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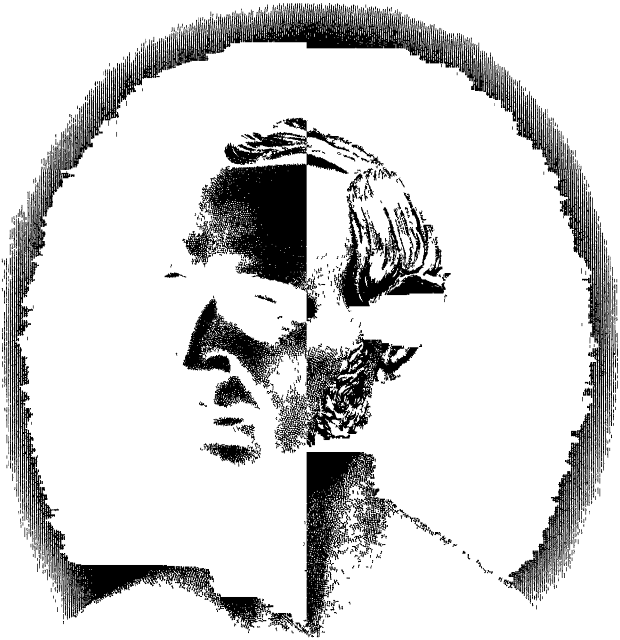

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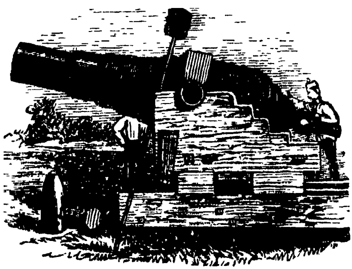

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CONTENTS.

SIR WILLIAM G. ARMSTRONG, C.B., LL.D., F.R.S.

(*With a Portrait.*)

NEARLY a quarter of a century ago, at Sedgwick, near Newcastle-upon-Tyne, one day there stood a thoughtful student watching the escape of steam from a locomotive safety-valve. Hundreds of persons may have witnessed the same effect with weak curiosity bordering upon indifference: they may have been startled by the blatant rush of the steam, and then thought no more of the subject. Not so, however, was it with the more attentive observer at Sedgwick, who, with a mind prepared by previous study, remarked in this occurrence a very extraordinary electrical phenomenon: he saw that whenever the engine man presented one hand to the lever of the valve, while the other was exposed to the steam, a brilliant spark appeared, "giving us the evolution of electricity during the conversion of water into vapour, which, upon an enormous scale, brings us much nearer to electric phenomena of volcanoes, water-spouts, and thunder-storms, than before."*

The patient observer at Sedgwick was William George Armstrong, who was then seeking relief from ungenial studies by devoting all his leisure to the pursuit of natural science. He belonged to a class of men who garner up knowledge as recreation; and he is described as then possessing an intellect persistent and clear enough to launch him into independent inquiry as soon as he should have attained the broad road of general scientific attainments. It was not long, therefore, before he commenced an original investigation of the subject of electricity. A series of elaborate experiments resulted in the production of the well-known Hydro-electric Machine, still the most powerful means of developing frictional electricity yet devised. For these successful labours, he was elected, at an unusually early age, a Fellow of the Royal Society.

We have commenced our sketch of the career of Sir William Armstrong with the above striking incident on account of its importance in confirming a choice of pursuit which had been followed more as a diversion than with settled purpose. William George Armstrong is the son of an alderman of Newcastle, and a leading merchant, who married the daughter of Mr. William Potter, of Walbottle Hall, in the same county. The son was born Nov. 26, 1810, at Newcastle-upon-Tyne—the birth-place of many a great engineer, and the scene of vast engineering triumphs. From childhood, young Armstrong is said to have shown mechanical tastes. Circumstances, however, fixed him to the profession of the law: accordingly, early in life he came up to London to read with his brother-in-law, Baron Watson, then a special pleader in the Temple. It is somewhat remarkable that the future judge, after fighting as cornet of dragoons in the Peninsula, had deserted arms for the law—"cedant arma togæ." His pupil, on the other hand,

* Faraday.

was destined to restore the balance, and change law for arms, beginning with the recreative studies we have already indicated.

Armstrong's intuitive bent for observation is shown in an incident of 1835, when, during an excursion into the wilder districts of Yorkshire, his attention was attracted by a mountain torrent, which, after fruitlessly falling from a great height, exhausted the remnant of its force in turning a water-wheel at its bottom. This was, indeed, finding "books in the running brooks." It at once occurred to him that if the stream were conveyed from the summit in a pipe, and caused to act by pressure at the base, the whole fall, instead of a twentieth part of it, would be made available. The idea thus caught took deep root in his mind, and the result was the great series of hydraulic machinery used in docks, &c., working cranes, and other purposes, by which the fame of Armstrong has long been known.

In 1845 was started the project of supplying Newcastle with water from Whittle Dean: Mr. Armstrong was its chief supporter, and acted as solicitor to the company. His practical knowledge of hydraulics gave him great influence in the undertaking. He now brought forward his long-cherished scheme of applying water-pressure to mechanical purposes. He had by this time invented his hydraulic crane, and exhibited a model of it to the Literary and Philosophical Society of his native town, where it was determined to test the invention upon the quay, using the pressure in the Whittle Dean Company's pipes as the motive power. The success was decisive. He now gave up the law, and turned mechanical engineer. Associating himself with some old friends, he established the now famous Elswick Engine Works; and was shortly afterwards confirmed in his new profession by being elected a member of the Institution of Civil Engineers.

For the next five years Mr. Armstrong was devoted to the development of his great invention. First he added to hydraulic machinery its most important feature, by which an accumulation or artificial head is substituted for the natural head of water gained by mere altitude. By this means the application of water-pressure is rendered practicable in every locality, and it has thus been extended to a marvellous variety of purposes. In all the national dockyards and arsenals, in nearly all our commercial docks, in railway stations, and even in the recesses of mines, this power may now be found working with a degree of safety, precision, and energy, unequalled by any other motive agency employed by man. An immense diversity of mechanical combinations has been required to render it competent for its multifarious duties. Cranes and hoists of every kind; machines for opening and closing ponderous dock-gates and huge swing-bridges, by the mere touch of a finger; capstans, turn-tables, wagon-lifts, machines for crushing ore, pumping water, shipping coals, hauling trucks, docking vessels, opening sluice-gates, and for a host of other purposes; have been contrived and brought into operation by Mr. Armstrong. In several of our great commercial docks the length of pressure-pipe amounts to several miles, and hundreds of hydraulic cranes and other machines are connected with it, all supplied from one steam-engine, which quietly pumps water into an accumulation, and suffers no disturbance from the fitful manner in which the water is drawn off. These great works, it will be remembered, germinated by the side of the stream and old-fashioned water-wheel in the mountainous wilds of Yorkshire.

In November, 1854, the battle of Inkermann was fought; and it will be recollected that the turn of the battle against the Russians was chiefly owing to the fire of two 18-pounder guns, weighing two tons each, and which by an almost superhuman effort were at a late hour brought into the field, and by their superior range crushed the Russian fire. Mr. Armstrong, on hearing of this incident, and the difficulty of bringing such heavy guns into action, bethought him whether equal range might not be obtained with lighter guns. He saw that if rifling were effective in small arms, it could not fail to be equally so in cannon; he saw, also, that if wrought-iron were employed instead of cast-iron in the manufacture of ordnance, a great reduction of weight could be effected. He at once prepared a design, which he submitted to the Duke of Newcastle, then Minister for War. His Grace thereupon gave Armstrong an order for six guns, the first of which was commenced in December, 1854, and finished in April, 1855. Although the gun was thus early finished, Armstrong kept it from the Government and the public, and commenced with it a course of experiments extending over three years; not until the close of which was the gun adopted by the Government. "But for the indomitable perseverance of Armstrong throughout this period (says the contributor of a memoir to the *Illustrated London News*) we should certainly never have bridged the enormous distance between this first 5-pounder and the last 600-pounder Armstrong guns. The principle of the construction of these guns is of simple origin. Armstrong's experiments on the strength of different tubes for guns showed that one formed, as in the fowling-piece, by twisting a long bar into a spiral, and then welding it into a continuous cylinder, was best and strongest of all. It was, however, impossible to make entire guns in one thickness upon this principle; he therefore surrounded the inner tube by a second one; that again by a third, and so on until the necessary thickness was built up. With this exterior construction he combined a steel barrel, and by this means he seems to have accomplished his design of producing ordnance that should combine the maximum of strength with the minimum of weight." Such are the constructive details of the first Armstrong gun. Although the patronymic, "strong in the arm," carries us back to the time of the bow, the weapon of centuries later will be not a whit less understood or appreciated on account of the anachronism of the name.

On the 30th of August, 1858, General Peel, then Secretary of State for War, appointed the Rifled Cannon Committee, with instructions to ascertain as speedily as possible, the best form of rifled guns for field service then known to the War Department. In his evidence before the committee of the House of Commons, General Peel assigns the following as the reasons which led him to take this course:—

"Before the Report was laid before me I had received what I must say, under the circumstances, appeared an exaggerated account of the results of the trials made at Woolwich with reference to this gun. The Indian Government, not waiting for the report of the committee, but in consequence of a report which Lord Stanley had received direct from a very distinguished officer of the Indian Artillery, Colonel Willoughby, had applied to the Government for a battery of guns. A very distinguished officer, General Brereton, who was then on a committee appointed to decide about shrapnell shells, came to me and stated that from the circumstance of his being at an adjacent butt he had seen the practice with the gun in question, and I think he told me there was nothing in the *Arabian Nights* half so wonderful as this new gun. The Commander-in-Chief came back with an account of the gun almost equally strong, and I believe the words of his Royal Highness were, that it could do anything but speak. On receiving the report of Colonel Lefroy I adopted the recommendation in that report, and appointed a special committee, in order that they might report to me what was the best rifled gun."—First Rep., p. 111.

General Peel's Rifled Cannon Committee reported Nov. 16, 1858, and recommended "the immediate introduction of guns rifled on Mr. Armstrong's principle for special service in the field" (First Report, p. 167). This Committee has been charged before the Ordnance Committee of the House of Commons with unfairness and with undue haste in arriving at its decision; but, after the most searching investigation, these serious charges have been completely rebutted, as appears from the following passage in the Committee's Report, 1863 —

"The range and precision of the gun were so vastly superior to all field ordnance known at that time that, after careful and repeated trials, the committee appointed to investigate the question recommended its adoption as the field gun of the service. Your committee are of opinion that the adoption of the Armstrong gun by the Secretary of State for War for special service in the field was fully justified."—(Rep. p. iv.)

About this time was formed the Elswick Company, near Newcastle, whose extensive works we shall presently describe.

According to the published Evidence, towards the close of 1848, the Government appear to have hesitated as to the expediency of the extent of the order for the supply of a large number of guns, which should be confined to 32-pounders; adding that the construction of heavy guns should be deferred till they had been more tested. This opinion, however, it would appear, came too late to prevent very large outlay; for General Peel, then War Secretary, is known to have repeatedly said that, in case of dispute, the Government must have made full compensation to the inventor, who, however, did not avail himself of this claim, but on January 15, 1859, assigned his interest in all patents for, and improvements in, the manufacture of ordnance; he, at the same time, refusing all remuneration. In return for this liberality Mr. Armstrong received the honour of knighthood, and was made a C.B.; and as it was found necessary to obtain his services in manufacturing the guns, and developing his system generally, Sir William Armstrong was forthwith appointed to the new office of Engineer of Rifled Ordnance, at the Royal Gun Factory. By his own desire, the duration of this appointment was limited; and in February last year, 1863, Sir W. Armstrong resigned the appointment in order to return to his old manufacturing establishment, which at that time stood in peculiar need of his services.

The Armstrong system of artillery having been introduced and greatly extended both in the land and sea service, and having encountered strong opposition from various quarters, a Committee of the House of Commons, termed the Select Committee on Ordnance, was appointed, June 20, 1862, "to inquire into the expenditure incurred since the beginning of 1858 on various natures of improved ordnance, whether obtained by contract or manufactured in the public departments, and into the results obtained by such expenditure." This committee having been reappointed February 20, 1863, and having sat through two sessions, concluded its labours July 23, 1863. An immense mass of evidence has been collected and published in their two Reports.

The country (says the writer of the able articles in the *Times* on these Reports) has great reason for satisfaction that such a committee should have been appointed, for it is certain that through its instrumentality the Armstrong system has been subjected to the severest conceivable ordeal. Every possible objection has been urged against it, and that before a tribunal of which the majority was assuredly not prepossessed in its favour. While all the avowed enemies of the system were called upon to give evidence, it is somewhat surprising, however, that artillery officers who have had the largest experience of the working of this gun, both at Shoeburyness and in actual service in China, should not have been invited to attend. Thus, Colonel Taylor, commandant and superintendent of the school of gunnery at Shoeburyness, and his able assistant, Captain Alderson, might have given most valuable, and, to the public, most acceptable testimony, for at Shoeburyness alone 37,000 rounds have been fired from Armstrong guns. (2nd Rep. p. 161.) The same may be also remarked of the artillery officers who served in China, not one of whom was summoned as a witness.

The Armstrong Gun has been more than once fully described in our *Year-Book;* but it will be interesting here to recapitulate the details. The Armstrong field gun—the term "field gun" being applied to guns not exceeding a 12-pounder—is a rifle breech-loader made of wrought-iron, and essentially differs from all guns previously invented, both in the nature of the rifling and in general construction. The rifling consists of a series of shallow spiral grooves extending over the whole internal surface of the barrel in front of the shot chamber; and the projectile is a cylinder of hard metal coated with lead, about twice the length of its diameter, flat-ended posteriorly and rounded off anteriorly. The shot enters easily at the breech, but cannot proceed beyond the commencement of the rifling, except by the yielding of the coat of lead, under the propelling force of the powder. The lead thus readily adapts itself to the grooves, and, as these are spiral, rotatory motion is necessarily communicated to the shot. By this simple expedient the shot is, as it were, surrounded with a tight packing, which effectually prevents windage, and therefore tends to render available the whole explosive force of the powder. The breech is closed with a movable ventpiece, which is firmly secured by a powerful and easily adjusted screw.

The Gun is constructed on what is termed the coil system, and is formed of a series of coiled tubes shrunk over each other. But let us hear Sir William Armstrong's own description of his original Gun, as he communicated it to the Ordnance Committee.—

"It was a gun with a steel tube, surrounded with coiled cylinders, similar in every respect to the tubes of gun barrels. Now, the peculiarity of that gun was not its being merely a built-up gun, because built-up guns are of very ancient date. In fact, I have no doubt that the original construction of all guns was by building up. It was not merely a hooped gun—that is to say, a gun strengthened by rings, because rings give only circumferential strength, and no longitudinal strength—but that gun was peculiar in being mainly composed of tubes, or pipes, or cylinders, formed by coiling spirally long bars of iron into tubes, and welding them upon the edges, as is done in gun-barrels. Now, whether any one had conceived that idea before is beyond my power to say, but I feel assured that no gun up to that time had been actually made upon that principle. The whole difficulty lay in the making. It is very easy now, with all our knowledge and experience, to define how such coils are to be made, but at that period it was a very difficult matter to accomplish, and it was not until I had made very many unsuccessful attempts that I succeeded in satisfactorily carrying it out."—2nd Rep. p. 133.

The general mode of construction of the Armstrong gun is applicable to all guns, whether rifled or smooth-bore, breech-loaders or muzzle-loaders; and accordingly, in several guns differing much from each other, this mode of construction has been adopted. Hence, no small confusion has arisen in the public mind with respect to the meaning of the term Armstrong Gun; and it is therefore necessary to distinguish carefully between general construction and special modifications.

The projectile peculiar to the Armstrong Gun, and designated the Segment Shell, is confessedly one of the most ingenious and important elements of the Armstrong system of artillery. It consists essentially of a large number of segmental pieces of cast-iron, arranged like bricks in a wall, and solidly compacted together by means of lead, a central cavity being left to receive the bursting charge of powder. The charge is ignited by means of fuzes, which are made to explode on striking an object, or, if desired, before impact. There are thus two kinds of fuzes, termed the percussion fuze and the time fuze, and particular varieties of each. It is not possible to render their construction intelligible by mere verbal description. Of its destructiveness, the committee sum up the evidence which they procured on this subject in the following decisive language:—

"The testimony as to the Armstrong shell has been universally favourable; it is described as the most destructive weapon ever used against wooden ships, and most formidable in its effects and range."—Rep. viii.

During his tenure of office, Sir William Armstrong laboured unceasingly in perfecting his great invention; and some idea of his toils may be formed by reference to the analogous labour of substituting rifled for smooth-bore small arms.

It is well known that this latter work has lasted for years, has involved immense waste, and is still unfinished. For instance, the authorities have had to deal with weapons of but one size and calibre, and carrying one sort of projectile. On the other hand, Sir W. Armstrong had to manufacture guns of all natures and sizes, from 6-pounder to the 600-pounder, and suited for land and sea. He has had to supply these guns with all systems of shot, shell, and fuzes; and has, besides, grappled with difficulties of a novel manufacture and of monster ordnance; nevertheless, 3000 of his guns have been introduced into the service; and "of these 3000," says the House of Commons Committee, in their recent Report, "not one has burst explosively;" nor have they had "any practical evidence before them, even at this moment, that any other method of constructing rifles exists which can be compared to that of Sir W. Armstrong."

