers, whereby it is conducted in regulated quantities to the several apartments of the building. I am of opinion, that it would not be easy to devise a better plan for the purpose of warming and ventilating a large house; and I am only sorry to observe, that the plan projected by the engineers has been *injudiciously* counteracted in two particulars.

The first of these is, that the external air, which supplies the fan, is made to traverse a great heap of coke before it can enter that apparatus, whereby it suffers such friction as materially to obstruct the ventilation of the house. The following experiments, which I made recently upon this point, will place the evil in a proper light: — Having fitted up Dr. Wollaston's differential barometer, as an anemometer, with oil, of specific gravity 0·900 in one leg of its syphon, and water of 1·000 in the other, covered with the said oil in the two cisterns at top, I found that the stream of air produced by the fan, in a cer tain part of the flue, had a velocity only as the number 8, while the air was drawn through the coke, but that it had a velocity in the same place as the number 11, whenever the air was freely admitted to the fan by opening a side door. Thus, three-elevenths, both of the ventilating and warming effect of the fan, are lost. I cannot divine any good reason for making the Members of the Reform Club breathe an atmosphere, certainly not improved, but most probably vitiated, by being passed in a moist state through a porous sulphurous carbon, whereby it will tend to generate the two deleterious gases, carbonic oxide and sulphuretted hydrogen, in a greater or less degree. It is vain to allege that these gases may not be discoverable by chemical analysis—can the gaseous matters, which generate cholera, yellow fever, or ague, be detected by chemical re-agents? No, truly; yet every one admits the reality of their specific virus. I should propose that the air be transmitted through a large sheet of wire-cloth before it reaches the fan, whereby it would be freed from the grosser particles of soot that pollute the atmosphere of London. The wire-cloth should be brushed every morning.

The second particular, which counteracts in some measure the good effects of the fan in steam ventilation, is the huge stove placed in the top story of the building. This potent furnace, consuming, when in action, 3 cwt. of coals per day, tends to draw down foul air, for its own supply, from the chimneys of the adjoining rooms, and thus to impede the upward current created by the fan. I have measured, by Dr. Wollaston's differential barometer, the ventilating influence of the said furnace stove, and find it to be perfectly insignificant,—nay, most absurdly so,—when compared with the fan, as to the quantity of fuel which each requires per day. The rarefaction of air in the stove chamber, in reference to the external air, was indicated by a quarter of an inch difference of level in the legs of the oil and water syphon, and this when the door of the stove-room was shut, as it usually is; the tube of the differential barometer being inserted in a hole in the door. The fan indicates a ventilating force equal to 2 inches of the water syphon, which is 20 inches of the above oil and water syphon, and therefore 80 times greater than that of the stove furnace; so that, taking into view the smaller quantity of fuel which the fan requires, the advantage in ventilation, in favour of the fan, is the enormous ratio of 120 to 1, at the lowest estimate. The said stove, in the attic, seems to me to be not only futile, but dangerous. It is a huge rectangular cast-iron chest, having a large hopper in front, kept full of coals, and it is contracted above into a round pipe, which discharges the burnt air and smoke into a series of horizontal pipes of cast-iron, about 4 inches diameter, which traverse the room under the ceiling, and terminate in a brick chimney. In consequence of this obstruction, the draught through the furnace is so feeble, that no rush of air can be perceived in its ash-pit, even when this is contracted to an area of 6 inches square;—nay, when the ash-pit was momentarily luted with bricks and clay, and the tube of the differential barometer was introduced a little way under the grate, the level of the oil and water syphon in that instrument was displaced by no more than one-tenth of an inch, which is only one-hundredth of an inch of water,—a most impotent effect under a daily consumption of 3 cwt. of coals. In fact, this stove may be fitly styled an *incendiary coal devourer*, as it has already set fire to the house; and though now laid upon a new floor of iron rafters and stone flags, it still offers so much danger from its outlet iron pipes, should they become ignited from the combustion of charcoal deposited in them, that I think no premium of insurance adequate to cover the imminent risk of fire. The stove being, therefore, a superfluous and dangerous nuisance, should be turned out of doors as speedily as possible. Its total cost, with that of its fellow in the basement story, cannot be much less than the cost of the steam-engine, with all its truly effectual warming and ventilating appurtenances.

I take leave to observe, that the system of heating and ventilating apparatus, constructed by Messrs. Easton and Amos, in the Reform Club House, offers one striking and peculiar advantage. It may be modified at little expense, so as to become the ready means of introducing, during the sultriest dog-days, refreshing currents of air, at a temperature of 10, 20, 30, or even 40 degrees under that of the atmosphere. An apparatus of this nature, attached to the Houses of Parliament and Courts of Law, would prove an inestimable blessing to our legislators, lawyers, judges, and juries. Of such cool air a very gentle stream would suffice to make the most crowded apartments comfortable, without endangering the health of their inmates with gusts of wind through the doors, windows, and floors.

It is lamentable to reflect how little has been done for the well-being of the sentient and breathing functions of man in the public buildings of the metropolis, notwithstanding our boasted march of intellect and diffusion of useful knowledge. Almost all our churches are filled on Sundays with stove-roasted air; and even the House of Commons has its atmosphere exhausted by the suction of a huge chimney stalk, with a furnace equal, it is said, to that of a 40 horse steam boiler. To gentlemen plunged in air so attenuated, condensation of thought and terseness of expression can hardly be the order of the day.

Nearly seven years have elapsed since I endeavoured to point public attention to this important subject in the following terms: — "Our legislators, when bewailing, not long ago, the fate of their fellow-creatures, doomed to breathe the polluted air of a factory, were little aware how superior the system of ventilation adopted in many cotton mills was to that employed for their own comfort in either House of Parliament. The engineers of Manchester do not, like those of the metropolis, trust for a sufficient supply of fresh air into any crowded hall, to currents physically created in the atmosphere by the difference of temperature excited by chimney draughts, because they know them to be ineffectual to remove, with requisite rapidity, the dense carbonic acid gas generated by many hundred powerful lungs." * At page 382. of the work just quoted, there is an exact drawing and description of the factory ventilating fan.

On the 6th of June, 1836, I took occasion again, in a paper read before the Royal Society, upon the subject of the *malaria* which then prevailed in the Custom House, to investigate the principles of ventilation by the fan, and to demonstrate, by a numerous train of experiments, the great preference due to it, as to effect, economy, and comfort, over chimney-draught ventilation. Yet at this very time, the latter most objectionable plan was in progress of construction, upon a colossal scale, for the House of Commons. About the same period, however, the late ingenious Mr. Oldham, engineer of the Bank of England, mounted a mechanical ventilator and steam-chest heater, for supplying a copious current of warm air to the rooms of the engraving and printing departments of that establishment. Instead of a fan, Mr. Oldham employed a large pump to force the air through the alternate cells of his steam chest. He had introduced a similar system into the Bank of Ireland about ten years before, which is now in full action.

About two years ago, Messrs. Easton and Amos were employed to ventilate the letter carriers' and inland office departments of the General Post Office, of which the atmosphere was rendered not only uncomfortable but insalubrious, by the numerous gas lights required there in the evenings. This task has been executed to the entire satisfaction of their employers, by means of fans driven by steam engine power. The said engineers made, about the same time, a set of machinery similar to that erected at the Bank of England, for warming and ventilating the Bank of Vienna. They are justly entitled to the credit of having been the first to execute, in all its bearings, the system of heating and ventilating buildings, having special respect to the health of their inmates, which I urged upon the public mind many years ago.

As fans of sufficient size, driven by steam power with sufficient velocity to warm in winter, and ventilate at all times, the most extensive buildings, may be erected upon the principles above described, without causing any nuisance from smoke, it is to be hoped that the Chapel of Henry VII. will not be desecrated by having a factory Vesuvius reared in its classical precincts, and that the noble pile of architecture of the new Houses of Parliament will not be disfigured with such a foul phenomenon.

The cheering and bracing action of condensed air, and the opposite effects of rarefied air upon human beings, formed the subject of several fine physiological experiments, made a few years ago by M. Junot, and described by him in the 9th volume of the *Archives Génerales de Médecine*: — "When a person is placed," says he, "in condensed air, he breathes with a new facility; he feels as if the capacity of his lungs was enlarged; his respirations become deeper and less frequent; he experiences, in the course of a short time, an agreeable glow in his chest, as if the pulmonary cells were becoming dilated with an elastic spirit, while the whole frame receives, at each inspiration, fresh vital impulsion. The functions of the brain get excited, the imagination becomes vivid, and the ideas flow with a delightful facility; digestion is rendered more active, as after gentle exercise in the air, because the secretory organs participate immediately in the increased energy of the arterial system, and there is therefore no thirst."

In rarefied air the effects on the living functions are just the reverse. The breathing is difficult, feeble, frequent, and terminates in an asthmatic paroxysm; the pulse is quick and most compressible; hæmorrhages often occur, with a tendency to fainting; the secretions are scanty or totally suppressed, and at length apathy supervenes.

These striking results obtained on one individual at a time, with a small experimental apparatus, have been recently reproduced, on a working scale, with many persons at once enclosed in a mining shaft, encased with strong tubbing, formed of a series of large sheet-iron cylinders, riveted together, and sunk to a great depth through the bed of the river Loire, near Languin. The seams of coal, in this district of France, lie under a stratum of quicksand, from 18 to 20 metres thick, (20 to 22 yards,) and they had been found to be inaccessible by all the ordinary modes of mining previously practised. The obstacle had been regarded to be so perfectly insurmountable, that every

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* Philosophy of Manufactures, p 380. published by Charles Knight. — London, 1835.

portion of the great coal basin, that extends under these alluvial deposits, though well known for centuries, had remained untouched. To endeavour, by the usual workings, to penetrate through these semi-fluid quicksands, which communicate with the waters of the Loire, was, in fact, nothing less than to try to sink a shaft in that river, or to drain the river itself. But this difficulty has been successfully grappled with, through the resources of science, boldly applied by M. Triger, an able civil engineer.

By means of the above frame of iron tubbing, furnished with an air-tight ante-chamber at its top, he has contrived to keep his workmen immersed in air, sufficiently condensed by forcing-pumps, to repel the water from the bottom of the iron cylinders, and thereby to enable them to excavate the gravel and stones to a great depth. The compartment at top has a man-hole door in its cover, and another in its floor. The men, after being introduced into it, shut the door over their heads, and then turn the stop-cock upon a pipe, in connection with the condensed air in the under shaft. An equilibrium of pressure is soon established in the ante-chamber, by the influx of the dense air from below, whereby the man-hole door in the floor may be readily opened, to allow the men to descend. Here they work in air, maintained at a pressure of three atmospheres, by the incessant action of leathern valved pumps, driven by a steam engine. While the dense air thus drives the waters of the quicksand, communicating with the Loire, out of the shaft, it infuses at the same time such energy into the miners, that they can easily excavate double the work without fatigue which they could do in the open air. Upon many of them the first sensations are painful, especially upon the ears and eyes, but ere long they get quite reconciled to the bracing element. Old asthmatic men become here effective operatives; deaf persons recover their hearing, while others are sensible to the slightest whisper. The latter phenomenon proceeds from the stronger pulses of the dense air upon the membrane of the drum of the ear.

Much annoyance was at first experienced from the rapid combustion of the candles, but this was obviated by the substitution of flax for cotton thread in the wicks. The temperature of the air is raised a few degrees by the condensation.

Men, who descend to considerable depths in diving bells, experience an augmentation of muscular energy, similar to that above described. They thereby acquire the power of bending over their knees strong bars of iron, which they would find quite inflexible by their utmost efforts when drawn up to the surface.

These curious facts clearly illustrate and strongly enforce the propriety of ventilating apartments by means of condensed air, and not by air rarefied with large chimney drafts, as has been hitherto most injudiciously, wastefully, and filthily done, in too many cases.

VERMICELLI is made with most advantage from the flour of southern countries, which is richest in gluten. It may also be made from our ordinary flour, provided an addition of gluten be made to the flour paste. Vermicelli prepared from ordinary flour is apt to melt into a paste when boiled in soups. It may, however, be well made economically by the following prescription: —

Vermicelli or Naples flour	21 lbs.
White potato flour	14 —
Boiling water	12 —
Total	47 lbs.

Affording 45 lbs. of dough, and 30 of dry vermicelli. With gluten, made from common flour, the proportions are: —

Flour as above	30 lbs.
Fresh gluten	10 —
Water	7 —
Total	47 lbs.

Affording 30 lbs. of dry vermicelli or macaroni.

W.

WATERS, MINERAL. The following Tables exhibit the Nature and Composition of the most celebrated Mineral Waters of Germany, according to the best Analyses. The Symbol N denotes Nitrogen or Azote; O, Oxygen; CO^2, Carbonic Acid; SH, Sulphuretted Hydrogen. Therm.; cent. scale; if not, R. for Reaumur.

TABLE I.—THE MOST IMPORTANT MINERAL WATERS OF WÜRTEMBERG.

Classification.	Places.	Specific Gravity and Temperat.	Quantity.	Gases.			Carbonated Salts.				Muriatic Salts.			Sulphuric Salts.			Other Constituents.	Total.	Author.
				N. O.	CO2.	SH.	Iron-oxide.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.			
							gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.		gr.	
1. Ferriferous Waters.	Biberach, Jordansbad (Moorgrund in Molasse)	1·000206 8°	10000 grammes	N + O 7·002cub.in.	63·025 p. 3 cub. in.	cub. in.= 16. oz.	0·262 = in 16	019 gr. oz.	2·380 = 1·83	0·344	Traces.	-	-	-	-	-	Silica, 0·084 gr. Organic Mat.	3·07 = 2·34 gr. in 16 oz.	C. Gmelin.
	Crailsheim (Keuper)	8°	16 oz.	-	2·51 c. in.	-	0·109	-	3·674	-	-	-	0·082	1·351	8·214	2·272	Sulph. of Pot., 0·033 gr. Sulphur, 0·059 gr.	15·794	Mayer.
2. Saline.	Offenhau (Muschelkalk)	10°	16 ,,	-	2·765 ,,	Traces.	-	-	1·32	0·21	21·69	0·71	0·79	4·57	3·85	21·60	Silica, 0·05 gr.	33·31	Gmelin and Schulz.
	Hall (Muschelkalk)	1·049 10°	16 ,,	-	-	-	0·035	-	1·69	-	157·44	0·62	0·67	1·44	9·12	1·44	Organic Matter, 0·41 gr.	173·16	Sandel.
	Rotenmünster. (Brine spring of Wilhelmshall)	1·19553 Spec. Grav.	100 pts.	-	-	-	-	-	-	-	24·5537	0·3919	0·0320	0·4986	-	-	-	25·4762	
	Schwenningen. (Brine spring of Wilhelmshall)	1·19776 9°	100 ,,	-	-	-	-	-	0·0224	-	24·1682	0·4134	0·0254	0·5239	-	-	-	25·1535	
	Mergentheim (Muschelkalk)	1·012 8–9°	16 oz.	-	13·53 ,,	-	Traces.	-	3·26	-	78·42	Potash. 0·38	-	32·04	16·50	2·70	-	134·2	C. Gmelin, 1829.
					8·033 ,,	-	0·02	-	4·10	0·33	45·10	-	7·00	30·36	7·43	0·86	Mineral Resin, 0·10 gr. Traces of Silica	95·3	Wrede, 1836.
	Calw. Artesian Spring, (Bunter Sandstein)	1·00265 5–10°	100 ,,	-	21·138 ,,	-	0·668	6·991	20·95	2·35	2·811	4·724	0·569	2·809	Nitrate of Pot. 13·039		Phosph. Lime, 0·460 gr. Silica, 1·26 gr. Extractive	56·631	Federhaff.
3. Thermal.	Wildbad (Granite) Old Spring	1006 27–37°	16 ,,	N + O $\frac{79·25 \quad 8·25}{100 \text{ cub. in.}}$	$\frac{12·5}{100}$,,	-	0·2	0·53	0·34	0·70	1·82	-	-	0·40	-	-	Sulph. Potash, 0·20 gr. Silica, 0·39 gr. A little Manganese	13·59	Sigwart and Weiss.
	Wildbad (Granite) New Spring, 1836	26·5	100 pts.	-	-	-	Traces.	9·163	9·109	1·198	24·57	-	-	3·477	-	-	Sulph. Potash, 1·861 gr. Silica, 6·693 gr. A little Manganese	56·071	Degen.
	Liebenzell (Bunter Sandstein and Granite)	1001·3 17·5–19·5°	16 oz.	$\frac{44·17 + 5·25}{100}$	$\frac{51·58}{100}$,,	Traces.	0·10	0·80	0·82	-	5·14	-	Traces.	0·61	-	-	Silica, 8·41 gr.	7·88	Naschold.
4. Cold neutral.	Tübingen (Wilhelmstiftsbrunnen. Keuper)	-	16 ,,	$\frac{43 + 18}{100}$	$\frac{39}{100}$,,	-	-	2·56	16·00	1·12	-	-	-	2·40	Potash. 2·40	-	Traces of Mur. of Soda, Magnesia, and Silica	24·48	Sigwart.
	Löwenstein (Theusser Bad-Keuper)	10°	16 ,,	-	1·3 ,,	-	-	-	1·97	0·95	-	-	0·35	1·1	11·28	2·75	Resinous Extract	18·40	Sigwart.
	Möglingen (Christenhof-Lias)	-	16 ,,	-	0·06 ,,	-	-	-	2·85	0·57	-	-	0·46	0·86	10·31	2·85	Traces of Carbonate of Iron and Resin	18·05	Sigwart.
	Rietenau (Keuper)	-	100 ,,	-	$\frac{21·8737}{100}$	-	-	-	16·4062	-	-	-	2·7615	2·9192	18·750	8·4107	Sulph. Potash. 0·3967 gr. Traces of Resin, Iron-oxide, Phosph. Acid. and Silico-fluoric Acid, with Humus, 1·3750 Lime	77·1443	Zwink.
	Giengen by Brenz. (Jura with Torfgrund)	1·0005 6·8°	16 ,,	0·32 + 0·06 cub. in.	2·68 ,,	-	-	0·019	2·031	0.166	0·021	0·009	0·049	-	0·061	-	Silica, 0·09 gr. Humate of Alumina, 0·065 gr.	2·526	Salzer.
	Ulm (Griesbad)	5–6·5°	16 ,,	-	-	-	0·044	-	1·625	0·105	-	-	1·875	-	-	-	Traces of Nitric and Sulphuric Salts.	3·649	Leube.
5. Acidulous Waters.	Imnau (Muschelkalk) Prince's Spring	-	16 ,,	N O = atm. air.	$\frac{30·351}{100}$,,	-	0·55	-	6·855	0·089	1·044	-	0·326	-	0·221	0·335	Silica, 0·029 gr. Organ. mat., 1·120 gr.	11·569	Sigwart.
	Imnau (Muschelkalk) Second lower Spring	-	16 ,,	> atm. air.	$\frac{27·119}{100}$,,	-	0·564	-	6·629	0·429	0·078	-	0·045	-	0.487	0·140	Silica, 0·092 gr. Organ. mat., 0·430 gr.	8·74	
	Imnau (Muschelkalk) Fifth lower Spring	-	16 ,,	< atm. air.	$\frac{27·551}{100}$,,	-	-	-	4·166	0·336	0·124	-	0·138	-	0·157	0·381	Silica, 0·205 gr. Organ. mat., 0·622 gr.	6·128	
	Niedernau (Muschelkalk) Old Springs	11–12°	16 ,,	-	1·21 V.	Traces.	0·08	-	7·44	0·86	-	-	0·58	0·28	Potash. 1·02	1·18	Silica, 0·12 gr. Oxiduiated Mang., 0·01 gr.	11·57	C. Gmelin.
	Niedernau (Muschelkalk) Carls Spring	6°·8	16 ,,	-	14 cub.in.	-	Traces.	-	5·807	1·637	-	-	0·214	-	-	0·402	Asphalt, 0·010 gr.	8·07	Sigwart.

TABLE I.—MINERAL WATERS OF WÜRTEMBERG—*continued.*

Classification.	Places.	Specific Gravity and Temperat.	Quantity.	Gases.			Carbonated Salts.				Muriatic Salts.			Sulphuric Salts.			Other Constituents.	Total.	Author.
				N. O.	CO2.	SH.	Iron-oxide.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.			
							gr.	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*		*gr.*	
5. Acidulous Waters.	Niedernau (Muschelkalk) Römerquelle	- -	14 oz.	- -	29 cu.in.?	- -	0·10432	- -	3·75	0·33571	0·21428	- -	0·26436	With Potash. 0·03571	- -	0·13326	Silica, 0·10714 gr. Extract. with Petroleum, 0·07857 gr.	5·02372	Ritter.
	Cannstadt (Muschelkalk and Keuper) Sulzerrain	15·5°	16 ,,	- -	23·12 ,,	- -	0·16	- -	7·00	0·05	19·75	- -	0·58	6·50	8·25	3·50	Sulph. Potash, 0·50 gr. -	46·34	Morstatt.
	Zoller'sche Quelle	- -	16 ,,	- -	19·28 ,,	- -	0·11	- -	8·68	- -	15·00	0·25	0·12	3·75	8·38	2·38	- - - -	38·68	
	Frösner'sche Qu. v. 1831	16°	16 ,,	- -	19·50 ,,	- -	0·25	- -	7·38	0·31	16·75	0·25	0·18	4·75	7·75	2·25	- - - -	39·87	
	Wirthschaft zum Ochsen	- -	16 ,,	- -	13·00 ,,	- -	Traces.	- -	4·100	Traces.	7·00	- -	- -	2·40	3·00	0·78	- - - -	17·18	
	Obere Sulz: Water -	16·3°	16 ,,	- -	15·55 ,,	- -	0·231	- -	9·100	0·475	19·711	- -	0·272	2·679	8·775	2·617	Sulph. Potash, 0·386 gr. -	44·24	
	Mud -	- -	- -	- -	- -	- -	33·35	- -	26·58	1·41	- -	- -	- -	- -	32·95	- -	Silica, 0·31 gr. Organic mat., 25·40 gr.	120	Sigwart.
	Berg (Muschelkalk and Keuper) Neckarinsel	15—16°	16 ,,	- -	21 ,,	Traces.	0·25	- -	8·00	Traces.	18·50	- -	0·37	8·25	7·25	1·00	- - - -	43·62	Morstatt.
	Städt. Kunstmühle	1·00548 14°	16 ,,	- -	22·1 ,,	Traces.	0·14	- -	9·00	0·25	18·15	- -	0·25	6·25	6·06	4·33	- - - -	44·37	
	Privil. Fabrik der Insel	- -	100·000 parts.	- -	- -	- -	With Alumina. 4·29	- -	110·18	8·10	205·79	- -	- -	0·92	81·68	65·56	- - - -	476·53	Degen.
	Teinach (Bunter Sandstein) Dächleinskasten	7·5°	16 oz.	- -	20·677 ,,	- -	Traces.	2·2387	3·4380	0·3979	0·3024	- -	Traces.	0·6589	- -	- -	Silica, 0·2995 gr.	7·3254	Federhaff,
	Dintenquelle	6·5°	16 ,,	- -	0·213 ,,	- -	With Mangan. 0·1216	0·4144	0·5376	0·0800	0·3152	With and	Potash Magn.	Potash & Lime with Carbon. of Soda,		- -	Silica, 0·0432 gr. -	1·5120	
	Ueberkingen (Jurakalk with Eisenrogenstein)	9°	16 ,,	- -	19·5 ,,	- -	0·072	0·390	6·827	0·247	- -	- -	- -	0·276	0·020	0·056	- - - -	7·888	Leube.
	Dizenbach (Jurakalk)	7°	16 ,,	- -	27·7 ,,	- -	- -	- -	3·6096	With Magn.	0·0199	- -	- -	0·0960	- -	Traces.	Organic matter with Sulphur, 0·0184 gr. -	3·7379	C. Gmelin.
6. Sulphurous Waters.	Boll (Bituminöser Mergelschiefer) -	1·00137 7—8°	16 ,,	N. 0·0134 V. of Water.	0·003 V. to 0·006	0·1705 V.	Potash. 0·03	1·03	1·44	0·03	0·22	- -	- -	3·34	- -	- -	Silica, 0·05 gr. Asphalt.	6·19	
	Kirchheim under Teck (Liasschiefer)	10°	16 ,,	- -	Undetermined.	- -	- -	0·77	0·60	0·29	0·34	- -	0·67	0·58	Traces.	- -	Silica, 0·06 gr. Sulphur	4·58	Mutschler.
	Reutlingen (Liasschiefer)	9—10°	16 ,,	N. 0·015 V.	0·087 V.	0·029 ,,	0·02	0·93	0·35	1·05	0·40	- -	- -	0·49	- -	- -	Carburetted Hydrogen, 0·021 V. Asphalt. Silica, 0·15 gr. Organ. mat., 0·57 gr. -	4·96	Sigwart and Vöhringer
	Sebastianweiler (Liasschiefer)	9—11°	16 ,,	N. with 3·07 per ct.	CO2 Carbonic Acid Gas.	2·26—4·33 p. Ct. V.	0·06	- -	3·72	0·41	0·59	- -	0·23	4·51	Trac. of Potash with Lime.	1·61	Silica, 0·18 gr. — Traces of Iodine and Manganese. Asphalt, 0·02 gr.	11·33	Sigwart.
	Hechingen (Liasschiefer)	8—9°	16 ,,	- -	Undetermined.	0·0564 V.	- -	- -	3·0878	1·2296	- -	- -	0·5181	3·4821	0·2167	1·4971	Sulph. Potash, 0·0187 gr. Silica, 0·1373 gr. -	10·1874	C. Gmelin.
	Roigheim near Mökmühl (Muschelkalk)	9·5—10°	16 ,,	- -	1·00 V.	0·27 ,,	0·03125	- -	1·7825	0·31125	0·24632	Alum. 0·00625	0·04921	0·34341	0·4375	0·34093	Silica, 0·04687 gr. Clay with Phosp. Acid, 0·05. Extractive, 0·13875 gr.	4·7830175	Sigw. and Heuffel.
	Neustädtchen a. d. Rems. (Muschelk) Water -	1·0005 9·7°	16 ,,	- -	Insignificant.	- -	0·44	- -	2·184	0·23	- -	- -	0·17	With Potash. 0·353	0·456	0·33	Silica, 0·102. Traces of Organic matter	3·869	C. Gmelin.
	Dried Mud -	- -	20 gr.	- -	- -	Sulph. of Zinc, 0·06	Iron-oxide. 0·37	- -	0·5	0·38	- -	- -	- -	- -	- -	- -	Quarzsand, 6·21 gr. Organ. mat., 1·56 gr. - Alumina, 1·107 gr. Loss, 0·03 gr.	20·0	
	Winterbach (Keuper) First Spring	8—9°	16 oz.	- -	2·0 cub.in.	0·28 cu.in.	- -	- -	0·285	0·143	0·285	With Magn.	- -	- -	1·567	1·142	- - - -	3·422	Sig. & Buhl.
	Second Spring	8—9°	16 ,,	- -	Undetermined.	0·67 ,,	- -	0·25	0·55	- -	0·83	- -	0·25	- -	1·66	0·55	- - - -	4·09	Grünzweig.