The long and searching account of the Parliamentary Reports which has appeared in the *Times*, concludes thus emphatically:—

"We have now presented what we believe to be a fair *résumé* of the evidence contained in the Reports of the Committee on Ordnance concerning the larger Armstrong service guns, and that evidence seems to prove,

"1. That the larger Armstrong guns, up to the 40-pounder inclusive, are in all respects satisfactory.

"2. That the 110-pounder is approved by all naval authorities of the largest experience and of the highest eminence as a service gun for issue in the proportion in which it has been introduced into the Navy.

"3. That, in the words of the Duke of Somerset, out of 'a total of 635 110-pounders' issued and in store, 'we have not one too many.'"

The public will receive with great satisfaction the assurance of Field-Marshal the Duke of Cambridge, Commander-in-Chief, that in rifled ordnance we are ahead of all other nations; and Colonel Bingham, Deputy Adjutant-General of Artillery, adds that the officers of artillery, who must be the most competent judges on this subject, entertain the same opinion as his Royal Highness.

We insert extracts to this effect from the evidence of both these authorities:—

"1251. With respect to any foreign system of ordnance, would your Royal Highness consider that our ordnance would bear a favourable comparison with that of any other army?—My conviction is that we are ahead of any other country."—2d Rep., p. 53.

"524. Colonel Dunne.—From your knowledge of the reports received from artillery officers of all classes, what is their opinion of the Armstrong gun, as compared with any other gun?—The general opinion is that the Armstrong field gun is the best rifled gun that there is anywhere in England or abroad."—Colonel Bingham, *ibid.* p. 20.

Gunnery, however, was not the first occupation of Sir W. Armstrong, nor is it likely to be his last. As a scientific man interested in many branches of knowledge, he appeared with great advantage as President of the British Association, at their late meeting at Newcastle, a position which he owed, not to the reputation of the Armstrong Gun, but to his place, on entirely independent grounds, in the world of science. His inaugural Address was received with much cordiality, nay enthusiasm, in this birthplace of engineers. "Gentlemen of the British Association," said Sir William, "I esteem it the greatest honour of my life that I am called upon to assume the office of your President. In that capacity, and as representing your body, I may be allowed to advert to the gratifying reception which the British Association met with on their former visit to this region of mining and manufacturing industry, and, as a member of the community which you have again honoured with a visit, I undertake to convey to you the assurance of a renewed and hearty welcome. A quarter of a century has elapsed since the Association assembled in this town, and in no former period of equal duration has so great a progress been made in physical knowledge. In mechanical science, and especially in those branches of it which are concerned in the application of steam-power to effect interchange between distant communities, the progress made since 1838 has no parallel in history. The railway system was then in its infancy, and the great problem of trans-Atlantic steam navigation had only received its complete solution in the preceding year. Since that time, railways have extended to every continent, and steamships have covered the ocean. These reflections claim our attention on this occasion, because the locality in which we hold our present meeting is the birthplace of railways, and because the coal mines of this district have contributed more largely than any others to supply the motive power by which steam communication by land and water has been established on so gigantic a scale. . . . Thus, the railway system, like all large inventions, has risen to its present importance by a series of steps; and so gradual has been its progress, that Europe finds itself committed to a gauge fortuitously determined by the distance between the wheels of the carts for which wooden rails were originally laid down. Last of all came the locomotive engine, that crowning achievement of mechanical science, which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance."

The great subject of our Coal resources, a salient point of Sir William's Address, will be found noticed elsewhere in the present volume. As examples of his Summary of the Science of the previous year, and his treatment of other topics of the Address, we quote the following passages :—

"In the course of the preceding observations I have had occasion to speak of the sun as the great source of motive power on our earth, and I must not omit to refer to recent discoveries connected with that most glorious body. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are enabled to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. I have still to advert to Mr. Nasmyth's remarkable discovery that the bright surface of the sun is composed of an aggregation of apparently solid forms, shaped like willow leaves or some well-known forms of Diatomaceæ, and interlacing one another in every direction. The forms are so regular in size and shape, as to have led to a suggestion from one of our profoundest philosophers of their being organisms, possibly even partaking of the nature of life, but at all events closely connected with the heating and vivifying influences of the sun. These mysterious objects, which, since Mr. Nasmyth discovered them, have been seen by other observers as well, are computed to be each not less than 1000 miles in length and about 100 miles in breadth. The enormous chasms in the sun's photosphere, to which we apply the diminutive term 'spots,' exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss. Sometimes they form a sort of rope or bridge across the chasm, and appear to adhere to one another by lateral attraction. I can imagine nothing more deserving of the scrutiny of observers than these extraordinary forms. The sympathy also which appears to exist between forces operating in the sun, and magnetic forces belonging to the earth, merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has with so much ability and effect devoted to the elucidation of the subject. I may here notice that most remarkable phenomenon which was seen by independent observers at two different places on the 1st of September, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face. This was attended with magnetic disturbances of unusual intensity and with exhibitions of auroræ of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before and continued after the event.

* * * * * *

"Few sciences have more practical value than meteorology, and there are few of which we as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but such as they are, they have been employed with considerable effect by Admiral FitzRoy in warning mariners of the probable approach of storms. We may hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may, perhaps, in some degree, assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations, that the decrease of temperature with elevation does not follow the law previously assumed, of 1° in 300 feet, and that, in fact, it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when clouds exist in a double layer. Rain-drops, he has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger."

We shall next quote Sir W. Armstrong's remarks upon the science with which his name is so proudly associated. "Gunnery" (said Sir William), "to which I shall make but slight allusion on this occasion, is intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck in the proportion to the work done or damage inflicted upon each. These considerations recently led me, in conjunction with my friend Captain Noble, to determine experimentally, by the heat elicited in the shot, the loss of effect due to its crushing when fired against iron plates. Joule's law, and the known velocity of the shot, enabled us to compute the number of dynamical units of heat representing the whole mechanical power in the projectile, and, by ascertaining the number of units developed in it by impact, we arrived at the power which took effect upon the shot instead of the plate. These experiments showed an enormous absorption of power to be caused by the yielding nature of the materials of which projectiles are usually formed."

Experiments are still required to clear up several apparently anomalous effects in gunnery, and to determine the conditions most conducive to efficiency both as regards attack and defence. It is gratifying to see our Government acting in accordance with the enlightened principles of the age by carrying on scientific experiments to arrive at knowledge, which, in the arts of war as well as in those of peace, is proverbially recognised as the true source of human power.

Foremost among the sights of Newcastle is the magnificent series of workshops and factories which compose the Ordnance Works at Elswick. "To speak of this series of factories—the casting, welding, fitting, rifling, and shell-making departments—as the property of one private individual seems almost ridiculous, for the magnitude and extent of these buildings, their immense development, and perfect organization, make them rather resemble a great national arsenal than a mere commercial adventure of a few individuals. Some of the boring and rifling tools used here are the largest and most perfect specimens of their kind ever made—they may, in fact, be said to be almost automatic in the power and intelligence with which they perform their task when once they are set in motion. Everything throughout the long series of factories is on the same perfect and extensive scale ; and some idea of the extent of the concern may be gained from the fact that the new plant alone has cost upwards of 200,000*l*., and that recently, when in full work in gun-making, 3700 skilled artisans were employed here. The Government having completed their full complement of field guns from Sir William's factory, have for the present stopped the manufacture of the large breech-loaders, such as the 70 and 110-pounders, until such time as Mr. Whitworth will consent to submit his guns to the long-talked-of competitive trial against Sir William. In the meantime, Elswick remains idle and useless to the country, for whose benefit alone will Sir William let it work ; for we believe there is not a single Government in Europe that has not applied either directly or indirectly for guns to Sir William Armstrong, but always applied in vain. A number of the new guns which Sir William has completed are now shown at Elswick, in which the difficulties of the breech-piece are, it is believed, entirely overcome. This is a side-loader, in which the breech is composed of massive wedges, working in grooves, which prevent their getting out of place or order, and in which, from the solidity of the wedge-pieces themselves, no crack or yield is likely to occur. As a matter of course all parts of the factory at Elswick abound in beautiful examples of hydraulic machinery, by means of which all the heavy work of lifting and moving large masses about is performed through the agency of a boy who starts or stops the hydraulic cranes."*

At Elswick was manufactured for the War Department, the 600-pounder gun, the details of which will be found in page 17.

During the past year, comparisons have been made between the Ordnance used by the Americans and that employed by ourselves. Both Federals and Confederates have far bigger guns, both afloat and ashore, than we have brought into use, but it is not yet established that the biggest guns are the best. It is beyond doubt that Charleston was shelled at five miles' distance—that is to say, a few shells from the batteries did actually fall into the town. But it is evident that the bombardment was altogether ineffective, and a Correspondent of the *Times* in the Southern States has related a report that after the first three or four rounds the projectiles all fell short, owing to the damage suffered by the guns. "This drawback being provided for by increased expenditure of cannon as well as cartridges, it is not at all certain that the Americans are ahead of us. We have evidence, in September last, that our 110-pounder Armstrongs could make excellent practice, and without bursting, at a range quite as long as that from which Fort Sumter was bombarded. The smaller Armstrongs had thrown their bolts more than twice that distance with a given elevation, so that the larger pieces might be expected to do at least as much as any American gun at Charleston. From this it follows that the range of our artillery is fully as great as that of the American artillery, and if the calibre of our pieces is lighter, their strength is far more to be depended upon. With respect to naval experience, the armour of the American ships is not regarded in this country as fit for the experimental target—the *Tecumseh*, which was launched last autumn at Jersey City, is protected only by five wrought-iron plates each one inch thick. We know that such plating is worthless, and that our artillerists would hardly be at the trouble of trying a gun against it. The Armstrong 110-pounder has smashed twelve such plates in a mass, and the old 68-pounder would do as much with equal ease."

The prefixed portrait has been engraved from a bust, the only one for which Sir William Armstrong has given a sitting. It is the work of Mr. Alexander Munro, and was in the International Exhibition of 1862. The bust is full of character and literal resemblance; but, we agree with a contemporary, that "the deeper and better part of the likeness consists in the expression of thoughtful intelligence in the eyes and brow, and in the characteristically bland and almost animate smile which plays about the mouth, yet without any loss of firmness in the chin and jaw;" while the firmness and manliness of execution stamp this as a first-rate work of art. It has been sculptured in marble for the Literary and Philosophical Society of Newcastle, and is placed there in the library, built by Sir William Armstrong, and generously presented by him to his fellow-townsmen.

* *Times* Report.

THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

THE ARMSTRONG GUN "BIG WILL."

(*See the Vignette.*)

THE smashing powers of Sir William Armstrong's 600-pounder shunt gun were tested on December 11, at Shoeburyness against the Warrior floating target.

The target is an exact counterpart of a section of the *Warrior's* side, and measures 18 ft. long by 10 ft. in height. It is constructed of iron plates of the best homogeneous metal 4½ in. thick, bolted to a backing of teak 18 in. in depth. Behind this come two sets of ¾ in. plates riveted to massive ribs of T iron, the whole being shored up by slanting beams of fir of immense thickness. The target was moored at 1000 yards distance from the firing points of the 600 and 300-pounder Armstrongs, and wooden targets for ascertaining the correct elevation for this range floated close by, a little clear of the iron one.

The first shot from "Big Will" was a dummy cast-iron shell weighing 600 lb., and was levelled with such unerring aim at the wooden target as to smash it literally to powder. The elevation of the piece in this instance was 2 deg. 5 min., and the charge 70 lb. The next shot was a steel shell with a cast-iron head weighing 610 lb., and containing no less than 24 lb. of powder, which is no less than four-fifths of its normal charge. After some discussion the gun was fired at 2 deg. 10 min. elevation, the shell passing just over the top of the target a little to the right of the central line. The next two shots—live steel shells similar in all respects to No. 2—demonstrated in a most surprising way the wonderful accuracy of the gun in obeying the slightest change in elevation. For shot No. 3 the piece was depressed to 2 deg. 3 min., the shell passing through the exact centre of the top of the target, and carrying away a piece of the wood framing, of a semicircular shape. The fourth shot was fired at only 3 minutes less elevation, and struck the target as near the centre as possible, making daylight through it, and exploding at the very moment of impact. The havoc made was found to have surpassed all expectation. A hole 2 ft. by 20 in. yawned in the 4½-in. plate, level with and a few inches on the left of the bull's-eye. The teak backing was splintered into fragments from the size of a cocoa nut to the merest fibre, and the ¾-in. plates and one of the ribs were completely torn away like so much paper. In front, below the hole, there lay a huge mass of iron plate, weighing three or four hundredweight, and looking like a piece of crumpled black rag. The plate above the one which was pierced was started from its place and bulged outward, nearly the whole of the bolts holding it to the target being broken away. In fact, all present allowed that since the great battle of gun *versus* plate had begun to be waged, there had never been such a complete triumph for the former combatant. In the mischief done, everything betokened a great excess of power; there is consequently every certainty of the effect being almost equally great at 2000 yards, as the velocity of the shot at that distance is only diminished by about 120 feet per minute.—*Abridged from the Times.**

The following Table of practice will give an idea of the accuracy of the 600-pounder shell. With the 60 lb. of powder, of course the range is much less than with 70 lb., and the weight of the shell fired with that charge was 90 lb. heavier than the solid shot. During the last few shots it was getting dark.

Round.	Charge.	Elevation.	Projectile.	Range.	Lateral Deviation.
1	70 lb.	1 deg.	510 lb solid shot.	748	1 yard left.
2	"	"	"	785	1·5 yard left.
3	"	"	"	789	On line of fire.
4	"	2 deg.	"	1160	12·5 yards left.
5	"	"	"	1148	1 5 yard left.
6	"	"	"	1184	On line of fire.
7	"	5 deg.	"	2400	4 yards right.
8	"	"	"	2338	2·5 yards left.
9	"	"	"	2308	On line of fire.
10	"	10 deg.	"	4080	2 yards right.
11	"	"	"	4176	On line of fire.
12	"	"	"	4187	4 yards left.
13	60 lb.	"	600 lb. hollow shell.	1880	2 yards left.
14	"	"	"	1898	33 5 yards left.
15	"	"	"	Not taken.	
16	"	"	"	Not taken.	

PARSONS'S NEW GUN.

THE Ordnance Select Committee have witnessed several experiments with the 6-pounder breech-loading rifled gun invented by Mr. Parsons. 100 rounds were fired within fifty-two minutes, which included some delay which took place in consequence of not being provided with a sufficient quantity of the proper description of ammunition. At the termination of the firing the weapon was found to be so hot that a hand could not be placed upon it. The breech was found to act with perfect freedom, and the gun to be perfectly gas-tight. Mr. Parsons maintains that his system is peculiarly adapted for guns of large calibre, as the sphere, which

* Excellent sketches of the gun and target will be found in the *Illustrated London News*, Nos. 1238 and 1240.

serves instead of a ventpiece, can be made of any size and strength, and it has not to be lifted out of its place in the operation of loading. The slot which is necessary in the Armstrong gun is also dispensed with.

NEW "GUN METAL."

THIS alloy is the invention of Baron de Rosthorn, of Vienna. Guns have hitherto been made either of wrought-iron, cast-iron, gun-metal, or steel, the last having been only recently introduced. Wrought-iron was very early employed, and afterwards abandoned; but it has again been brought into use by Mr. Clay, who forged the great Horsfall gun, and by Sir William Armstrong. Mr. Whitworth has applied with success a variety of iron intermediate between wrought-iron and common steel, now known as "homogeneous metal;" it is not a recent invention, as was proved in the *Times* of August 13, 1862. This metal has undergone the process of complete fusion, and is therefore free from the slag which is always disseminated to a greater or less extent through wrought-iron, causing unsoundness of weld, however carefully it may have been worked. Gun-metal or bronze is copper alloyed with about 10 per cent. of tin; and guns formed of it are usually, but erroneously, termed brass, instead of bronze, guns.

The alloy now proposed to be employed, partially or wholly, as a material for guns, is designated sterro-metal, from the Greek word signifying "firm." It consists of copper and spelter, with small proportions of iron and tin, and to these latter its peculiar properties are attributed. It has a brass yellow colour, is close in grain, is free from porosity, and has considerable hardness, whereby it is well adapted for bearing-metal, or other purposes where resistance to friction is needed. It is susceptible of a fine polish. For this reason, and on account of its compact structure, it is stated to be now exclusively used by Vienna engineers for the pumps of hydraulic presses. The mechanical properties of the alloy have been carefully examined at the Polytechnic Institution, Vienna, in the presence of competent observers.

The specimens of metal operated on in the preceding experiments were analysed at the Austrian Mint. The results are as under:—

	Polytechnic Metal.	Arsenal Metal.
Copper	55·04	57·63
Spelter	42·36	40·22
Iron	1·77	1·86
Tin	0·83	0·15
	100·00	99·86

Experience has shown that the proportion of spelter may vary from 38 to 42 per cent. without materially affecting the quality of the alloy. The difference in the amount of tin in these analyses is considerable, and greater than might have been expected.

The specific gravity of the forged metal is 8·37, and that of the same metal drawn cold into wire 8·40. The hardness of the cast metal is stated somewhat to exceed that of ordinary gun-metal, and to increase by forging. The great tensile strength of sterro-metal, as compared with gun-metal, is remarkable. Mr. Anderson gives only 17 tons as the average tensile strength of the best specimens of gun-metal tested at the Arsenal, Woolwich. Aluminium bronze, composed of nine parts by weight of copper and one of aluminium, was found by the same careful and trustworthy observer to have a tensile strength of about 48 tons: but two other specimens, which were not quite sound, had only a mean tensile strength of about 22½ tons. Mr. Anderson gives about 26 tons as the average tenacity of wrought-iron in bar, such as is employed at Woolwich in the manufacture of the Armstrong gun, and about 95 tons as the average tenacity of the strongest kinds of steel which have withstood the Woolwich proof rounds. There are, however, kinds of steel very much stronger, but they have failed to resist these proofs.

But sterro-metal possesses another quality, which, in reference to its application for guns, is regarded as more important than its high tenacity—namely, great elasticity. It is not permanently elongated until stretched beyond 1-600th of its length; but within that limit it is perfectly elastic, and recovers its original form after the stretching force is withdrawn. Gun-metal is permanently elongated when stretched beyond 1-1590th of its length, and wrought-iron beyond about 1-1500th of its length. It is computed that a tube, of which the radius of the bore is 4·719 centimetres (about 1¾ in.), and the external radius 11·524 centimetres (about 4½ in.), will, if made of metal having for its limit of elasticity 1 in 1500, resist a pressure equal to 267 atmospheres, and that a similar tube of forged sterro-metal will resist a pressure equal to 763 atmospheres.

The inventor proposes that in heavy ordnance the interior should consist of a tube of sterro-metal, and that over this wrought or cast-iron should be shrunk from the breech to beyond the trunnions. Sterro-metal, it should be stated, is from 35 to 40 per cent. cheaper than gun-metal. Field guns from 4 to 12-pounders have been made of single pieces of metal worked by the action of an hydraulic press, whereby expensive forging is avoided; and reliable experiments have demonstrated that the metal thus treated has precisely the same properties and the same tensile strength as bars of it drawn out under the steam hammer.

Nothing short of repeated and searching trials with gunpowder on the large scale will suffice to establish the suitableness of sterro-metal for ordnance. It remains to be seen whether the tremendous concussions occasioned by firing will not seriously injure this new alloy, and whether the surface of a metal containing so large a proportion of spelter will not be sensibly corroded. Should, however, experience decide in favour of this alloy, we shall have another striking example of the influence of a small amount of one metal in greatly modifying the properties of a large mass of another metal, or metallic alloy.—*Abridged from the Times.*

GREEK FIRE.

We have heard much of "Greek Fire" during the civil war in America. "We do not know," says the *Mechanics' Magazine*, "of what 'Greek fire' is composed, neither do we know the origin of the phraseology. From certain obscure documents of the Eastern Empire, we suppose the designation 'Greek fire' means either a rocket or a liquid combustible material, composition unknown, which, being projected through tubes or in jars, set fire to combustible substances. During the Russian war, Capt. Disney exhibited at a public meeting certain glass shells, which, when thrown against a hard substance, burst, and, in a few seconds, set fire to all combustible material with which they came in contact. Before this, Capt. Norton had suggested a small-arm incendiary rifle projectile. At one time, scarcely a month passed without a little letter appearing in our columns from the last-named gentlemen, describing some 'Beelzebub' machine, which had for its object rapid and certain destruction in war." During the Crimean war, Mr. J. Macintosh called the attention of the Government to the extraordinary efficacy of certain projectiles, which he called "liquid-fire" shells, and to the application of other fiery materials in warfare. A special committee was appointed to inquire into the whole question, and a series of experiments was tried at Shoeburyness, by which inflammable materials were consumed at a distance of 800 yards. In August, 1855, Mr. Macintosh patented another invention. The following passage occurs in the specification :—

"I fill diaphragm shells with coal-tar naphtha, mixed with phosphorus and bisulphuret of carbon, having a bursting charge sufficient to open the shells. When fired, the bursting of these shells scatters the contents in all directions, and the shower of inflammable material, falling among cavalry and troops, ignites spontaneously, causing their immediate disorganization. Fired into shipping, these shells, bursting on deck or below, scatter the inflammable material in all directions, and the spontaneous combustion which arises causes inevitable and irremediable injuries and destruction to the crew, who are unable to escape except by dropping overboard, and the vessel itself is speedily consumed, aid from the crew having been rendered impossible as just described. Fired into harbours, dockyards, or towns, the result is alike destructive and decisive."

The use of such shells may be denounced as inhuman and contrary to the usages of civilized warfare.

The Charleston Harbour correspondent of the *New York Times* details the following results :—

"A number of experiments with Greek fire have been recently made by Mr. Short, the inventor, in presence of several officers of rank, with a view of contradicting the impression that the shells containing the fire exploded prematurely. The gun was placed in position on the beach, and pointed seaward. Ten tin tubes, each of which is 3 in. in length and ¾ in. in diameter, and filled with the material composing the Greek fire, were then dropped in a conical shell and filled round with powder. The first shell thrown exploded prematurely, in consequence, it is said, of a defect in the fuse. The shells subsequently fired had white lead placed round the fuse-cap, and, with perhaps one or two exceptions, fully accomplished all that had been claimed for them. A dozen shells were fired, nine of which exploded at a distance of 1200 yards.

To show the powerful effect of the Greek fire, a number of tubes were lighted and submerged in water, where they were allowed to remain till nearly burnt, and then taken out, but the bright blue flame was not extinguished. Other tubes were lighted and completely buried in moist sand, which was closely packed, and this also failed to quench the fire. The tubes burn for about a minute and a half. When first ignited, the fire issues from one end of the tube with a fierce rushing sound, not unlike that which accompanies the flight of a rocket, and extends the distance of a yard, but it soon sinks down to a dazzling blue flame of about 2 in. in length, losing its peculiarity of sound, and thus continues to burn to the end. An ignited tube in a basin of water gives the latter the appearance of boiling. It emits a heavy sulphurous smoke in large quantities."

GUN-COTTON.

At the meeting of the British Association in 1862, a joint Committee from the Chemical and Mechanical Committees was formed to inquire into and report on the Austrian Gun-Cotton. The Reports from the two sections of this Committee were read to the Association, in 1863, at Newcastle, Dr. W. H. Gladstone reading that relating to the Chemical portion of the subject. Mr. Scott Russell read the Report on the Mechanical portion of this question, by which it appears that greater effects are produced by gases generated from gun-cotton than by gases generated from gunpowder; and it was only after long and careful examination, that the Committee were able to reconcile this fact with the low temperature at which the mechanical force is obtained. His Report states:—

The great waste of force in Gunpowder constitutes an important difference between it and Gun-cotton, in which there is no waste. The waste in gunpowder is 68 per cent. of its own weight, and only 32 per cent. is useful. This 68 per cent. is not only waste in itself, but it wastes the power of the remaining 32 per cent. It wastes it mechanically, by using up a large portion of the mechanical force of the useful gases The waste of gunpowder issues from the gun with much higher velocity than the projectile; and if it be remembered that in 100 lb. of useful gunpowder this is 68 lb., it will appear that 32 lb. of useful gunpowder gas is wasted in impelling a 68-lb. shot composed of the refuse of gunpowder itself. There is yet another peculiar feature of gun-cotton. It can be exploded in any quantity instantaneously. This was once considered its great fault; but it was only a fault when we were ignorant of the means to make that velocity anything we pleased. General von Lenk has discovered the means of giving gun-cotton any velocity of explosion that is required, by merely the mechanical arrangements under which it is used. Gun-cotton in his hands has any speed of explosion, from 1 ft. per second to 1 ft. in $\frac{1}{1000}$ of a second, or to instantaneity. The instantaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects on the surrounding material. The slow combustion is made use of when it is required to produce manageable power, as in the case of gunnery. It is plain, therefore, that, if we can explode a large mass instantaneously, we get out of the gases so exploded the greatest possible power, because all the gas is generated before motion commences, and this is the condition of maximum effect. It is found that the condition necessary to produce instantaneous and complete explosion is the absolute perfection of closeness of the chamber containing the gun-cotton. The reason of it is, that the first ignited gases must penetrate the whole mass of the cotton, and this they do, and create complete ignition throughout, only under pressure. This pressure need not be great. For example, a barrel of gun-cotton will produce little effect and very slow combustion when out of the barrel, but instantaneous and powerful explosion when shut up within it. On the other hand, if we desire gun-cotton to produce mechanical work, and not destruction of materials, we must provide for its slower combustion. It must be distributed and opened out mechanically, so as to occupy a larger space, and in this state it can be made to act even more slowly than gunpowder; and the exact limit for purposes of artillery General von Lenk has found by critical experiments. In general, it is found that the proportion of 11 lb. of gun-cotton occupying 1 cubic foot of space, produces a greater force than gunpowder, of which from 50 to 60 lbs. occupies the same space, and a force of the nature required for ordinary artillery. But each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns when used as $\frac{1}{4}$ to $\frac{1}{3}$ weight of powder, and occupying a space of $1\frac{1}{10}$ of the length of the powder cartridge. The mechanical structure of the cartridge is of importance as affecting its ignition. The cartridge is formed of a mechanical arrangement of spun cords, and the distribution of these, the place and manner of ignition, the form and proportion of the cartridge, all affect the time of complete ignition. It is by the complete mastery he has gained over all these minute points that General von Lenk is enabled to give to the action of gun-cotton on the projectile any law of force he pleases.

Its cost of production is considerably less than that of gunpowder, the price of quantities which will produce equal effects being compared. Gun-cotton is used for artillery in the form of a gun-cotton thread or spun yarn. In this simple form it will conduct combustion slowly in the open air, at a rate of not more than 1 foot per second. This thread is woven into a texture or circular web. These webs are made of various diameters, and it is out of these webs that common rifle cartridges are made, merely by cutting them into the proper lengths, and inclosing them in stiff cylinders of pasteboard, which form the cartridges. (In this shape its combustion in the open air takes place at a speed of 10 feet per second.) In these cylindrical webs it is also used to fill explosive shells, as it can be conveniently employed in this shape to pass in through the neck of the shell. Gun-cotton thread is spun into ropes in the usual way up to 2 in. diameter, hollow in the centre. This is the form used for blasting and mining purposes; it combines great density with speedy explosion. The gun-cotton yarn is used directly to form cartridges for large guns by being wound round a bobbin so as to form a spindle like that used in spinning-mills. The bobbin is a hollow tube of paper or wood, the object of the wooden rod is to secure in all cases the necessary length of chamber in the gun required for the most effective explosion. The gun-cotton circular web is inclosed in close tubes of india-rubber cloth to form a match line, in which form it is most convenient and travels with speed and certainty. In large quantities, for the explosion of mines, it is used in the form of rope, and in this form it is conveniently coiled in casks and stowed in boxes.

As regards conveyance and storage of gun-cotton: it results from the foregoing facts, that 1 lb. of gun-cotton produces an effect exceeding 3 lb. of gunpowder in artillery. This is a material advantage, whether it be carried by men, by horses, or in waggons. It may be placed in store and preserved with great safety. The danger from explosion does not arise until it is confined. It may become damp, and even perfectly wet, without injury, and may be dried by mere exposure to the air. This is of great value in ships of war, and in case of danger from fire, the magazine may be smbmerged without injury. As regards its practical use in artillery, it is easy to gather from the foregoing general facts how gun-cotton keeps the gun clean, and requires less windage, and therefore performs much better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the matter of fouling. In gun-cotton there is no residuum, and therefore no fouling. Experiments made by the Austrian Committee proved that 100 rounds could be fired with gun-cotton, against 30 rounds of gunpowder. From the low temperature produced by gun-cotton the gun does not heat. Experiments showed that 100 rounds were fired with a 6-pounder in 34 minutes, and the gun was raised by gun-cotton to only 122° Fahrenheit, whilst 100 rounds with gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated. The firing with the gunpowder was, therefore, discontinued; but the rapid firing the gun-cotton was continued up to 180 rounds without any inconvenience. The absence of fouling allows all the mechanism of a gun to have much more exactness than where allowance is made for fouling. The absence of smoke promotes rapid firing, and exact aim. There are no poisonous gases, and the men suffer less inconvenience from firing in casemates, under hatches, or in closed chambers. The fact of smaller recoil from a gun charged with gun-cotton is established by direct experiment: its value is ⅔ of the recoil from gunpowder, projectile effect being equal. To understand this may not be easy. The waste of the solids of gunpowder accounts for one part of the saving, as in 100 lb. of gunpowder 68 lb. have to be projected in addition to the shot, and at a much higher speed. The remainder, General von Lenk attributes to the different law of combustion. But the fact is established.

The comparative advantages of gun-cotton and gunpowder for producing high velocities, are shown in the following experiment with a Krupp's cast-steel gun 6-pounder. With ordinary charge 30 oz. of powder produced 1338 ft. per second. With charge of 13½ oz. gun-cotton produced 1563 ft. The comparative advantages in shortness of gun are shown in the following experiments, 12 pounder:—

	Calibres.	Charge.	Velocity, feet per second.
Cotton,	length 10	15·9 oz.	1426
Powder,	,, 13½	49 (normal powder charge)	1400
Cotton,	,, 9	17	1402

—As to advantage in weight of gun, the fact of the recoil being less in the ratio of 2 : 3 enables a less weight of gun to be employed, as well as a shorter gun, without the disadvantage to practice arising from lightness of gun. As regards endurance of gun, bronze and cast-iron guns have been fired 1000 rounds without in the least affecting the endurance of the gun. As regards its practical application to destructive explosions of shells, it appears that from a difference in the law of expansion, arising probably from the pressure of water in intensely-heated steam, there is an extraordinary difference of result, namely, that the same shell is exploded by the same volume of gas into more than double the number of pieces. This is to be accounted for by the greater velocity of explosion when the gun-cotton is confined very closely in very small spaces. It is also a peculiarity that the stronger the shell the smaller the fragments into which it is broken.

As regards mining uses, the fact that the action of gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of its far higher efficacy in mining than gunpowder. The stronger the rock, the less gun-cotton, comparatively with gunpowder, is necessary for the effect; so much so, that while gun-cotton is stronger than powder as 3 to 1 in artillery, it is stronger in the proportion of 6 274 to 1 in a strong and solid rock, weight for weight. It is the hollow-rope form which is used for blasting. Its power of splitting up the material is regulated exactly as wished. As regards military and submarine explosion, it is a well-known fact, that a bag of gunpowder nailed on the gates of a city will blow them open. In this case gun cotton would fail. A bag of gun-cotton exploded in the same way is powerless. If one ounce of gunpowder is exploded in scales, the balance is throw down; with an equal force of gun-cotton nothing happens. To blow up the gates of a city a very few pounds of gun-cotton, carried in the hand of a single man, will be sufficient, only he must know its nature. In a bag it is harmless; exploded in a box it will shatter the gates to atoms. Against the palisades of a fortification: a small square box containing 25 lb., merely flung down close to it, will open a passage for troops; in actual experience on palisades a foot diameter and 8 feet high, piled in the ground, backed by a second row of 8 inches diameter, a box of 25 lb. cut a clean opening 9 feet wide. To this, three times the weight of gunpowder produced no effect whatever, except to blacken the piles. Against bridges. a strong bridge of oak, 24 feet span, was shattered to atoms by a small box of 25 lb. laid on its centre; the bridge was not broken, it was shivered. As to its effects under water: in the case of two tiers of piles, in water 13 feet deep, 10 inches apart, with stones between them, a barrel of 100 lb. gun-cotton, placed 3 feet from the face and 8 feet under water, made a clean sweep through a radius of 15 feet, and raised the water 200 feet. In Venice, a barrel of 400 lb. placed near a sloop in 10 feet water, at 18 feet distance, threw it in atoms to a height of 400 feet. All experiments made by the Austrian Artillery Committee were conducted on a grand scale,—36 batteries, six and twelve pounders (gun-cotton) having been constructed, and practised with that material. The reports of the Austrian Commissioners are all based on trials with ordnance, from six pounders to forty-eight pounders, smooth bore and rifled cannon. The trials with small fire-arms have been comparatively few, and are not reported on. The trials for blasting and mining purposes were also made on a large scale by the Imperial Engineers' Committee, and several reports have been printed on the subject.

Professor Miller made a few interesting experiments on various kinds of gun-cotton, with the view of showing the effect produced by their explosion. A small quantity of the cotton, in the form of loose thread, was first lighted, and burnt slowly, with a brilliant flame, and without smoke. Another kind was next burnt, in the shape of rope, the combustion having more the appearance of gunpowder, but producing no smoke. A third quantity, enclosed in an india-rubber case, was next placed on the table, and, on a light being applied to it, the cotton instantaneously exploded, and was all burnt off, the india-rubber case, in which it had been enclosed, being left uninjured. A small heap of loose gun-cotton was then placed on a piece of tin, and on its being lighted it burnt off in a bright flame, with no explosion, and leaving no ash. A small train of gunpowder was next placed on a sheet of paper on the table and lighted, and the large quantity of smoke which was produced presented a strong contrast to the result produced by the burning of the gun-cotton.