Table II.—CONSTITUENTS OF THE MOST IMPORTANT MINERAL WATERS OF GERMANY, EXCEPTING THOSE OF WÜRTEMBERG.

N denotes with O Atmospherical Air (Nitrogen and Oxygen),—CO^2 Carbonic Acid Gas.

Classification.	Places.	Specific Gravity and Temperat.	Quantity.	Gases.		Carbonated Salts.				Muriatic Salts.			Sulphuric Salts.			Other Constituents.	Total solid Parts.	Authors.
				N. O.	CO2.	Iron-oxide.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.			
			oz.			*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	
1. *Chalybeate Waters.*	Pyrmont, Trinkquelle (eisenschüss. Sandstein)	1·005 10° R.	16	Atm. air. 50—55 p.C. SH: $\frac{3\cdot14}{100}$ cub. in.	$\frac{168\cdot5}{100}$ cub. in.	0·7389	4·5102	5·8733	0·3150	0·4046	(Hydrosulphuret of Soda: 0·0657)	0·8274	3·5181	7·6148	5·005	Sulphate of Lithia, 0·0030 Phosphate of Potash and Lime, 1·012 Carbonate of Manganese, 0·0200 Sulphate of Strontia and Baryta, 0·0222 Silica and Resin, 0·0954. 0·1133	29·7246	Brandes and Krüger.
	Meinberg, Trinkquelle	1·0012 6—10° R.	16	$N=\frac{0\cdot505}{100}$ $O=\frac{0\cdot085}{100}$	$\frac{131\cdot217}{100}$	0·0800 0·0100 Manganese oxidulated.	- -	1·4500	0·1536	- -	- -	0·8134	1·1547 0·0185 Pot. (0·027 Sulphuret of Sodium)	0·2805 0·0042 Strontian. 0·0002 Baryt.	1·491	Iod. magn.: Traces - Subphosphate of Alumina, 10·0008 Phosphate of Lime, 0·0001 Silica, 0·0600 Resin and other extracts, 0·6600	5·9621	Brandes.
a) Earthy-saline Chalybeate Waters.	Driburg, Trinkquelle (dolomitischer Muschelkalk)	1·004 8° R.	16	- -	41·65	0·512	0·072 Oxidul. Mang.	9·123	- -	- -	- -	0·535	3·888	8·425	4·250	- - -	26·805	Du Mesnil.
	Hofgeismar, Trinkquelle (Braunkohlen Formation)	1·003 12·5° R.	16	N = 0·389 O = 0·046	16·62	0·300540	0·000020 Mangan.	4·724643	- -	8·196180	0·178268 Potash.	0·132857	2·249553	- -	2·194586	Subphosphate of Alumina, 0·0142 Silica, 0·414812. Resinous matter, 0·000018	18·402902	Wurzer.
	Liebenstein - -	7·5° R.	16	- -	26·0	2·00	- -	3·923	- -	2·300	1·111	3·060	1·600	0·500	- -	- - -	14·494	Trommsdorff.
	Boklet, Ludwigsquelle (Flötzkalk)	1·008 9° R.	16	- -	- -	0·65	- -	7·25	1·25	27·50	1·25 Potash.	0·75	6·25	0·5 with humus.	- -	Silica, 0·50	45·90	Vogel.
	Brückenau (Basaltgebirge)	1·006 7—8° R.	16	- -	35·5	0·25	- -	0·55	0·15	0·30	0·65 Potash.	- -	- -	0·2 with animal substance	0·60	Silica: Traces	2·70	—
	Rohitsch (grobkörniger Kalk)	1·0048 9° R.	16	- -	58·0	1·200	2·250	7·900	2·900	0·66	0·111	0·625	21·333	4·142	2·875	Alumina, 0·333 Extractive, 0·100	43·935	Suess.
	Riepoltsau, Josephsquelle (Urgebirg)	1·005 8° R.	16	- -	32·04	0·76 0·57 Mang.	- -	9·78	0·16	0·12 Potash: Trace.	Fluate of Lime: Trace.	0·24	15·60	0·48	-	Phosph. of Soda, 0·24 —— Magnesia and Alumina, 0·18 Silicate of Alumina, 1·09 Bituminous extract 0·12	29·04	Kölreuter.
	Griesbach (Urgebirg) -	1·002 8° R.	16	- -	22·07	3·0	- -	· -	- -	0·5	- -	- -	6·25	19·0	- -	- - -	28·75	—
b) Alkaline, &c.	Eger, Franzensbad (Flötzgebirge with Steinkohlenlagern)	1·0058 9·3° R.	16	- -	40·85	0·235 0·043 Mang.	5·1886	0·0376 Lith. 1·8002 0·0031 Stro.	0·672	9·2306	- -	- -	24·5047	- -	- -	Phos. of Lime, 0·0230 —— Alumina, 0·0123 Silica, 0·4731	42·2452	Berzelius.

TABLE II.—MINERAL WATERS OF GERMANY—*continued.*

Classification.	Places.	Specific Gravity and Temperat.	Quantity.	Gases.		Carbonated Salts.				Muriatic Salts.			Sulphuric Salts.			Other Constituents.	Total solid Parts.	Authors.
				N. O.	CO2.	Iron-oxide.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.			
			oz.			*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	*gr.*	
b) Alkaline-saline Chalybeate Waters.	Marienbad, Ferdinandsquelle (porphyrartiger Granit)	1·0046 7·5° R.	-	- -	13,736	0·3995 0·092 Mang	6·1302	4·0112	3·0489	8·9965	- -	- -	22·5362	- -	(Silica 0·6697)	Carbonate of Lithia, 0·0676 —— Strontia, 0·0054 Phosphate of Alumina, 0·0054	45·962	Berzelius.
	Godelheim, Stahlquelle (Braunkohlenlager)	- -	-	- -	40·0	1·75 0·16 Mang.	- -	2·75	1·25	6·50	0·50	0·50	2·50	2·00	1·75	Silica, 0·75 Extractive, 0·20 Resin, 0·50 Phosphate of Potash & Lime: Traces.	21·11	Witting.
	Schwalbach, Weinbrunnen	1·001 9° R.	16	- -	22·0cu.in.	0·66351	0·50000	1·63649	4·24324	0·25225	- -	0·20270	0·37837	0·48648	- -	Alumina, 0·32432	8·6873	Rube.
	Königswarth, Trinkquelle (Basaltgebirge with Torflagern)	- -	- -	- -	151·37 100	0·431	0·443	3·238	- -	0·047 0·062 P.	- -	- -	0·089 Pot.	- -	- -	Subphosphate of Alumina, 0·019 Silica, 0·653. Humic Acid, 0·157	6·772	Steinmann and Berzelius.
	Cudowa, Trinkquelle (Urgeb. and Sandstein)	1·006 7—9° R.	16	- -	43·0	0·9062	12·1525	1·8713	13·614	1·9492	- -	- -	4·3508	- -	- -	Extractive, 0·8654 -	35·6894	Kneissler.
	Reinerz, tepid Spring (Urgebirge)	1·02 14° R.	16	- -	20·28	- -	13·850	5·200	1·340	0·560	- -	- -	2·027	- -	- -	Potash and Manganese, carbonate of iron in the cold springs	22·977	Mogalla and Günther.
	Niederlangenau (Quadersandstein)	- -	16	- -	30·7	0·421	0·871	0·947	0·115	2·720	- -	1·767	0·132	- -	- -	- - -	7·973	Trommsdorff.
	Steben (Thonschiefer)	1·002 7—8° R.	16	- -	27·5	0·65	0·75	1·65	0·20	0 08	- -	- -	0·05	- -	- -	Humic Acid, 0·12. Silica, 0·5	4·00	Vogel.
	Tönnstein (Trass) -	- -	16	- -	21·04	0·10	7·25	9·00	- -	0·95	- -	- -	0·80	- -	- -	- - -	18·10	Funke.
c) Earthy and Copperas-holding Chalyb. Waters.	Wildhagen, Thalbrunnen (Uebergangsgebirge)	1·0011 8° R.	16	- -	21·33	0·500	- -	2·500	2·213	0·125	- -	- -	- -	- -	0·357	Silica, 0·42. Resin, 0·05	6·165	Stuke.
	Freudenthal (Maximiliansquelle	6° R.	16	- -	49·62	0·26	- -	1·89	1·3	0·065	- -	- -	0·17	0·59	- -	Silica, 0·13 - -	4·311	Scholz.
	Alexisbad, Selkenbrunnen	6·5 R.	- -	- -	- -	0·574 Sulphuretted Oxule. Iron.	- -	- -	- -	1·085 Oxidule of Iron.	- -	0·281	0·675	0·739	0·651	Sulphate of Manganese, 0·328 Resin, 0·436. Silica, 0·109	4·876	Trommsdorff.
	Bukowina, Niederquelle	9·5 R.	- -	- -	- -	1·960 Sulphuretted Oxule. Iron.	- -	- -	- -	0·920 Oxidule of Iron.	- -	- -	- -	0·480	2·080 Alumina.	Alumina, 0·380. Oxide of Iron, 0·16 Silica, 0·120. Extractive, 0·120	6·220	Lachmund.
2. *Cold Salt Springs*	Bilin, Josephsquelle (Klingsteinporphyr)	1·00653 9—10° R.	16	0·215 cu. in.	33·58	0 019 0·011 Mangan.	23·948 0·88 Lithion.	2·319 0·014 Strontian.	1·976	2·927	- -	- -	5·539	1·891 Pot.	- -	Subphosphate of Alumina, 0·014 ——— Lime, 0·005 Silica, 0·388	39·204	Steinmann.
	Fachingen (Thonschiefer)	8° R.	16	- -	19·6874	0·0892	43·2578	2·4965	1·7313	4·3119	- -	- -	0·5836	- -	- -	Phosphate of Soda, 0·0186. Silica, 0·0873 Nitrate of Magnesia, 20·274	52·3762	Bischof.
	Saidschütz, Hauptbrunnen (Volcanic Formation)	1·01761 16—20° R.	16	0·105	3·304	0·108 0·028 Mangan.	0·024 Strontian.	4·838	1·100	- -	- -	2·606	27·113	2·496 22·932 Pot.	78·753	Subphosphate of Alumina, 0·018 Silica, 0·061. Humic Extract, 0·385	160·718	Steinmann.

	Püllna, Bitterwasser -	7° R.	Dried Salts.	- -	6·939	- -	- -	0·770	6·406	- -	- -	16·666	123·800	2·6 4·8 Pot.	93·086	Subphosphate of Lime, 0·003 Silica, 0·176	242·307	Struve.
	Marienbad, Kreuzbrunnen (porphyrartiger Granit)	1·00941 9·5° R.	16	- -	8·384	0·1750 0·0384 Mangan.	7·1532 0·1144 Lith.	3·9345 0·0038 Strontia.	2·7187	13·5636	- -	- -	38·1158	- -	- -	Subphosphate of Alumina, 0·0031 Silica, 0·3878	66·1892	Berzelius.
	Pyrmont, saline Spring (bunter Sandstein)	1·0112 8·8° R.	16	- -	100 100	0·065 with Mangan.	6·238	6·920	- -	65·498	- -	12·076	12·246	5·516	0·087 L.	Resin, 0·100 -	108·746	Brandes.
	Elmen near Schönbeck, Brine-spring (Kalkstein)	- -	16	- -	Undetermined.	0·025	- -	0·065	- -	146·98	0·120 P.	1·680	1·800 0·120 Pot.	2·480	0·300	- - -	153·57	Herrmann.
	Nenndorf, Trinkquelle (Muschelkalk)	1·003 8° R.	16	N. 0·53 O. 0·13	1·31 cu.in. 1·66 SH.	0·062825	0·007177 Mangan.	1·707539	0·865046	0·987476	- -	0·549313	4·613480	7·292484	0·797390	Resin, 0·038615. Fluate of Lime—traces Alumina with Silica, 0·011453 Azote with Sulphur, 0·268595 - -	17·210395	Wurzer.
	Ischl, Brine (Salzformation)	- -	16	- -	- -	- -	- -	- -	- -	223·00	0·780	7·100	4·855	1·027	1·820	- - -	238·591	
	Kissingen, Ragozibrunnen (Flötzkalk and Sandstein)	8·5—9·5° R.	16	- -	26·25 cub. in.	0·68 with Mangan.	0·82 with traces of Lithion.	3·55 with traces of Strontia.	2·50	62·05	0·91 Pot. 0·05 Am.	6·85	2·00	2·50	(Hyd. Ac. 0·70)	Phosphate of Soda, 0·17. Extract, 0·15 Alumina, 0·18. Silica, 2·25	85·36	Kastner.
3. *Thermal.* *a)* Non-sulphurous Thermal.	Baden-Baden, Hauptquelle (Flötzkalk)	43—54° R.	16	- -	0·333 cub.in.	0·111	- -	- -	- -	17·500	1·500	0·500	- -	2·75	- -	- - -	22·361	—
	Wiesbaden, Kochbrunnen (Thonschiefer)	1·0047 56° R.	16	N, CO^2 = 54 : 46		0·078	- -	1·650	0·700	44·225	5·480 1·200 Pot.	0·790	0·700	0·42	- -	Extractive, 1·750 Silicate of Magnesia, 0·600	57·593	—
	Ems, Kesselbrunnen (Uebergangsgebirge)	37—40 R.	16	- -	- -	0·0625 0·1250 Mang.	20·0000	2·0000	2·0000	3·0000	0·5000	0·2500	1·0000	- -	- -	- - -	28·9375	—
	Schlangenbad, alter Brunnen (Thonschiefer)	1·00055 21—23° R.	16	N. 0·025 cub. in.	1·875	- -	3·25	- -	- -	1·10	- -	- -	- -	- -	- -	- - -	4·35	—
	Teplitz, Hauptquelle (Urgeb. and Basalt)	39·5° R.	16	- -	2·4	0·036	12·240	0·340	- -	0·776	- -	- -	1·696	- -	- -	Resin and extractive, 0·1. Silica, 0·42	15·608	Ambrozi.
	Gastein (Urgebirge) -	37° R.	16	- -	- -	0·0484 0·0138 Mang.	0·0597	0·3394	0·0100	0·2834	0·1405 Pot.	- -	1·4331 0·0292	- -	- -	Silica, 0·3315 Phosphate of Alumina, 0·0292	2·7182	Hünefeld.
	Carlsbad, Sprudel (Urgeb. and Basalt formation)	59—60° R.	16	- -	11·85	0·0278 0·00645 Mang.	9·69500	10·05005 0·00737 Strn.	1·36965	7·97583	- -	- -	19·86916	- -	- -	Silica, 0·57715. Fluor spar, 0·02458. Subphosphate of Alumina, 0·00246	49·60719	Berzelius.
	Bertrich (Grauwackenschiefer)	1·00165 25—26° R.	16	- -	0·1	0·480	0·740	0·720	0·080	1·200	- -	- -	8·160	0·560	0·860	Silica, 0·400 -	13·200	Mohr.
	Burtscheid (Uebergangskalk) Hottest non-sulphurous Spring.	1·004 62°	16	N. 19·000 O. 0·040	7·60	0·055 Strn.	6·722	0·295	0·242	22·057	0·573 Flr. Spar.	- -	3·465	- -	(0·656 Silica.)	Phosphate of Soda, 0·161, with Lithia, 0·0006 Animal matter, 0·232	34·5586	Monheim
	Burtscheid (Uebergangskalk) Sulphurous Trinkquelle	1·003 46·5° R.	16	N. 18·867 SH. 0·053	7·712	0·042 Strn.	6·599	0·241	0·113	21·625	0·485 Flr. Spar.	- -	2·567 0·624	- -	(0·553 Silica.)	Phosphate of Soda, 0·142, with Lithia, 0·0005 Animal matter, 0·208	32·8715	—
b) Sulphurous Thermal.	Aachen, Kaiserquelle (Uebergangskalk with Thonschiefer)	1·004 37—46° R.	16	N. 18·533 SH. 0·133	8·00	0·043 Strn.	6·610	0·232	0·152	20·716	0·479 Flr. Spar.	- -	2·121 0·620	- -	(0·540 Silica.)	Phosphate of Soda, 0·146, with Lithia, 0·0006 Animal matter, 0294	31·9536	—
	Warmbrunn, Grafenbad (Urgebirge)	1·00035 30° R.	16	- -	8·00	- -	5·072	1·101	- -	0·833	- -	- -	2·814	0·463	- -	Resin, 0·605 -	10·888	Tschörner.

TABLE II.—MINERAL WATERS OF GERMANY—*continued.*

Classification.	Places.	Specific Gravity and Temperat.	Quantity.	Gases.		Carbonated Salts.				Muriatic Salts.			Sulphuric Salts.			Other Constituents.	Total solid Parts.	Authors.
				N. O.	CO2.	Iron-oxide.	Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia	Soda.	Lime.	Magnesia.			
			oz.			gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	
	Oestr. Baden (Flötzkalkstein)	1·004 29—30 R.	16	SH. 3·33	1·77	- -	- -	0·252	0·184	- -	0·323	0·117	0·298	0·402	0·408	Silica, 0·012 - -	2·100	Schenk.
	Landeck, St. Georgenbad (Gneus)	23·5° R.	16	SH. 4·333	1·25	- -	- -	0·132	- -	0·025	0·066	- -	0·858	0·400	- -	Alumina, 0·1. Silica, 0·3. Extractive, 0·016	1·897	Mogalla and Günther.
4. *Acidulous Waters.*	Selters (eisenhaltige Thonlager)	1·00369 14° R.	16	- -	15·57	0·1542 with Mangan.	15·4093	1·8672	1·5953	16,2855	- -	- -	0·5653	- -	- -	Phosphate of Soda, 0·7233 Silica, 0·2892	36·8893	Bischoff.
	Roisdorf, Trinkquelle	1·00449 9·5° R.	16	- -	19·86	0·0557 with Mangan.	6·0406	2·1657	3·0628	14·5997	- -	- -	3·6727	- -	- -	Phosphate of Soda, 0·0505 Silica, 0·1240. Alumina, 0·008	20·7797	—
	Schwalheim (Basalt)	1·0022 8·5° R.	16	N. 0·367 O. 0·122	37·55	0·191377	0·775683	4·254243	- -	0·777800	0·581530 Pot.	- -	0·965254	0·571334 Pt.	- -	Alumina, 0·053657 Silica, 0·089429	17·260307	Wurzer.
	Kissingen, Maximiliansbrunnen (Flötzkalk and Flötztrapp)	9·5° R.	16	- -	30·24	- -	0·35	2·70	1·82	18·24	1·02 Pot.	3·05	1·85	0·77	- -	Phosphate of Soda, 0·12. Traces of Hydrobromate of Magnesia Silica, 0·47.	30·39	Kastner.
	Soden, Winklerbrunnen	1·00742 14° R.	16	- -	18·569	0·253 with Mangan.	- -	5·068	3·847	40·611	0·407 Pot.	- -	- -	0·322	- -	Alumina, 0·029. Silica, 0·629 Brome and humlc Salts	51·171	Schweinsberg.
	Salzbrunn, Oberbrunnen (Uebergangsgebirge)	1·00241 5—6° R.	16	- -	$\frac{98}{100}$	0·018	8·000	2·002	1·001	1·012	- -	- -	3·002	- -	- -	Silica, 0·024 -	15·059	Fischer.
	Franzensbad, kalter Sprudel (vulkanische Gebirge)	1·00588 9·3° R.	16	- -	39·4	0·2000 0·0040 Mang.	7·1733	1·6000 0·0013 Strn.	0·0133	8·6000	- -	- -	26·92000	- -	- -	Phosphate of Lime and Magnesia, 0·0280 Silica, 0·0560	44·6079	Trommsdorff.
	Pyrmont, acidulous, (bunter Sandstein)	1·0001 8·3° R.	16	- -	$\frac{83·5}{100}$	- -	0·3062	1·8110	0·1684	0·0118	- -	0·1262	0·3782	0·3156	0·6030	Resin, 0·0080 Traces of Lithia, Baryta, and Strontia.	3·7284	Brandes.
5. *Sulphurous Waters.*	Sironabad (Basalt) -	- -	16	SH. 0·767 cub. in.	0·834	0·042	0·226	0·883	0·037	1·970	- -	0·214	1·364	0·209	- -	Extractive. Resinous, 0·053 Watery, 0·069	5·067	Büchner.
	Weilbach - -	15° R.	16	SH. 4·0	9·0	- -	4·500	2·125	1·250	0·750	- -	0·930	1·125	- -	- -	Sulphurous Resin, 0·375	11·055	Creve.
	Nenndorf, Spring under the Vault (Steinkohlenlager)	1·0032 8° R.	16	N. 0·72 SH. 1·19	2·61	0·035198 with Mang.	- -	2·690182	0·418832	0·799002	- -	0·782087	5·187053	7·635612	0·708092	Resin, 0·004325. Azote, 0·032215 Sulphur, 0·1395. Alumina, 0·008054 Silica, 0·020938	18·467790	Wurzer.
	Eilsen, Georgenbrunnen (Muschelkalk and Schieferthon) -	1·00373 9—10° R.	16	SH. 7·68	6·72	- -	- -	1·400 10·9 Sulphuretted Hydrogen.	0·264	0·333	0·462	1·200	5·726	12·066	3·000	Extractive, 0·066 Azote, 0·132 Silica, 0·132. Alumina, 0·066	35·847	Westrumb.

Meinberg, Schwefelquelle (schwarzes Moorlager)	7·5—13° R.	16	N. 1·41 O. 0·08 SH. 2·13	8·11/100	0·0080 with Mangan.	- -	2·1494	0·1723	- -	- -	- -	5·8444 0·0677	8·3355 3·0057 Pot.	1·7333 0·008 Stront.	Subphosphate of Alumina, 0·0100 Silica, 0·12. Animal matter	19·4894	Brandes.
Winslar. Sulphur Spring	1·0005/11° R.	16	SH. 15·0	10·0	- -	- -	1·950	- -	0·500	0·525	0·350	2·750	17·166	5·125	Alumina, 0·100. Silica, 0·150	28·616	Usinger.
Langensalza - -	10° R.	16	SH. 3·732	1·628	- -	- -	2·200	0·650	- -	1·250 Sulphd. hydrogen.	0·250 0·150 Sul. hyd.	1·950	11·150	2·000	Sulphur-resin, 0·1. Alumina, 0·25 Silica, 0·15. Extractive, 0·075	20·075	Trommsdorff.
Kreuth, Stinkergraben	9° R.	16	SH. 1·35	2·625	0·125	-	7·0625	0·375	- -	- -	0·125	- -	5·875	2·75	Silica, 0·5625. Humus, 0·125	17·00	Vogel.
Boklet, Schwefelquelle (Flötzkalk with Basalt)	1·0085/9° R.	16	SH. 0·2	21·0	0·40	0·50	2·50	0·50	0·25	0·50 Pot.	- -	0·25.	- -	- -	Silica, 0·10 - -	5·00	—
Rosenheim - -	- -	16	SH. 0·1	- -	0·01	0·06	1·01	0·05	0·01 with Potash.	- -	- -	0·08	- -	- -	Humus, 0·01. Silica, 0·01	1·24	—

Classif.	Places.	Authors.	Quantity.	Combustible Matters.				Salts.	Oxides.		
				Sulphur.	Resin.	Extractive.	Fibre.		Iron-oxide.	Silica.	Alumina.
			parts.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.
6. *Mud Baths.*	Eilsen - -	Westrumb.	100	4·25	0·12	- -	6·6 1·12 Slime.	2·4	3·0 calcareous earth.	21·36 and with Carbon.	5·2
	Fiestel - -	Witting. -	100	0·75	1·75	3·0 4·0 Hum.	0·5	53·3 Sol. 29·81 Insol.	3·45 with Mangan.	50·25	3·25
	Günthersbad	Buchholz -	1000	- -	4·0 Wax.	0·75	110·0 Carbon.	158·0	3·0	92·25 Sand.	42·0
	Oestr. Baden	Schenk -	240	215·8	- -	- -	- -	8.60 Soluble. 15·60 Insol.			
	Marienbad -	Steinmann.	2128	- -	- -	14·18 Soluble.	852·67 Combustible with water.	3·61 Soluble Salts.	9·539	128·139	0·862

Classif.	Places.	Quantity.	Muriatic Salts.			Sulphuric Salts.			Other Matters, with the Total.		Authors.
			Soda.	Lime.	Magnesia.	Soda.	Lime.	Magnesia.			
		oz.	gr.	gr.	gr.	gr.	gr.	gr.		gr.	
7. *Sea Baths.*	Norderney	16	174·000	- -	62·666	1·333	8·000	- -	- - -	245·0	Bluhm.
	Cuxhaven	16	116·0	1·0	58·0	2·0	6·0	10·0	Veget. soil, 1·0 - -	240	Schmeisser
	Föhr -	16	179·33	- -	67·0	- -	7·0	11·0	Extractive, 0·66 -	264·99	Becker.
	Düsterbrock -	16	92·0	Traces of Potash.	30·0	- -	3·5	6·0	Carb. of Lime, 0·4 - Resinous matter, 0·5	132·4	Pfaff.
	Dobberan, Salzquelle -	16	109·502 1·0 Potash.	5·075	16·208	3·782	10·600	9·21 3	Carb. of Lime and Magnesia, 4·204 Red Carb. of Iron, 0·35 - - Extractive, 0·88 - Silica, 0·200 -	= 160·116	Hermbstädt.
	Carbonic Acid, 3·572 cub. in. Azote, 0·832 cub. in.										