Professor Abel read a short report, giving a description of the Austrian system of manufacture of gun-cotton, and a detailed account of the results of experiments made in this country, with the view of determining the nature and properties of Austrian gun-cotton. In concluding his report, Professor Abel gave it as his opinion that, under a properly regulated system, the production of gun-cotton was not more difficult and complicated, and was attended with considerably less risk of accident to the workmen and the manufacturing establishment, than the production of gunpowder.

Captain Galton said the subject reported upon was exceedingly important, but it must be borne in mind, in connexion with the subject, that the Austrians had within a recent period discontinued the use of this material for guns. He begged to suggest that a proposal be submitted to the committee to the effect that it be requested to continue its labours in this inquiry.

In reply to a question, Mr. Scott Russell said there was a precise and definite length in the gun-barrel which the gun-cotton must occupy. If it occupy a shorter or longer space in the barrel, its effect is totally different, and therefore it is a vital point that there should be in the centre of a gun-cotton cartridge, or in the outside of it, some rigid and inflexible material which should compel the cotton to occupy precisely that space, no more and no less.

For the discussion which followed the reading of this paper, the reader is referred to the report in the *Athenæum*, No. 1872.

The subject is considered of so much importance, that the

British Association, though it has re-appointed the joint-committee to continue its inquiries, has passed a resolution to urge on the Government the appointment of a Commission by means of which a more complete investigation, and such as the subject unquestionably deserves, may be made, than the means at the disposal of the Association will admit of.

TARGETS FOR GUNNERY EXPERIMENTS.

CAPT. GALTON has read to the British Association a paper upon this important inquiry. The author stated the earlier experiments showed that 4½-inch plates at least were necessary to resist shot. This thickness of iron still left the plate liable to be hurt or fractured and knocked off even when not directly penetrated, and the extent to which it would thus suffer would in some degree be regulated by the backing. The plan adopted in the Warrior target was simply that suggested by the idea of bolting a plate of iron to the sides of a wooden ship. The iron skin of the *Warrior* is covered with two layers of teak planking, each 9 in. in thickness, the one horizontal, the other vertical, and outside of those is the armour-plate, 4½ in. thick, secured by bolts screwed up with nuts inside of the ship. The wood backing was to prevent the injuries sustained by the plate from being communicated immediately to the ship, but it afforded no effectual support to the plate itself. The next class of target to which Capt. Galton referred were those having a rigid backing, being wholly composed of iron. Mr. Hawkshaw had proposed one consisting of a thick front plate, backed by a series of thin plates secured by rivets. Mr. Scott Russell had proposed a most ingenious arrangement by which the strong front plates were kept in position without any rivets or bolt-heads being exposed. Others had also been tried. The trials of these targets had demonstrated that a perfectly rigid backing was not desirable. The arrangement required for the armour-plating of a ship was, a strong front plate, in which deflection under blows should be prevented, but which should have some cushion behind to prevent the full concussion of the blow being communicated to the side of the ship. The target to which he (Capt. Galton) wished to draw attention, was constructed on these principles. It had the metal placed in a form suited to resistance, and it had a cushion of wood interposed between the target and the ship. This target was invented by Mr. Chalmers. When submitted to the Admiralty, it was refused to be allowed to be made at the Government expense, but Sir Morton Peto was so satisfied with its principle that he assisted Mr. Chalmers in bringing it out. It consists of, first, a thick front plate, as the top flange of a beam; second, of ribs to support it, as the web of a beam; and thirdly, of a plate of iron to hold up the ribs, as the bottom flange of a beam, and the ribs are supported laterally by timber to prevent their lateral deflection. Between this and the side of the ship, a cushion of timber is interposed. This target underwent a similar trial to the Warrior target, and the result showed that it was the best target that had been tried, though it was not intended to suggest that it was perfect. As regards cost, Mr. Chalmers's plan would enable 200 tons of the front plate, costing from 40*l.* to 50*l.* a ton, to be replaced by iron from 15*l.* to 20*l.* a ton for the ribs and back plate. It was, however, in this direction that experiments for devising the best form of armour-plating should be made.

Mr. Scott Russell thought that, however varied targets might be in design, wood should enter into their construction.

Mr. J. Nasmyth expressed his opinion that, for armour-plates to answer the end for which they were designed, they must be backed by some elastic substance, and the substance, in his opinion, best adapted to give the requisite elasticity was compressed wool. As Capt. Maury was present, he should like to have his opinion on the subject of cotton, and whether it had been found to answer so far as his experience went.

Capt. Maury said he had not had an opportunity of gaining a great deal of experience on this subject, nor had he had an opportunity of witnessing the experiments that had been made upon cotton. There had been experiments to test the capability of cotton to resist cannon-balls, but the results had by no means been satisfactory. He thought that cotton had got a false reputation. In the early days of the American difficulty, they thought that cotton could resist balls successfully, but when it came to the test they found the bales did not answer the purpose.

Prof. Pole said that Mr. Nasmyth had been kind enough to lay his plan of using compressed wool before the Iron Plate Committee. They wished to have the plan tried, and a recommendation to that effect had been made, so that its amount of resistance might be ascertained, but some official difficulties had hitherto prevented its being done.

Mr. Scott Russell said the whole course of experience had been to show that they must arrest and shatter the shot at the earliest possible moment, and in the shortest space of time when it struck the armour.

IMPORTANT TARGET EXPERIMENTS AT SHOEBURYNESS.

One of the general principles eliminated from the mass of experiments has been that the thickness of the armour-plates themselves is a matter of almost secondary importance when compared with the construction of the backing which keeps them up to their work. Thus, Mr. Chalmers's target, composed of 3¾-in. plates properly backed after his system, has withstood a hammering from the guns which no other target of any kind had ever borne at Shoeburyness with such impunity. This was entirely due to the backing. The Warrior target, composed of 4½ in. plates, backed up with 18 in. of solid teak, laid transversely in beams 9 in. thick, in like manner withstood a terrific pounding. On Dec.

8, was tried the Bellerophon target, put forward by Mr. E. J. Reed, who, if his theories are right, promises to revolutionize our whole system of iron-clad frigate building. The Warrior target weighs about 335 lb. to the square foot, and it was thought to be venturing as far as it was safe to go in the new frigates of the Minotaur and Northumberland class when their bulk was increased to 347 lb. per foot. Yet Mr. Reed's target weighs no less than 381 lb. per foot, and it is perhaps the heaviest target ever put forward at Shoeburyness which professed to represent the broadside of a seagoing frigate. The size of the target is, in round numbers, 20 ft. by 18 ft. This is covered in front by two armour-plates, each 20 ft. by 4 ft. 3 in., and no less than 6 in. thick. The method of its construction is briefly as follows:—The inner skin of the ship is composed of two thicknesses of wrought-iron plates each three-quarters of an inch thick, with a layer of felt between the two thicknesses, so that here we get no less than 1½ in. of iron to start with. On this skin is laid four large angle-irons of great strength, each placed 2 ft. apart from the other, so as to form, as it were, four longtitudinal troughs 2 ft. wide and 9½ in. deep, the depth of the angle-irons themselves. In these troughs the teak balks are laid 10 in. thick, so that the extra half inch can be cut off to a true surface for the reception of the 6-in. armour-plates. Thus, then, there are no less than 7½ in. of iron and 9½ of teak. Each armour-plate is secured by 22 bolts, about 2 ft. apart longitudinally and 2 ft. 9 in. vertically, those for the upper plate being 2½ in. in diameter, and for the lower 2¾ in. The bolts securing the wood backing are 1 in. diameter, and the ribs supporting the inner skin are on very much the same principle as those used in all iron frigates, only apparently stronger, and placed two feet apart.

Such is the general outline of Mr. Reed's target, in the construction of which, as far as the longitudinal girders are concerned, it will at once be seen that an idea has been suggested by the target of Mr. Chalmers. The general opinion before the practice began on Dec. 8 was that it was solid enough to resist anything; but with this opinion another was freely expressed by iron-ship builders present, that Mr. Reed would find it difficult to make a vessel so coated an efficient seagoing frigate without such an amount of displacement as might be fatal to its speed. This, however, is merely an opinion. The guns were laid at the customary 200 yards' range, Colonel Taylor, as usual, carefully superintending all the arrangements for the firing. The first rounds were merely routine—a 68-lb. solid shot, with a 16-lb. charge and 110-pounder Armstrong shortened to a weight of 66½ lb., fired with the same charge. Both these struck the upper plate, and made the usual indent of nearly two inches deep, but effected nothing more than that which they always do—that is to say, show the quality of the iron plates against which the guns have to contend. On this occasion the iron was literally perfect, and throughout the rest of the experiments the opinion was universal, that better plates had never been tested at Shoeburyness. Even under the heaviest shot, though indented deeply, they showed scarcely any perceptible symptom of buckling out; and though struck on the edge and around the bolt-holes, it was almost impossible to crack them. A salvo of two 68-pounders and two 110-pounder Armstrongs, with shot shortened to 66½ lb., was next fired, but of these four guns one missed the target altogether, one touched it so slightly on its upper edge that, as far as damage was concerned, it may also be called a miss; the remaining two struck close together, one on each side of a bolt, so that the bolt itself was squeezed up like putty, and projected slightly outwards, but still held firm. Two shots coming so close were a hard trial for any plate, but it stood it perfectly, without any sign of crack or ragged edges. The back of the target was absolutely unhurt, and so perfect was the workmanship of the whole mass, that from the commencement to the end of the day scarcely a rivet was started. A cylindrical, round-headed 66-lb. shot was next used, but effected nothing, and then the Whitworth 70-pounder muzzle-loading gun was loaded with a steel shell, charged with 2½ lb. of powder, and fired with a 12 lb. charge. As regarded the target, this effected nothing, though its indent at once showed by its severity the immense superiority of steel projectiles against armour-plates over the old gray cast-iron shot. The indent made by this shell, though only 2 lb. heavier than the 68-pounders, was at least 40 per cent. deeper, and its fragments cut into the mass of iron as if it had been so much wood. When steel projectiles were first used, from the same guns and with the same charges as common shot, they, as a rule, gave an increased penetration of from 30 to 35 per cent. over the cast iron. Later experiments, however, have added even to this high percentage of superiority, and looking at the rapid improvement in the manufacture of the metal used for these projectiles, there seems to be no reason why we should not look for still higher results. Sir William Armstrong sent steel shot to Shoeburyness of such perfect metal that even after penetrating a 6-in. plate they have been so little injured that they could with safety have been used again. One thing is absolutely certain, that our present cast-iron shot will never be able to effect much against armour ships.

Mr. Whitworth's 150-pounder was next tried. In consequence of there being a slight flaw in this fine piece, Mr. Whitworth reduced its firing charge from 27 lb. to 23 lb., the shell, of homogeneous metal (which is only a hard name for soft steel), weighing 151 lb., with 5 lb. of powder as a bursting charge. Much was expected from this formidable shot, but, unfortunately, it failed—the shell from some mysterious cause bursting about 20 yards from the muzzle of the gun, and sending its fragments in all directions screaming hoarsely through the air.

The Armstrong rifled gun was then tried with a spherical cast shot of 151 lb., fired with 35 lb. of powder. This struck, with the rather high velocity of 1570 ft. per second, on the edge of the upper plate, making an indent of 3½ in., breaking one bolt, slightly bulging the inner skin of the target, and therefore starting the ribs of the ship itself just enough to be perceptible. Beyond this, however, it effected nothing of importance. The plates still remained as tough and unbending as ever; there was no sign of cracking in them, and every rivet, to the astonishment of all on the ground, stood fast. A steel spherical shot of the same weight was fired from the same gun with the same charge, and this, rather unfairly for the target, struck between the slightly parted edges of the upper and lower plates. It completely buried itself, and must have passed through the entire plate, but, strange to say, though two bolts gave way, all the rivets held on; and, although the immense mass was bedded in the substance of the target, it produced scarcely any effect worth speaking of on the inner skin, which, as far as fighting purposes are concerned, remained as good as before it was fired at. A shot from a 7-in. muzzle-loading of the Ordnance Select Committee was fired with 120-lb. steel shell loaded with 2 lb. of powder. This accomplished absolutely nothing, though it might have done a good deal more than it was intended, inasmuch as one of its fragments flew back to the guns and buried itself 2½ feet in the ground, close to where some of the visitors were standing. A shot from the rifled 300-pounder (a cast-iron projectile), fired with 35 lb. of powder, did very little, in spite of the weight of the mass hurled against the target. It made an irregular dent of 3¼ in. deep, and bent back the upper plate a little more than 2 in., making the first real crack in the plate at the point we have mentioned as being where the two shots struck on the bolt-head. From this spot there was now, for the first time, seen a perfect crack, nearly a foot long, and extending quite through the plate, apparently; but this was all. The last shot fired was from Mr. Whitworth's 150-pounder, loaded with a steel shell and 5 lb. of powder. This struck the lower plate, and exploding, buried itself deeply; but though it had evidently penetrated the plates, it had failed to make any perceptible impression on the inside of the target itself.

The result of the whole day's experiments gave to the target the most complete victory—a victory almost as great as that achieved by the target of Mr. Chalmers. In estimating the relative merits of the two targets—beyond all doubt the strongest and best constructed in principle ever experimented on—it must not be forgotten that Mr. Reed's target is larger by some 40 superficial feet than Mr. Chalmers's. In thickness of metal it is 20 lb. per square foot heavier, and its cost of construction 400*l.* more. To these facts we may add that Mr. Chalmers's target was assailed with 15 more rounds than were fired at Mr. Reed's—15 rounds which were fired with 130 lb. of powder, and threw no less than 1500 lb. weight of metal against the target of M . Chalmers more than were fired against that of Mr. Reed. The general conclusion from these experiments was, that both targets stood almost equally well: which is lightest and cheapest, and best adapted for iron frigate building, remains to be proved.—*Abridged from the Times.*

TRIAL OF ARMOUR-PLATES, STEEL GUNS, ETC., AT ST. PETERSBURGH.

On Wednesday, the 17th of October, N.S., further trials took place at St. Petersburgh with the experimental 9-in. rifled cast-steel gun. The *Times* states that this gun is of solid cast steel, made by Krupp, and throws a 300-lb. shell, or a 450-lb. solid shot. The results of previous experiments with this gun led the Russian Government to order fifty of them, which are now in course of delivery. The principal objects of the experiments on the 7th inst. were to ascertain the best description of shell, and to test the quality of armour-plates supplied by Messrs. John Brown and Co., of Sheffield.

First, a series of cast-iron shells, 300 lb. each, were fired at different ranges, and then shells made by Krupp were fired at the 4½ in. armour-plates. The first shell, of hard cast steel, was 22½ in. long (2½ diameters), with a flat end 4 in. in diameter. Fired with 50 lb. of powder at 700 ft. distance, it passed through the plate, oak and teak backing, and broke into many pieces, although filled with sand only. The second and third shells were also of Krupp's steel, the same length, but with 6½-in. ends. These shells pierced plates, wood, &c., and also went to pieces, although only filled with sand. The fourth shell was made by M. Poteleff, of puddled steel, on Aboukoff's system, the same dimensions as the second and third, and went through iron, teak, &c., but was only bulged up from 9 in. to 12 in., and the end flattened; not a single crack being visible in the shell. The fifth shell, the same as the fourth, passed through iron, teak, and the second target, and went at least a mile beyond. The sixth and seventh were from Krupp, and were charged with powder; they were quite flat-ended, 9 in. diameter. One exploded in the plate, the other in the wood. The eighth and ninth shells were of cast iron, and, although they passed through the plates, were of course destroyed. Evening prevented further trials, which will yet be made on the same plate.

The results on the plate were highly satisfactory. In a space of 4 ft. 6 in. by 3 ft. 6 in. eight holes were made without any crack of the slightest description; and the marine officers present were highly satisfied, because they are obtaining 4000 tons of plates from Messrs. John Brown and Co., for their different ships.

The English Government would do well to note the progress the Russians are making in gunnery. Cast steel guns are decidedly before any yet produced in England of any other metal. The 9-in. gun of Krupp has been fired with 300-lb. shells and 50 lb. of powder about 70 times without any flaw, and the Russian Government will shortly be in a position to obtain in St. Petersburgh a large supply of cast-steel guns, made from Russian iron, by Russians, on Aboukoff's system, which is very near the same as Krupp's.—*Mechanics' Magazine.*

WARREN'S "IMPREGNABLE AND UNSINKABLE FLOATING CASEMATE BATTERY," &c.

MR. WILLIAM W. WARREN, of Milton-next-Gravesend, proposes a system of construction for an "impregnable and unsinkable floating casemated battery, submarine gun and armour-plating, adapted for stationary batteries, and for convoying troop-ships, &c." In an abridged, but still a lengthy description, he says:—"I prefer constructing the centre portion of the vessel of rolled wrought-iron double-flanged vertical ribs, from 12 to 18 inches wide, and from 2 inches to 4 inches thick, firmly riveted and bolted together, or of angle or T iron—solidity and stiffness being the great object—on which are placed the various layers of malleable metals, taking care to stop all chemical or galvanic action by means of bituminous composition, mixed with hair; and were it not for the cost, I would prefer using the finest copper-plating only over the iron, so as to act on the principle of a gradual tenacity of resistance, thereby easing and stopping the momentum and distributing the shock, and thus prepare the iron-plating to finally resist, without splitting or destroying the plate; or the roof-deck and sides of centre position of battery can be protected with oak or other wood, compressed in short lengths, and confined, the cross-grain of wood being opposed to the action of fire." Mr. Warren's invention has been presented to the Admiralty, and he has permission to erect a target at Shoeburyness on his compressed wood cross-grain principle; but the cost, which is 5000*l.*, prevents him.

RUSSIAN IRON-CLAD BATTERY.

AT the Thames Iron and Ship-building Works, has been constructed a most novel-formed Floating Battery, for the Russian Government. The vessel in question, the *Pervenetz*, is a steam-propelled iron-clad ram battery of 30 guns, in structure similar to the *Warrior* and other vessels of that class; but, instead of the beautiful bow of the noble ship just mentioned, she is built with a form of stem which closely resembles the snout of the rhinoceros, giving the vessel a most extraordinary and formidable appearance, the hawser-holes being painted, after the Chinese fashion, to resemble eyes. The same character of line is followed at the stern, and the armour carried back so as completely to protect the screw and rudder. The sides of the vessel are inclined at an angle of twenty-seven degrees, and completely covered from stem to stern by 4½-in. plates of the toughest scrap-iron (with a backing of teak 9 in. thick), which descend throughout to 5 ft. below her load-line, and she launched half-covered with them. Her length between the perpendiculars is 220 ft.; beam, 53 ft.; and 26 ft. 6 in. depth of hold; burden in tons, 2812, builders' measurement. The engines, of 300-horse nominal power, will be furnished by Messrs. Maudslay, Sons, and Field, of their patented three-cylinder principle, super-heated and surface-condensing apparatus, with all the latest improvements. Her armament will consist of twenty-eight 68-pounders on the main deck, the ports 6 ft. 6 in. clear of the water-line, and on the upper deck two rifled pivot guns of the largest calibre. All the latest improvements have been introduced throughout her equipment, and the lower masts are of iron. Her building has been under the immediate direction of Captain Lesorskey, the superintendent of Cronstadt.

THE GUN QUESTION.

In the *Mechanics' Magazine*, Nov. 6, 1863, the question is thus glanced at :—"How to construct a Gun of sufficient strength to fire heavy shot with heavy charges, and with accuracy at short or long ranges, is the artillery problem of the day. Strength of material and structure is the object eagerly sought by Ordnance authorities and projectors. Sundry and various are the devices to attain that end. Some contend that the coil system, in spite of the Armstrong failures, is the *ne plus ultra;* homogeneous iron is the *panacea* of the Whitworth school; cast steel is the hope of those who believe in Krupp; several varieties of built-up and strengthening systems, comprising the Blakely, the Lancaster, the Haddon, and the Lynall Thomas, have ardent advocates; the steel tube, cased in cast iron, is the latest invention, to which Parsons and Palisser are rival claimants. Among so many plans, no wonder the Ordnance Select Committee are puzzled which to choose. But plain cast iron is again holding up its head. The excellent quality of the old Carron metal is remembered. Since the days of its celebrity, still further improvements in cast iron have been made, and a strong feeling prevails with makers of cold-blast pigs, that they can produce refined metal of a quality which will surpass all other kinds of iron, and be superior even to steel for heavy ordnance. Strength of material, no doubt, is of the utmost importance; but what has suddenly given to it so much prominence? It is the discovery recently made of the destructive effects of the forcing system of rifling. That vicious method of giving accuracy and range to guns, entails the necessity of an enormous addition to their strength and weight, as well as to their cost.

The Correspondent of the *New York Tribune* will have startled many of the warm friends of neutrality in Great Britain, by its announcement that the citadel of Charleston has been laid in ruins by the fire of a battery, of which half the guns were manufactured in British workshops, and must have been exported from a British port since the commencement of hostilities. The battery in question, which accomplished the destruction of Fort Sumter consisted, as it appears, of four guns, two of which were American 200-pounder Parrott's, and two were British 80-pounder Whitworth's. The correspondent of the *New York Tribune*, in describing the action of these guns, states that "something over 700 shots were fired from the 200-pounder Parrotts, of which more than half struck the fort. From the Whitworths 222 solid shot were fired, of which 98 hit the fort, and 124 went over or fell short." It will have occurred most probably to some of your readers, that it is hardly consistent with the good faith of a neutral nation, that Great Britain should have permitted guns of such a novel character and of such extraordinary powers of destruction to be exported from British ports to the Federal States to be employed against a Power with which Great Britain is at peace, more particularly as such guns can be procured in no other country but Great Britain.—*Letter to the Times*, Sept. 21, 1863.

IRON SHIPS-OF-WAR.

MR. E. J. REED, Constructor of the Royal Navy, has delivered to the Literary Institution at Greenwich, a paper on the subject of "Ships of War." After describing the various iron-cased ships which have been built in England, Mr. Reed contended that the *Warrior* and ships of her class were too long. He firmly believed that the same rate of speed could be obtained from shorter vessels. The attention of the Admiralty had been much devoted to this question, and he could assure them that no more iron ships for the Royal Navy would be laid down of such a length as 400 feet. While one of these long vessels had a large portion at each extremity exposed, a shorter vessel could be armour-plated from end to end, and would sail as many knots per hour. These matters did not escape the attention of those now at the head of naval affairs. [Mr. Reed then entered into certain particulars in justification of his appointment to his present office.] Mr. Reed then discussed the question of the comparative merits of ships built entirely of iron, or with a backing of timber, and expressed an opinion in favour of the latter class. The late disaster to the *Prince Consort* proved in a remarkable manner the vast strength of the wooden hull of that ship. An officer who was sent to Kingston to inspect the vessel after she came to grief reported:—"From one end of the ship to the other, not one bolt-head had been disturbed." It scarcely ever happened that an ordinary wooden ship, without an iron plate upon her, after encountering a Channel storm, returned to port with such trifling damage as that done to the *Prince Consort*. He could state with the utmost confidence that the Admiralty was now building a corvette which the swiftest iron vessel now afloat could not hope to escape, and which would be armed in a most effective manner.

CAPTAIN COLES'S IRON-CLAD SHIPS.

CAPTAIN C. P. COLES, in a communication to the *Mechanics' Magazine*, says:—The present transition state of navies, and the great progress which has been made in the construction of large guns, especially in America,* leave but little doubt that we are as certain to pass from 68-pounders to 300-pounders, as we were from 32-pounders to 68-pounders when iron-clad ships became a matter of necessity; these convictions have induced me to print the following tables and calculations, showing the relative cost of constructing and maintaining a fleet of iron-clad ships with broadside ports that cannot carry these guns, and shield ships that would carry them. The comparative destructive powers of these vessels must be computed from the actual weight of broadside thrown from guns protected by armour-plates; and to make this comparison as clear as possible, I have separately compared the *Prince Albert* shield-ship with four different classes of iron-clad vessels with broadside ports; enabling some conclusion to be arrived at as to the comparative cost, tonnage, and fighting powers of shield-ships and ships with broadside ports.

In comparing the destructive powers of these ships' broadsides, it has to be remembered that the mere weight of metal, if taken alone, would convey but a small idea of the effect they would produce; as a few heavy projectiles from large guns might destroy a ship which would receive little or no injury from a broadside of the same weight of metal, made up of a number of shot of a smaller nature. But setting aside the great advantages of heavy shot, it is now known that shells, under favourable circumstances, can be made to penetrate iron plates 4½ in. and 5½ in. thick. These shells, to be effective, must contain large bursting charges, and be of great size and weight—two conditions which necessitate the employment of guns too heavy to be used in ships with broadside ports.

Taking the comparative costs of the vessels, as given in the table, a saving may be stated at nearly 3,000,000*l.*, viz.:—

In construction	£1,853,566
6954 men being required, at £48 each = £333,792 per annum, representing a capital of . .	£953,600
Total . .	£2,807,166

Apart from the above considerations, a matter of even greater importance is at issue. The great draught of water of these enormous and unwieldy ships with broadside ports, renders it indispensable that our docks and basins should be reconstructed to receive them. They are, for the same reasons, rendered incapable

* The following extract is from a letter, dated New York, Jan. 20, 1863, and is of undoubted authority:—"The number of 15 in. guns already cast and mounted is 34. The foundry at Pittsburgh is turning out three a week, the foundry at Providence one a week, and the foundry at Boston two a week: making an actual production of one 15 in. gun a day. These guns fire a solid round shot of 450 lbs. weight, and a shell of 370 lbs. weight, containing 17 lbs. of powder. The charge of powder in the gun is from 40 lbs. to 50 lbs., and you can easily imagine the effect to be terrific. With this gun we do not aim so much at penetrating as crushing; and the idea is, that the sides of one of your iron-plated ships would be entirely broken by shots of such enormous weight, moving with an initial velocity of 1400 feet per second, a rate which we have reached with recent trials at the Washington Navy Yard."

of entering many of the foreign ports, or approaching, if needs be, within an effective distance of an enemy's coast; whereas with the light draught of water, and the smaller dimensions of shield-ships, no such objections present themselves. For such ships, the existing docks in our Government establishments are large enough; and in time of war those of our merchant-yards would be available, if required.

See the Tables in the *Mechanics' Magazine*, March 6, 1863.

COST OF SHIPS.

AN account has been issued showing the charges for works upon Her Majesty's ships in the financial year 1861-2. The sum of 613,829*l.* was expended in building vessels in the dockyards, and 932,323*l.* in building by contract or purchasing; also 368,292*l.* upon ships commenced as wooden ships but converted into iron-cased vessels while building, and 118,480*l.* upon ships launched as sailing ships and subsequently converted into screw steamships. The sum of 1,003,047*l.* was expended in fitting out or refitting steam vessels and in repairs and maintenance; also 183,395*l.* in fitting out, refitting, repairing, and maintaining steam vessels permanently employed as troop, store, or surveying vessels, tenders, yachts, &c., and 63,898*l.* for sailing vessels. 69,168*l.* was laid out in the building and maintenance of yard craft, steam-tugs, &c., and 9,642*l.* in fitting and maintaining hulks. Details are given for each ship. The Accountant-General proposes to submit a further account for the same year, showing the cost of manufacturing and repairing articles of store in the several workshops and factories in the dockyards; and to supply before the close of the Session an account showing the value of the stock in hand in each dockyard on the 31st March, 1863.

STEEL FOR SHIPBUILDING.

MESSRS. JONES, QUEGGAN, and Co., of Liverpool, have built two large ships of steel—one a sailing ship, named the *Formby*, of 1271 tons tonnage, built for the East India trade; the other a paddlewheel steamer named the *Hope*, of 1492 tons. At a *déjeûner* which took place after the launch, Mr. Jones made some remarks on these vessels. He said that steel is much stronger than iron, weight for weight, and consequently in shipbuilding that equal strength can be given with less weight of steel than of iron. The strain resisted by iron-built ships had been found to be from 19 to 20 tons per square inch, while the resistance of steel is found to range from 42 to 48, giving a mean of 45 tons for steel, or considerably more than double that of iron. Keeping these results in view, the *Formby*, a vessel built of steel, required 500 tons of material in her hull, while a similar ship made of iron would have required 800 tons. The difference in weight of hull would cause a difference of nearly two feet in displacement in favour of the steel vessel, requiring also less propelling power. In the case of steamers the advantages were still more obviously in favour of steel. If the *Persia*, a steamer of 3600 tons and 900-horse power, had been built of steel instead of iron her displacement would have been diminished about one-sixth, and she would have been enabled to carry double her present cargo. Mr. Reed, the Chief Constructor in the Royal Navy, who was present, said he should watch with great interest the career of the two ships which had just been launched. He remarked that merchant ships can be built to test a principle when war ships cannot, as the ormer can be examined and repaired annually, while the latter are sent abroad for periods of three or four years. He perfectly agreed with what had been said of the importance of steel for the construction of small ships, and stated that the Government took great interest in the question of employing steel as a material for shipbuilding.—*Times.*

IMPREGNABLE SHIPS-OF-WAR.

Mr. W. W. Warren proposes to construct ships-of-war which shall be impregnable, and capable of discharging their guns under the water-level.

"I prefer," writes Mr. Warren, "constructing the centre portion of the vessel of rolled wrought-iron double-flanged vertical ribs, from 12 to 18 in. wide, and from 2 to 4 in. thick, firmly riveted and bolted together, or of angle or T iron, solidity and stiffness being the great object, on which are placed the various layers of malleable metals, taking care to stop all chemical or galvanic action by means of bituminous composition mixed with hair; and were it not for the cost, I would prefer using the finest copper-plating only over the iron, so as to act only on the principle of a gradual tenacity of resistance, thereby easing and stopping the momentum, and distributing the shock, and thus prepare the iron-plating to finally resist, without splitting or destroying the plate; or the roof-deck, and sides of centre position of battery can be protected with oak, or other wood, compressed in short lengths, and confined, the cross-grain of wood being opposed to the action of fire.

"The fore-and-aft and other portions of the battery, not requiring armour-plating, to be constructed with wrought-iron ribs, with an outer skin only, and to be filled in with hexangular or honeycomb compartments, of the maximum size of shot, made in short lengths, and firmly riveted and bolted together, so that, in case of water entering, it is confined to the track of the ball, after which it can be easily stopped, and by an arrangement of valves can be pumped out. To wooden-ships, if armour-plated at all, I would apply the plating inside thereof, thereby making the external wood act as a buffer or padding. The port-hole for discharging the submarine gun must be provided with water-tight metal flap, instantly closing after the recoil of gun, the barrel of gun acting in a stuffing-box, with a water-tight box adjoining for adjusting cap to muzzle. The port-hole to be provided with a slide valve, as an extra precaution. The cap can be made of any reasonable length, so as to displace a greater volume of water, and, if necessary, a telescope tube can be adjusted to port-hole and elongated by a rack and pinion movement, or an ordinary muzzle-loading gun can be used, by simply applying a waterproof flexible hose, of sufficient length to allow of the recoil of gun, and having movable collars attached to muzzle and port-hole. The hexangular cellular system is not only capable of displacing and carrying any weight of armour-plating, but is admirably adapted for the reconstruction of existing wooden ships, thereby making them seaworthy and unsinkable at a comparatively small expense, without the necessity of armour-plating at all, simply by placing the hatchways to lower deck; and is likewise admirably adapted for the construction of life-boats, floating docks &c., on account of it reducing the maximum amount of external injury to the minimum amount of internal damage."

Mr. Warren's principle of construction seems to be good; and, in the absence of experiment, it would be premature to pronounce an opinion on the probable success with which guns could be discharged under water.—*Mechanics' Magazine.*

NEW UNSINKABLE IRONCLADS.

THE building of the new iron war-frigate *Bellerophon,* which has been commenced at Chatham Dockyard, will inaugurate a new era in iron shipbuilding, the Lords of the Admiralty having for the first time admitted the importance of having the vessels of our future iron fleet constructed on what is termed the double-bottom or unsinkable principle. Unlike a wooden vessel of war, the bottom of an iron ship is so weak in comparison with its other parts, and so liable to injury, that unless the ship is divided internally into numerous independent compartments or chambers, a comparatively slight touch of a rock, or other such injury below water, would expose her to the risk of almost instant destruction. In the new iron-cased ship *Bellerophon,* throughout the entire central portion, in which the engines, boilers, magazines, &c., are placed, the bottom of the ship will be double, the inner and outer bottoms or hulls being placed from three to four feet apart, in order that there may be ample space between for cleaning and painting both when desirable. As this space between the two bottoms will not be required for use, it will be divided into numerous water-tight compartments in the usual manner, and will consequently form a series of buoyant cells, any one or more of which may be injured without the sea being admitted to the others or to the ship. Beyond the central portion of the vessel, at each end, the lower deck will be used as an interior bottom, and the space below it made available for stowage by means of iron water-tight trunks, rising above the water-line. It is this combination of water-tight trunks with water-tight decks—the former being intended as a means for entering below the latter—which constitutes what is known as "Lungley's unsinkable principle," by aid of which not only is the division of the vessel into water-tight compartments accomplished without obstructing ventilation, but the vertical trunks themselves form ventilating apparatus of the best possible kind. In addition to what has been already described, the *Bellerophon* will be constructed with water-tight internal walls, completing the double bottom, and thus will, in fact, be made a double ship from end to end.—*Times.*

STEERING SCREW.

MR. J. W. CURTIS, C.E., has invented a Screw which will steer as well as propel a vessel. The peculiarity of this screw is, that a universal joint is placed within the hollow boss of the screw, which is thereby connected with the main shaft, the centre of gravity of the screw and the centre line of the rudder intersecting the centre line of the main shaft, so that the entire weight of the screw is borne by the shaft; and by means of a tail or spindle to the screw projecting from the boss working in the rudder, or an iron carrier in lieu of rudder, whatever may be the movement of the tiller or wheel, it communicates an equal movement to the screw, which becomes not only the propelling but also the guiding power of the ship, as before mentioned.