WEAVING OF HAIR CLOTH. In addition to the description of this art, under " Hair" in the Dictionary, I shall give here a short notice of the best kind of shuttle for weaving hair. *Fig.* 177. shows in plan A, and in longitudinal section B, a shuttle which differs from that of the common cloth weaver only in not having a pirn enclosed in the body of the box-wood, but merely an iron trap *a*, which turns in the middle upon the pin *b*. This trap-piece is pressed up at the one end, by the action of the spring *c*, so as to bear with its other end upon the cleft of the iron plate *d*, which is intended to hold fast the ends of the hair-weft: *d* and *c* together are called the jaw or mouth, whence the popular name of this shuttle. The workman opens this jaw by the pressure of his thumb upon the spring end of the trap *a*, introduces with the other hand one or more hairs (according to the description of hair cloth) into the mouth, and removing his thumb, lets the hair be seized by the force of the spring. The hairs having one end thus made fast are passed across the warp by the passage of the shuttle, which is received at the other end by the weaver's left hand. The friction rollers, *x*, *x*, are like those of fly-shuttles, but are used merely for convenience, as the shuttle cannot be thrown swiftly from side to side. The hand which receives the shuttle opens at the same time the trap, in order to insert another hair, after the preceding has been drawn through the warp on both sides and secured to the list. A child attends to count and stretch the hairs. This assistant may, however, be dispensed with by means of the following implement, represented in *fig.* 178. C, C, is the view of it from above, or the plan; D, is a side view; E, a longitudinal section, and F, an oblique section across. The chief part consists in a wooden groove, or chamfered slip of wood, open above, and rounded on the sides. It is about twenty-one inches in length, about as long nearly as the web is broad, therefore a little shorter than the horse-hairs inserted in it, which project about an inch beyond it at each end. They are herein pressed down by elastic slips *e*, of Indian rubber, so that the others remain, when one or more are drawn out by the ends. The ends of the grooves are flat where the Indian rubber spring exerts its pressure, as shown by the dotted line at F. The spring is formed by cutting out a double piece from the curvature of the neck of a caoutchouc bottle or flask, fastening the one end of the piece by a wire staple in the groove of the shuttle, whereby the other end, which alone can yield, presses upon the inlaid hairs. Wire staples like *f* (in the section E) are passed obliquely through two places of the groove or gutter, to prevent the hairs from springing up in the middle of the shuttle, which is suitably charged with them. The workman shoves the tool across the opened warp with the one hand, seizes with the other the requisite number of hairs by the projecting ends, and holds them fast, while he draws the shuttle once more through the warp. The remaining hairs are retained in the groove by the springs, and only those for the single decussation remain in the web, to be secured to the list on either side. A weaver with this tool can turn out a double length of cloth of what he could do with the mouth-shuttle.

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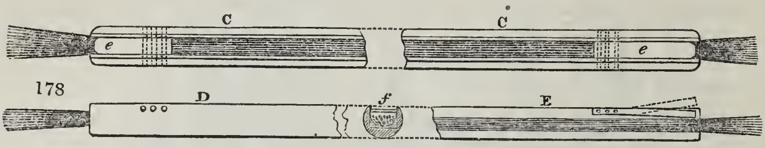
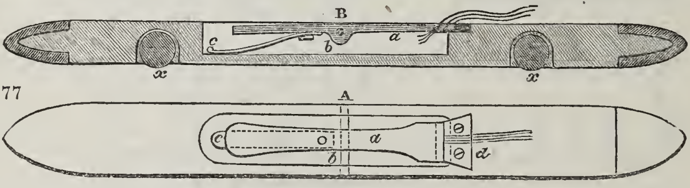


177



WHALEBONE. A patent was granted to Mr. Laurence Kortright in March 1841, for improvements in the treatment of whalebone, which consist in compressing the strips in width to increase their thickness, so as to render the material applicable for forming walking-sticks, whip handles, parasol and umbrella sticks, ramrods, archery bows, &c. He accomplishes this purpose by bending the strips together, introducing them into a steam chest, thereby softening them, and in that state compressing them into a compact mass by appropriate machinery; for a description, with figures, of which, see *Newton's Journal*, C.S. xxi. 444.

WHITE LEAD. Mr. Thomas Richardson, of Newcastle, one of the most distinguished chemists of Liebig's school, obtained a patent in December 1839, for a preparation of sulphate of lead, applicable to some of the purposes to which the carbonate is applied. His plan is to put 56 pounds of flake litharge into a tub, to mix it with one pound of acetic acid (and water) of specific gravity 1·046, and to agitate the mixture till the oxide of lead becomes an acetate. But whenever this change is partially effected, he pours into the tub, through a pipe, sulphuric acid of specific gravity 1·5975, at the rate of about 1 pound per minute, until a sufficient quantity of sulphuric acid has been added to convert all the lead into a sulphate; being about 20 parts of acid to 112 of the litharge. The sulphate is afterwards washed and dried in stoves for the market. I have examined the particles of this white lead with a good achromatic microscope, and found them to be semi-crystalline, and semi-transparent, like all the varieties of carbonate precipitated from saline solutions of the metal.

Mr. Leigh, surgeon in Manchester, prepares his patent white lead, by precipitating a carbonate from a solution of the chloride of the metal by means of carbonate of ammonia. On this process, in a commercial point of view, no remarks need be made. In Liebig and Woehler's Annalen for May 1843, Chr. Link has communicated his investigation of two sorts of lead, prepared in the Dutch way, by the slow action of vinegar and carbonic acid upon metallic lead, under the heat of fermenting horse-dung. The one sort was manufactured by Sprenger, the other by Klagenfurth of Krems. He also examined 3 specimens of the Offenbach white lead. They all agreed in composition; affording 11·29 per cent. of carbonic acid, and 2·23 of water; corresponding to the formula, $2\ (\mathrm{PbO},\ \mathrm{CO_2}) + \mathrm{PbO},\ \mathrm{H_2O}$; that is, in words, 2 atoms of carbonate of lead with 1 atom of oxide and 1 atom of water — in round numbers, thus, $\overline{2 \times 134} + 112 + 9$.

Mulder observed specimens of white lead, of different atomic proportions of carbonate, oxide and water from the above, and discovered that the quality improved as the carbonate increased. The white lead by the Dutch process, as made by Messrs. Blackett of Newcastle, is certainly superior as a covering oil pigment to all others. Its particles are amorphous and opaque.

A patent was granted to Mr. Hugh Lee Pattinson in September 1841, for improvements in the manufacture of white lead, &c. This invention consists in dissolving carbonate of magnesia in water impregnated with carbonic acid gas, by acting upon magnesian limestone, or other earthy substances containing magnesia in a soluble form, or upon rough hydrate of magnesia in the mode hereafter described, and in applying this solution to the manufacture of magnesia and its salts, and to the precipitation of carbonate of lead from any of the soluble salts of lead, but particularly the chloride of lead; in which latter case the carbonate of lead, so precipitated, is triturated with a solution of caustic potash or soda, by which a small quantity of chloride of lead contained in it is converted into hydrated oxide of lead, and the whole rendered similar in composition to the best white lead of commerce. The manner in which these improvements are carried into effect is thus described by the patentee: — I take magnesian limestone, which is well known to be a mixture of carbonate of lime and carbonate of magnesia, in proportions varying at different localities; and on this account I am careful to procure it from places where the stone is rich in magnesia. This I reduce to powder, and sift it through a sieve of forty or fifty apertures to the linear inch. I then heat it red-hot, in an iron retort or reverberatory furnace, for two or three hours, when, the carbonic acid being expelled from the carbonate of magnesia, but not from the carbonate of lime, I withdraw the whole from the retort or furnace, and suffer it to cool. The magnesia contained in the limestone is now soluble in water impregnated with carbonic acid gas, and to dissolve it I proceed as follows: — I am provided with an iron cylinder, lined with lead, which may be of any convenient size, say 4 ft. long by 2½ ft. in diameter; it is furnished with a safety-valve and an agitator, which latter may be an axis in the centre of the cylinder, with arms reaching nearly to the circumference, all made of iron and covered with lead. The cylinder is placed horizontally, and one extremity of this axis is supported within it by a proper carriage, the other extremity being prolonged, and passing through a stuffing-box at the other end of the cylinder, so that the agitator may be turned round by applying manual or other power to its projecting end. A pipe, leading from a force-pump, is connected with the under side of the cylinder, through which carbonic acid gas may be forced from a gasometer in communication with the pump, and a mercurial gauge is attached, to show at all times the amount of pressure within the cylinder, independently of the safety-valve. Into a cylinder of the size given I introduce from 100 to 120 lbs. of the calcined limestone with a quantity of pure water, nearly filling the cylinder; I then pump in carbonic acid gas, constantly turning the agitator, and forcing in more and more gas, till absorption ceases, under a pressure of five atmospheres. I suffer it to stand in this condition three or four hours, and then run off the contents of the cylinder into a cistern, and allow it to settle. The clear liquor is now a solution of carbonate of magnesia in water impregnated with carbonic acid gas, or, as I shall hereafter call it, a solution of bicarbonate of magnesia, having a specific gravity of about 1·028, and containing about 1600 grains of carbonate of magnesia to the imperial gallon.

I consider it the best mode of obtaining a solution of bicarbonate of magnesia from magnesian limestone, to operate upon the limestone after being calcined at a red heat in the way described; but the process may be varied by using in the cylinder the mixed hydrates of lime and magnesia, obtained by completely burning magnesian limestone in a kiln, as commonly practised, and slaking it with water in the usual manner; or, to lessen the expenditure of carbonic acid gas, the mixed hydrates may be exposed to the air a few weeks till the lime has become less caustic by the absorption of carbonic acid from the atmosphere. Or the mixed hydrates may be treated with water, as practised by some manufacturers of Epsom salts, till the lime is wholly or principally removed; after which the residual rough hydrate of magnesia may be acted upon in the cylinder, as described; or hydrate of magnesia may be prepared for solution in the cylinder, by dissolving magnesian limestone in hydrochloric acid, and treating the solution, or a solution of chloride of magnesium, obtained from sea-water by salt-makers in the form of bittern, with its equivalent quantity of hydrate of lime, or of the mixed hydrates of lime and magnesia, obtained by completely burning magnesian limestone, and slaking it as above. When I use this solution of bicarbonate of magnesia for the purpose of preparing magnesia and its salts, I evaporate it to dryness, by which a pure carbonate of magnesia is at once obtained, without the necessity of using a carbonated alkali, as in the old process; and from this I prepare pure magnesia by calcination in the usual manner; or, instead of boiling to dryness, I merely heat the solution for some time to the boiling point, by which the excess of carbonic acid is partly driven off, and pure carbonate of magnesia is precipitated, which may then be collected, and dried in the same way as if precipitated by a carbonated alkali. If I require sulphate of magnesia, I neutralise the solution of bicarbonate of magnesia with sulphuric acid, boil down, and crystallise; or I mix the solution with its equivalent quantity of sulphate of iron, dissolved in water, heated to the boiling point, and then suffer the precipitated carbonate of iron to subside; after which I decant the clear solution of sulphate of magnesia, boil down, and crystallise as before. When using this solution of bicarbonate of magnesia for the purpose of preparing carbonate of lead, I make a saturated solution of chloride of lead in water, which, at the temperature of 50° or 60° Fahr., has a specific gravity of about 1·008, and consists of 1 part of chloride of lead dissolved in 126 parts of water. I then mix the two solutions together, when carbonate of lead is immediately precipitated; but in this operation I find it necessary to use certain precautions, otherwise a considerable quantity of chloride of lead is carried down along with the carbonate. These precautions are, first, to use an excess of the solution of magnesia, and secondly, to mix the two solutions together as rapidly as possible. As to the first, when using a magnesian solution, containing 1600 grs. of carbonate of magnesia per imperial gallon, with a solution of chloride of lead saturated at 55° or 60° Fahr., 1 measure of the former to $8\frac{1}{2}$ of the latter is a proper proportion; in which case there is an excess of carbonate of magnesia employed, amounting to about an eighth of the total quantity contained in the solution. When either one or both the solutions vary in strength, the proportions in which they are to be mixed must be determined by preliminary trials. It is not, however, necessary to be very exact, provided there is always an excess of carbonate of magnesia amounting to from one-eighth to one-twelfth of the total quantity employed. If the excess is greater than one-eighth no injury will result, except the unnecessary expenditure of the magnesian solution. As to the second precaution, of mixing the two solutions rapidly together, it may be accomplished variously; but I have found it a good method to run them in two streams, properly regulated in quantity, into a small cistern, in which they are to be rapidly blended together by brisk stirring, before passing out, through a hole in the bottom, to a large cistern or tank, where the precipitate finally settles. The precipitate thus obtained is to be collected, washed and dried in the usual manner. It is a carbonate of lead, very nearly pure, and suitable for most purposes; but it always contains a small portion of chloride of lead, seldom less than from 1 to 2 per cent., the presence of which, even in so small a quantity, is somewhat injurious to the colour and body of the white lead. I decompose this chloride, and convert it into a hydrated oxide of lead by grinding the dry precipitate with a solution of caustic alkali, in a mill similar to the ordinary mill used in grinding white lead with oil, adding just so much of the ley as may be required to convert the precipitate into a soft paste. I allow this paste to lie a few days, after which, the chloride of lead being entirely, or almost entirely decomposed, I wash out the alkaline chloride formed by the reaction, and obtain a white lead, similar in composition to the best white lead of commerce. I prepare the caustic alkaline ley by boiling together, in a leaden vessel, for an hour or two, 1 part by weight of dry and recently-slaked lime, 2 parts of crystallised carbonate of soda (which, being cheaper than carbonate of potash, I prefer) and 8 parts of water. The clear and colourless caustic ley, obtained after subsidence, will have a specific gravity of about 1·090, and, when drawn off from the sediment, must be kept in a close vessel for use.

WINES. In a case tried before the Court of Exchequer, at the instance of the Board of Customs, in December 1843, of an attempt to obtain the drawback upon a large quantity of damaged Claret offered for exportation, I had observed, in my examination of the wine, that on the addition to it of water of ammonia to super-saturate its acidity, a large flocculent precipitate of decomposed gluten fell, and the supernatant liquor lost its ruby colour, and became yellow-brown. I have tried sound samples of genuine claret, very old, as well as new, by the same test, and I have found the ruby colour to remain but little impaired; contrary to the allegation of the chemist of the defendants in the lawsuit. The wine was declared by the verdict of a jury and the decision of the judge to be unworthy of being admitted for drawback, and therefore forfeited to the Crown.

WINES, BRITISH, are made either from infusions of dried grapes (raisins) or from the juices of native fruits, properly fermented. These wines are called *sweets* in the language of the Excise, under whose superintendence they were placed till 1834, when the duties upon them were repealed, as onerous to the trade and unproductive to the revenue. The raisins called Lexias are said to produce a dry flavoured wine; the Denias a sweet wine; the Black Smyrnas a strong-bodied wine, and the red Smyrnas and Valencias a rich and full wine. The early spring months are the fittest time for the wine manufacture. The masses of raisins, on being taken out of the packages, are either beaten with mallets or crushed between rollers in order to loosen them, and are then steeped in water in large vats, between a perforated board at bottom and another at top. The water being after some time drawn off the swoln and softened fruit, pressure is applied to the upper board to extract all the soluble sweet matter, which passes down through the false bottom, and flows off by an appropriate pipe into fermenting tuns. The residuary fruit is infused with additional water, and then squeezed; a process which is repeated till all the sweets are drained off, after which the "rape" is subjected to severe pressure in a screw or hydraulic press. The wine, in the process of the vinous fermentation, is occasionally passed through a great body of the rape to improve its flavour, and also to modify the fermentative action; it is afterwards set to ripen in casks, clarified by being repeatedly racked off, and fined with isinglass.

WOOD PAVING. Amongst the numerous illustrations of the durability and resistance of wood paving, reference may be made to the specimens: —

	Yrs.	Mths.
At Whitehall, 1093 yards, laid in December 1839 - - -	3	4
In Fore Street, 521 yards, laid in October 1840 - - - -	2	6
Under the Arch in Scotland Yard, 54 yards (8 feet wide), laid in Oct. 1841	1	6

The first, in every respect a perfect piece of pavement, has been for more than 3 years subjected to a constant traffic, including the utmost amount of percussion from velocity, and the extremest pressure from the ponderous engines which have been transported over its surface. Scarce less may be said of that in Fore Street, whilst the specimen in Scotland Yard has successfully withstood at least a like amount of pressure, the traffic from the wharfs in Great Scotland Yard being no less than 78,000 tons per annum; the passage, narrowed within the limit of a single carriage line, exposing the wood to the most critical test of resistance.

Slipperyness is not a natural defect in wood paving. The accumulations on wood pavement are drawn from the proximate areas of granite and macadam. In granite the imperfect structure admits of the constant oozing of dust and filth; in macadam the surface is always wearing into dirt and slop. In dry, hot, or cold weather the stone-paved streets of London are proverbially as slippery as glass, whilst slipperyness on wood pavement may be altogether obviated by cleanliness; and that may now be ensured by the use of Whitworth's cleansing machine, which has already been successfully tried in some of the principal streets — thanks to the Commissioners of Woods and Forests.

It is impossible not to perceive the great amount of suffering and loss that may be saved in horses by the wood pavement. Cabmen and omnibus drivers assure us that, in the winter season, for a month or two only, there is any serious cause for complaint, and then there is as much or more danger on other pavements; whereas, during the summer months, the advantages of wood over all other pavements is immense; the great mortality of horses in the streets of London, from over-driving during the hot weather, is well known; so far as wood is concerned, the reduction of effort must necessarily decrease the destruction in a greater ratio than even 5 to 2.

WOOD-PRESERVING. Mr. Bethell's invention consists in impregnating wood throughout with oil of tar and other bituminous matters, containing creosote, and also with pyrolignite of iron, which holds more creosote in solution than any other watery menstruum.

The wood is put in a close iron tank, like a high-pressure steam-boiler, which is then closed and filled with the tar oil or pyrolignite. The air is then exhausted by air-pumps, and afterwards more oil or pyrolignite is forced in by hydrostatic pumps, until a pressure equal to from 100 to 150 pounds to the inch is obtained. This pressure is kept up by the frequent working of the pumps during six or seven hours, whereby the wood becomes thoroughly saturated with the tar oil, or the pyrolignite of iron, and will be found to weigh from 8 to 12 pounds per cube foot heavier than before.

In a large tank, like one of those used on the Bristol and Exeter Railway, 20 loads of timber per day can be prepared.

The effect produced is that of perfectly coagulating the albumen in the sap, thus preventing its putrefaction. For wood that will be much exposed to the weather, and alternately wet and dry, the mere coagulation of the sap is not sufficient; for although the albumen contained in the sap of the wood is the most liable and the first to putrefy, yet the ligneous fibre itself, after it has been deprived of all sap, will, when exposed in a warm damp situation, rot and crumble into dust. To preserve wood, therefore, that will be much exposed to the weather, it is not only necessary that the sap should be coagulated, but that the fibres should be protected from moisture, which is effectually done by this process.

The atmospheric action on wood thus prepared renders it tougher, and infinitely stronger. A post made of beech, or even of Scotch fir, is rendered more durable, and as strong as one made of the best oak; the bituminous mixture with which all its pores are filled acting as a cement to bind the fibres together in a close tough mass; and the more porous the wood is, the more durable and tough it becomes, as it imbibes a greater quantity of the bituminous oil, which is proved by its increased weight. The materials which are injected preserve iron and metals from corrosion; and an iron bolt driven into wood so saturated remains perfectly sound and free from rust. It also resists the attack of insects; and it has been proved by Mr. Prichard, at Shoreham Harbour, that the *teredo navalis*, or naval worm, will not touch it.

Wood thus prepared for sleepers, piles, posts, fencing, &c., is not at all affected by alternate exposure to wet and dry; it requires no painting, and after it has been exposed to the air for some days it loses every unpleasant smell.

This process has been adopted by the following eminent engineers — viz., Mr. Robert Stephenson, Mr. Brunel, Mr. Bidder, Mr. Brathwaite, Mr. Buck, Mr. Harris, Mr. Wickstead, Mr. Prichard, and others; and has been used with the greatest success on the Great Western Railway, the Bristol and Exeter Railway, the Manchester and Birmingham Railway, the North Eastern, the South Eastern, the Stockton and Darlington, and at Shoreham Harbour; and lately, in consequence of the excellent appearance of the prepared sleepers, after three years' exposure to the weather, an order has been issued by Mr. Robert Stephenson, that the sleepers hereafter to be used on the London and Birmingham Railway are to be prepared with it before being put down.

The expense of preparing the wood varies from 10*s.* to 15*s.* per load, according to situation, and the distance from the manufactories where the material is made.

Mr. Bethell supplies the material at a low price from his manufactories, either at Nine Elms, Vauxhall; Bow Common; or Birmingham; and parties prepare the timber themselves.

For railway sleepers it is highly useful, as the commonest Scotch fir sleeper, when thus prepared, will last for centuries. Those which have been in use 3 years and upwards look much better now than when first laid down, having become harder, more consolidated, and perfectly waterproof; which qualities, combined with that of perfectly resisting the worm, render this process eminently useful for piles, and all other woodwork placed under water. Posts for gates or fencing, if prepared in this manner, may be made of Scotch fir, or the cheapest wood that can be obtained, and will not decay like oak posts, which invariably become rotten near the earth after a few years.

Y.

YEAST, ARTIFICIAL. Mix two parts, by weight, of the fine flour of pale barley malt with one part of wheat flour. Stir 50 pounds of this mixture gradually into 100 quarts of cold water, with a wooden spatula, till it forms a smooth pap. Put this pap into a copper over a slow fire; stir it well till the temperature rise to fully 155° to 160°, when a partial formation of sugar will take place, but this sweetening must not be pushed too far; turn out the thinned paste into a flat cooler, and stir it from time to time. As soon as the wort has fallen to 59° Fahr., transfer it to a tub, and add for every 50 quarts of it 1 quart of good fresh beer-yeast, which will throw the wort into brisk fermentation in the course of 12 hours. This preparation will be good yeast, fit for bakers' and brewers' uses, and will continue fresh and active for 3 days. It should be occasionally stirred.

When beer-barm has become old and flat, but not sour, it may be revived by mixing with every quart of it a small potato, boiled, peeled, and rubbed down into a paste. The mixture is to be placed in a warm situation, where it will speedily show its renewed activity, by throwing up a froth upon its surface. It must be forthwith incorporated with the dough, for the purpose of baking bread. When the barm has become sour, its acid should be neutralised with a little powdered carbonate of soda, and then treated as above, when it will, in like manner, be revived. A bottle of brisk small beer may furnish ferment enough to form, in this way, a supply of good yeast for a small baking.

The German yeast imported into this country in large quantities, and employed by our bakers, in baking cakes, and other *fancy* bread, is made by putting the *unterhefe* (see BEER, *Bavarian*), into thick sacks of linen or hempen yarn, letting the liquid part, or beer, drain away; placing the drained sacks between boards, and exposing them to a gradually increasing pressure, till a mass of a thin cheesy consistence is obtained. This cake is broken into small pieces, which are wrapped in separate linen cloths; these parcels are afterwards enclosed in waxed cloth, for exportation. The yeast cake may also be rammed hard into a pitched cask, which is to be closed air-tight. In this state, if kept cool, it may be preserved active for a considerable time. When this is to be used for beer, the proportion required should be mixed with a quantity of worts at 60° Fahr., and the mixture left for a little to work, and send up a lively froth; when it is quite ready for adding to the cooled worts in the fermenting back.

YEAST, PATENT. Boil 6 ounces of hops in 3 gallons of water 3 hours; strain it off, and let it stand 10 minutes; then add half a peck of ground malt, stir it well up, and cover it over; return the hops, and put the same quantity of water to them again, boiling them the same time as before, straining it off to the first mash; stir it up, and let it remain 4 hours, then strain it off, and set it to work at 90°, with 3 pints of patent yeast; let it stand about 20 hours; take the scum off the top, and strain it through a hair sieve; it will be then fit for use. One pint is sufficient to make a bushel of bread.

Z.

ZINC. Mr. Nicholas Troughton, of Swansea, obtained a patent in May 1839 for improvements in the manufacture of this metal. His invention relates to the application of a peculiar apparatus in roasting the ores, and in smelting the zinc. *Fig.* 179.

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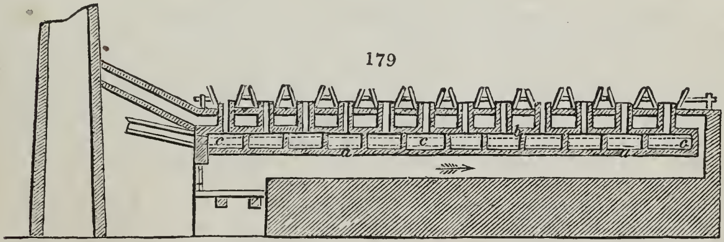

represents the section of a series of retorts for calcining zinc ores, arranged and constructed according to this invention. The retorts shown in this figure are composed of a series of fire-tiles or parallelogram slabs. *a*, *a*, *a*, are the slabs or tiles, which constitute the bottoms of the retorts; *b*, *b*, are the slabs, which constitute the upper surfaces or tops of the retorts; and *c*, *c*, are slabs, placed vertically, to produce the sides of the retorts. The back ends of the retorts are closed by similar tiles or slabs, having a hole through them for the passage of the vapours evolved from the ores; these vapours are conveyed in any direction by the flue at that end, and being thus separated from the products of combustion, may be separately acted on, according to either of the patentee's former inventions, which treat of the separated vapours of copper ores in the process of calcining or roasting such ores; or the separated products of the ore may be allowed to pass into the atmosphere. The patentee states, that by treating zinc ores in furnaces or retorts, such as are above described, considerable saving of fuel will result, and the zinc ore will be more evenly roasted or calcined.

The front ends of the retorts are closed by means of tiles or doors, having a small hole or opening in each, for the passage of atmospheric air; and the holes may be closed, or more or less open, according to the object required. The retorts are charged through the hoppers above, which have proper slides to close the openings into the retorts; the quantity charged into each retort being sufficient to cover the lower surface thereof two or three inches deep. During the operation the ore must be raked from time to time, to change the surfaces, and the retorts should be kept to a moderate red heat.

The second part of this invention relates to an arrangement of apparatus or furnace for calcining zinc ores, wherein the ore is subjected to the direct action of the products of combustion. *Fig.* 180. shows a longitudinal section of the furnace, which is so constructed that while one portion of the zinc ore is being heated in a manner similar to the working of an ordinary calcining surface, other zinc ore is going through a preparatory process by the heat that has passed away from the ore which is undergoing the completing process of calcining. This furnace may be heated by a separate fire, to burn by blast or by draft; or the flue from the smelting furnace may be conducted into the entrance of this furnace, and the otherwise waste heat of the smelting furnace will be thus brought into useful application for calcining or roasting of zinc ore; and this part of the invention is applicable, whether it be applied to the furnace, or to the retorts herein-before explained, and will be found a means of saving much fuel in the processes of obtaining zinc from ore. *a, fig.* 180., represents the furnace, which is suitable for blast, and a constant supply of fuel is kept up in the chamber *b*, there being a close cover, with a sand-joint. *c*, is the bed or floor on which the ore is spread, in like manner to an ordinary reverberatory furnace; the ore is stirred about on the floor by passing the ordinary rakes or instruments through the openings, *d, d*; and when the process has been sufficiently carried on, the ore is discharged through the openings *e, e*, which, at other times, remain closed by fire-tiles. The heat of the fire, and the flame thereof, passing in contact with the ore on the floor or bed, *c*, also acts on the roof, *f*, and that roof, *f*, being hot, reverberates the heat on to the floor or bed, at the same time the heat, which passes through the roof, heats the ore in the upper chamber, *g*; and, in addition to such heat passing through the roof, the flame and heat from the furnace, having passed over the zinc ore, in the lower compartment of the apparatus, enters into and passes over the ore in the chamber *g*; and, in doing so, heats the roof *h*, of that chamber, and also the ore contained therein; and it will be seen that there is a third chamber, *i*; the heat, therefore, which passes through the roof *h*, heats the ore in the chamber *i*. In working this arrangement of calcining furnace or apparatus, when the charge is withdrawn from the lower chamber, the charge in the chamber *g* is to be raked into the lower chamber, through the openings for that purpose, which, at other times, are kept covered with fire-tiles, as shown in the drawing; and the charge in the chamber *i* is to be raked into the chamber *g*, and a fresh supply of ore charged into the chamber *i*.

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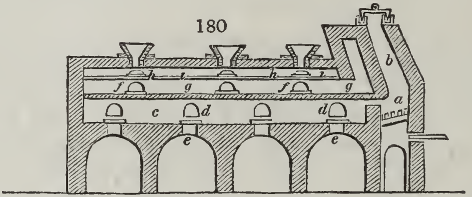

The third part of this invention relates to a mode of arranging a series of retorts side by side, and of applying heat thereto in the process of smelting or distilling zinc from the ore. According to the practice most generally pursued in smelting zinc, the ore is submitted to the action of heat in crucibles, having descending iron pipes, which enter into vessels containing water: all which is well understood, as well as the process of smelting or distilling zinc from the ores. *Fig.* 181. is a side elevation of two sets of

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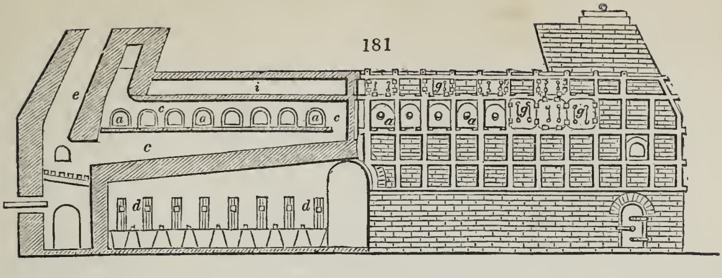

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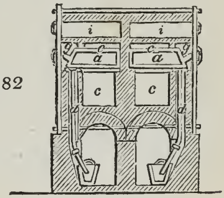

furnaces and retorts, arranged according to this invention, one of the furnaces being in section; and *fig.* 182. is a transverse section of the same. *a, a*, are a series of retorts of fire-clay, arranged, side by side, on a shelf of slabs or fire-tiles. These retorts are each closed at one end and open at the other, such open end being closed, when in operation, by a tile or door, *b*, fitting closely, and luted with fire-clay, as will readily be traced in the drawing. Each series of retorts is placed in a chamber, *c, c*, in such a manner that the heat and flame of the fire will pass from the fireplace or furnace, and act on one side of the retorts; and having passed along all the series, will proceed to the upper part of the chamber, *c, c*, and heat the other side of the retorts; and as the fires are maintained and urged by means of blasts of atmospheric air, the heat may be maintained and regulated with great advantage, and at comparatively small cost. The blasts of air may be produced by any ordinary blowing machinery, but rotatory blowers are preferred, and the air may be cold or heated. When anthracite coal is used as the fuel, the patentee prefers adopting the hot blast, at a temperature of at least 500° Fahr., and such heating may be performed by any of the well-known means now very generally resorted to for heating the blasts of air for smelting iron. *d, d*, are iron pipes, descending from the retorts and entering into vessels containing water, similar to the apparatus at present in use for like purposes. Each chamber, *c*, is heated by its separate furnace or fireplace, which have openings, to be closed when at work; and in order to keep up a supply of fuel to the fire, each fireplace has an inclined chamber, *e*, which is filled with fuel, and then closed air-tight by the cover, *f*, fitting into a sand-bath or joint, in order to prevent draught upwards. By this means the lower portion only of the fuel will be in an ignited state when at work. *g, g*, are a series of iron doors, one opposite the mouth of each retort; these doors are capable of being removed by sliding them upwards, till the portions cut out at the sides come opposite the dips or holders, *h, h*, when the doors may be removed, in order to get at the retorts. *i*, is a chamber in which the ore is heated previous to its being placed in the retorts. The arrangement of the brickwork, the construction and setting of the furnaces, being clearly shown in the drawing, no further description need be given.

The patentee remarks, that he is aware attempts have been made to employ retorts in the smelting of zinc, and he does not, therefore, claim the same generally; but he does claim, in respect to the third part of this invention, the mode of placing a series of retorts in a chamber, *c*, and causing the heat and flame to pass along, under and over, such series of retorts, as above described; and he also claims the mode of smelting zinc by means of blast, whether the heat of the fuel is caused to act on a series of retorts or vessels, in the manner shown, or on other arrangements of retorts or vessels, placed in a suitable chamber or chambers. — *Newton's Journal*, XXIII. p. 81. *C. S.*

APPENDIX.

ALKALIMETRY. Twenty-eight years have elapsed since I was led, by peculiar circumstances, to construct a very simple method of testing alkalis, the principle of which I soon afterwards applied to acids, bleaching powder, dye stuffs, and most other chemical substances extensively used in manufactures.* In 1814 and 1815, during the summer vacation of my Glasgow classes, I was engaged in delivering courses of lectures on chemistry in the Belfast Academical Institution, and had many of the most eminent members of the Linen Board of that town for my pupils. Being occasionally consulted upon the qualities of the alkalis, which were used to the value of 200,000*l.* by the linen bleachers of Ireland, I saw the importance to them of a simple alkalimetrical test, both for purchasing and for using their barillas and potashes. The following extract from the Belfast *News Letter*, of July 9th, 1816, will show the nature of my contrivance:—

> "This day one of the porters of the Linen Hall, Belfast, was called into the library room at the request of Dr. Ure, who being quite unknown to Dr. Ure, and never having seen any experiments made with acids and alkalis, he took the instrument at our desire, which being filled with coloured acid, by pouring it slowly on adulterated alkali, which we had previously prepared, he ascertained exactly the per centage of genuine alkali in the mixture. Belfast, 25th June, 1816.
>
> "(Signed) John S. Ferguson, Chairman.
> James M'Donnel, M. D.
> John M. Stoupe.
> S. Thomson, M. D."

Of these gentlemen, two were leading members of the Linen Board, and the others the two principal physicians of the town. The publication of the details of my method of alkalimetry was delayed till arrangements were made for its general introduction, under the direction of the Linen Board of Dublin, whose professor of chemistry, Mr. W. Higgins, as well as Dr. Barker, professor of chemistry in Trinity College, granted certificates of the "accuracy and the national importance" of the instrument. The alkaline matter then imported into Ireland was often largely contaminated with common salt, even to the extent of 80 or 90 per cent. During the procrastination of the Board, I lent my Treatise on Alkalimetry to Dr. Henry, of Manchester, who inadvertently published an account of it, though with reference to me, in the next edition of his *Elements of Chemistry*. Having, in the long interval since, contrived many modifications of the instrument, and having extended its principle to testing other articles, I am induced to offer it now to the world, in consequence of the recent appearance of a publication upon the same subject, by two very ingenious chemists of Liebig's school, Drs. R. Fresenius and H. Will. Of their system of alkalimetry, &c. a copious abstract appeared in the *Annalen der Chemie und Pharmacie* for July last, and about the same time a pamphlet was published by Winter, at Heidelberg, under the title *Neue Verfahrungsweisen zur Bestimmung des Werthes der Pottasche und Soda, der Saüren, und des Braunstein;* or "New Processes for determining the Value of Potash and Soda, of Acids, and Black Oxide of Manganese." However accurate these processes may be, and however apt for a German or French student of chemistry, they are, in my apprehension, not at all fitted for the familiar use of manufacturers and dealers in any country, and certainly not for those of the United Kingdom.

Descroizilles was the first person who contrived an instrument, called an Alkalimeter, to ascertain the alkaline strength of potash and soda, without much calculation. His method was described in the *Annales de Chimie* for 1806, tom. lx., and a translation of it appeared in our *Philosophical Magazine*, vol. xxviii., for July

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* Among others to nitrate of potash, nitrate of soda, and to white lead, either in powder or in paint. My nitrometer enables a person not at all versant in chemistry to ascertain in a quarter of an hour, but by two distinct processes, the quantity of pure nitrate, in either of these salts, to one part in 200. The cerussa-meter is equally simple and expeditious.

and August of the following year. His apparatus consisted of a glass tube, 8 or 9 inches long, and 7 or 8 lines in diameter, closed at one end, but terminated at the other in a kind of small funnel (with a beak or spout), connected to the tube by a narrow neck, having a calibre of two lines and a half. Upon the shoulder, under the throat, there was a hole for admitting air to the long tube in the act of being emptied, by sloping its mouth downwards. This cylindrical vessel was to contain 38 grammes of water, which space was divided into 76 equal parts, which it was extremely important to proportion accurately. The liquor was prepared by taking concentrated sulphuric acid, at 66° Baumé (1·845 spec. grav.), and diluting it with nine times its weight of water. The instrument being poised in a balance, he introduced into it very exactly two grammes of the above test acid, and when the instrument stood upright, he scratched a line at the level of the liquor, and thus proceeded by addition of successive grammes to graduate the whole, till 36 were added, after which he subdivided these spaces by lines into 72 demi-gramme volumes. He then proceeds to describe eight different subsidiary articles required for his operations: —

"*Alkalimetrical trials of potash.*—Weigh exactly one deci-gramme of potash, put it into a glass, and pour upon it about four fifths of a decilitre of water; facilitate the solution of the potash by stirring it with a small chip of wood, three or four times in an hour and a half, a minute at each time. When the solution is effected, pour it into the small tin measure, No. 4., which is to be then filled up with water; pour it back again into the glass, in which you must still pour a measure full of pure water; stir this new mixture also three or four times within half an hour, in order to facilitate the precipitation of a slight sediment, which soon falls down. This sediment being completely formed, slope the glass with caution, in order to fill with clear liquor the small measure; then empty this last into another large glass; after this place round the edges of a plate drops of syrup of violets; pour also into the alkalimeter test liquor until the line marks 0; take it afterwards with the left hand, inclining it upon the glass which contains the moiety of the clean alkaline solution: the acid liquor will fall into it by hasty drops, or in a very small thread, which you may moderate at pleasure, by retarding the entrance of the air at the lateral hole or vent, upon which must be placed the end of the finger; at the same time, with a small stick or match, assist the mixture and facilitate the development of the carbonic acid which is manifested by effervescence. When you have emptied the alkalimeter to about the line 40, try if the saturation approaches, by drawing your small stick from the mixture, and resting it upon the drops of syrup of violets, which should become green, if the potash is not of a very inferior quality. If, on the contrary, the violet colour is not altered, or what would be worse, if it be changed into red, there would be, in the first case, an indication of saturation, and in the second a proof of super-saturation. But this is not the case with good potashes: at that line, the liquor tried can alter the syrup of violets into green only; or cause to return to the violet, and even to the green, the drops which had been changed into red at the time of a former trial; we must, therefore, in general add more acid, which occasions a new effervescence. This addition must always be made with caution. and we must touch every time a drop of syrup of violets in order to stop. When at last the latter assumes a red hue, then, after having restored the alkalimeter to a perpendicular position, in order to see at what line the testing liquor stops, you must reckon one degree less, in order to compensate the excess of saturation. The mean term of potashes is 56; this implies that they require for their saturation *fifty-five hundredths* of their weight of sulphuric acid."

For the analysis of commercial sodas of all kinds, M. Descroizilles prescribes using ten and a half deci-grammes of this alkali, instead of the ten deci-grammes for potashes, and proceeds as above detailed. In his table of results annexed, we find American potashes called 60° to 63°.

American pearl ashes - - -	50° to 55°
Dantzic potash - - -	45 to 55
Alicant soda - - - -	20 to 33

It is obvious, from these statements, that the alkalimeter so made and graduated denoted comparative, but not absolute, quantities of alkalies present in the commercial samples. The rest of his very long memoir is occupied with what he calls the graduation of potashes and sodas, the economy of their graduation, the proportions of carbonic acid in them, the processes of caustification, the presence of potash in all lime which is burnt by a wood fire, origin of neutral soda, and probable origin of natrum; without any more explicit instructions. The instrument, as left in this vague state, never was employed, nor could it come into use, among English manufacturers and dealers.

The next alkalimeter, of which an account has been published, was my own. In constructing this instrument, I availed myself of the lights recently shed on chemical proportions by Dr. Dalton's atomic theory, and I thus made it to represent, not relative, but absolute measures of the amount of real alkali existing in any commercial sample. The test-liquor used at that time was sulphuric acid, which is most readily and accurately diluted to the requisite degree by means of a glass bead, very carefully made, of the specific gravity that the standard acid should have. In order to make the test-liquor, therefore, nothing more is requisite than to put the bead into distilled water, and to add to it somewhat dilute but pure sulphuric acid, slowly and with agitation, till the bead rises from the bottom, and floats in the middle of the liquor at the temperature of 60° Fahr. The delicacy of this means of adjustment is so great, that a single degree of increase of heat will cause the bead to sink to the bottom—a precision which no hydrometer can rival. The test-tube, about 14 inches long, contains generally 1000 grains of water, and is graduated into 100 equal parts by means of equal measures of mercury. The test-liquor is faintly tinged with red cabbage or litmus; so that the change of colour, as it approaches to the saturating pitch, on adding it to 100 grains of the commercial alkali, becomes a sure guide in conducting the experiment to a successful issue. One hundred measures of this test-liquor neutralise exactly 100 grains of absolute soda (oxide of sodium), and of course very nearly 150 of potash. A bead may also be adjusted for test-liquors, of which 1000 grain measures neutralise 100 of potash, and therefore $66\frac{2}{3}$ of soda, as well as other proportions, for special purposes of greater minuteness of research. One may be so graduated as to indicate clearly a difference of $\frac{1}{100}$ of a grain of ammonia. In making such nice experiments, it is of course requisite to free the alkaline matter beforehand from sulphurets, sulphites, and hyposulphites, by igniting it in contact with chlorate of potash, as long since recommended by Gay-Lussac. With such means in careful hands, all the problems of alkalimetry may be accurately solved by an ordinary operator.

On the same principle, my *Acidimeter* is constructed; pure water of ammonia is made of such a standard strength by an adjusted glass bead, as that 1000 grain measures of it neutralise exactly a quantity of any one real acid, denoted by its atomic weight, upon either the hydrogen or oxygen scale or radix; as for example, 40 grains of sulphuric acid. Hence it becomes a universal acidimeter; after the neutralisation of 10 or 100 grains of any acid, as denoted by the well defined colour in the litmus-tinted ammonia, the test-tube measures of ammonia expended being multiplied by the atomic weight of the acid, the product denotes the quantity of it present in 10 or 100 grains. The proportion of any one free acid in any substance may thus be determined with precision, or to one-fiftieth of a grain, in the course of five minutes. Like methods are applied to Chlorometry, and other analytical purposes, with equal facility; adapting the test-liquor to the particular object in view. Instead of using beads for preparing the alkalimetric and acidimetric test-liquors, specific gravity bottles, or hydrometers, may of course be employed; but they furnish incomparably more tedious, and less delicate means of adjustment. To adapt the above methods to the French weights and measures, now used generally also by the German chemists, we need only substitute 100 *deci-grammes* for 100 grains, and proceed in the graduation, &c. as already described.

The possession of two reciprocal test-liquids affords ready and rigid means of verification. For microscopic analyses of alkaline and acid matter, a graduated tube of small bore, mounted in a frame with a valve apparatus at top, so as to let fall drops of any size, and at any interval, is desirable; and such I have employed for many years. Of this kind is my ammonia-meter, used in the ultimate analysis of guanos and other azotized products, in conjunction with a modified apparatus on the principle of that of Varrentrapp and Will. It may be remarked, that when the crude alkali contains some hyposulphite, it should not be calcined with chlorate of potash, because one atom of hyposulphurous acid is thereby converted into two atoms of sulphuric, which of course saturate double the quantity of alkali, previously in combination with the hyposulphurous acid. In such cases it is preferable to change the condition of the sulphurets, sulphites, and hyposulphites, by adding a little neutral chromate of potash to the alkaline solution, whence result sulphate of chromium, water, and sulphur, three bodies, which will not affect the accuracy of the above alkalimetrical process.

In the *Annals of Philosophy* for October, 1817, I described a new instrument for analysing the earthy and alkaline carbonates, and for determining the quantity of base present in them from the volume of carbonic acid, disengaged by their solution in acids, upon the data of the atomic theory. This method was applied to the analysis of the carbonates of ammonia, soda, potash, lime, magnesian limestone (dolomite), &c.

" The indications of the above analytical instrument are so minute as to enable us, by the help of the old and well-known theorem for computing the proportions of two metals from the specific gravity of an alloy, to deduce the proportions of the bases from the volume of gas disengaged by a given weight of a mixed carbonate."*

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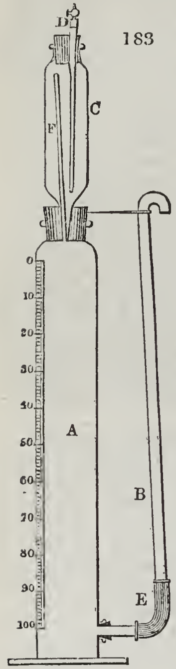

That small instrument consisted of a bent glass tube, open at one end, and terminated at the other with an egg-shaped bulb from two to three inches in diameter, and it required for operating with it, about five pounds of quicksilver. The following glass apparatus (*fig.* 183.) will be found more generally convenient, and equally exact. A is a cylinder 2 inches in diameter, and 14 inches long. It contains 10,000 grains of water in the graduated portion; o, or zero being at the top. It has a tubulure in the side close to the bottom, through the cork of which a short tube passes tight, and is connected to a collar of caouchouc, E, which serves for a joint to the upright tube, B, resting near its open upper end in a hooked wire. Through the cork in the *mouth* of the cylinder, the taper tail of the flask C passes air-tight. The small tube F, open at both ends, is cemented at bottom into the tail of C, and rises to the shoulder of the flask. The cork of C is perforated, and receives air-tight the taper tube D, which can also be closed with the stopcock.

In operating with this apparatus, proceed as follows: —

Fill the cylinder with water, and cover its surface with half an inch of oil. Insert the tail of the flask. Put into the flask C, 58·6 grains of carbonate of potash, or 45·2 of carbonate of soda, according as common pearl-ash or soda-ash is to be tested, along with as much water as will cover fully the lower end of D, and then introduce this tube. Have a bottle containing about 40 parts of oil of vitriol, previously mixed with 60 of water, and cooled. Take of this, in a pouring or dropping glass, 100 water grain measures, and suck this quantity gradually up into the tube D, then shut the stopcock. On opening it slightly the acid will fall into C, and as slowly as may be prudent. The carbonic acid gas, forthwith disengaged, will depress the water in A, cause an overflow of it from the tube B, which, being held in the left hand, must have its swanbeak placed over a basin, and progressively lowered to the level of the descending water in the cylinder. When all the sulphuric acid has been introduced by the right hand, the orifice of D is to be corked, and the tube B continually lowered with the left, till the effervescence being finished, the water in A remains stationary. The number on the centigrade scale, opposite to the surface of the oil, deducting 100 grain measures for the bulk of dilute acid added, denotes the per centage of pure carbonate of potash, or of soda, in the sample under examination. The above prescribed weights of these two carbonates, when pure, disengage each by the action of sulphuric acid (used here in small excess) 10,000 water grain measures of carbonic acid gas, or 100 measures of the scale on A. The cylinder which I employ contains about 12,000 water grain measures, so that the bottom of the centigrade scale is fully two inches above the level of the lower tubulure. This capacity and the graduation into 120 parts, will be found convenient in certain cases, particularly in analysing bicarbonates of potash and soda.†

We may estimate 10,000 water grain measures of carbonic acid at 60° Fahr. to weigh 18·4 grains, and we thus perceive what a magnified scale we should possess, if we applied the *vernier* contrivance here, as we do to barometers. At any rate, he must be an awkward operator who cannot determine the value of an alkaline carbonate, by the above means, to one part in a thousand.

In operating upon limestones, marles, &c., 42·1 grains should be taken as the standard weight of assay, because that weight of pure carbonate of lime should give out on solution in dilute muriatic acid 10,000 water grain measures of carbonic acid gas. Since 100 water grain measures of liquid hydrochloric acid, specific gravity 1·14, will supersaturature the lime in the above weight of carbonates, that quantity may be used in the experiment. The preceding instrument will be found more convenient in experimenting, as also the system of indication, than one on similar principles constructed by the ingenious Dr. Mohr, of Coblenz.

In examining bicarbonates of potash and of soda, the weights to be used in the above apparatus are 42 grains of the former, and 35¼ grains of the latter, each of which

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* *Dictionary of Chemistry*, 1821.

† For the greatest precision hot acid may be used in the above experiment, by taking in a graduated test-tube seventy-five grains of water, and filling it up to the line 100 with concentrated sulphuric acid. This mixture being poured in successive portions into the flask C (represented much too large in proportion to the cylinder A), will ensure the expulsion of all the carbonic acid from C, which may be afterwards cooled by wrapping round it a towel dipped in cold water.

quantities, if the salts be perfect, will disengage 10,000 water grain measures of carbonic acid gas, by the action of sulphuric acid. There will be no harm in taking the formerly prescribed measure of the sulphuric acid, though considerably less would answer the purpose. The centigrade measures of gas obtained in A will indicate the carbonated state of the two alkalies respectively. Their alkaline force may be most readily ascertained by my old alkalimeter, with coloured test acid. Since the bicarbonates usually sold in our shops, especially that of soda, are far from being exact atomic compounds, they should be always examined, both for their base and acid, which may also be well done in the following way, where the quantity of carbonic acid gas is determined by weight instead of by volume.

For this purpose, a small compact apparatus of the annexed form (*fig.*184.) will be found convenient; it is to be used in conjunction with my alkalimeter. A in the dotted line is the phial for receiving the carbonate to be tested. B, the funnel into which the test acid is to be poured; C C, an inverted syphon filled with pieces of chloride of calcium for absorbing the aqueous vapours exhaled by the carbonic acid. The loss of weight in the phial above that in the tube of test acid shows the quantity of acid gas, and the indication of the alkalimeter tube, that of alkaline base, from which data the proportion of neutral carbonate and bicarbonate may be immediately deduced. Thus, 100 grains of bicarbonate of soda should give out $51\frac{3}{4}$ grains of carbonic acid, and saturate 37·6 centigrade measures of the test acid, equivalent to 37·6 grains of real soda. But if neutral carbonate of soda be present, less gas will be given out, and more or less alkali may be indicated, according to the degree of dryness of the neutral soda. The amount of water in the bicarbonate may be determined by igniting 20 grains in a test tube, connected with the chlorcalcium inverted syphon; $10\frac{1}{3}$ grains of carbonic acid gas should be expelled, and $2\frac{1}{8}$ of water, making a total loss of $12\frac{11}{24}$ grains, of which $2\frac{1}{8}$ will be found as water absorbed by the chlorcalcium. But since a very moderate heat suffices to expel the second atom of carbonic acid from the bicarbonate of soda, the readiest mode of estimating its quality is to heat, over a spirit lamp, in a small flask, or retort, connected air-tight by a tube with the mouth of the cylinder A, (*fig.* 183.), $70\frac{3}{4}$ grains of the supposed bicarbonate. Of the perfect salt this quantity should give out pretty exactly 10,000 grain measures of gas; and whatever aliquot part of this volume is evolved will indicate, without calculation, the relative value of the substance as a bisalt. Thus if 8500 grain measures of gas are obtained, 85 parts of bicarbonate of soda are present in 100. The crystalline form of bicarbonate of potash is a tolerably good criterion of its quality.

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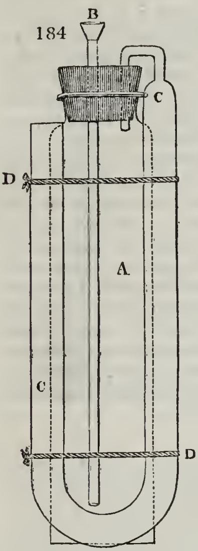

The quantity of caustic alkali mixed with carbonate may be readily determined, with sufficient accuracy, by the expert use of my alkalimeter; because, till the caustic portion be nearly neutralised, little or no carbonic gas is expelled. When the effervescence at length begins, the test measures already expended denote the percentage of caustic alkali. It is not right to disregard the alkali which is present in the state of sulphuret, because as such it is effective in many processes of the chemical arts; in the manufacture of yellow soap, crown glass, in the bleaching of linen and cotton goods, &c. The alkalimeter, directly applied, will show the alkali present in this form, when compared with that indicated after ignition of the crude alkali with chlorate of potash, or after its treatment with yellow chromate of potash.*

A few years ago I had the following apparatus made for the ready analysis of carbonates, by ascertaining the loss of weight they suffered from the disengagement of their carbonic acid gas, during their solution in an acid. A, B, (*fig.*185.) are two globes, of about two inches in diameter each; A has its inferior neck strangled into a bore nearly capillary; B stands lower, with its centre line on a level with the narrow neck of B. The tubes of these globes are about one-half inch in diameter. C is shut at top with a perforated cork, through which enters, air-tight, a small glass tube, which is bent across to the mouth of the tube E, and then passes down into it a little below the centre line of

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* If the alkaline carbonate contains sulphuret, sulphite, or hyposulphite, a teaspoonful of yellow chromate of potash may be added to it, wherefrom result sulphate of chromium, water, and sulphur, which remain in the apparatus without affecting its weight. The mutual action of neutral chromate of potash, and of sulphuret of potash, &c., has been discussed in an ingenious paper published by Döpping, in the *Annalen der Chemie* for May, 1843, p. 172.

the globe B. This globe is rather more than half filled with sulphuric acid, when the instrument is employed in the analysis of the carbonates. The standard weight of carbonate of soda $= 24\frac{1}{8}$ grains, or of carbonate of potash $= 31\frac{1}{3}$ grains, is then put into A, having previously laid a minute globe of glass over the lower orifice; the cork, with its small tube, is now firmly adjusted; and the apparatus is weighed in its upright position, either by suspension with a hook to the end of the beam, or by resting it on the scale in a light socket of any kind. It is next laid hold of, and inclined so as to cause a little of the acid in B to pass over into A. Effervescence ensues with greater or less vehemence, according to the nature of the carbonate and quantity of the acid introduced. Should it be too violent, and threaten an overflow by intumescence, it can be instantly abated to any degree by the slightest slope of the instrument. Now, this power of control forms the peculiar feature and advantage of this contrivance; whereas in all other forms of such apparatus that I know, whether by sucking over or pouring in, if a little too much acid comes upon the carbonate, the experiment is effectually marred. The gas disengaged in A must necessarily traverse the sulphuric acid in B, and be stripped of its moisture before escaping into the air. Having supersaturated the alkaline base, and cooled the apparatus, we weigh it again, and the loss of weight in grains and tenths denotes the per centage of soda or potash, provided their neutral carbonates had been the subjects of experiment. For limestone, on the same plan of computation, $22\frac{3}{4}$ grains may be taken. It deserves to be noted, that the present instrument has only one junction, and needs no chloride of calcium, a substance so apt by its swelling to burst the glass tubes that contain it.*

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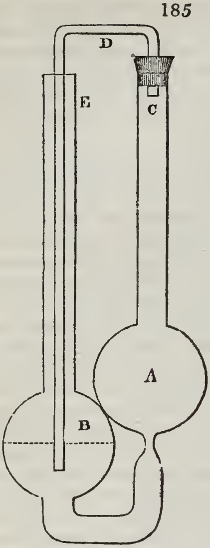

II. ACIDIMETRY.

I have already stated, that water of ammonia of standard strength, faintly tinted with litmus, affords a most exact and convenient acidimeter, when poured or let fall from a graduated dropping-tube. Bicarbonate of potash also, when dissolved in water, so that 1000 grain measures contain one atom of the salt counted in grains, is a good test-liquor for the same purpose; for if the centigrade-measures expended in effecting neutralisation are multiplied by the atomic weight of the given acid, the product is the quantity in grains of acid present.