Her Majesty's gun-boat *Charger*, of 60-horse power, having been fitted, by Messrs. Young and Magnay, of Limehouse, with one of those screws, several experiments were performed to test the power of the screw in twisting the vessel into every imaginable position, the result being highly satisfactory, and demonstrating that it is no longer needful to apply double screws, hydraulic steering apparatus, or to add any other extra complications to the machinery of a steamer, when by a wave of her own screw, her motion can be directed and controlled at will. Revolving turrets will become obsolete if our present colossal screw line-of-battle ships can, by the application of this original contrivance, be made to revolve upon their centres, and deliver their entire broadsides alternately, as fast as the guns can be loaded, and in as short a time as the cumbersome turret, with its single gun, can be revolved and trained to the required position. The invention appears to have attracted the serious attention of the Admiralty, as is evidenced by the grant of the gun-boat for the experiment. Admiral Belcher, who witnessed the trial in the Thames, expressed his satisfaction at the prospect of one of the great questions of the day being solved in so simple a manner, and appeared highly pleased at the result of the experiment.—*Illustrated London News.*

JOINTED STEAM-SHIPS.

THE *Connector*, Jointed Steam-ship, is stated to possess great advantages for coasting and inland traffic purposes over the ordinary screw steamers. Except her great length and narrowness, there is nothing very peculiar in her outward aspect, but the singular extremes of these dimensions, in a vessel of such light draught, at once attract attention. Still more curious, however, is her appearance when the swell of a river steamer reaches her, when the joints come into action and the whole of the long hull undulates in a snaky sort of fashion, so unlike the steady rise and fall of common ships that, at the first glance, the *Connector*, as the ship is called, seems coming to pieces. She seems, in truth, as if her back was broken in many places, which is actually the fact, though, in the case of this small steamer, the divisions in her length are the new principles of construction, the advantages of which she is built to illustrate and, as her builders hope, develope. The theory of the *Connector* steam-vessel is borrowed from the idea of an ordinary train, with the engine or motive power distinct from the rest of the sections of the ship, and capable of being attached to any number of portions of the vessel or joints. The steamer is built in four joints, each joint being a perfect wrought-iron portion of the *Connector's* hull, and capable of being fitted to or disconnected from the rest of the ship with the most perfect ease, and in the space of a few seconds almost. Every section has a rough sort of bow and stern of its own, so as to enable it when detached to be moved by sails easily in the water, all except the last section or joint, which, as containing the motive power, the engine and screw, is of course properly shaped. As regards the stem, though the bows are the same as the other joints, the joints themselves by which the different parts are bolted together are very powerful, and move easily, allowing the different sections to rise and fall with the slightest motion of the water. The inventor of this singular vessel is of opinion that a proper connector ship should consist of in all 10 parts, nine for cargo and one for motive power, the latter always to be at sea with three sections filled with cargo,—three sections, in fact, being filled with cargo and three discharging, so that the steam-power section itself need never be idle. According to this theory, it is contended that the capital sunk in the cost of steam machinery need never be in a manner useless while the vessel is waiting to receive her cargo. But the chief cost of steam power for vessels is the fuel and the wear and tear of engines, neither of which would be in the least degree diminished by keeping the machinery constantly going. —*Times.*

NEW WAR VESSEL.

A NEW war vessel is in course of construction at Cincinnati. This strange craft is known as "Elliott's War Turtle." It is shaped like a large punch-bowl, with the propeller in the form of a turbine-wheel, placed at the bottom, and so arranged as to take water in through eight radial tubes, which may be opened or closed by valves, the said tubes connecting with the propeller and outer edge or hull of the vessel. The propeller passes the water downward from its cylinder and revolves always in the same direction, and when the vessel is to be moved forward in any direction one or more of the valves is opened, thereby relieving the pressure on that side, while the pressure still remains on the opposite side to propel the vessel. The turret is very similar in appearance to those on the Monitors, but is built fixedly and firmly on the top of the vessel, and lined inside with heavy timber. It revolves with the boat by the action of the water upon the rudders placed in the mouth of the radial tubes. It mounts four guns.—*New York World.*

COLOSSAL FRENCH FRIGATE.

A COLOSSAL iron-coated steam frigate, called the *Numancia*, has been launched at La Seyne, near Toulon. This leviathan is an iron frigate completely plated over a teak sheathing, and carries 40 guns of the largest calibre in a covered battery, besides some pieces *en barbette* on her upper deck. She is to be rigged as a sailing frigate, and her masts, of a single piece, were brought from the forests of California. Her engines are nominally of 1000-horse power, but the power may be increased to 4000-horses. Her coal-bunkers contain 1000 tons, and her crew will consist of 700 men. Her length on the deck is 288 ft., her breadth 52 ft., her draught of water 23 ft. She is supposed to be the largest iron-coated frigate afloat. Her iron plates are 13 centimetres thick, and weigh 1,300,000 kilogrammes. Her armour has been tried against the heaviest shot, and is supposed to be bullet proof. Notwithstanding her great weight, which exceeds 7500 tons, it is expected that this frigate will possess extraordinary speed and great facility of manœuvring, in consequence of the immense power of her screw, as well as from her admirable lines. The *Numancia* was only sixteen months on the stocks.—*Mechanics' Magazine.*

IRONCLADS ON THE MERSEY.

Two iron-clad vessels, *El Toussoon* and *El Mounassir*, built by Messrs. Laird, it was suspected for the Confederate Government, but, undoubtedly, on French account, are described as two of the most formidable frigates afloat. They are 230 ft. over all, 42 ft. beam, with 19 ft. 6 in. depth of hold; tonnage, 1850 o.m.; horse power, 350. They will combine speed with good seagoing qualities. They are very flat-bottomed, with exceedingly fine ends, and will sit low in the water. Their draught when loaded will be about 15 ft.; estimated speed, 11 knots. The stem is so formed that the vessel may be used as a ram, and the stern, which overhangs, affords protection to the screw and rudder from shot or collisions. The rig is that of a bark, the masts, which are telescopic, and the lower yards, being of iron. The armour-plating on the sides of the vessel is 4½ inches thick amidships, and rather less at the ends. The plates, the joining of which together is imperceptible, are fitted into a teak backing of great strength. The deck is of 5in. teak, protected with iron. The bulwarks let down in case of action, in order to allow the turret guns to fire over them. They have two cylindrical turrets on Captain Coles's principle—one before and the other abaft the engine-room, heavily plated. These turrets are made for two guns each. The pilot-house is formed of teak and iron. At either end of the vessel are raised decks, which afford excellent accommodation for the officers and crew. In the captain's cabin provision is made for two heavy stern guns, and heavy guns can be trained from the forecastle deck. These vessels have capacity for 300 tons of coal. All the machinery is below the water-line.

THE GREAT EASTERN STEAM-SHIP.

THE unprofitable results of the strong exertions of the Great Ship Company are thus stated in a late Report of the Directors. While the number of passengers conveyed across the Atlantic exhibits satisfactory progress, the earnings from this as well as from the freight have been materially reduced by the severe competition between the two great rival companies that has been carried on throughout the season, as will be seen in the following table, from which we have merely struck out the shillings and pence :—

Date of voyage, 1863.	Number of Passengers.		Actual receipts of freight and passage-money each voyage.	Receipts of freight and passage-money as they would have been at rates of August, 1862.
	Out.	Home.		
May	564	388	£14,312	£17,900
June	1033	323	11,810	18,730
August	1139	248	11,186	20,585
			£37,308	£57,223

The report especially alludes to the accident off Montauk Point, to which the present unfortunate state of affairs is chiefly attributable, from the delay and heavy expenses attending the repairs. The hurricane with which the ship had to contend on her last outward passage to New York was the subject of much comment by some of the passengers, who appear to have been more frightened than hurt. It is also specially stated that, although she laboured considerably in consequence of the partial disablement of her paddle-wheels in the earlier part of the passage, no injury resulted to her hull or machinery, nor is the slightest symptom of straining observable in any part of the vessel. From the accounts, it appears that the expenses of the *Great Eastern* during the past season were about 20,000*l.* in excess of her earnings, and, by a curious coincidence, is the difference between what the ship earned in her three voyages this year at the reduced rates, and what she would have earned under those of last year.

THE WARRIOR IRON FRIGATE.

In November last, this noble iron frigate, 40, Capt. Arthur C. Cochrane, C.B., was inspected, when the following was stated to be the condition of her hull and machinery :—

Every part of the structure—frame, fastenings, and plating—has been found in the most perfect condition ; even the sleepers on which rest the huge boilers and machinery bear about them the same appearance of massive strength and solidity as on the day they received the first portion of their weights, and it is believed they have not moved a hair's breadth from the line of their original position. The whole structure of the hull is thus, as far as can be reasonably asserted under the unavoidable circumstances of a partial inspection, as sound as on the day the vessel was first sent afloat from her builder's yard. From published reports, the public know that the *Warrior* has seen a good deal of rough weather since she has been commissioned : and indeed, as an example of the kind of weather she has at times had to contend with, it may be mentioned that on one occasion she took a sea on board of such volume, that the stokehole itself was swamped, every gauge-glass in front of the boilers broken, and the whole place filled with steam, hot ashes, and water. It has been the care of the Admiralty to officer the *Warrior* as carefully below as on deck, and in the midst of the confusion occasioned by this sudden invasion of sea-water the men were kept steadily to their work, and the ship continued her progress without a check. The present state of the *Warrior's* hull, therefore, showing as it does, such unequalled excellence of material and workmanship, must be a matter of great pride and gratification to both the Admiralty and the Thames Ironworks Company. Since coming into harbour every bearing of engine, shaft, and screw, has been most minutely and carefully examined, and not a defect of any kind, however slight, has been found to exist. On the contrary, these parts are more perfect, perhaps, than when the engines were first put together, for whatever of roughness or unevenness might have existed then, has now been worn down to a polished smoothness, and friction has been reduced to the minimum point. With reference to Trachsell's ozone gas, now in use in the engine-room and screw-alley of the *Warrior*, the gas being 28 times heavier than common air, a current of air becomes necessary to carry it to the burner. This is obtained by a double India-rubber bellows or blower, worked by a weight and geared wheels, which carries a current of air equal to 12 33 cubic feet per hour, or 148 cubic feet in 12 hours, absorbing 307·469 cubic inches of ozone—equal to 1·102 gallons for 15 lights for 12 hours—each light being equal to that of three composite candles at eight to the pound. The cost of lighting the engine-room and screw-alley with 15 of the ozone lights for 12 hours is 4s 5d., against 16s. 4d. for 33 oil and candle lamps, the ozone gas giving 11 per cent. more light. With regard to the *Warrior's* general efficiency as a man-of-war, there can be no doubt that she holds now, as she has held from the first hour of her launch, the foremost place in our navy. Her acknowledged faults consist in her extreme length, great draught of water and deficiency in turning power, faults which certainly render her services unavailable in narrow or shallow waters. Her pre-eminent virtue consists in her speed, at present unparalleled by any ship-of-war afloat. The *Defence* and *Resistance* class are more manageable under steam in any confined space, but they do not possess anything like the speed of the *Warrior*, and therefore their favourable points are nullified. The main-deck guns of the *Warrior* are undoubtedly as heavy as can be worked in a seaway on the broadside of our present iron-clads, and they can inflict no great injury during a naval action on the plates of a ship clothed with 5-in. armour. These facts speak strongly for the introduction of a more powerful gun into the navy—one, in fact, which shall crush an enemy's plate, in lieu of making as the 68-pounder does, simply an indentation of about an inch and a quarter in diameter.

We believe that at the present moment our Admiralty is engaged, on the designs of Mr. Reed, in the construction of a vessel which is expected, with a fifth of the *Warrior's* tonnage, to carry the full thickness of the *Warrior's* armour, and to solve the problem of an effective iron-cased ship which shall be neither immoderately large nor immoderately expensive.

"THE VALIANT" IRON-CLAD.

This important addition to our iron-clad fleet, constructed by the Thames Shipbuilding Company, was launched in October last. The *Valiant* is one of quite a new class of iron frigates—a connecting link, so to speak, between the *Warrior* and the vessels of the *Defence* and *Resistance* class. Her length over all is 280 ft., her extreme breadth 56 ft., and her depth, from her spar-deck 39 ft. Her armament of 34 guns will be distributed as follows: —On the main deck twenty-four 68-pounders, 95 cwt. smooth-bore guns, and six 110-pounder Armstrong guns; and on the upper deck four 110-pounder Armstrong guns, which will be furnished from the Royal Arsenal.

Her bows, without having a regular beak to be used as a ram, are still sufficiently projecting beneath the water-line to enable her, if she got a chance of striking an enemy, to inflict fearful mischief, without in the least risking the safety of her own hull. She is a sister ship to the *Hector*, which was launched from the Clyde at the close of last year. In the construction of the hull the principle is the same as that of all the iron frigates—that is to say, the *Valiant*, within her armour of teak and iron, is a perfect web of wrought-iron ribs and longitudinal girders. Like the new frigates, however, she is to be plated from stem to stern in armour, the stern being almost as fine as her bows, and with an additional plating of iron over her outer sternpost and rudder-head. About eighty feet from the bows inboard she is fitted with a semicircular shield, which extends from one side of the vessel to the other, and rises from the main deck to the level of her bulwarks on the spar-deck. This is coated with 4½-in. armour-plates, and lined with teak as with the broadside. On the main deck it is closed; but on the upper deck it is pierced for two of the heaviest guns, for use in chasing an enemy, or when bearing down on one to strike her as a ram. Her armour-plates are manufactured at Messrs. Brown's works, Sheffield.

The *Valiant* will be fitted with horizontal engines, of 800-horse power, by Messrs. Maudslay, Sons, and Field. The two-bladed screw propeller is 20 ft. in diameter, and is constructed with a variable pitch. When in full power, it is anticipated that the engines will work about sixty revolutions in the minute. There are six boilers, three on each side, the stoking-room being between them; and the ship is also fitted with a pair of auxiliary engines, of the aggregate power of forty horses.

THE FIRST STEAM-BOAT IN ENGLISH WATERS.

(*To the Editor.*)

Invercurgill, New Zealand,
Oct. 9, 1863.

In the *Year-Book of Facts* for 1863 is an extract from the *Dumbarton Herald*, relative to the first steam-boat on English waters, which is alleged to be the *Margery*. Allow me to say, as one who has carefully investigated the subject, that this is incorrect, as I shall presently show. George Dodd (son of Ralph Dodd, a well-known and enterprising engineer), from 1814 to 1828 had perhaps more to do with establishing steam-boats on the Thames, than any other individual. He it was who started the *Richmond* packet, in 1814, of 60 tons, and 14 h.p., between Richmond and London, which was the first steam-boat that, at all events, succeeded in plying for hire on the Thames; for it was tremendous uphill work contending against the Watermen's Company, who for a long while succeeded in preventing any steam-boat plying for hire, unless navigated by free watermen. The *Richmond*, however, was not the first steamer seen on the Thames. Sir Marc Brunel, as may be seen in his Life by Beamish, previously made a voyage to Margate in a boat of his own, propelled by a double-acting engine, and met with much opposition and abuse, the landlord of the hotel where he stopped, actually refusing him a bed. In 1813, according to Stuart, in his *History of the Steam-engine*, a Mr. Dawson, an Irishman, and Mr. Laurence, of Bristol, attempted to run steamers on the Thames, but succumbed to the opposition of the Thames watermen. The *Margery* commenced running in 1815, and only ran for a short time. She was constantly breaking down ; and on reference to a work of Dodd, published in 1818, it will be seen that the *Margery* was sold to the French Government. Dodd, in 1815, went to Glasgow, purchased a steam-boat called the *Argyle*, renamed her the *Thames*, and navigated her all the way from the Clyde to the Thames, calling at Dublin and Milford. This was the most wondrous feat of the day. SAMUEL DARTON.

TURRET SHIPS-OF-WAR.

THE *Royal Sovereign* is now being converted into a turret-ship at Portsmouth Dockyard, which induces us to detail the machinery of her turrets ; and also to give a general idea of their construction with their frame of T-shaped iron ribs projecting from the inner skin, and filled in with teak, the iron lattice-work outside both, embraced in its turn by the teak cushion on which rest the 5½in. armour-plates.