Acidimetry may be likewise exactly performed by measuring in the cylindric gas-meter (*fig.* 183.) the volumes of carbonic acid gas disengaged from pure bicarbonate of potash or soda, by a given weight of any acid, taking care to use a small excess of the salt. Thus, for example, 16·8 grains of dry and $20\frac{2}{3}$ of hydrated sulphuric acid disengage 10,000 water grain measures of gas from bicarbonate of potash. Therefore, if $20\frac{2}{3}$ grains of a given sulphuric acid be poured into the flask of *fig.* 183., upon about 50 grains of the bicarbonate, powdered and covered with a little water, it will cause the evolution of a volume of gas proportioned to its strength. If the acid be pure oil of vitriol, that weight of it will disengage 10,000 grain measures of gas; but if it be weaker, so much less gas — the centigrade-measures of which will denote the per centage value of the acid. If the question be put, how much dry acid is present per cent. in a given sulphuric acid, then 16·8 grains of the acid under trial must be used; and the resulting volume of carbonic acid gas read on the scale will denote the per centage of dry acid.†

For nitric acid, we should take 22·6 grains; for hydrochloric or muriatic acid, 15·34; for acetic acid, 21·6; for citric acid, 24·6; for tartaric acid, 28 grains: then in each case we shall obtain a volume of carbonic acid gas proportioned to the strength and purity of these acids respectively. The nitric, hydrochloric, and acetic acids are referred to in their anhydrous state; the tartaric and citric in their crystalline. If the latter two acids be pure, a solution of 24·6 grains of the first and of 28 of the last

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[*] 1000 water-grain measures of sulphuric acid of specific gravity 1·032, or 32 above water, neutralize 32 grains of soda, and, consequently, one atom, on the hydrogen scale, of each of the other bases, reckoned in grains.

Having in the course of many years subjected my tables of sulphuric, nitric, and muriatic acids, as well as of ammonia, to strict cross-examination, I have found them trustworthy for all alkalimetrical and acidimetrical purposes.

[†] The bicarbonate must be free from carbonate, a point easily secured by washing its powder with cold water, and drying it in the air.

will disengage from 50 grains of bicarbonate of potash 10,000 grain measures of carbonic acid gas.*

Acidimetrical operations may likewise be performed by determining the *weight* of carbonic acid gas expelled from the bicarbonate of potash or soda, by a given quantity of any acid, in the apparatus either *fig.* 184. or *fig.* 185. Here the weights to be taken are as follows, in reference to

	Grains.
Dry Sulphuric acid - -	9·127
„ Nitric - - - - -	12·33
„ Hydrochloric - -	8·29
„ Acetic - - - - -	11·67
Crystallized Tartaric - -	13·31
„ Citric - -	15·13

Each of these quantities of real acid, with 25 or 26 grains of bicarbonate of potash, will give off 10 grains of carbonic acid gas; and hence whatever weight the apparatus loses, being reckoned in grains and tenths of a grain, denotes the per centage of acid in the sample under trial, without the necessity of any arithmetical reduction. Persons accustomed to the French metrical system may use deci-grammes instead of grains, and they will arrive at the same per centage results.

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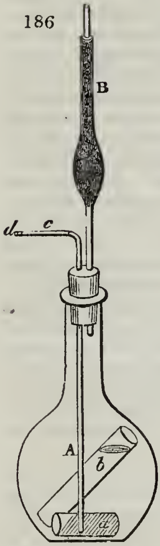

The preceding experiments, in reference to the weight of carbonic acid gas expelled for the purpose of either alkalimetry or acidimetry, may also be made by means of the ordinary apparatus represented in *fig.* 186. A is a small matrass which contains the acid or carbonated alkali at its bottom; and conversely the alkali or acid, for their mutual decomposition in the small test-tube, shown first at *b* nearly upright and filled, but afterwards at *a*, horizontal and emptied. B is a bulbous tube filled with fragments of chlorcalcium for absorbing the aqueous vapour that rises with the carbonic acid gas, and *d c* is a small bent tube which dips into the liquid in the matrass. The weighings, &c., may be conducted as already detailed; and when the effervescence is completed, the residuary gas is sucked up through B, while the atmospheric air enters to replace it at the orifice *d* of the bent tube.

The NEW methods which pervade the whole treatise of Drs. Fresenius and Will are all based on the principle of estimating alkalinity, acidity, and the oxygen in manganese (or chlorometry) by the weight of carbonic acid gas evolved. As in taking these measures the gas must be discharged without carrying water off with it, an elegant and ingenious little piece of apparatus has been invented by the authors for effecting that purpose, and it will do it well. A and B (*fig.* 187.) are two flasks (wide-mouthed medicine bottles may be employed). A must have a capacity of from 2 ounces to 2½ ounces of water; it is advisable that B should be somewhat smaller, say of a capacity of about 1 to 1½ ounces. Both flasks are closed by means of doubly perforated corks. These perforations serve for the reception of the tubes *a*, *c*, and *d*. *c* is a tube bent twice at right angles, which enters at its one end just into the flask A, but descends at its other end, near to the bottom of B. These tubes are open at both ends when operating; except the top end *b* of the tube *a*, which is closed by means of a pellet of wax. The substance to be examined is weighed and put into the flask A, into which water is then poured to the extent of one third of its capacity. B is filled with common English sulphuric acid to about half its capacity. Both flasks are then corked (by which they become united by the rectangular tube), and the apparatus is weighed.

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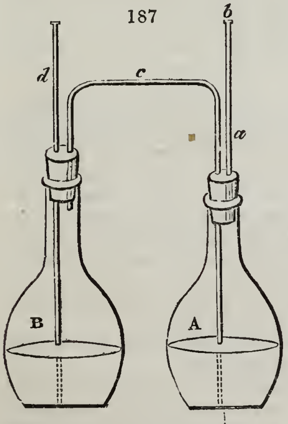

The air of the whole apparatus is next rarefied by applying suction to the tube *d*: the consequence is, that the sulphuric acid contained in B ascends into

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* The expulsion of the gas may be completed by surrounding the flask with a towel dipped in hot water.

the tube *c*, and thus a portion of it flows over into B. Immediately upon its coming into contact with the carbonate contained in A, carbonic acid gas is disengaged, and in its escape must necessarily traverse the oil of vitriol in B, and therein deposit all its aqueous vapour before issuing from *d*. The sulphuric acid in passing over into A heats the mixture at the same time, and thus promotes the expulsion of the gas. Whenever this ceases to flow, a little more sulphuric acid must be sent over into A by suction from *d* (or rather from a recurved tube attached, *pro tempore*, to it); an artifice which may be repeated till no more gas can be expelled, even when the contents of A are heated, as they must be at the end by the excess of oil of vitriol.

" From the aperture *b* of the tube *a*, which has been all the time closed, the bit of wax is now to be removed, and to the tube connected with *d*, suction is to be applied, till all the carbonic acid lodged in the apparatus be replaced by atmospheric air. The whole is to be then cooled, wiped, and weighed; the loss of weight indicates exactly the quantity of carbonic acid which existed in the carbonate submitted to experiment. The process is no less neat than it is simple, and does honour to the ingenuity of its inventors. Their mode of deducing the per centage of alkali from the quantity of carbonic acid discharged in the operation is also quite exact, and suitable for continental chemists familiar with gramme weights and calculations, but certainly not for persons conversant only with ounces, drams, and scruples, or even with grain subdivisions. The whole book, however excellent, needs, for the British public, transposition, before it can serve in this country the purpose intended by its scientific authors. Thus, in section 4., where several results of their analyses are given, the statements have a somewhat mysterious aspect. Should any one ask why the oracular number of 4·83 grammes of carbonate of soda is used as their standard weight for analysis, he can obtain no response in the book, either in a note or anywhere else. A German or French student, familiar with chemical computation, will probably be able to discover that 4·83 grammes of pure carbonate of soda contain, by Berzelius's tables of atomic weights, 2 grammes of carbonic acid; for 53·47 (1 atom of carbonate) : 22·15 (1 of carbonic acid) : : 4·83 : 2·00. Such is the simple solution of this apparent enigma, and of some other similar puzzles in the book. Indeed, unless the reader is aware of that proportion, he cannot see the grounds of the accordance in the results between experiment and theory, or why the numbers 2·010, 1·993, and 2·020 are presented as specimens of great precision. This accordance gives satisfaction when it is known that these numbers, in experiments 1, 2, and 3, oscillate on one side or other so near to the theoretical number 2·00. But 4 grammes and 83 centi-grammes, as also 1 gramme and 995 milli-grammes, are awkward weights for an ordinary English chemist or apothecary, which would require a month or two's residence in the laboratories of Giessen and Paris to manipulate with readiness.

Again, in testing carbonate of potash, our authors take 6·29 grammes as their unity of weight, undoubtedly, because, if pure, it should discharge, by saturation with the sulphuric acid, 2 grammes of carbonic acid. Here, however, they have not stuck so rigidly as the school of Giessen usually does to Berzelius's atomic numbers; for his atom of carbonate of potash is 69·42; whence, 22·15 : 69·42 : : 2·00 : 6·68, hydrogen = 1·00; or 276·44 : 866·33 : : 2·00 : 6·268 oxygen = 100.

Admitting the value of the new method in testing neutral carbonates, it cannot be directly applied to the mixed carbonate and bicarbonate of soda, so commonly sold in this country for bicarbonate; nor is it applicable to the case of a mixture of caustic and carbonated alkali, without the tedious process of previous treatment with carbonate of ammonia and heat.

The new German method of *acidimetry* consists in determining how much carbonic acid gas is disengaged from a standard bicarbonate of soda, by a given weight of any acid. The twin-flask apparatus (*fig.* 187.) is used. The weighed portion of acid is put into A, and a sufficient quantity of the soda into a test tube, which is suspended upright with a silk thread fastened by the pressure of the cork to the mouth of the flask. On letting the thread loose, the test tube falls, and the cork being instantly replaced, the whole gas evolved is forced to pass through the sulphuric acid in B, and there to deposit its moisture. The experiment is conducted in other respects as already described for alkalimetry.

The following extract from Drs. Fresenius and Will's *New Methods of Alkalimetry*, &c. will show the Giessen plan of calculating results: —

" The amount of anhydrous acid contained in the hydrated acid under examination is determined from the amount of carbonic acid escaped, as follows:

" Two measures of carbonic acid bear the same proportion to one measure of the anhydrous acid in question, as the amount of carbonic acid expelled does to the amount sought of anhydrous acid. Thus, let us suppose, for instance, we had examined dilute sulphuric acid, and obtained 1·5 grammes of carbonic acid, the arrangement would be:

$$550\ (2 \times 275) : 501 = 1{\cdot}5 : x$$
$$x = 1{\cdot}36.$$

The amount of sulphuric acid operated upon consequently would contain 1·36 grammes of anhydrous acid. Let us suppose the weight of this amount to have been 15 grammes, the sulphuric acid under examination would contain a per centage amount of 9·06; for

$$15 : 1{\cdot}36 = 100 : x$$
$$x = 9{\cdot}06."[*]$$

"SECTION XXIX. *Stating the Quantities of the various Acids to be used in their Examination.*—To enable our readers at once, without the trouble of calculation, to determine from the weight of carbonic acid expelled, the exact amount of anhydrous acid contained in those acids which are of most frequent occurrence, we have subjoined lists of certain quantities to be taken of each acid for experiment, so that the number of centi-grammes of carbonic acid expelled will directly indicate the per centage amount of anhydrous acid in the acid under examination.

"Multiples of those weights may of course be substituted for the numbers given, according to the degree of dilution of the acid under examination. In such cases the number of centi-grammes of the carbonic acid expelled must be divided by the same number, which has served as the multiplier.

"These numbers are obtained by dividing the atomic weight of the acid by 550 (2 × 275, one eq. of carbon[†]), as follows:—

"Two eq. of carbonic acid, corresponding to one eq. of the acid to be examined, how much should be taken of the latter to expel 1·00 grammes of carbonic acid?

"The arrangement for sulphuric acid, for instance, is as follows:

$$550 : 501 = 1{\cdot}00 : x$$
$$x = 0{\cdot}91 \text{ (or, more correctly, } 0{\cdot}911\text{).}$$

"When examining acids, it is most advisable to use that multiple of the unity (according to the degree of concentration) which will expel from one to two grammes of carbonic acid.

"I. SULPHURIC ACID.

"Unity 0·91 grammes (or, more correctly, 0·911 grammes)
"Multiples:

$2 \times 0{\cdot}911 = 1{\cdot}822$ grammes.
$3 \times 0{\cdot}911 = 2{\cdot}733$ "
$4 \times 0{\cdot}911 = 3{\cdot}644$ "
$5 \times 0{\cdot}911 = 4{\cdot}555$ "
$6 \times 0{\cdot}911 = 5{\cdot}466$ "
$7 \times 0{\cdot}911 = 6{\cdot}377$ "
$8 \times 0{\cdot}911 = 7{\cdot}288$ "
$9 \times 0{\cdot}911 = 8{\cdot}199$ "
$10 \times 0{\cdot}911 = 9{\cdot}110$ "
$15 \times 0{\cdot}911 = 13{\cdot}665$ "
$20 \times 0{\cdot}911 = 18{\cdot}220$ "
$30 \times 0{\cdot}911 = 27{\cdot}330$ " &c.

"Thus, knowing that 0·91 of anhydrous sulphuric acid will expel 1·00 of carbonic acid, it will be easy to determine what multiple ought to be used, according to the degree of concentration of the acid to be examined."[‡]

III. CHLOROMETRY,

And the Testing of Black Oxide of Manganese for its available Oxygen.

The value of manganese may be estimated very exactly by measuring the quantity of chlorine which a given weight of it produces with hydrochloric acid; the chlorine being at the same time estimated by the quantity of solution of green sulphate of iron, which it will peroxidize. A process of this kind was long ago practised with chloride of lime (bleaching powder or liquor) by Dr. Dalton; and it has been since improved by Mr. Waltercrum. As the conversion of two atoms of green sulphate of iron into red sulphate requires only one atom of oxygen, this change may be effected by the re-action of one atom of chlorine in liberating one atom of oxygen, while this appropriates one of hydrogen from the hydrochloric acid.

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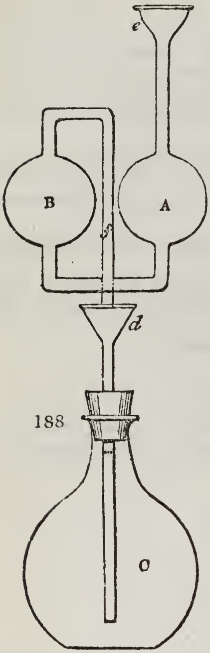
[*] *New Methods of Alkalimetry, &c.* pp 93, 94.

[†] A typographical error in Mr. Bullock's edition; it should be *carbonic acid*

[‡] *New Methods of Alkalimetry, &c.* pp. 103—105.

The weight of 2 atoms of green sulphate of iron is 278 = (139 × 2), consisting of 2 atoms of protoxide = 72, + 2 of sulphuric acid = 80, + 14 of water = 126; in all = 278; and this weight is equivalent to 36 of chlorine, to 8 of oxygen, and to 44 of peroxide of manganese.* Therefore, if we take a solution of copperas, containing 278 grains in 1000 water grain measures, that volume of liquid will represent, by the conversion of its protoxide into peroxide, exactly one atom, either of peroxide of manganese = 44 grains, or 1 atom of chlorine = 36. Hence the following plan of research: —

Into the flask or phial c of my chlorometric apparatus (*fig.* 188.), put 100 grains of the manganese to be tested, and into the globes A, B pour out of an alkalimetrical tube charged with 1000 grain measures of the above *equivalent* copperas solution, from 200 to 500 grain measures, according to the supposed quality of the manganese; then introduce through the funnel *d* some hydrochloric acid of known specific gravity (suppose 1·1), containing nearly 20 per cent. of chlorine, also from a charged alkalimetrical tube, and apply gentle heat to the bottom of the flask by placing it in a capsule of water standing over a spirit lamp. The chlorine evolved will rise up through the tube *f*, which passes merely beyond the cork, and will enter into the solution in B and A, converting it into red sulphate. Have ready some dry paper imbued with solution of red ferrocyanide of potassium (red prussiate of iron). Dip a slip of whalebone into the liquor in the globe A, through the funnel *e* (represented in the figure rather too high above the globe), and touch the paper with its point. As long as it forms a blue spot, some of the iron still exists as black oxide, and the process is to be urged by the addition of a little more hydrochloric acid to the manganese, as long as chlorine gas continues to be disengaged, and while it maintains the level of the liquor in A above that in B. Whenever the liquor, by the re-action of the chlorine, ceases to stain the test-paper blue, more of the solution from the graduated tube must be added till it begins to do so. By the cautious administration of the hydrochloric acid on the one hand, and of the copperas liquor on the other, the term of saturation will be arrived at in a few minutes. The manganese has then produced all the chlorine which it can yield. The number of water grain measures, of the liquor, or degrees of its alkalimeter scale being multiplied by 44, will give a product denoting the percentage of pure manganese present in the sample; or being multiplied by 36, a product which will denote the quantity of chlorine by weight which 100 grains of it can serve to generate.



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Since one atom of pure manganese (44 grains), in producing 36 grains of chlorine, consumes 2 atoms = 74 grains of hydrochloric acid, the quantity of this acid expended from the graduated tubes, beyond the due proportion of chlorine obtained, will show how much of the acid is unprofitably consumed by foreign substances in the manganese. In fact, every grain of chlorine should, with pyrolusite, be generated by an expenditure of little more than 2 grains of real muriatic acid, or 10 grains weight of the dilute acid, = about 9 grain measures of the graduated tube. Liquid hydrochloric acid of spec. grav. 1·093 contains in 1000 grain measures exactly 200 grains of real acid. Hence 100 grains of pure pyrosulite should produce about 82 grains of chlorine, and consume about 169 of real muriatic acid = 845 grain measures of liquid acid, spec. grav. 1·093. Instead of taking 100 grains of manganese as the testing dose, 10 or 20 grains may be taken, according to the dimensions of the apparatus and the exactness of the operator.

But if it be wished to obtain direct per centages of *manganese* by the graduated tubes without the trouble of reduction, then for a dose of 10 grains take a solution of fresh green copperas (free from adhering moisture), containing 632 grains in 10,000 grain measures. Proceed as above directed. If the manganese be a pure peroxide, 10 grains of it

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* Berzelius, in the 4th edition of his *Lehrbuch*, rates the atom of the green sulphate of iron (ferrous sulphate) at 129·43, hydrogen = 1, and considers it, after Mitscherlich, to contain only 6 atoms of water. I have ascertained, by the most careful experiments, that it contains 7 atoms of water; and that 139 grains of it, or 138·44 (Berzelius) are equivalent to 1 atom of chlorbarium, and to very nearly 40 grains of peroxide of iron.

This remarkable error has probably arisen from an attempt to measure the proportion of water in the salt from its loss of weight by desiccation. But I have found it impossible by this means to expel more than 6 atoms of water without causing partial decomposition of the salt by disengagement of sulphuric acid. The copperas so dried acquires such an affinity for water, that it absorbs fully one tenth of its weight of moisture from the atmosphere in the course of an hour.

will generate as much chlorine as will peroxidize exactly 1000 grain measures, or 100 degrees by the test-tube of the copperas solution. But if the manganese contain only 40 or 50 per cent. of peroxide, then 40 or 50 centigrade measures of the said solution will be equivalent to the chlorine evolved from it by the re-action of hydrochloric acid.

If the object is on the other hand to obtain direct indications as to *chlorine*, then a test solution of copperas, containing 772 grains in 10,000 grain measures, will serve to show, by the peroxidizement of each 10 grain measures, or of one degree of the centesimal scale of the test-tube, the re-action of one grain of chlorine available for bleaching, &c. in the chloride of lime or of soda, &c. The test solutions of copperas should be kept in well-corked bottles, containing a little powdered sulphuret of iron at their bottom, which is to be shaken up occasionally in order to preserve the iron in the state of protoxide.

The manganese should always be treated with dilute nitric acid before submitting it to the above-described ordeal; and if it exhibits effervescence, 100 grains of it should be digested with the acid for a sufficient time to dissolve out all the carbonates present, then thrown upon a filter, washed and dried before weighing it for the testing operation. The loss of weight thereby sustained denotes the per-centage of carbonates, and if calcareous it will measure the waste of acid that would ensue from that source alone, in using that manganese for the production of chlorine.

That manganese is most *chlorogenous* which contains no carbonates, the least proportion of oxide of iron, and of sesquioxide of manganese.

The plan of testing manganese with oxalic and sulphuric acids was originally practised by M. Berthier and Dr. Thomson, but is lately modified by Drs. Fresenius and Will, who employ oxalate of potash, as likely to afford more exact results. They prescribe a multiple by 3 of 993 milli-grammes = 2·979 grammes, as the quantity of manganese best adapted to experiment; but this quantity will not be found convenient by ordinary British operators.

I, therefore, take leave to prescribe the following proportions: — Into the vessel A of my twin-globe apparatus (*fig.* 185.) put 100 grains of the ground manganese under trial, along with 250 grains of oxalate of potash and a little water; poise the whole in the scale of a balance; then, by gentle inclination, cause a little of the strong sulphuric acid to pass from B up into A. The oxygen thereby liberated from the manganese, reacting in its nascent state upon the oxalic acid, will convert it into carbonic acid gas; which, in passing through B, will deposit its moisture before escaping into the air. Whenever the extrication of gas ceases, after such a quantity of oil of vitriol has been introduced into the globe A, as both to complete the decomposition of the oxalic acid and to heat the mixture, withdraw the cork for a moment, to replace the carbonic acid with air, then cool, and weigh the apparatus. The loss of weight, in grains, will denote the per centage value of the manganese; that is, the proportion per cent. of perfect peroxide in the sample. If the manganese be pure no black powder should remain.

The preceding experiment is founded upon the following principle: — One atom of peroxide of manganese = 44, contains one atom of oxygen separable by sulphuric acid, and capable of converting one atom of oxalic acid into two atoms of carbonic acid, also = 44, which fly off; and cause therefore a loss of weight equal to that of the whole peroxide. To one atom of oxalic acid, which consists of three atoms of oxygen, and two of carbon — if one atom of oxygen be added, the sum is obviously four atoms of oxygen and two of carbon = 2 atoms of carbonic acid.

The apparatus (*fig.* 187.) of Drs. Fresenius and Will will answer perfectly well for making the same experiment, the manganese being put into A, with about two and a half times its weight of oxalate of potash, and the sulphuric acid being drawn over into the mixture by suction, as above described.

The economy of any sample of manganese in reference to its consumption of acid, in generating a given quantity of chlorine, may be ascertained also by the oxalic acid test: — 44 grains of the pure peroxide, with 93 grains of neutral oxalate of potash, and 98 of oil of vitriol disengage 44 grains of carbonic acid, and afford a complete neutral solution; because the one half of the sulphuric acid, = 49 grains, goes to form an atom of sulphate of manganese, and the other half to form an atom of sulphate of potash.

The deficiency in the weight of carbonic acid thrown off will show the deficiency of peroxide of manganese; the quantity of free sulphuric acid may be measured by a test-solution of bicarbonate of potash, and the quantity neutralised, compared to the carbonic gas produced, will show, by the ratio of 98 to 44, the amount of acid unprofitably consumed.

In *fig.* 183., the tube, D, may also be graduated, and may contain the quantity of acid, for the purpose either of alkalimetry or acidimetry; and if the lower orifice be capillary, it will allow none of its contents to flow out, till the stopcock in the top orifice is opened.

In *fig.* 184., such a tube as D (*fig.* 183.) may be substituted with advantage for the funnel, B; and as that tube, D, may be made of such dimensions as to contain enough of acid to supersaturate the bases of the carbonates in the phial, A, there will be no necessity for a separate vessel to hold the decomposing acid. Thus the apparatus becomes very light, convenient, and may be placed in the small scale of a fine balance; whereas the twin matrasses of Drs. Fresenius and Will, (*fig.* 187.), as furnished by Mr. Bullock, require a very large pan or scale to stand in. I flatter myself, that the instrument, *fig.* 184., so mounted, will be found an acceptable present to practical chemists, and that it will enable them readily to examine, not only carbonates, but also manganese and bleaching substances, with great precision, by the weight of carbonic acid gas disengaged, on the principles above explained.

Into the twin globe apparatus, (*fig.* 185.), after the sulphuric acid is poured into B, a little water should be poured into C, before the carbonate is introduced into the latter. By this means the capillary throat of the tube under A will not be apt to get choked with concrete salt.

The following quotations are from the work of Drs. Fresenius and Will, as edited by Mr. Bullock for the English reader. An accurate comparison may thus be made between the relative utility of their methods and mine to the practice of ordinary operators.

"SECTION XXXIV. *Examination of Manganese: having at the same time due regard to the Amount of Acid required for its complete Decomposition.* — We have stated, at Section 30., that it is not a matter of indifference, with regard to the amount of acid employed in the production of chlorine from manganese, what are the minerals which this substance contains in admixture with the peroxide. The following modification of our method will give the most correct information on this point:

"Sulphuric acid of commerce is taken, and its amount of anhydrous acid determined, as directed at Section 26., or by means of an accurate hydrometer. Of this sulphuric acid as much is weighed into A, (*fig.* 187.) as to give an amount of 5·47 grammes of anhydrous acid.

"The following table will show the amount which ought to be taken, according to the various degree of concentration of the acid:

Specific weight found.	Percentage amount of Anhydrous Acid found.	Amount to be used for the examination.	Specific weight found.	Percentage amount of Anhydrous Acid found.	Amount to be used for the examination.
1·8485	81·54	6·708	1·8336	76·65	7·136
1·8480	81·13	6·742	1·8313	76·24	7·174
1·8475	80·72	6·776	1·8290	75·83	7·213
1·8467	80·31	6·811	1·8261	75·42	7·252
1·8460	79·90	6·846	1·8233	75·02	7·291
1·8449	79·49	6·881	1·8206	74·61	7·331
1·8439	79·09	6·916	1·8179	74·20	7·371
1·8424	78·68	6·951	1·8147	73·79	7·412
1·8410	78·28	6·987	1·8115	73·39	7·453
1·8393	77·84	7 027	1·8079	72·97	7·495
1·8376	77·40	7·067	1·8043	72·57	7·537
1·8356	77·02	7·101			

"As much water is then poured into A as will fill the flask to about one-fourth; and, lastly, from 6·5 to 7 grammes of neutral oxalate of potash, or from 5·5 to 6 grammes of neutral oxalate of soda, are added; 2·98 grammes of the (finely-pounded) manganese to be examined are then weighed (the manganese must have been previously tested for carbonate alkaline earths: compare this section at the end) into a small glass tube, such as used in acidimetry, and described in Section 25. About the same quantity of pure pyrolusite *, in powder, is then put into another similar tube. The tube, with the manganese to be examined, is then suspended in A (*fig.* 187.), as described at Section 26., and the apparatus prepared, as directed at Section 3. The

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* "Any variety of pyrolusite will serve this purpose, provided it be free from other manganese ores. If it contains heavy spar, it may be employed directly; but should it contain alumina or lime, it must be treated first with dilute nitric acid, at a gentle heat, until all soluble parts have been dissolved; it is then washed and dried. Artificially prepared, hydrated peroxide of manganese may be substituted for pyrolusite.

apparatus is then placed on one scale of a balance, together with the other little tube containing the pyrosulite, and exactly weighed.

"The cork of A is then somewhat raised to allow the little tube with the manganese to fall into the flask. The evolution of carbonic acid commences immediately, and continues until all the manganese is decomposed. When the operation begins to get on more slowly, the flask, A, is placed in boiling water, and allowed to remain there until no more bubbles appear. The little wax-stopper is then removed* from *a*, the flask, A, taken out of the hot water, and suction applied to *d*, until the sucked air tastes no longer of carbonic acid. The apparatus, after having been allowed to cool, is wiped dry, and replaced in the original scale, where the little tube with the pyrolusite still remains; weights are then substituted for the loss of carbonic acid. The number of centigrammes required, divided by three, directly indicates the per centage amount of peroxide of manganese (*vide* Section 32.). The centigrammes substituted for the loss of carbonic acid are then removed from the balance, and the little tube with the pyrosulite is thrown into A. (The little wax-stopper must of course previously be replaced on *a*). If no fresh evolution of carbonic acid takes place, the manganese examined consists of pure pyrosulite, and the experiment is at an end. But should a fresh evolution of carbonic acid take place, the operation must be further conducted, and brought to a close, exactly as just stated (*vide suprà*). The apparatus is then replaced on the balance, with an additional weight of three grammes on the same scale. If this is sufficient to restore a perfect equilibrium, no loss of acid has taken place; the manganese, indeed, contains other matters in admixture, but only such as do not consume any acid. But if the scale with the apparatus sinks, this is a certain sign that a portion of the acid has been lost by combining with the oxides which the manganese under examination contains. The number of centigrammes required to restore the perfect equilibrium of the balance, multiplied by 0·6114, immediately indicates how much anhydrous sulphuric acid has been wasted in the decomposition of 100 parts of the manganese under examination. The same number, multiplied by 0·333, indicates the amount of acid wasted in every 100 parts of sulphuric acid employed for the decomposition of the manganese in question. The same number, multiplied by 0·5552, indicates how much anhydrous hydrochloric acid would be wasted in the decomposition of 100 parts of the manganese. The same number, multiplied by 0·333, indicates also how much acid would be wasted in every 100 parts of hydrochloric acid employed for the decomposition of the manganese.

"These figures result from the following equations:

"I. 275 (eq. of carbonic acid) : 501 (eq. of sulphuric acid) = the carbonic acid obtained *minus* (in proportion to the sulphuric acid used) : x.

$$x = \text{this carbonic acid} \times \tfrac{501}{275},\ i.\,e. \times 1{\cdot}822.$$

Thus, the number obtained for x indicates the amount of sulphuric acid corresponding to the amount of carbonic acid obtained *minus*.

"II. 2·98 of manganese : 100 = x of equation I. : x.

$$x = x \text{ of I.} \times \tfrac{100}{298},\ i.\,e. \times 0{\cdot}33557.$$

"The x of the first equation tells us how much sulphuric acid has been wasted without contributing to the decomposition of 2·98 grammes of the manganese; the x of the second equation tells us the same for 100 parts of manganese.

"If, therefore, the amount of carbonic acid obtained *minus* be directly multiplied by the product of the quotients of I. and II.,

1·822 and 0·33557,

i. e. with 0·61141 (the number given above), the amount of anhydrous sulphuric acid wasted in the decomposition of every 100 parts of manganese will immediately be found.

"III. 5·47 (the amount of sulphuric acid used):

100 = the x of I. : x.

$$x = \text{the } x \text{ of I.} \times \tfrac{100}{547},\ i.\,e. \times 0{\cdot}18282.$$

"Of 5·47 of sulphuric acid, the x of I. has been wasted, 100 corresponds to the x of III.

"The x of III. is, therefore, found directly by multiplying the amount of carbonic acid obtained *minus* with the product of the quotients, 1·822 and 0·18282, *i. e.* = 0·33301.

"The figures for hydrochloric acid are found in the same manner (4·967 of hydrochloric acid must be taken instead of 5·47 of the sulphuric acid)."†

---

* "This must of necessity be done while the flask is still standing in the hot water, or else the sulphuric acid will recede upon the apparatus being removed from the hot water."

† *New Methods of Alkalimetry, and of determining the Commercial Value of Acids and Manganese.* By Drs. C. R. Fresenius and H. Will. Edited by J. Lloyd Bullock. Pp. 123—128.

ARTESIAN WELLS. *Fig.* 189, is that referred to in the foot-note of page 10.

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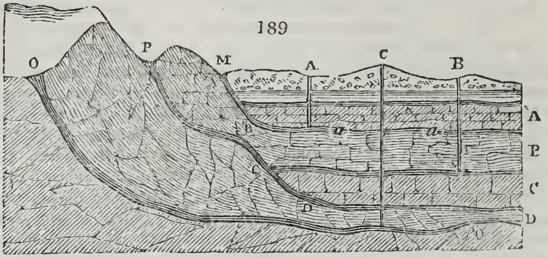

BEER. A gentleman well acquainted with the brewing of porter in London has favoured me with the following information.

Essentia bina has been discontinued by the London porter brewers since the employment of black malt, which is prepared by roasting in such a cylinder as coffee is usually roasted in over a fire. A peculiar flavour has sometimes been imparted by using roasted barley instead of malt. The usual quantity of yeast employed in the London porter breweries is from 5 to 7 tenths per cent. The grist, as it is technically termed, or charge for a mash-tun, is composed of from $\frac{2}{3}$ to $\frac{4}{5}$ pale malt, and the rest of high dried malt, of which about from $\frac{1}{15}$ to $\frac{1}{25}$ black. The oil of birch bark is not used by any respectable brewers in this country. The proportion of hops for double stout is seldom more than 15 pounds to the 8 bushels of malt.

FLAX. The new roving machine, called by the ingenious inventor, Mr. W. K. Westley, of Leeds, the Sliver Roving Frame, seems to be a *philosophical induction* happily drawn from the nature of the material itself, and accommodated to its peculiar constitution. It is remarkable for the simplicity of its construction, and, at the same time, for its comprehensiveness; requiring no nicety of adjustment in its application, and no tedious apprenticeship to be able to work it.

It is known, that the glutinous matter of the plant may be softened by water, and hardened again by heat; of this fact advantage is taken, in order to produce a roving wholly without twist; that is, in the form of a ribbon or sliver, in which the fibres are held together by the glutinous matter which may be natural to them; or which may, for that purpose, be artificially applied. The sliver roving, as long as it remains dry, possesses all requisite tenacity, and freely unwinds from the bobbin, but on becoming again wetted in the spinning frame, it readily admits, with a slight force, of being drawn into yarn, preserving the fibres quite parallel.

The diagram, *fig.* 190., shows in explanation, that

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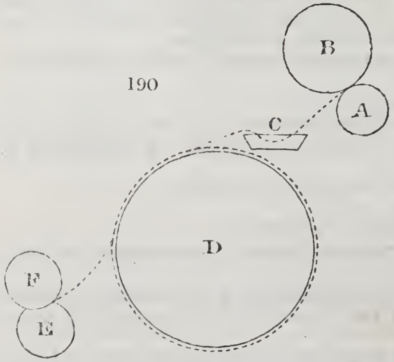


A, is the drawing roller of the roving frame in front of the usual comb.

B, the pressing drawing roller.

C, a shallow trough of water.

D, a cylinder heated by steam.

E, a plain iron roller for winding.

F, a bobbin lying loose upon the winding roller, and revolving upon it, by the friction of its own weight.

The roving, or sliver, as shown by the dotted line, after leaving the drawing rollers A B, passes through the water, in the trough C, which softens the gluten of the fibres; and then it is carried round by the steam cylinder D, which dries it, and delivers it hard and tenacious to the bobbin F, on which it is wound by the action of the roller E.

This is the whole of the mechanism required in producing the sliver roving. All the complex arrangements of the common cone roving are superseded, and the machine at once becomes incomparably more durable, and easier to manage; requiring only half the motive power, and occupying only half the room. A frame of 48 bobbins is only 6 feet long, and affords rovings sufficient to supply 1200 spinning spindles.

The machine is very general in its application, being equally well adapted for heavy as for fine rovings.

In making a roving in the usual way, the twist, in addition to other circumstances, sets a limit to the degree to which a material of a given fineness may be roved; because the quantity of twist required to give a roving the necessary cohesion, increases in proportion as the number of fibres composing that roving diminishes, till it accumulates to such a degree, that the fibres are prevented from drawing regularly, or, if drawn, are broken and scattered by the violence of the action. It is impossible, therefore, to make a light roving, good for any thing, out of a coarse material; but in the sliver roving, there is no difficulty in making a roving of almost any fineness, with little reference to the quality of the material employed, because, while one fibre can be glued to another by any portion of its extremity, a roving may be made.

It becomes easy, with a sliver roving, to use a double or triple roving on the spinning frame. The great advantage of this practice has long been well known, and acted upon, in the spinning of cotton; but in that of flax, it has hitherto been unattainable: yet the vast benefit to be expected, from doubling on the spinning frame all the equalisation of the previous preparation, is too self-evident to be insisted upon.

The sliver roving, made however fine, is perfectly solid, tenacious, and compact; no fibres in it, when once laid straight, can afterwards be ruffled or disturbed; and, as they are placed in the yarn in the exact position in which they leave the combs, being kept straight without any ruffling or tangling from twist, the inelastic nature of the material is not injured, and the yarn acquires a superior lustre, roundness, and strength.

The sliver roving is drawn with less force than the twisted roving, and is therefore less liable to make *snarls* in the yarn; while it has another advantage arising from the absence of twist. The fibres of flax and tow being various in length, an uniform twist upon them will naturally retain the longer fibres more effectually than the shorter ones, which will hence have a tendency to run into thick places in the yarn. From this inconvenience the sliver roving is completely free.

In the spinning frame, there is also a benefit derived from the bruising action of the detaining roller: the pressure is supposed to split the fibres laterally, and thereby make them finer, in the same way as a board would be split by being passed through iron rollers, under a pressure; but it is evident that in a twisted roving a portion of each fibre must escape this action, by winding round the body of the roving, and, consequently, the fibres can be but partially split. By this circumstance, in addition to the direct loss of benefit, a new and serious evil is created; a fibre split has always, in the split portion, one end longer than another, and the longest end, of course, arrives first at the drawing rollers. Now, if the fibre be only partially split; if that portion whose end arrives first be not wholly separated from the rest of the fibre; it follows, that when the longer end is seized by the drawing rollers, the shorter end will be drawn into a knot, or thickening; because its fore end is still held back by the adhesion of its contiguous fibres, while its back end is drawn forwards, by being still attached to its original fibre. In the sliver roving, the fibres, being perfectly straight and parallel, are exposed to the bruising of the rollers equally, and are split uniformly and entirely from end to end.

The sliver roving, being so much simpler in construction than any other, is capable of running quicker; but if running only at the same speed, it will produce from 25 to 30 per cent. more work, because it is never stopped in order to be doffed. The bobbins are so placed, that the attendant has only to remove a filled bobbin, and replace it with an empty one, without the slightest interruption to the progress of the machine. Owing to this circumstance, the attendant is provided with an easy and uniform employment for her time, instead of occasionally doing nothing, and again hurrying through the labour of doffing; and the work also, being simpler, may be performed by cheaper hands.

It must be noted that doffing is of frequent occurrence, especially in heavy numbers, and occupies much time where one person has to doff a great many spindles, and it is often inconvenient, where other hands are called from their work to assist: but it is not only in doffing that time is lost; it is in wiping, picking, and oiling the numerous flyers and spindles carefully, and which should not be hurried; and, moreover, when the machine requires thorough cleaning, the complication of its mechanism materially increases the loss of time as well as expense; so that the saving effected by not stopping the frame to doff becomes very considerable, and soon repays the whole cost of the machine.

Each bobbin has, in fact, its own regulating motion, independent of the rest; and this is at all times correct, without requiring any fresh adjustment or adaptation to different thicknesses of roving, enabling the spinner to rove at the same time, on the same frame, as many sorts or thicknesses of roving as there are bobbins in a frame; whereas on the common machine he is compelled to rove but one sort or thickness at a time; and whenever he alters the sort, the mechanism requires a fresh adjustment, involving the chances of error, and attended with loss of time and waste of material.

THE END.

London:
Printed by A. Spottiswoode,
New-Street-Square.

APPENDIX

TO

THE SECOND EDITION

OF THIS

SUPPLEMENT.

AMYGDALINE is a principle of bitter almonds and of bay-laurel berries. It is obtained by digesting, in a retort, alcohol of 0·825 at its boiling temperature upon the meal of bitter almonds, then distilling off the alcohol by the heat of a water-bath till the residuum assumes the consistence of syrup. To the residuum, diluted with a little water, some yeast is to be added, and the mixture is to be set aside in a warm place for some time to ferment. Whenever the fermentation is over the liquor is to be filtered, and evaporated on the water-bath to a syrupy consistence. On mixing this syrup with alcohol of 0·825 the amygdaline falls in a white crystalline powder, which, after being squeezed between folds of filtering-paper, is to be finally purified, by repeated crystallizations, with alcohol. Its crystals are silky-looking scales, or short needles, without smell, but with a slight taste of bitter almonds. When heated they exhale the fragrance of hawthorn flowers, and burn into a bulky charcoal. Cold alcohol hardly dissolves them, but boiling alcohol pretty copiously. They are very soluble in water, and produce therefrom by evaporation and cooling large transparent prisms, of a silky aspect, which contain 6 atoms, or 10·57 per cent. of water. Their composition in the dry state is as follows: —

40 atoms of	carbon	52·98	in 100 parts.
27 —	hydrogen	5·84	—
1 —	azote	3·06	—
22 —	oxygen	38.12	—
1 atom amygdaline (*Liebig*)		100·00	

The purpose of the fermentation above prescribed is to decompose a portion of sugar, extracted by the alcohol from the bitter almonds along with the amygdaline, of which latter they afford from 3 to 4 per cent.

Almonds, both bitter and sweet, contain also another curious principle, called *emulsine* by Liebig, and *synaptase* by Robiquet. It is soluble in water, but is precipitated from it in flakes by alcohol. It coagulates at the temperature of about 140° Fahr. like white of egg. On mixing a solution of 10 parts of amygdaline in 100 parts of water, with 1 part of synaptase in 10 parts of water, a peculiar decomposition immediately takes place. The mixture becomes opaline without losing its transparency; it assumes the odour of bitter almonds, and yields, on distillation, hydrocyanic (prussic) acid, and the hydrure of benzoil (pure essence of bitter almonds), mixed with vapours of water. Coagulated synaptase has no perceptible action on amygdaline. These facts explain a series of puzzling phenomena, which have been long known. Fresh bitter almonds contain emulsine (synaptase), amygdaline, and an unctuous oil, all in such a state that the first two cannot react upon each other; and by removing the water by desiccation their mutual action becomes impossible. On squeezing the almonds the oil is drawn out, and on treating the cake with boiling alcohol the amygdaline is dissolved out, and the synaptase is coagulated; but on moistening the bitter almonds with water, the reaction of the two principles becomes instantly effective, as shown by the production of the smell and taste of hydrocyanic acid and of the essential oil. By throwing the bitter almond meal into boiling water the synaptase immediately coagulates, and the above mutual reaction can no longer be obtained, nor the above volatile products. In order properly to prepare the essence of bitter almonds it is therefore necessary to mix 1 part of bitter almond meal with 20 parts of lukewarm water, to leave the mixture to digest for 24 hours, and only then to submit it to distillation. 100 parts of amygdaline produce 47 parts of the crude essence of bitter almonds, which contain 5·9 parts of hydrocyanic acid.

ARSENICAL POISON, DETECTION OF. It is well known that fluids mixed with glutinous matter are very liable to froth up when hydrogen is disengaged in them from the mutual action of zinc and a dilute acid; and that the froth obstructs the due performance of the experiment of Marsh. It is equally known, that much of the arsenic contained in the poisonous liquid so tested, escapes condensation and eludes measurement. A committee, appointed by the Prussian government, have contrived an ingenious modification of Marsh's apparatus, which I have simplified into the annexed form: — A, is a narrow glass cylinder, open at top, about 10 inches high, and 1¼ or 1½ inch diameter inside; B is a glass tube, about 1 inch diameter outside, drawn to a point at bottom, and shut with a cork at top. Through the centre of this cork, the small tube C passes down air-tight, and is furnished at top with a stop-cock, into which the bent small tube of glass (without lead) E is cemented. The bent tube F is joined to the end of E with a collar of caoutchouc, or a perforated cork, which will be found more convenient.

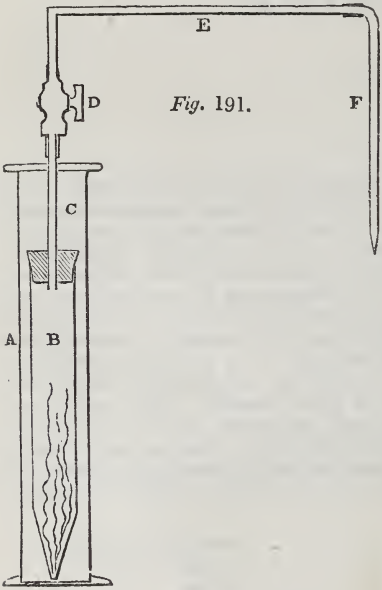


Fig. 191.

The manner of using this apparatus is as follows: — Introduce a few oblong slips of zinc, free from arsenic, into B, and then insert its air-tight cork with the attached tubes. Having opened the stop-cock, pour into A as much of the suspected liquid, acidulated with dilute hydrochloric or sulphuric acid (each pure) as will rise to the top of the cork, after B is full, and immediately shut the stop-cock. The generated hydrogen will force down the liquid out of the lower orifice of B into A, and raise the level of it above the cork. The extremity of the tube F being dipped beneath the surface of a weak solution of nitrate of silver, and a spirit flame being placed a little to the left of the letter E, the stop-cock is then to be slightly opened, so that the gas which now fills the tube B may escape so slowly as to pass off in separate small bubbles through the silver solution. By this means the whole of the arsenic contained in the arseniuretted hydrogen will be deposited either in the metallic state upon the inside of the tube E, or with the silver into the characteristic black powder. The first charge of gas in B being expended, the stop-cock is to be shut, till the liquid be again expelled from it by a fresh disengagement of hydrogen. The ring of metallic arsenic deposited beyond E may be chased onwards by placing a second flame under it, and thereby formed into an oblong brilliant steel-like mirror. It is evident, that by the patient use of this apparatus the whole arsenic in any poisonous liquid may be collected, weighed, and subjected to every kind of chemical verification. If F be joined to E by means of a perforated cork, it may readily be turned about, and its taper point raised into a position such as when the hydrogen issuing from it is kindled, the flame may be made to play upon a surface of glass or porcelain, in order to produce the arsenical mirror.

Or, the preceding process may be made supplementary to that of boiling the arsenical foul liquor, acidulated with hydrochloric acid upon slips of clean copper, whereby the arsenic is precipitated upon the copper in a metallic film, or thin crust more or less brilliant. If one of the slips of copper thus coated be placed in the tube B of the above-described apparatus, it will give off its arsenic without the annoyance produced by the frothing up of a glutinous mixture.

DAGUERREOTYPE PRINTING; or transformation of the Daguerreotype picture into an engraved plate fit for the printing press. An invention for this purpose, as invented by a foreigner not named, was made the subject of a patent by Mr. Claudet in 1843.

The process is divided into two parts, consisting of a preparatory and finishing operation.

Preparatory Engraving. — For this operation, which is the most delicate, it is necessary to have, 1. A saturated solution of caustic potash. 2. Pure nitric acid at 36° of the areometer of Beaumé (spec. grav. 1·333). 3. A solution of nitrite of potassa, composed of 100 parts of water and 5 parts of nitrite, by weight. 4. A solution of common salt, composed of water 100 parts, and salt 10 parts, by weight. 5. A weak solution of ammoniacal chloride of silver, with an excess of ammonia. The ammoniacal chloride of silver must be diluted with 15 or 20 parts of pure water. In the description of the process, this solution will be called ammoniacal chloride of silver. 6. A weak solution of ammonia, containing 4 or 5 thousandths of liquid ammonia. This solution will be called ammoniacal water. 7. A weak solution of caustic potash, containing 4 or 5 thousandths of the saturated solution, which will be called alkaline water. 8. A solution composed of water 4 parts, saturated solution of potash 2 parts, alcohol 1 part, all in volume. This solution will be called alcoholised potash. 9. Acidulated water, composed of water 100 parts, and nitric acid 2 parts, in volume. Besides, it is necessary to have three capsulæ or dishes, made of porcelain, large enough to contain the plate, and covered with an air-tight piece of ground plate-glass, and two or three more capsules, which do not require to be covered; two or three glass funnels, to wash the plate; and two or three glass holders, in the shape of a spoon or shovel, by which the plate is supported when put in and taken out of the solution, without touching it with the fingers.

The Daguerreotype plate is submitted to the engraving process, after having been washed in the hyposulphite of soda, and afterwards in distilled water.

First process for biting in or engraving the Plate. — The following solutions must be put in the capsules, in sufficient quantity, so as to entirely cover the plate: — 1. Acidulated water. 2. Alkaline water. 3. Alcoholised potash, in covered capsules. 4. Caustic potash, in covered capsules. 5. Distilled water.

The plate being put upon the glass holder or spoon, is plunged in the acidulated water, and agitated during a few seconds, then put into a glass funnel, and washed with distilled water. It is taken again with the glass spoon, and plunged in the capsule containing alcoholised potash. This capsule is covered with its glass cover, and then heated, by means of a spirit-lamp, to about 144° Fahrenheit. The plate must remain in the capsule half an hour, during which the solution is heated now and then, and agitated. During that time the following acid solution, which will be called *normal acid*, must be prepared; it is composed as follows: — Water 600 parts, nitric acid 45 parts, solution of nitrite of potassa 12 parts, solution of common salt 45 parts. These proportions are in volume. The normal acid must be poured into a capsule, covered with its glass cover, and a sufficient quantity must be kept in the bottle.

When the plate has been immersed in the alcoholised potash during half an hour, it is taken out of the solution by means of the glass holder, and immediately plunged in the alkaline water, and agitated pretty strongly; from thence it is put in distilled water. (A)

This being done, the plate is plunged in the acidulated water, and moved about therein for a few seconds: it is then put into the normal acid. When the plate has been immersed a few seconds in the acid, it is taken out by means of the glass holder, taking care to keep it as much as possible covered with the solution, and it is immediately placed horizontally upon a stand, and as much acid as the plate can hold is poured upon it from the bottle: it is then heated with a spirit-lamp, but without attaining the boiling point. During this operation it is better to stir or move about the acid on the plate by pumping it, and ejecting it again, by means of a pipette or glass syringe; after two or three minutes the acid is thrown away, the plate is put in the glass funnel, and there well washed with water, and afterwards with distilled water. (B)

Then, without letting the plate dry, it is put upon the fingers of the left hand, and with the right hand some ammoniacal chloride of silver, which is moved about the surface by balancing the hand, is poured upon it; the solution is renewed until the chloride, formed by the action of the acid, is dissolved; the plate is then washed by pouring upon it a large quantity of ammoniacal water, and afterwards some distilled water. (C)

Without allowing the plate to dry, it is then put in the caustic potash, and the capsule being placed upon the stand, the potash is heated up to the boiling point; it is then left to cool (D); and beginning again the operations described from A to D, a second biting is obtained; and by repeating again the operations described in A and B, a third biting is produced. The plate is then dried; in this state the black parts of the plate are filled with chloride of silver.

The plate is then polished until the white parts are perfectly pure and bright. This polishing is done with cotton and "ponce" (pumice stone); afterwards, the chloride of silver, filling the black parts, is cleansed by the means described in B and C. The plate is dried, but before drying, it is well to rub the plate slightly with the finger, in order to take off from the black parts any remains of an insoluble body, which generally stick to it. The preparatory engraving is then finished, and the plate has the appearance of a very delicate aquatint engraved plate, not very deeply bitten in.

Nevertheless, if the operation has been well managed, and has been successful, it is deep enough to allow the printing of a considerable number of copies.

Note. — Sometimes, instead of treating the plate with the boiling potash in the capsule, a similar result may be obtained by placing the plate upon the sand, covering it with the solution, and heating it by means of a spirit lamp, until, by evaporation, the potash passes into a state of ignited fusion. By this means the grain is finer, but the white parts are more liable to be attacked.