The *Royal Sovereign* is being fitted with four turrets, the one forward being the largest of the four, and intended to carry two 300-pounder smooth-bore guns ; while the three others will be of less diameter, and will carry only one gun each of the same calibre. From the inner skin of the turret, formed of ½-inch boiler plate, project outwards iron ribs T-shaped, 10 inches in length and 20 inches apart, the spaces between these ribs being filled in solid with teak. Round the outer circumference of this combination of teak and iron ribs, is a crossed trellis-work of ¾-inch iron, and on this trellis-work, and through all and outside all is bolted 8 inches of solid teak. Round the outer surface of the turret on the 8-inch teak cushioning are laid the solid 5½-inch rolled armour-plates, bent, immediately on leaving the rolls, to the required segments of a circle, at the Parkgate Works, Yorkshire. In the immediate front of the turret or vicinity of the two ports, however, the resisting power of the 5½-inch armour-plate is further supplemented by a 4½-inch rolled plate, so that in the section of the turret's entire circumference which will be exposed to the shot of an enemy, the defensive powers of the turret will consist of, from outwards, 10½ inches of iron, 3½ inches of teak, 5 inches of ¾-inch iron trellis-work, 10-inch iron T-shaped ribs filled in with teak, and the inner iron skin. The outer circle of armour-plates is bolted, or "married," as we believe it is technically expressed, round the turret's upper rim, to a massive iron ring 19 feet in diameter, 14-inch by 2-inch iron, and weighing 2 tons 9 cwt. This part of the turret's defence will extend to just beneath the upper deck, but is strengthened and protected by a massive iron rim, wrought in sections, and riveted together in the strongest possible manner; the armour-covered portion of the turret projecting above the upper deck and, with the rim, being together in shape exactly like a broad-brimmed coachman's hat of the olden times. The turret itself, of course, rests with the guns and their carriages upon a massive circular platform or turn-table, the outer rim of which is fitted with a ring-road of stout iron teeth, by applying to which a cogwheel, worked by a winch by either eight or less men at the handles, as may be required, the turret is made to revolve upon the machinery below. During a visit of the Admiralty to Portsmouth, the foremost turret, complete in all respects except its armour-plating, which, however, was represented in weight by its equivalent in pigs of iron ballast, revolved in a complete circle in 4 min. 40 sec. with eight men at the winch handles; and in the presence of Mr. Reed, Chief Constructor of the Navy, a quarter circle was turned and back again the same distance in one minute. Subsequently, however, with eight men at the winch handles, it turned a quarter circle in 23 sec., or a complete circle in 1 min. 32 sec., thus enabling the two guns in the turret to be brought to bear from one broadside to the other in 46 seconds.

The *Royal Sovereign's* turret "machinery," with the bed upon which it rests, we will now endeavour to describe, premising that the diameter of the turret is less than that of the turn-table or the machinery upon which the turn-table revolves. Level with the ship's lower deck, or, as it now must be, her main and lower deck both, upon upright timbers, from the ship's keelson, are laid logs of teak about 20 inches square, and extending over a space of nearly 80 feet in circumference. On these square timbers has been constructed the bed proper which supports the turret, turn-table, and machinery. It is in appearance a gigantic cartwheel, 26 ft. in diameter, the nave and periphery being constructed of English and American oak, the periphery entirely of banded strips of American, and the spokes of English oak. The periphery of the wheel measures 24 in. by 12 in., and the spokes each 18 in. by 12 in., all fitted with the nicest accuracy and bolted down immovably to the square logs of timber resting on the uprights underneath. The axle to this monster wheel exists in the iron cylinder, which will give entrance to the magazine below from the turn-table, and which, 26 in. in diameter, 7ft. 6 in. in length, and 3 tons each in weight, are fixed upright through the centre of the wheel's nave; two cast-iron collars, each 6 ft. in outer diameter, and each some hundredweight, being fixed, one on the upper and the other on the under side of the deck, and securing the axle or cylinder thus in its position immovable as a rock. The upper part of this cylinder, therefore, projects upwards of 2 ft. from the wheel's nave, and becomes the pivot upon and round which the turn-table and turret revolve. From a brass collar which encircles this cylinder, next the nave of the wheel, radiate outward 24 iron rods, on the outer ends of which are fixed 24 beveled iron wheels, 18in. in diameter and 19in. broad, and which, set in a double circular iron framing, work round a metal roadway laid on the periphery of the wheel, a second brass collar round the cylinder being fitted with a set of small brass beveled wheels, the turn-table thus fitting over and round the cylinder or axis, and resting with its inner circumference on the small brass rollers which encircle the cylinder, and its outer circumference upon the 24 beveled wheels which work upon the iron roadway laid upon the periphery of the wheel. Every part connected with the iron-work of the turret, executed under the superintendence of Mr. A. Murray, Chief Engineer to the Admiralty at Portsmouth, is very massive in its character, and is beautifully finished, and, so far as any judgment may be formed at present, there is nothing to suggest the slightest fear of the *Royal Sovereign's* turrets revolving freely under the heaviest storm of shot that can be brought to bear upon them, or under circumstances of the greatest possible inclination which may be given to the ship's deck in the roll and tumble of a channel sea.

The side armour of the ship, 5½in. plates, from the Atlas Works, Sheffield, is supported behind by 3ft. of solid timber, which is strengthened and supported in its turn by alternate wood and rolled iron beams, placed at one-half the usual distance apart, to each of which iron knees of great weight are attached, and by the cross diagonal iron banding over the inner skin of the ship.

The alternate wood and iron beams are covered with 1 in. iron plates, all of which at their butts and edges are riveted together with 4 in. straps of 1 in. iron. Stringer plates also run fore and aft this iron deck. Over all this iron is now being fixed the upper deck proper of the ship, which consists of 6-in. oak plank, and over a certain circumference of this oak planking, in the immediate vicinity of each turret, will be fixed the ring of tapered armour plating, which will form the glacis of each turret at its base. The ship, owing to the fact of her having been converted from a Symondite three-decker, will necessarily draw too much water to manœuvre close in with the shore in shallow waters, but she will doubtless be, when completed (if armed with guns equivalent in their power to the American Monitors), the most formidable ship-of-war in the English navy, whether for purposes of offence or defence.

Such is the *Royal Sovereign*, the first of England's turret ships, a vessel that, if armed with weapons of offence equal to her defensive powers, may stand a favourable comparison with the best of the American Monitors. When completed and ready for service, however, it might be a wise act to take her outside the Wight, and give each of her turrets a concentrated broadside of 68-

pounders from a steam-frigate going past at full speed. Such an experiment, startling as it may seem at first sight, would most probably save the country some millions sterling during the next few years, whether the *Royal Sovereign* proves to be a successful or unsuccessful experiment as our first turret ship. We, however, believe she will prove the former.

The *Royal Sovereign* is destined to be an experimental ship in more ways than one, as in her will be tested for the first time the merits of a newly patented system of self-acting ship ventilation invented by Dr. Edmonds, staff-surgeon on board Her Majesty's ship *Victory*, which professes not only to furnish an ample supply of pure fresh air to the crew, but also to effect the very important object of preserving the ship's timbers from decay or dry-rot, by creating a constant circulation of air throughout the framework of the ship. This is effected by converting the timber spaces from the keel upward, between the "ribs," so to speak, of the ship into draught channels leading into a tunnel-shaft fore and aft on each side of the ship's berthing deck, which communicates by cross shaftings with the funnel, the draught of the funnel furnishing the motive power for the suction of a continuous current of air upwards through the ship's timbers, and carrying off the foul air and gases from the ship's hold and bilges without tainting the air the crew breathe on the berth deck.—*Abridged from the Times.*

The *Rolf Krake*, built by Napier and Son, for the Royal Danish navy, is of peculiar construction, being low in the water and of considerably greater breadth than is usual for vessels of her length. She has been built from plans approved by Captain Coles, the inventor of the cupola war-ship. Her length is 185 ft., breadth 33 ft., depth 14½ ft., tonnage 1246 tons. Her engines are of 240 horse-power. She is only some 5 ft. above the water-line, with bulwarks to fold down in action, and she displays two revolving cupolas rising 4½ ft. above the deck, and 21 ft. in diameter. She is armour-plated from stem to stern, the plates being 4½ in. in thickness, and increasing to 7½ in. at the port-holes, with the addition of 9 in. of teak lining inside. Her armament will be four 68-pounders—two in each tower, worked from the inside. The deck is entirely clear of obstruction, excepting the funnel and a small fixed tower aft for steering the vessel; in fact, the whole work is done under cover of armour-plates, and she appears as one piece of solid iron from stem to stern.

IRON-CLAD FRIGATES.

THE various iron-clad frigates must apparently differ not less in speed than in size, not less in outward form than in the thickness of their armour-plating. Though all have the same object in view, nearly every one is built on a different plan. According to Mr. Reed's theory, the size of the class of *Warriors* at present afloat is a radical and dangerous error, and the Admiralty reply to this by building still larger ones, but leave themselves a loophole of escape by at the same time constructing one of Mr. Reed's size and plan, which is utterly opposed to their own. The experience of *La Gloire* and the wooden armour-plated ships of the French navy is considered by scientific men both here and there to be conclusive against that method of construction. So we are building them rather extensively, though the trip of the *Prince Consort* points ominously to the result we may expect. Captain Coles says virtually that all but cupola ships are wrong, and that his will knock Mr. Reed's "into a cocked hat." So cupola ships are being built also. Now it is being said that the iron-clads built by Mr. Laird in the Mersey—vessels of only 1800 tons, but carrying 4-in. armour-plates—are the real things, after all, and that their form and build are the models which the Admiralty ought to adopt if they hope to prosper. Here, therefore, we have clearly six systems, with scarcely any single point of resemblance between the competitors, beyond that each agrees to decry the other as a costly and almost worthless sham. Of the *Minotaur*, the *Northumberland*, and the *Agincourt*, the *Minotaur* has been launched, and, with the *Northumberland*, is described as by far the strongest wrought-iron fabrics that have ever been riveted together since wrought iron was first used by man. It is unnecessary to recapitulate in all their technical detail of ribs and girders the manner in which the *Minotaur* is welded into one piece from end to end. She is the first launched of the new class of *Warriors*—4½ in. of iron and 18 in. of teak; the *Minotaur* and *Northumberland* class are 5½ in. of iron and 9 in. of teak. The reduction of the timber and increase of the iron were at the time rather hastily made, and against the advice of many competent to give a judgment on such matters. Since then, however, it has been shown that the thickness of the backing to the armour-plates is to the full as important as the thickness of the armour-plates themselves, and the *Minotaur* target tried at Shoeburyness failed, to say the least, to realize the expectations which were formed of its powers of resistance. Opposed to a vessel of the *Minotaur* class, *Big Will*, it is now evident, would have no difficulty in sinking it with a couple of shots. In size and estimated speed, however, the new class frigates are an improvement on the old. They are 20 feet longer than the *Warrior*, and will have engines of 100 nominal horse-power greater.

GIGANTIC SHEERS.

THESE monster iron sheers have been erected in the Southampton Docks, under contract, by Messrs. Day and Co., of the Northam iron works. They are of the following dimensions:—Length of the front legs, 110 ft.; length of the back leg, 140 ft.; power of the engine to work them, 20-horse power; proof strains to be 100 tons vertical lift, and 80 tons with an overhang of 35 ft. from the dock wall. The whole of this work has been successfully carried out under the superintendence of Mr. Alfred Giles, the Dock Company's engineer. The enormous bundles of rail iron, forming the testing weight of 100 tons, were raised from the railway trucks, which run under the sheers, and deposited on the quay; after which 80 tons were lifted and run out 35 ft. from the dock wall, and brought back again in a remarkably quick and satisfactory manner. This is effected by an improvement introduced by Mr. Thomas Summers, of the above-named works, in the construction of sheer-legs, which renders them simpler and easier to work than those on the ordinary plan. In the new sheers the back leg is made to act both as a prop and a guy to the front legs, and its bottom end slides in an iron groove strongly bolted to its foundation. The movement of the back leg along this groove is effected by a powerful wrought-iron screw, 43 ft. long and 8 in. diameter, and worked by the same steam-engine as is used to work the hoisting gear. The length of the groove is 48 ft., and the sheers are run either in or out in about four minutes. The rate of hoisting for weights up to twenty tons is about 12 ft. per minute, and for heavier weights a more powerful purchase is used, giving a rate of from four to six feet per minute. It is believed that no direct lift of 100 tons has ever been made before by one apparatus.—*Times.*

CHARING-CROSS RAILWAY BRIDGE.

THIS novel railway construction has been described to the Institution of Civil Engineers by Mr. Harrison Hayter.

It was stated that the bridge consisted of nine spans,—six of 154 ft. and three of 100 ft.—the centre opening of the Hungerford Suspension-bridge having been divided into four spans each of 154 ft., that on the Surrey side into two spans also of 154 ft. each, and the opening on the Middlesex side into three spans each of 100 ft.—the superstructure over the latter being fan-shaped. The width of the river, at the side of the bridge, was 1350 ft. The greatest depth of water between the two brick piers of the original bridge was 13 ft. below low-water spring tides, and the average depth was about 9 ft.; the rise of spring tides being 17¼ ft. The level of the rails was 31 ft. above Trinity high-water mark, and there was a clear minimum headway under the bridge of 25 ft. above the same datum.

The superstructure was carried by cylinders sunk into the bed of the river, and by the piers and abutments of the suspension-bridge, the abutments having been considerably lengthened The cylinders, excepting at the fan end, were 14 ft. diameter below the surface of the ground, and 10 ft. diameter above, the junction between the two sizes being effected by a conical length. There were four piers formed of these cylinders, each consisting of two cylinders, 49 ft. 4 in. apart from centre to centre. They were of cast iron, 1⅛ in. in thickness throughout, and the circumference was divided into segments, with interior flanges round all the edges, through which the segments were bolted together; and a horizontal interior rib was also cast in the middle of each segment. There were thus continuous vertical lines of ribs, securing a strong columnar arrangement.

The strata through which the cylinders were sunk consisted of mud and gravel, of varying thicknesses, overlying the London clay. The sinking was effected by excavating the material from the inside—at first by divers, but after the London clay was reached and the water was pumped out, in the ordinary way—and by weighting the cylinders, to an average load of 150 tons each. These cylinders were sunk to depths of 52 ft., 62 ft., and in one case to 72 ft., below Trinity high-water mark. They were filled with Portland cement concrete up to where the conical length commenced, and above with brickwork, set in Portland cement mortar, to the underside of the granite bearing blocks, which were 2 ft. 6 in. in thickness, and projected 1 in. above the top of the cylinders, in order that the weight might not come on the upper edge of the ironwork. With a view of testing the strength of the foundations, the two cylinders in the pier nearest to the Surrey side, after being completed up to the level of high water, and filled with concrete and brickwork, were each weighted with 700 tons, being about equal to the greatest load they could possibly have to sustain, supposing the four lines of rails on the bridge to be loaded with locomotive engines. This caused the cylinders to sink permanently 4 inches. To bring the other cylinders to a bearing, so as to prevent any settlement after the completion of the bridge, from the weight of the permanent and moving loads, they were each weighted with 450 tons, when it was found that they permanently sank, on an average, 3 in. each. Each pair of cylinders forming a pier was connected together transversely by a wrought-iron box girder, 4ft. deep, which also served as a cross-girder for supporting the roadway. Assuming the four lines of way on the bridge to be loaded with locomotive engines, the pressure on the base of the cylinders would amount to eight tons per square foot, and on the brickwork at the top of the cone to about 9 tons per square foot.

The superstructure of each of the 154-feet openings consisted of two main girders, to the under-side of which were suspended cross-girders for carrying the roadway platform. These cross-girders extended beyond the main girders, and formed a series of cantilevers on the outer sides, for supporting two footpaths, each 7 feet wide in the clear. The main girders were of wrought-iron, and were not continuous, but extended only over one opening. Each girder had to support, inclusive of its own weight, a maximum distributed load of 750 tons. The extreme depth of these girders was 14 feet, and the depth between the centres of gravity of the top and bottom members was 12 feet 9 inches. The sides of the girders between the bearings were divided into fourteen equal parts by a pair of vertical bars, connected to the top and bottom by pins of puddled steel, 7 inches diameter at the ends of the girder, decreasing to 5 inches diameter at the centre; and each division contained a double set of two diagonals crossing each other. The top and the bottom of these girders were of boiler-plate, and consisted of horizontal tables 4 feet and 3 feet wide respectively, and of four vertical ribs, the two outer rows being 24 inches deep, and the two inner rows 21 inches deep. The aggregate thickness of the plates in the horizontal table of the top in the centre of the girder was $3\frac{1}{8}$ in., and in the bottom $3\frac{13}{16}$ in., without the angle-irons, and of $4\frac{1}{8}$ in. and $4\frac{13}{16}$ in. respectively with the angle-irons, but exclusive of the angle-iron covers. It was arranged that, with the greatest load, the maximum strains should not exceed 4 tons per square inch in compression, and 5 tons per square inch in extension. All the rivet-holes were drilled by machines capable of drilling several holes at one time. This plan was, under the circumstances, less costly than punching, besides which a great saving was effected in putting the work together. The diagonals acting as ties were of Howard's rolled suspension links, each separate tie being composed of two or three links, as required, riveted together. The diagonals acting as struts were each in one solid forging, and were united together in pairs by zigzag bracing of wrought iron. In the centre of the girder, where the diagonals acted as both struts and ties, the pairs were united together in the two central spaces by the zigzag work. The dimensions of the struts varied from 12 in. by 3 in. at the ends to 6 in. by $2\frac{1}{2}$ in. in the middle, and of the ties from 12 in. by $2\frac{1}{2}$ in. at the ends to 6 in. by 2 in. in the middle. The ends of the girders over the piers were boxed in with plates $\frac{3}{8}$ in. thick, stiffened by angle and T irons. Over the cylinders the girders rested on sheet-lead, laid upon the granite blocks. On the brick piers and the Surrey abutment they rested upon roller bed-plates. The girders were put together in place on a staging, the upper and lower platforms of which were accurately adjusted to the proper camber. The whole of the plates were drilled, and the struts and ties were completed before being sent to the works. The weight of each main girder was 190 tons. One of the main girders was tested when in its place with a distributed load of 400 tons, when the greatest deflection observed was $1\frac{5}{16}$ in., and the permanent deflection after the load was removed was $\frac{1}{2}$ in.