Last operation of biting in. — This operation requires some of the re-agents before named, and also,

1. A siccative ink, made of linseed oil, rendered very siccative by boiling it sufficiently with litharge; it may be thickened with calcined lamp-black.
2. An electrotype apparatus, and some solutions fit to gild, and copper the plate.

Means of operating.—The plate must be inked as copper-plate printers do, taking care to clean off the white parts more perfectly than usual; the plate is then to be placed in a room sufficiently warm, until the ink is well dried, which requires more or less time, according to the nature of the oil employed. The drying of the oil may be hastened by heating the plate upon the stand with the lamp, but the slow process is more perfect and certain.

When the ink is well dried, the white parts are cleaned again, by polishing the plate with cotton and ponce, or any other polishing powder: a ball of cotton, or any other matter, covered with a thin piece of caoutchouc or skin, can be used for this purpose. When polished, the plate is ready to receive the electro-chemical coating of gold, which will protect the white parts.

Gilding.—The gilding is obtained by any of the various processes of electrotyping which are known. The only indispensable condition is, that the surface obtained by the precipitation must not be liable to be attacked by any weak acid; a solution answering this purpose is made of 10 parts (by weight) of ferrocyanide of potassium, 1 part of chloride of gold, and 1000 parts of water, used with a galvanic battery. During the gilding the plate must be turned in several positions, in order to regulate the metallic deposit. In some cases the gilding may be made more perfect, if the plate is covered with a thin coating of mercury before being put in the gilding solution.

When the plate is gilded, it must be treated with the boiling caustic potash, by the process already indicated for the preparatory engraving, in order to cleanse it from all the dried oil or ink, which fills the hollows. The plate is then washed and dried, and when the oil employed has been thickened with the lamp-black, the surface of the plate is rubbed with crumb of bread, in order to cleanse and take off the black remaining; then the white parts being covered and protected by a varnish not liable to be attacked, and the black parts being uncovered and clean, the plate can be bitten in by aquafortis, according to the ordinary process used by engravers.

This operation must be done upon the stand, and not by immersing the plate in the solution.

Before this last biting-in, if the preparatory engraving has not succeeded well, and the plate still wants a sufficient grain, it can be given by the various processes of aquatint engraving.

Before submitting the plate to the operation of printing, in order to ensure an unlimited number of copies, it is necessary, as before stated, to protect it by a slight coating of copper, which is obtained by the electrotype process; otherwise the printing would soon wear the plate. This coating must be kept very thin, lest the fineness of the engraving, and the polish of the white parts, should be destroyed. In this state the plate can be delivered to the printer.

After a certain number of impressions have been obtained, it will be perceived that the coating of copper is worn in some places: then this coating must be removed, and a fresh one applied in its place. For this purpose the plate must be purified and cleansed by warm potash, and plunged in a weak acid, composed as follows: — Water, 600 parts; nitric acid, 60 parts; nitrous acid of engravers, 5 parts; all in volume. This acid will dissolve the coating of copper, and the plate being coppered again, by the same means as before, may be again submitted to the operation of printing; and as nothing can prevent the success of a repetition of the same operation, any number of impressions may be obtained. The coating of copper can also be removed by caustic ammonia.

The Daguerreotype plate engraved by this process may be also reproduced and multiplied by the electrotype process, the same as any other engraved plate.

The essential points of this process, which constitute the present invention, consist, —

First, in the discovery and employment of certain properties of a mixture composed of nitric acid, nitrous acid, and hydrochloric acid, in determined or fixed proportions. The two last-mentioned acids may be employed either in a free state, or combined with alkaline or other bases. This mixed acid has the property of biting the pure silver, which forms the black parts of the Daguerreotype picture, without attacking the white parts formed by the amalgam of mercury. The result of the action of the biting is, to form on the black parts of the picture an insoluble chloride of silver; and this chloride of silver, which, when formed, stops the action of the acid, is dissolved by ammonia, which allows the biting to continue.

Secondly, in the discovery of certain properties of a warm solution of caustic potash, and in the employment of the said solution, by which the mercury forming the picture is better and deeper amalgamated with the silver under it, so that many imperceptible points of the amalgam are affected in such a manner that the acid has no action upon them.

Thirdly, in the discovery and employment of a process which produces a grain favourable to the engraving, by which the biting on the plate is rendered deeper. This is effected by filling the parts engraved with a siccative ink, or any other substance, and then gilding the plate by the electrotype process: the gold is not deposited on the parts protected by the ink. When the plate is gilded, the ink is cleansed by the caustic potash, and the plate may be submitted to the effect of an acid, which does not attack the coating of gold, but bites only on the silver in the parts already engraved by the first operation.

Fourthly, in the employment of a process by which the plate is protected from the wear of the printing operation. This is effected by covering the plate, before printing, with a slight coating of copper, by the electrotype process, and when the coating begins to wear, by printing, it is removed by a weak acid, or by ammonia, which dissolves the copper without affecting the silver under it. The plate is coppered again, and after another printing the same operation is repeated, so that a considerable number of copies may be printed without much injury to the engraving.—*Newton's Journal*, C. S. xxv. 111.

DYEING. A patent was obtained in 1840 by Mr. Charles Köber for fixing colours better in wool and woollen cloth, by boiling them first of all in a weak solution (about 3 pounds to 100 of scoured wool) of bichromate of potash, along with about 2 pounds of argal, for an hour and a half; and next day dyeing them of any colour in the usual way. He produces a fast green by dyeing the wool blue, making it into cloth, and then dyeing this yellow, by fustic, with a mordant consisting of 6 or 7 pounds of a solution of muriate of tin, specific gravity 1·2612 or 30° Baumé, along with alum and argal. He prepares his indigo blue vat, with soda, lime, and bran, instead of woad, madder and bran, as usually employed.

GAS-METER. The difficult problem of a good *dry* gas-meter has been at length solved by Messrs. Croll and Richards, in their recently obtained patent invention. I am of opinion, that it is a perfect philosophical instrument, both in principle and performance; capable of measuring the consumption of coal gas with geometrical precision, and free from all the fallacies to which several of the water gas-meters are liable. This new gas-meter is a drum with flat discs, which have a direct and not an angular motion, and is on that account preferable to any dry meter with which I am acquainted.

GLASS. A fine red colour may be given to glass by combining with it in the melting-pot a small portion of a sulphuret of chromium, containing one atom of sulphur to two of the metal. Dr. Kopp, the author of this statement, does not say precisely how this peculiar sulphuret is to be formed; for the common sulphuret contains 3 atoms of sulphur to 2 of the metal. It would seem to be by a partial decomposition of the sulphate of chromium.

GUANO. Since I wrote the memoir on guano in this Supplement, very large importations have been made from the coast of Africa, especially from the island of Ichaboe, and of very various qualities, as will appear from the several analyses which have been published, as made by other chemists as well as myself. Of many of these analyses it may be remarked that they are quite defective, in not determining the amount of azotised animal matter, or of its equivalent potential ammonia — a constituent of guano of the first-rate value, being that which promotes the fertility of soil for several years, whereas the actual ammonia in the saline state is apt to be speedily wasted by the sun and rains, and can be considered therefore as food for only one season. My attention was first strongly drawn to these imperfect analyses by the report of one made by Professor Johnston upon a guano of which a sample was also put into my hands for analysis by the importers, Messrs. Anthony Gibbs and Sons, of London. The cargo was imported from Peru by the Providence, towards the end of last August. Professor Johnston's statement is as follows : —

" Water, and volatile ammonia	5·24
Organic matter, and ammoniacal salts	58·00
Salts soluble in water, consisting of sulphate and muriate of soda	6·37
Insoluble siliceous matter	1·07
Phosphate of lime, and a little phosphate of magnesia	25·37
Carbonates of lime, magnesia, &c.	3·95
	100·00 "

By this analysis we can form no idea of the quality of the guano, because the proportion of ammonia, whether actual or potential, is not stated; and we are therefore left as much in the dark about the marketable or agricultural value of the article as we should be of a cargo of rum, of which the excise proof specific gravity, or proportion of alcohol, was not given. The determination of the precise amount of ammonia is one of the nicest parts of the analysis — one which may be regarded as quite indispensable, and without which the cost of an analysis should not be more than ten shillings, if that of the more complete analysis, including the proportion of the actual and potential ammonia, be two guineas, which is my general fee. As to the carbonate of lime and magnesia, I entirely doubt the accuracy of the analysis, since I found neither of them in it, nor in any genuine excrement of sea-birds which I have had occasion to examine. In fact, the ignited residuum of guano rarely affords even a trace of effervescence with dilute hydrochloric acid.

The following analysis of guano surprised me not a little, being formally issued from a most respectable establishment : —

" *Apothecaries' Hall, August* 24. 1844.

" Gentlemen, — I have submitted the sample of guano from Ichaboe, left with me, to a careful chemical analysis and investigation, and beg to report that it is the best in quality for agricultural purposes that has yet come under my notice; besides the annexed analysis, I find that it contains nitrogenous organic ingredients capable of yielding 24 per cent. of ammonia : —

" Salts of organic acids, salts of ammonia, and organic acids, all soluble in cold water	33·0
Insoluble organic matter, acids, &c.	9·5
Phosphate of lime	30·0
Chloride of sodium, sulphate of soda, and phosphate	1·0
Water of crystallisation and moisture	25·0
Insoluble in acids (argillaceous)	1·5
	100·0

" By the term 'organic acids' I mean the uric acid, and acids of that class, rich in nitrogen, and therefore capable of yielding a rich manure and vegetation. The per centage of phosphate of lime is also higher than the average.

(Signed) " Robt. Warrington, Chem. Operator.

" *Messrs. Miller and Potter,*
Owners of the Joseph Hume, from Ichaboe."

This *printed* report — calculated to produce astonishment in the trade, to lead to a rapid sale of the article at a high price, as exhibiting a guano rich beyond the boasted treasures of Peru, and to excite ship-owners to send off a fresh fleet to the African El Dorado — was given to me by a gentleman who dealt in that manure, and soon after a sample of the said guano was sent to me for my professional analysis.

The results of a very careful chemical investigation, verified by repetition, were very different indeed from that of the Apothecaries' Hall. I could find no uric acid in it, nor any acid of that class rich in nitrogen, and no alumina. But instead of giving the details of my own analysis, I shall present those of a professor of chemistry in London, conversant with the analysis of organic matter, and particularly with the ultimate analysis for determining the " nitrogenous organic ingredients, capable of yielding 24 per cent. of ammonia," according to Mr. Warrington. That gentleman's analysis of the guano per Joseph Hume is as follows: —

> "50 grains of guano in the moist state, decomposed with an equal weight of carbonate of potash, gave 4·13 grains of ammonia, or 3·4 grains of nitrogen.
>
> 25 grains of guano, carefully dried at 212°, were then mixed with hydrate of soda and quicklime, and ignited. They produced 2·17 grains of nitrogen.
>
> Hence we have, in 100 parts of guano in the moist state, —

Nitrogen, in the condition of (actual) ammonia	6·80
Ditto (in the potential state)	2·64
Total quantity of nitrogen	9·44

> The (actual) ammonia I believe to be chiefly in the state of oxalate."

Since 14 of nitrogen are equivalent to 17 of ammonia,
9·44 are equivalent to 11·46 instead of 24!

— a result very different indeed from that of the Apothecaries' Hall chemistry. — Is argillaceous matter insoluble in acids at the Hall?

My own analysis made as to the ammonia, in presence of a most respectable chemist, but not of the professor above referred to, agrees very closely with the preceding. The guano was a good African cargo, fully equal in value to the average of that from Ichaboe, and did not stand in need of puffing to make it fetch a fair price in the market. Indeed, such an extravagant character as Mr. Warrington gave it, was more likely to raise suspicions, than to give satisfaction to dealers.

The Apothecaries' Hall analysis gives 30 of phosphate of lime; 1 of chloride of sodium, sulphate of soda, and phosphate; 25 of water; and 1½ of insoluble in acids (argillaceous); in all 57½, leaving 42½ for the other constituents in 100 parts. Now, as Mr. Warrington is also secretary to the Chemical Society of London, he should offer to its president, and the members, the following problem for a prize essay: *Given 33 parts of salts of organic acids, salts of ammonia, and organic acids, all soluble in water, with 9½ parts of insoluble organic matter, acids, &c., to extract from these 42½ parts, 24 parts of ammonia.* The chemist of the London school who shall achieve this feat, will throw Berzelius, Faraday, Liebig, and Dumas into the shade.

It has been objected, I am told, to my method of determining the *potential* ammonia of guano — viz., the ammonia equivalent to the azotised organic matter — that the process of igniting it in mixture with hydrate of soda and quicklime is inapplicable, because an unknown portion of ammonia must escape and be lost in the act of mixing the guano with these decomposing agents; but this objection will not be made by any skilful experimentalist who pursues the steps pointed out by me — namely, to dry the guano thoroughly beforehand by a steam heat, and to mix it finely pulverised with the fine powder of the mixed soda and lime. I made this experiment in the presence of Professor Redwood, upon a guano from Ichaboe, which contained nearly 8 per cent. of actual ammonia, and no ammonia whatever was exhaled during the complete but gentle trituration of the ingredients together in a porcelain mortar. At my request, Mr. Fownes, lecturer on chemistry at the Middlesex Hospital, who studied at the University of Giessen, made the same experiment, and he writes me, — "I have great pleasure in confirming your observation, that the carefully-dried guano may be cautiously mixed with the alkali in Wills' process, without loss of ammonia, by a little management."

In fact, the ammonia is so enveloped in the organic matter and phosphate of lime of guano, that when freed from moisture, no ammonia is separated during the short period requisite for mixing its powder intimately with the dry powder of lime and soda.

The following Report of Professor Johnston upon his analysis of a sample of guano, imported in the Maid of Alicant, was recently sent to me by eminent guano merchants in London for my opinion upon his mode of estimating the relative value of that article merely from the proportion of water it may contain. As this analysis, like his other one given above, does not exhibit the quantity of ammonia, either actual or potential, in the guano, it is therefore, in a chemical point of view, as worthless as an assay of a silver, copper, or tin ore would be, which did not state the precise amount of metal present in it.

(COPY.)

"8. Bank Street, Edinburgh, March 10. 1845.

"Gentlemen, — At the request of Mr. Souter, of Banff, I enclose a copy of the analysis of a sample of guano, from the Maid of Alicant, sent to me for examination by that gentleman, and of the opinion I have given him in reference to its value.

"I have the honour to be, yours truly, J. F. Johnston.

“It is a good Ichaboe guano, of fair average quality in every other respect but that of the quantity of water it contains. In this respect it is about 4 per cent. below the average of the numerous varieties of guano examined in my laboratory. I consider about 23 per cent. of water to be about the average; so that you are entitled, if what I received be an average of the cargo, to a deduction of 4 per cent. by the terms of your agreement.”

Here follows his

“*Analysis of Guano,* ex *Maid of Alicant.*

“Water	27·39
Organic matter and ammoniacal salts	40·04
Common salt, sulphate and phosphate of soda and potash	7·51
Phosphate of lime and magnesia	23·63
Carbonate of lime	0·21
Insoluble siliceous matter	0·97
Loss	0·25
	100·00”

My extensive experience in the analysis of guano during nearly four years leads me to regard this rule of the Professor as entirely fallacious. The proportion of water present in Ichaboe guano depends very much upon the proportion of animal organic matter which it contains. When this is wasted by the atmospheric elements, when it has undergone the *eremacausis* of Liebig, and has degenerated into a carbonaceous *caput mortuum,* it is less retentive of moisture, and also of less weight relatively to the unchangeable silica, phosphate of lime, and magnesia.

In last October an Ichaboe guano, analyzed by me for an eminent merchant in the city of London, which contained only 23 per cent. of water, appeared doughy from moisture; an appearance caused by the almost total absence of animal organic matter, and the great proportion of phosphate of lime. It contained only 1·85 per cent. of actual ammonia, no uric acid or other azotized matter capable of yielding ammonia by slow decomposition in the soil. Now, the guano *ex* the Joseph Hume, as quoted above, though it contained 2 per cent. more water, was not doughy, but pulverulent. By Mr. Johnston's rule this guano was 2 per cent. worse than the preceding, and yet it was intrinsically 50 per cent. at least better, because it contained nearly 7 times more ammonia, a double quantity of animal organic matter, and that in a fresh state, along with 30 per cent. of phosphate of lime. In fact, a decomposed guano, with 23 per cent. of water, and so little ammonia as the above, is worth little more than the value of the bone earth in it.

I have this day (17th March, 1845) despatched the report of my analysis of an Ichaboe guano to a gentleman in Leominster. Though a dry-looking powder, it contains no less than 29 per cent. of water, and is notwithstanding an excellent article, being the pure and little-wasted excrement of sea-birds. These statements clearly prove that the proportion of water constitutes no sure criterion of the value of guano, but that this is to be deduced from a collation of all its useful constituents, most especially the exact proportion of its ammonia, actual and potential, which Mr. Johnston's analyses do not not state, next of its alkaline salts, particularly those of potash, then of its phosphate of lime and magnesia, and of its uric acid. I here subjoin the reports of the analyses of two different samples of guano for my Leominster correspondent.

“1. *C. sample. Ichaboe.*

“Specific gravity, 1·3 to water 1·0; being the lowest density of any guano which has hitherto passed through my hands, and indicating it to be pure bird excrement. 100 parts consist of—

“1. Animal organic matter, partially decomposed, affording 7·82 per cent. of actual ammonia, and 1·02 of potential ammonia; in all, 8·84 of ammonia	37·3
2. Fixed alkaline salts, of which about the one-half is valuable potash salts, the other sulphate and muriate of soda	4·7
3. Phosphate of lime, with a little phosphate of magnesia	28·0
4. Siliceous sand	1·0
5. Moisture separable at the heat of 212° Fahr.	29·0
“It contains hardly a trace of uric acid.	100·0

“2. *Sample P. Peruvian.*

“Specific gravity 1·4; being a low density for so dry a guano.

“100 parts consist of—

"1. Animal organic matter, in a fresh state, affording 3·74 of actual, and no less than 12·92 of potential ammonia; in all 16·66 of ammonia, along with 9 of uric acid	60·5
2. Fixed alkaline salts, about two-thirds of which are potash salts, so valuable for corn crops, and about one-third sulphate and muriate of soda	2·5
3. Phosphate of lime, with a little phosphate of magnesia	23·0
4. Siliceous fine sand (drifted into the guano)	6·0
5. Moisture separable at a heat of 212° Fahr.	8·0
	100·0"

From its large proportion of rich organic matter, uric acid, and potential ammonia, this guano will communicate fertility to the soil for several years; whereas the sample *C.* is to be regarded as a quicker manner for one season. Both will act perennially by their bone phosphate.

Andrew Ure, M. D. F. R. S., &c.

HAIR DYE. The compound of lime and litharge, prescribed in the Dictionary for dyeing hair, should be used with great caution, as, when applied in a too-little diluted state, it is apt to destroy the hair. A much better and a perfectly safe hair dye presents itself in pyrogallic acid, which may be prepared for this purpose by exposing powdered nutgalls to heat in a hemispherical glass or porcelain vessel, covered with tissue or filtering paper pasted round its edges, and surmounted with a bell glass. The pyrogallic acid rises in vapour, which, being filtered from its oily impurities through the paper, condenses on the inside of the bell glass. The pyrogallic acid thus obtained is to be dissolved in water, purified by digesting the solution with animal charcoal, then concentrated, and mixed with some alcohol to prevent its decomposition. This tincture applied to the hair, browns it; but it must not be allowed to touch the hands, as its stain cannot be easily effaced.

MANGANESE. The recovery of this metal in the state of peroxide from the several waste products of the chemical arts, in which it is so extensively consumed, has been long a desideratum in manufactures. This important problem has at length been happily solved by Mr. S. de Sussex, of the Millwall chemical works, near London; and in doing so, he has conferred a precious boon on the chemical world, which I hope will be honestly and thankfully repaid by the sale of licenses under his patent, specified only a few days ago. I have great pleasure in enriching the second edition of my Supplement with an authentic description of the valuable series of processes embodied in his plans.

The *nature* of the said invention is to regenerate or reproduce peroxide of manganese, more or less pure, from salts and other combinations of that metal which contain it in a lower state of oxidation. By this invention we can reconvert the residuum that is left after the disengagement of chlorine or oxygen from manganese, and which is a product of little or no value, into a substance of great value, namely, that superoxide of manganese, which is peculiarly fitted, by the large proportion of oxygen it contains, to serve the purpose of affording either chlorine or oxygen gas again, according to the process it is subsequently subjected to. The said residuary matters, after the extrication of the chlorine in the manufacture of chloride of lime, or bleaching powder, and of chlorate or hyperoxymuriate of potash, consist principally of chloride and sulphate of manganese; but as these residuums may and have been occasionally converted more or less into sulphuret of manganese when they are used to purify coal gas from its sulphur or sulphuretted hydrogen, the patentee includes not only the above sulphate and chloride, but also the sulphuret of manganese, among the waste or refuse products, which he converts into a valuable peroxide of that metal. He applies, moreover, this invention to the conversion of all oxides, carbonates, and other combinations of manganese whatever, whether native or factitious, which contain the metal in an inferior state of oxidation, into a superoxide of manganese, adapted to produce chlorine by the agency of hydrochloric acid, and oxygen by the agency either of heat alone, or of heat along with sulphuric acid.

The *manner* in which the said invention is to be carried into execution is as follows: — The conversion of manganese, whether combined or uncombined from a lower state of oxidation into the higher state of superoxide, is effected by two distinct operations. First, it is well known that when peroxide of manganese, called in its purest native state, pyrolusite, and also grey manganese ore, is digested with hydrochloric or muriatic acid, the oxygen of the metal combines with the hydrogen of the acid to form water, and leaves the chlorine of the acid free, while the manganese, thus partially stripped of its oxygen, combines with the rest of the hydrochloric acid to form a muriate of manganese. Likewise, when more or less dilute sulphuric acid, common salt (chloride of sodium), and peroxide of manganese, are so mixed and treated as to be made to re-act on one another, the hydrochloric acid, which is disengaged, is converted by the oxygen of the manganese into water and chlorine, while both the soda produced from the common salt, and the partially deoxidised manganese, combine with the sulphuric acid into sulphate of soda and sulphate of manganese. He converts either the chloride, sulphate, sulphuret, or carbonate, into a sesquioxide or deutoxide of manganese, by one or other of the three following processes: — First, he subjects dried chloride of manganese to a strong heat, produced either by the united action of burning fuel, and a jet or jets of an oxy-hydrogen blowpipe, or of a stream of atmospheric air thrown upon the burning fuel by a fan or other suitable impulsive power, thus forming a kind of blowpipe or blast-furnace, in which the chemical decomposition and re-action are rendered quicker and more complete. The furnace is constructed like an ordinary reverberatory furnace, with the addition of a box or chest of iron open at top, set in the fire-place, close to the bridge, which box is filled with iron turnings, borings, or other small fragments of iron, upon which, in their strongly ignited state, water is allowed to trickle or drop down slowly from a pipe, so as to be decomposed, and to disengage a stream of hydrogen, which is impelled over the bridge of the furnace upon the hearth by means of a fan or other blowing machine acting at the entrance or door of the fire-place. The manner in which the furnace is regulated is as follows: — The fuel, either common coals, coke, anthracite, wood, turf, &c. is first lighted upon the grate, and being subjected to the blast of air, soon creates such a temperature as to raise the box of iron turnings to a red-white heat, in which state the water being allowed to trickle down into the said box, is decomposed with the copious disengagement of hydrogen gas. The chloride of manganese may be exposed on the hearth of the reverberatory furnace either in a more or less concentrated liquid state, or in a dry state, to the action of the intensely powerful flame, generated as above described, and becomes thereby decomposed by the hydrogen, with the disengagement of its chlorine in the state of hydrochloric acid or muriatic acid gas, while the remaining protoxide of manganese becomes at the same time oxidized into the deutoxide. The hydrochloric acid gas disengaged is condensed by means of vaults or large chimneys, containing wet coke or flint nodules in the way often practised in soda manufactories. Instead of the above described hydrogen flame, he employs sometimes a simple reverberatory furnace with ordinary fuel, either with or without blast, in which he resolves the chloride of manganese into hydrochloric acid and peroxide of manganese, but he prefers the compound flame of hydrogen and ordinary fuel.

In his second process, instead of acting on chloride of manganese by the flame of combustible matter on the hearth of a furnace, he subjects the chloride of manganese, put into fire clay retorts, to an intense heat, by which he expels the chlorine partly in the state of hydrochloric acid, and partly of chlorine, and the manganese left in the retorts may be afterwards peroxidized by a process to be presently described.

In his third process he mixes together chloride of manganese and carbonate of lime, or quicklime, in the proper equivalent proportions for mutual decomposition, and he subjects that mixture to the strong heat of the above described compound hydrogen flame, whereby he obtains a mixture of chloride of calcium (muriate of lime), and oxide of manganese, which he peroxidizes by a process about to be described. Magnesia, or magnesian limestone, may be substituted for lime, or its carbonate, in this process. When the carbonate of lime is used, with rather too low a heat in the furnace, carbonate of manganese may be formed. In all cases, the resulting mixture of chloride of calcium or magnesium, and oxide of manganese, is to be treated with water, so as to dissolve out the said chlorides, and leave the oxide of manganese.

The following is his plan of decomposing sulphate of manganese, however formed, so as to obtain from it an oxide of manganese, to be peroxidized by an after process: —

He mixes the sulphate of manganese with saw-dust, ground coke or charcoal, or any like combustible matter, only in such proportion as to be capable of decomposing the sulphuric acid present, when the mixture is subjected to a strong calcining heat in retorts of iron, or preferably of fire-clay, whereby he obtains a sulphuret of manganese, mixed with more or less oxide of manganese. He finishes this operation, by introducing into the said residuary mixture, fragments of coke, charcoal or coal, and continuing the application of heat for some time, while the mouth of the retort is left open, whereby he desulphurates the manganese in a greater or less degree, and converts its sulphuret into an oxide. In case any salt, or other compound of soda, should have been mixed with the sulphate of manganese, the soda compound is to be separated from the manganese by means of water, after the above described calcination in the retorts. The sulphuret of manganese sometimes produced in coal gas works, as a residuum of the purification of the gas, may be desulphurated in retorts as above described, or preferably by exposing it mixed with pieces of coke, charcoal, coal or wood, on the hearth of the above described reverberatory hydrogen furnace. The coke, &c. should be used not in powder, but in distinct pieces, whereby it may be readily separated from the oxide of manganese afterwards, either by a sieve or other suitable means.

The following is his manner of performing the second operation, or series of operations, whereby he converts the deutoxide of manganese produced in the before-described processes, as also all lower oxides and the carbonated oxide of manganese, whether natural or factitious, into a superoxide fit for affording chlorine by the action of hydrochloric acid, and oxygen by heat; and he produces the said peroxidizement in one or other of the three following ways. First, he converts the said oxides or carbonates from their lower to the much higher state of oxidation of an acid of manganese, by subjecting a mixture of them with alkaline matters, such as potash or soda, either caustic or carbonated, on the hearth of a reverberatory furnace, to the joint agency of heat and atmospherical oxygen, which may or may not be impelled and diffused by mechanical means. He finds that about one part of the oxide or carbonate of manganese, mixed with about three parts of alkaline matter, forms a suitable proportion for the production of an acid of manganese. The said mixture fuses with the production of a manganate or permanganate of potash or soda, according as one or other alkali has been used in the mixture. The fused mass is run or laded out of the furnace, and when cooled is dissolved in hot water. This solution, of what is sometimes called chameleon mineral, on being exposed freely to the air, becomes decomposed, by the absorption of carbonic acid gas, into peroxide of manganese, which precipitates in a black powder, and carbonated alkali which remains in solution. Where carbonic acid gas can be conveniently procured at a very cheap rate, the above described decomposition of the chameleon mineral may be promoted by a due application of the said acid gas. Or, otherwise, the alkaline bicarbonates obtained from a preceding decomposition of chameleon mineral, may be employed for decomposing a fresh-made solution of the said chameleon, whereby a precipitate of peroxide of manganese is immediately obtained. The supernatant alkaline liquor is in all cases decanted or run off, and reserved for subsequent use. He also decomposes chameleon mineral with the production of peroxide of manganese by the action of various organic products, such as starchy or gummy matters, but he greatly prefers to effect the desired production of peroxide of manganese by carbonic acid gas, or an alkaline bicarbonate. His second method of producing peroxide of manganese from its lower oxide or carbonate, consists in subjecting a mixture of about one equivalent chemical proportion of either of these, and about one equivalent of lime, to the chlorine expelled by heat from chloride of manganese contained in the retort, as heretofore described. Or, by treating one equivalent proportion of that lower oxide of manganese, called by chemists sesquioxide or deutoxide, with one half of an equivalent proportion of aqueous or liquid hydrochloric acid, he obtains simultaneously one half of an equivalent proportion of protochloride of manganese in solution, and one half an equivalent of peroxide in the state of a black powder. A like re-action, with the production of a solution of protochloride of manganese, and black peroxide, may be effected by treating the said sesquioxide with aqueous hydrochloric acid in one vessel, and transmitting therefrom the chlorine disengaged into another vessel, containing a like sesquioxide in a moist state.

His third method of converting into peroxide of manganese, its lower oxide or carbonate, consists in directing over the surface of either of these, in a moist state, the deutoxide of azote, frequently called nitrous gas, which is obtained as a waste product in certain chemical operations, as in the manufacture of oxalic acid, or nitrate of lead, or of copper, &c.

In this case, the nitrous gas becomes reduced to a lower state of oxidation, and by imparting oxygen to the lower oxide of manganese, converts it into peroxide

MANURE MANUFACTURE. The fœcal matter so abundantly collected and dried in Paris, to form their dry portable manure, called *poudrette*, is now mixed in its preparation with a small portion of a solution of sulphate of iron (*copperas*), whereby it loses its offensive smell, and may be evaporated without causing a nuisance to the neighbourhood. The ammonia, as well as the sulphuretted and phosphuretted hydrogen, which together concur to produce the nauseous effluvia, are at once condensed by this salt; the ammonia by its acid, and the gases by its oxide. When the putrid contents of a cesspool are mixed with a little copperas, they soon become nearly inodorous. This cheap metallic compound should be applied, under the administration of the police, to all the masses of putrefying dung which are deposited in the purlieus of London, and of the other large towns in the United Kingdom.

OXALIC ACID. By exposing 100 parts by weight of dry sugar to the action of 825 parts of hot nitric acid of 1·38 specific gravity, evaporating the solution down to one-sixth of its bulk, and setting it aside to crystallize, from 58 to 60 parts of beautiful crystals of oxalic acid may be obtained, according to Schlesinger.

SILVERING OF GLASS. A coating of silver, not of tin amalgam as on common mirrors, is deposited on glass by the following process of Mr. Drayton. The plate being surrounded with a raised border of glazier's putty, is then covered with a solution of nitrate of silver, with which a little alcohol, water of ammonia, as also oils of cassia and cloves, have been mixed. The silver is precipitated by the re-action of the alcohol and oils in a metallic state. This method will serve to silver small irregular and polygonal surfaces of glass very conveniently; but the cost of the precious metal, &c. will preclude its application to large mirrors.

SOILS, ANALYSIS OF. Having been recently engaged in a minute chemical examination of the soil of a large farm, remarkable for perennial fertility without manure*, I have been led to adopt some simplified methods of analysis, which may to a certain extent be practised by ordinary farmers, and may throw some light on the means of improving permanently the composition of their lands. The field from which the sample subject of analysis was taken, is situated on Marsh Farm, in Haveling Level, in the parish of Hornchurch, Essex, not far from the banks of the Thames, and nearly opposite to Erith. R. M. Kerrison, Esq., M.D. F.R.S., the proprietor, informs me that no manure has ever been applied to this farm of 200 acres during a period of at least fifty years, except once; and in that season the wheat became so heavy as to be in a great measure spoiled. It produces every variety of crop most abundantly.

The substratum, which lies beneath a three-feet bed of the soil, is an alluvial deposit, replete with decaying vegetable matter; the remains probably of some ancient forest, which existed prior to the formation of the Daggenham Breach, through which the river had inundated a large district of country, and kept it submersed till about two centuries ago; when it was stopped out by the aid of a Parliamentary grant, administered under the direction of a skilful engineer. The soil over the whole farm is of very uniform texture and appearance; being a finely comminuted friable loam, quite free from stones, consisting of a fortunate mixture of fine siliceous sand, clay, oxide of iron, and carbonate of lime, with minute proportions of phosphate of lime and magnesia, but very little organic matter. It would seem, therefore, to derive its principles of fertility chiefly from the atmosphere, and the emanations from the subsoil.

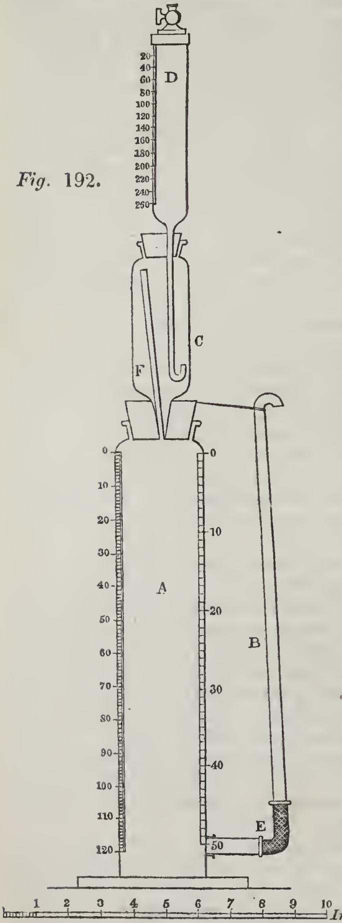
The specific gravity of the soil, in its average state of dryness, is 2·2 to water called 1·0; indicating the presence of but little vegetable matter.

100 parts of it collected after a period of ordinary dry weather lose 11·2 by a steam heat of 212°, and readily re-absorb that portion of moisture when again exposed to damp air. When the dried residuum is calcined at a dull red heat, six parts of vegetable substance are burned away; at a higher temperature the carbonate of lime would become calcined, and cause an additional loss of weight, which might inconsiderately be mistaken for organic matter.

The first problem in an agricultural analysis, is to find the proportion of calcareous matter, as carbonate and phosphate of lime. This may be easily solved with the aid of the following instrument (*fig.* 192.), which may be called the *Limestone Meter*, one of which was presented and explained by me to the Council of the Royal Society of Agriculture on the 29th of May last.

A, is a cylinder of glass, two inches in diameter, and fourteen inches long, graduated on one side with a scale, into spaces of 100 water-grain measures from 0 to 12,000, marked 10, 20, 30, &c.; and graduated on the other side into spaces of 240 water-grain measures, each. The former scale is used for the analysis of all sorts of alkaline carbonates, and also of acids;

Fig. 192.



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* All the stable-yard dung is sold by the farmer.

the latter is adapted to the direct analysis of carbonate of lime and marls; and indirectly to that of phosphate of lime and carbonate of magnesia.

The cylinder A, has a tubulure in its side near to the bottom; this is closed with a cork, in the axis of which a short glass tube is cemented, hooped externally to a collar of caoutchouc E, which serves as a joint to the upright long glass tube B, held near its upper recurved end in a hooked wire.

The top of the cylinder A is closed with an elastic cork, through a perforation in which the taper tail of the little phial C passes air-tight. The small tube F, open at both its ends, is cemented on its outer surface, into the bottom of the phial C, so as to close it, while the tube itself opens a free passage to gas, from the shoulder of the phial down into the cylinder A.

The mouth of the phial C is shut with a cork, through which the small end of the tube D passes air-tight. The tube D is graduated into spaces of 10, 20, &c. water-grain measures up to 250, and is closed at top with a stop-cock. Its lower and capillary extremity is recurved.

In ascertaining with this instrument the proportion of real carbonate of lime, in any limestone, marl, or soil, proceed as follows: —

Lift out the phial C, and pour water into the cylinder A till it stands about half an inch below the line marked 0, and fill up this space with common linseed-oil. Restore the phial C to its place, pressing it in air-tight. Then take out its cork with its graduated tube, and introduce into the phial as many grains weight of the soil or marl as it is proper to operate upon. Of an average limestone 50 grains are sufficient, because the magnified scale of the *lime-proof* is adapted to the analysis of 50 grains of pure carbonate of lime. Of soils and marls, 100, 200, or even 500 grains, may be taken, because these substances will rarely contain one-tenth their weight of carbonate of lime. But as the result may always be obtained within five minutes, at the cost of half a farthing, several successive experiments may be made on different weights of the sample. Having introduced the proper weight of the object into the phial, cover it with water, till this stands a little above the point to which the recurved tube descends. Holding D in the hand, dip its bent point into a phial containing ordinary muriatic (hydrochloric) acid, diluted with its own bulk of water, and applying the mouth to the opened stop-cock, suck up the acid into the tube till this be about two-thirds full, then turn the key of the cock before it is taken from the lips, and the acid will not drop out when the tube is held upright. Replace the cork with its tube D in the phial C. Detach the long tube, B, from its wire-rest with the left hand, and hold its curved extremity above an empty basin; then with the right hand open the stop-cock of D, to let a little acid run down upon the marl, but shut it almost instantly again, lest too much acid should escape, and cause so brisk an effervescence as to occasion an overflow of the mixture into the small tube F. The disengaged carbonic acid escapes through the tube F, presses on the surface of the oil in A, and causes a stream of water to flow from the tube B, into the subjacent basin. When the water ceases to run, open the stop-cock again, when more acid will descend, cause a fresh extrication of gas, and a further flow of water. The curved end of the tube B should be progressively lowered, as the oil falls in A, so as to maintain its level and that in the tube, in the same horizontal plane. Whenever gas ceases to be extricated by the muriatic acid, the experiment is completed, and the number on the *lime-meter* scale opposite to the upper surface of the oil, denotes the number of grains of carbonate of lime, in the quantity of limestone, marl, or soil, put into the phial C for experiment. A little carbonic acid gas remains condensed in the muriatic solution, but this is not more than equivalent to the bulk of liquid acid introduced into the capacity of the apparatus; so that no compensation need be made in this account. For the purpose of minute chemical research, that portion of gas may be expelled by surrounding the phial C with a cloth wrung out of hot water, and the volume of dilute acid added, may also be taken into the account. Thus the composition of carbonates by an acid, and of acids by a bi-carbonate, may be determined by means of this instrument with equal rapidity and precision.

The contents of the phial may be poured out into a porcelain capsule, gently heated, and thrown on a filter. The lime of the carbonate, as well as the phosphate of lime and the magnesia, will pass through in solution along with a very little iron. On supersaturating the acidulous liquor with water of pure ammonia, phosphate of lime (if present) will fall, and may be drained on a filter and dried. Taken off the dried filter, and digested with a little dilute sulphuric acid, sulphate of lime will result, characterised by its entire insolubility in dilute alcohol. Hence the sulphate washed with vinous spirits, dried and calcined, will represent by its weight one-fifth more than the original weight of the phosphate. By the action of the sulphuric acid, the iron precipitated by the ammonia with the phosphate is got rid of.

The magnesia, unless its proportion has been very great, will all remain dissolved as ammonia-muriate, and its quantity may be ascertained by precipitating it either with soda, or phosphate of soda. In the former case, the substance obtained when washed on a filter, dried and ignited, is pure magnesia; in the latter, it is the ammonia-phosphate of magnesia; and when dried at the moderate heat of 120° Fahr., it represents by its weight about six times that of the magnesia present; or for 100 parts, $16\frac{1}{3}$ of magnesia.

When a complete analysis of a soil is to be made, the following apparatus is convenient: —

A large glass flask, or matrass, with a sucked-in or concave thin bottom. This should hold at least a quart of water; and when the soil and dilute acid are introduced, it is to be placed on a stand over the gentle flame of a spirit lamp, while the beak of a large glass funnel, having its mouth covered with a porcelain basin, filled with cold water, is inserted into the neck of the flask. By this arrangement a continual ebullition may be maintained in the mixture of soil and acid, without loss of acid, or nuisance from its fumes, because the vapours are condensed whenever they reach the cold basin above the funnel, and a perpetual cohobation takes place. A boiling heat may be kept up in this way till every constituent of the soil, except the silica, becomes dissolved. Muriatic acid is generally preferred for the analysis of soils, and in somewhat greater quantity than the bases in the given weight of soil can neutralise. The funnel and porcelain basin should be properly supported upon the rings of a chemical stand. I generally subject 100 grains of soil to the action of boiling dilute acid in this way for 6 or 8 hours; at the end of that period I throw the contents of the matrass upon a filter, and supersaturate the filtered liquid with ammonia, The silica which remains on the filter having been washed in the process, is dried, ignited, and weighed.

The alumina, iron-oxide, and phosphate of lime, thrown down by the ammonia, being washed in the filter, and dried to a cheesy consistence, are removed with a bone or tortoise-shell blade into a silver basin, and digested with heat in a solution of pure potash, whereby the alumina is dissolved, when its alkaline solution is to be passed through a filter, then saturated with muriatic acid, and next supersaturated with ammonia. Pure white alumina falls, which is to be separated on a filter, washed, dried, ignited, and weighed.

The iron and phosphate of lime on the alkaline filter may be dried, gently ignited, and weighed, or otherwise directly separated from each other without that step, by the action of dilute alcohol, acidulated with sulphuric acid, at a gentle heat. Thus the iron oxide will be dissolved, and its solution may be passed through a filter, while the sulphate of lime will remain upon it, to be dried, ignited, and weighed. Five parts of it correspond to four of phosphate. The iron is obtained by precipitation with water of ammonia, filtration, and ignition.—*For phosphoric acid, see the sequel.*

The first filtered liquor, with excess of ammonia, contains the lime of the carbonate, and the magnesia. The former is separated by a solution of oxalate of ammonia, with digestion in a moderate warmth for a few hours, filtration, and very gentle ignition of the washed dry powder, when the pure carbonate of lime is obtained. The magnesia, existing in the filtered liquor as an ammonia-muriate, may be obtained by precipitation with soda, or phosphate of soda, as already described.

For some refractory soils, in which the alumina exists as a double or triple silicate, it becomes necessary to fuse 50 grains of the sample, in fine powder, mixed with four times its weight of dry carbonate of soda, the mixture being put into a platinum crucible, and into a cavity in its centre, 50 grains of hydrate of potash being laid.

The crucible being slowly raised to a red-white heat, affords a fused liquid quite homogeneous, of a grey or brown colour, according to the metals present in it. Manganese gives a purple tint; and iron a reddish brown. The fused matter should be poured out into a shallow platinum basin; and, whenever it cools, it should be pulverised, dissolved in dilute muriatic acid, the solution evaporated to dryness, the dry mass again digested in hot water, acidulated with muriatic acid, and the whole thrown upon a filter. Pure silica will remain on the filter, to be washed, dried, ignited, and weighed.

The filtered liquor contains the remaining constituents of the soil, and is to be treated as already described.

Besides these systematic investigations, researches may be made for certain peculiar substances, and especially the neutro-saline constituents. In this view 100 grains of the soil may be triturated with 20 times their weight of distilled water, placed in a beaker, till the clayey matter subsides, and the clear portion may then be decanted into a filter. A little of the filtered liquor should be tested with nitrate of barytes, and also with oxalate of ammonia; and if each portion yields a precipitate, they show the presence of sulphate of lime; and the following steps ought to be taken to eliminate it entirely: 200 grains of the soil should be triturated with a quart of distilled water, holding 50 grains of sal-ammoniac in solution. The mixture should be allowed to clarify itself by subsidence, when the supernatant clear liquor is to be filtered, and evaporated down to 2 ounce measures, and then mixed with that bulk of strong whiskey (11 per cent. overproof). The whole sulphate of lime will be now separated from the fluid, and after being drained on a filter, may be dried, ignited, and weighed.

For determining the alkaline salts, the water filtered from the 100 grains of the soil should be evaporated down to one-fifth of its bulk, and then treated—1st, with nitrate of barytes, for the sulphates; 2d, with nitrate of silver for the muriates; 3d, with oxalate of ammonia, for the nitrate or muriate of lime (provided no sulphate of lime is indicated by the first test); 4th, with litmus paper, for alkaline or acid reaction; 5th, with soda-chloride of platinum for potash salts, which are very valuable for the growth of many plants.

The portion of soil tested for potash salts should, before being digested in water, be gently calcined, to ensure the expulsion of every particle of ammoniacal salt, otherwise the precipitate afforded by soda-chloride of platinum would be fallacious.

Another peculiar research of great importance is that which determines the amount of ammonia in a soil; and which may exist either ready formed, or in its elements, capable of affording a portion of the azotic food so indispensable to vigorous vegetation. The actual ammonia is easily obtained by distilling the soil along with some milk of lime. The distilled water will contain all the volatile alkali, which may be measured by the number of drops of a standard dilute acid, which it will saturate.

The *potential* ammonia, slumbering, so to speak, in its embryo elements, may be estimated by igniting 200 grains of the soil with its own weight of a mixture of hydrate of soda and quicklime, as described in my memoir on "Guano," in this Supplement.

I have subjected the soil of Dr. Kerrison's farm to the various modes of research above enumerated, and have obtained the following results:—

1. By the application of my *limestone-meter* I obtained carbonic acid gas, equivalent to 9 grains of carbonate of lime.

2. By igniting 200 grains of the soil along with 200 grains of mixed quicklime and hydrate of soda, in the appropriate apparatus, I obtained 0·34 grains of ammonia, or 0·17 per cent. of the weight of the soil. Hence, 600 grains of the soil contain the azotic equivalent of one grain of ammonia. This remarkable fact reveals most plainly one secret source of the uninterrupted production of rich crops of cereals and other plants from it, without receiving any manure. How appropriate to such land is Virgil's beautiful title of the subject of his "Georgics," *justissima tellus!*

3. By the process of cohobation for 8 hours, with dilute muriatic acid, as also by the process of fusion with alkalis in a platinum crucible, and the subsequent treatment above detailed, I obtained—

1. Silica	56·0
2. Alumina	8·0
3. Oxide of iron	5·5
4. Carbonate of lime	9·0
5. Sub-phosphate of lime	0·4
6. Magnesia (carbonate)	0·5
7. Moisture separable by steam-heat	11·3
8. Organic matter, chiefly vegetable mould	6·6
9. Moisture separable at a red-heat	2·7
	100·0

besides traces of muriate of soda, and muriate of lime (chlorides of sodium and calcium). The iron exists mostly in the state of protoxide, a circumstance owing, probably, to exhalations from the subsoil of sulphuretted, phosphuretted, and carburetted hydrogen. The fresh soil is of a grey colour, but becomes ochrey-red by calcination.

100 grains of the said soil, dried at 212°, absorb 8 grains of moisture in 24 hours; while 100 grains of the comparatively sterile soil of Regent's Park, dried equally, absorb only 5 grains: a difference due chiefly to the finer comminution of the former.

Since the phosphates are such precious ingredients towards fertilising soils, it is desirable to possess a clear and simple test of their presence. For this purpose digest the soil, for an hour or so, with a moderate heat, in dilute nitric acid, free from muriatic (viz. which affords, when largely diluted, no precipitate, by the addition of a solution of nitrate of silver.) Throw the mixture on a filter, and to the filtered liquid add potash-water, cautiously, till the instant that a precipitate begins to appear; then drop into it a weak solution of nitrate of silver. If any phosphoric salts be present, a yellowish precipitate will immediately fall, which is re-soluble in an excess of nitric acid. Whatever is not thus dissolved is chloride of silver, and ought to be separated by filtration. On adding then weak water of potash (not ammonia) cautiously to the filtered liquid, the pure phosphate of silver will be obtained, without any alumina or iron, provided the liquid be still acidulous in a slight degree. It ought to be remembered that chloride of silver falls in a *white* curdy form, quite different from that of the phosphate of silver. The portion of soil used for this experiment should be fresh, and not calcined, because the *phosphates*, when ignited, afford white precipitates with salts of silver. The stronger the solution of the phosphoric saline compound is, the more characteristic is the yellow precipitate with silver; and then ammonia may be used for effecting the partial saturation of the acid excess. Sulphate of magnesia is an excellent re-agent for detecting phosphoric acid, and for separating it from the above acid solution, when it is partially neutralised with ammonia; for the magnesia forms, with the phosphoric acid and ammonia, the insoluble granular precipitate of ammonia-magnesian phosphate. A solution of sulphate of magnesia, containing a little sal-ammoniac, is probably the best test-liquor for detecting phosphates in faintly acidulous, but still better in neutral, solutions.

In almost all soils of an arable nature under cultivation in this country, there is a sufficiency of calcareous matter present to counteract the combination of phosphoric acid with alumina or oxide of iron, for which reason it would be an idle refinement of agricultural analysis to search for phosphates of alumina and iron. As for manganese, often associated with iron, it exists in too small a proportion, and is possessed of too little value, to make it worth while to effect its separation. It gives to calcined iron-oxide a black hue, and is characterised in its saline solutions by the flesh-coloured precipitate which it affords with hydro-sulphuret of ammonia, after the whole of the iron has been thrown down by boiling the solution of the two metals with pure carbonate of lime.

The organic matter in any soil may be correctly estimated by calcining its powder pretty strongly till the carbonic acid be expelled from the lime in it. The loss of weight, deducting that due to the carbonic acid gas (which is known from an independent experiment), gives the quantity of organic matter. Its quality is determined by the ultimate analysis by means of hydrate of soda and quicklime, as previously stated.

The phosphoric acid may be also estimated by digesting the ignited soil in nitric acid, precipitating the filtered solution with acetate of lead in excess. If phosphoric acid be present it will produce phosphate of lead, mixed with a sulphate, if any sulphuric acid existed in the soil. Wash, ignite, and weigh the precipitate. Digest in nitric acid, decompose the solution with sulphuric acid, add alcohol, throw the mixture upon a filter, and weigh the sulphate of lead remaining left upon it. From this weight, that of the oxide of lead becomes known; since 152 of sulphate of lead contain 112 of oxide. The quantity of sulphuric acid found by nitrate of barytes in another equal portion of the soil, being added to the oxide of lead just determined, will constitute a sum, which, being subtracted from the weight of the acetate of lead precipitate, will represent the amount of phosphoric acid in the soil.

In the very elaborate analyses of the ashes of different kinds of wheat, by Fresenius and Will in Germany, Bichon in Holland, Boussingault in France, and others, one half of the whole was found to be phosphoric acid.

In the preceding method of analysis the detection of potash is made directly by means of the soda-chloride of platinum. The following process is adapted to determine the quantity of that important alkali, as well as of soda. The solution of the soil in hydrochloric acid is to be treated with barytes water till the liquid blues reddened litmus paper; it is then heated and thrown upon a filter. By this means the whole of the sulphuric and phosphoric acids, as also of the oxide of iron, the magnesia and the lime that was combined with the phosphoric acid, is separated. The precipitate is to be washed till the water which passes ceases to be affected by nitrate of silver. To the clear liquor, gently heated, carbonate of ammonia mixed with caustic ammonia is to be added, to throw down all the barytes. The whole is to be left in repose for a little till a granular precipitate falls, and it is then to be thrown upon a filter and washed. The filtered liquor being evaporated to dryness, the residuum is to be ignited in a platinum or silver capsule, to expel all the ammonia, when it can contain only the alkaline metals, potassium and sodium, in the state of chlorides. After being weighed, it is to be dissolved in a very little water, when a trace of magnesia may appear (which can be eliminated and weighed); and the amount of potash is to be estimated from the weight of the precipitate produced by soda-chloride of platinum. The difference of the weight of the whole chloride and of that corresponding to the potash just found gives the quantity of sodium-chloride, and of course of soda in the soil.

TOBACCO. In confirmation of the justness of my remarks upon the equivocal nature of the fermentation test adduced by the Excise chemists, as to the presence of sugar in tobacco (*Supplement*, pp. 255, 256.), I have now the satisfaction of quoting the following experimental results obtained by Schlossberger and Döpping, in their recent elaborate dissertation upon yeast:—"Out of yeast, by which sugar may be decomposed, sugar itself may be easily formed. This fact ought, however, the less to surprise us, since Piria has described a fermentation whereby sugar is formed out of salicin with emulsin." *

It is also known to chemists, that in the fermentation of an infusion of bitter almonds, or of a solution of 10 parts of amygdaline and 1 part of synaptase, in 110 parts of water, a greater quantity of sugar (as indicated by the alcohol formed) is obtained, than what the elements can produce.—See *Liebig's Chimie Organique*, I. 276.

ZINC PURIFYING, may be effected by melting the impure metal with lead in equal parts in a deep iron pot, stirring them well together, skimming off the impurities as they rise, covering the surface with charcoal to prevent oxidation, and keeping them in a fused state for three hours. The lead descends to the bottom by its greater density, and leaves the zinc above, to be drawn off by a pipe in the side of the melting-pot. This contrivance is the subject of a patent granted to Mr. William Godfrey Kneller in 1844.

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* "Es zeigt sich also hier das Paradox erscheinende Resultat, dass *aus der Hefe*, die den Zucker zersetzt, leicht *selbst Zucker gebildet werden kann*. Doch darf dieses weniger auffallen, seit Piria eine Gährung beschrieben hat, wobei Zucker gebildet wird aus Salicin mit Emulsin."—*Annalen der Chemie und der Pharmacie*, von Wöhler und Liebig, L. I. 208.

THE END.

London:
Printed by A. Spottiswoode,
New-Street-Square.