The cross girders of the 154 ft. openings were of wrought iron, and were generally similar in character to the main girders, from which they were suspended at intervals of 11 ft. apart, from centre to centre. They were 4 ft. deep in the middle, and 2 ft. $1\frac{1}{8}$ in. deep where the cantilevers were united to them outside the main girders. The top and bottom consisted of two plates, 18 in. wide by $\frac{5}{8}$ in. thick, the sides being of lattice bars united to the top and bottom by angle-irons. The cantilevers decreased from 2 ft. $1\frac{1}{8}$ in. at their junction with the cross girders to 1 ft. 2 in. deep at their extremities. Each cross girder, including the two cantilevers, weighed 9 tons. When two of these cross girders, without the cantilevers, were tested with a load of 140 tons, equivalent to 70 tons on each girder, the maximum deflection in the centre was

1 in., and the permanent deflection when the load was removed was ¼ in.

The superstructure of the three 100 ft. openings of the fan end was supported by the brick pier and abutment on the Middlesex side of the suspension bridge, and intermediate to these by two rows of seven and of nine cast-iron cylinders respectively. These cylinders were 10 ft. diameter below the ground level, the outer ones being 8 ft. diameter, and the inner ones 6 ft. diameter above that level. They were sunk to depths averaging 40 ft. below Trinity high-water mark, and were filled with Portland cement concrete to about 5 ft. above that level; but it was not considered necessary to fill in the remaining portion of these cylinders. On account of the great width of the fan end, which increased from 49 ft. 4 in. at the brick pier to 168 ft. at the abutment, the plan of supporting the road-way on cross girders, suspended from outside main girders, was inadmissible, and as it was not desirable to introduce intermediate main girders, projecting above the line of rails, the roadway was carried by interior plate girders, laid at right angles to the piers and abutment, and by the outside main girders, which were laid at the angle of inclination of the fan. The outside main girders were of the same depth, and were generally of the same character, although lighter in all the parts, and were fixed at the same level as the girders of the 154 ft. openings. The interior plate girders were of the ordinary construction, 5 ft. deep, or one-twentieth of the span, and weighed 26 tons each. The triangular spaces between the outside main girders and the outer interior plate girders were filled in with cross girders, terminated by cantilevers, projecting beyond the face girders, and similiar to those outside the main girders of the 154 ft. openings.

The roadway platform over the 150 ft. openings consisted of planking 4 in. thick, spiked to longitudinal timbers, 15 in. by 15 in., placed underneath the rails, and bolted to the cross girders. Over the fan end, the platform consisted of planking 6 in. thick, secured to the girders. The footpath platforms were of planking 6 in. thick.

The first cylinder of the Charing-cross bridge was pitched on the 6th June, 1860, and its construction extended over a period of about three years. The weight of wrought-iron in the bridge including the steel pins, was 4,950 tons and of cast-iron 1950 tons. The total cost, including the abutments, would be 180,000*l.*, or 1*l.* 15*s.* per square foot, and 131*l.* per lineal foot. The cylinders of the 154 ft. openings cost complete 20*l.* per lineal foot; the outer cylinders of the piers of the fan end cost about 12*l.* and the inner ones about 10*l.* per lineal foot. The bridge was designed by Mr. Hawkshaw (President Inst. C E.), the engineer to the Charing-cross Railway Company, and was carried out under his immediate supervision, Mr. John H. Stanton being the resident engineer. Mr. George Wythes was the contractor for the construction of the railway, but this bridge was sublet to Messrs.

Cochrane & Co., whose representative on the works was Mr. Joseph Phillips.

But it is as an engineering work chiefly that the bridge is best worth notice, and presents some very curious features, one of these being the enormous strength concentrated both in the cylinder piers and in the girders in the smallest compass. The cylinders obtained for the column of brickwork built inside them afterwards, a foundation as solid as rock itself, and one not likely to be disturbed by any changes which may occur in the bed of the river by the scour which may be expected from the formation of the Thames Embankment, the scour being a source of evil which has hitherto proved fatal to the foundations of nearly all our metropolitan bridges. Again, with the superstructure, although the span is moderate, 154 ft., yet the quantity of metal required in each of these girders amounts to 200 tons, and the skilful way it has been massed together to afford the requisite strength, and yet give little indication of it in its light and almost elegant appearance, is certainly unsurpassed.

This account of the Charing-cross Extension would be incomplete, if we did not add that it is intended to connect the Charing-cross station by a double line of rails with the North-Western, Great Northern, and Midland lines. Fortunately, the level of the Charing-cross station, with regard to those termini, is such that an underground line in an open cutting, passing by tunnel under all the streets and under the Strand, can yet make its junction at a level into the Hungerford-bridge. With such an important link connecting the southern lines with the great systems north of the Thames, passengers can book through from Southampton, Dover, or Brighton, to any part of England or Scotland without changing carriages. The importance of such a saving of inconvenience and time will be understood by all travellers who know that to traverse London from the north to catch a southern train is, in point of loss of time, equal to 100 miles of rail added to their journey. In point of trouble and annoyance it is infinitely worse than 200.—*Proceedings of the Institution of Civil Engineers.*

An iron railway bridge is also in course of construction from the Southwark bank, opposite Cory's wharf, to Steelyard wharf, on the City side of the river. This bridge will be constructed of iron girders, supported on cast-iron cylinders. Its total length will be about 645 ft., and the width of the roadway, to carry 5 lines of rails, will be about 60 ft. It will not be provided with a footway for passengers; the roadway will be carried over the river on cylinders 12 ft. in diameter, filled with solid brickwork. Between these there will be five openings or waterways, each about 130 ft. wide, while the distance between high-water mark and the girders of the central span will be 25 ft. The engineer is Mr. Hawkshaw, and the contractors are Messrs. Cochrane, of Dudley Woodside. The estimated cost of this City bridge, which will be about half the length of that at Charing-cross, is about 120,000*l.*

INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following Premiums for papers read at the meetings during the session 1862-3 :—

1.—A Telford medal, and a Telford premium, in books, to John Brunton, M. Inst. C E., for his "Description of the Line and Works of the Scinde Railway."

2.—A Telford medal, and a Telford premium, in books, to James Robert Mosse, M. Inst. C.E. for his Paper on "American Timber Bridges."

3.—A Telford medal, and a Telford premium, in books, to Zerah Colburn, for his Paper on "American Iron Bridges"

4 —A Telford medal, and a Telford premium, in books, to Harrison Hayter, M. Inst. C E., for his Paper on "The Charing-Cross Bridge."

5 —A Telford premium, in books, to William Michael Peniston, M. Inst. C.E., for his Paper on "Public Works in Pernambuco, in the Empire of Brazil."

6.—A Telford premium, in books, to William Henry Preece, Assoc. Inst. C.E., for his Paper "On Railway Telegraphs, and the Application of Electricity to the Signalling and Working of Trains."

7.—A Telford premium, in books, to Alexander Woodlands Makinson, M. Inst. C.E , for his Paper "On some of the Internal Disturbing Forces of Locomotive Engines."

8 —A Telford premium, in books, to Daniel Miller, for his Paper on "Structures in the Sea, without Cofferdams—with a Description of the Works of the New Albert Harbour at Greenock."

9.—A Telford premium, in books, to Robert Crawford, Assoc. Inst. C.E., for his Paper on "The Railway System of Germany"

10.—A Telford premium, in books, to William Cudworth, M. Inst. C.E., for his Paper on "The Hownes Gill Viaduct, on the Stockton and Darlington Railway."

11 —A Telford premium, in books, to James Grant Fraser, M. Inst. C.E., for his Paper, "Description of the Lydgate and of the Buckhorn Weston Railway Tunnels."

NEW METHOD OF WORKING RAILWAYS BY STATIONARY ENGINES.

A PAPER by Messrs. Hawthorn, describing their new method of Working Railways by Stationary Engines, has been read to the British Association. Messrs. Hawthorn, after referring to other systems of working railways by fixed engines and ropes, in all of which the rope was attached to the carriage, proceeded to describe their method, as follows :—They propose with the ordinary construction and gauge of railway to place in the intermediate space between a double line of rails a series of doubled-grooved sheaves, fixed in spindles or axles, which pass across under the rails, extending a little over the centre of each line ; a plain wheel or roller is fixed upon each end of these axles by which the motion is communicated to the train from a stationary engine or engines placed at a convenient point of the line, by the means of an endless wire or other rope, passing alternately over and under the grooved sheaves to the extremity of a section of the line, where it is taken round a large loop-sheave and returned to the engine, now passing over each sheave which it before passed under, and *vice versâ*— the double groove providing for the rope crossing itself without contact. Having traversed twice along the line of sheaves, the rope goes again on to the large winding sheave of the engine, on which a sufficient number of turns are taken to ensure the requisite friction.

From this arrangement of the rope on the sheaves, it will be seen that every alternate sheave runs in the same direction, and every intermediate sheave in the contrary direction; and this motion is communicated to the traction wheels or rollers before mentioned. It is proposed to construct the carriages for passenger lines on the principle of those used in America and on the Canadian railways, of a length of from 60 to 75 ft., and supported on bogies, and capable of seating from 120 to 150 passengers, each carriage to be fitted with traction bars—these bars extending over two or more alternate traction rollers—and to be furnished with the ordinary flanged wheels for running on the rails. The traction bars, of which there are two, are placed side by side, at such a distance from each other as may be necessary to meet the requirements of the line; and these traction bars are worked either in connexion with or independent of each other by a suitable arrangement of levers or other gearing, by which either of the bars can be raised or depressed, thereby bringing a portion of the weight of the carriages upon the traction wheels or rollers, thus giving motion to the train of carriages in either direction; or both these bars can be raised out of contact with the traction wheels or rollers, and the train left free from all tractive force. The traction bars will be nearly the full length of the carriage, and the traction rollers will be placed about 18 ft. apart, or at the rate of 293 per mile. The carriage made in this way is adapted for running with either end first, being provided at each end with a platform, on which the driver stands to work the traction bars; and it is considered that for ordinary traffic one carriage will be sufficient to form a train, but two or more may be attached to each other, or the number of trains of a single carriage increased to meet the requirements of the traffic. The motion of the train can be quickly and certainly retarded or stopped by raising one bar and depressing the other, in the manner of a brake, thereby reversing the direction of the driving motion. A separate or independent traction carriage may be used, fitted with the traction bars and gear: but it is considered that such an arrangement would, in most cases, only be adding a useless and unnecessary weight to the useful portion of the train.

The present line of underground railway through London, from Paddington to Farringdon-street, is favourable to the use of the locomotive engine, where so much of the surface of the ground under which it passes is unoccupied by buildings, and readily admits of a good deal of open cutting and ventilation at the stations, which cannot be the case where the railway passes under the densely populated parts of a city, as those projected in London must do. In such cases it will be necessary to provide for working in a continuous tunnel of perhaps three or four miles in length, in which the steam and smoke of locomotive engines would prove obnoxious to a much greater extent than is experienced on the present line, which is only partially an underground railway. As there does not appear to be any means of remedying these evils, except at a very extravagant cost, it is believed that the new system may be introduced with advantage in such cases as are above referred to, viz. railways passing under large towns, or in situations where opportunities do not occur of having openings to the surface. The maintenance of the engines will be considerably less than with locomotives, to balance the expense of keeping in working order the sheaves, ropes, &c., which will cost more than an ordinary line. Both calculation and experiment on the adhesion required to propel a train remove any reasonable doubt of being able, by the new system, to obtain sufficient tractive force by the traction bars and rollers, and it is evidently quite feasible to increase this tractive force if required.

INDIAN RAILWAY PROGRESS.—THE BHORE GHAUT INCLINE.

THIS highly important railway communication has been opened in the Bombay Presidency; bringing the high lands of the Deccan—2000 feet above the sea level—into close connexion with the low lands of the Presidency, and with the town of Bombay itself; and thus converting the Deccan into a kind of suburban district for the citizens. The Bhore Ghaut Incline of the Great Indian Peninsula Railway has occupied more than seven years in construction, and during the greater part of that time there have been 45,000 workmen daily employed upon it. The incline is a series of tunnels through mountains of rock, and viaducts stretching across valleys, alternating with each other; each part a triumph of modern science and skill.

The incline reaches at one long lift the height of 1832 feet, the highest elevation yet attained by any railway incline. It is 15½ miles long, and its average gradient consequently 1 in 46·39. The highest gradient is 1 in 37, and the sharpest curve 15 chains radius. The tunnels are twenty-five in number, the greatest length of any of them being 341⅓ yards. There are eight viaducts, one consisting of eight arches of 50 feet and being 129 feet high, and another of a like number of arches with a maximum height of 143 feet. The quantity of cutting amounts to 2,067,738 cubic yards, and of embankments to 2,452,308 cubic yards. There are twenty-two bridges of various spans, and seventy-four culverts. The total cost of the works has been 1,100,000*l.* or 68,750*l.* a mile.

The construction of the incline was let by contract to Mr. Faviell during the autumn of 1855. In March, 1859, Mr. Faviell relinquished his contract, and the Company carried on the works under the management of their resident engineers, Messrs. Adamson and Clowser, until the following November, when Mr. Solomon Tredwell, to whom the contract had been re-let in England (in the previous August), commenced operations. On Mr. Tredwell's decease, shortly thereafter, Mrs. Tredwell conducted the business of the contract, until, in March, 1860, Messrs. Adamson and Clowser were permitted to resign the Company's service and accept the office of contractor's managers; Messrs. West and Tate being appointed resident engineers on the part of the Railway Company.

NEW STUPENDOUS RAILWAY BRIDGE.

AMONG the extensive railway works projected is the construction of a Railway Bridge across the Forth, to facilitate the communication between the Eastern Lowlands of Scotland and the North; the traffic at present passing either by the route of the Western Lowlands to the North, *i.e.*, *viâ* the Scottish Central Railway, to Stirling and Perth, or by a railway ferry at Burntisland, which is found expensive, cumbrous, and liable to detention. The point proposed to construct a bridge at first was Queensferry: but the Admiralty object to any structure which would prevent their ships passing to the anchorage above; while the depth of the water is also another reason why the only bridge permissible there should be a railway bridge. But the span of such a bridge would exceed anything hitherto known. Consequently, a point farther up the river had to be selected. The point which the Parliamentary notices state to have been fixed upon is a point about four miles above Queensferry, and is stated to be the point at which the Edinburgh and Glasgow Railway on the south side, and the Dunfermline Railways on the north side of the Frith, run nearest to the respective shores.

This new bridge is proposed to be constructed by an independent Company, who will afford running powers and facilities to all the railway companies choosing to make use of it. It is obvious that it must be used by the several lines running to the east coast from Edinburgh, and also, we should apprehend, by the Caledonian. These lines will all be able to reach the bridge by very short extensions.

This bridge, which will be built on about fifty piers, will necessarily be of great length—nearly as long, it is said, as the Victoria Bridge across the St. Lawrence. It will not, however, involve by any means the same cost of construction. The cost of the Frith of Forth Bridge is not estimated to exceed half a million; whilst the Victoria Bridge, which had to be exported, as it were, to Canada, cost nearly a million and a half.

VIBRATION OF RAILWAY TRAINS.

THE vibrations occasioned by Railway Trains passing through a tunnel formed the subject of experiments by Sir James South, made by him in 1847 over the Watford tunnel, in Cassiobury Park, the property of the Earl of Essex, in consequence of the attempt, in 1846, to run a line of railway through Greenwich Park in what seemed a dangerous proximity to the Royal Observatory. Suitable first-class apparatus was set up in an observatory erected for the purpose, so that night or day, if clear, an observer could have the reflected image of the star in the mercurial vessels ready to testify against the tremors caused by any train. In *The Proceedings of the Royal Society* Sir James has recently printed the result of his observations, thinking that, although all danger to the Observatory is past at present, yet that no observatory can now be considered secure from railway injury. He says that, "with the ordinary disturbance to which an observatory is liable (as wind, carriages, or persons moving near it), the reflected image of a star breaks up into a line of stars perpendicular to the longest side of the mercury-vessel. With increased agitation another line of stars perpendicular to the first appears, making a cross. With still more the cross becomes a series of parallel lines of stars; still more makes the images oscillate, and at last all becomes a confused mass of nebulous light. The first of these (the line) is not injurious to one class of observations; but the others are, and therefore the second (the cross) was taken as a measure of the beginning and end of injurious disturbance. Signal-shots were fired when a train passed the southern entrance of the tunnel, and a shaft 1162 yards from it. Hence the train's velocity was obtained, and thence its position at any given time." These observations led Lord Auckland, then First Lord of the Admiralty (1847), to say that "they would be quite conclusive if the question of carrying a tunnel through Greenwich Park were again agitated."

IMPROVED RAILWAY SIGNALS.

MR. W. PATERSON has described to the Scottish Society of Arts an improved Signal, and method of working single lines of railway without accident. The method suggested by Mr. Paterson was, carrying out the suggestion of Captain Tyler, in his report on the Winchburgh Railway accident, that main signals, as well as distant signals, ought to be placed at both ends of single lines; that distant signals, with the necessary gearing, be placed from 500 to 600 yards distant from each connexion; that main signals be placed at the point where two lines begin to converge to the point of junction, whether at crossing places or single lines, or where the double line is closed in one line. These last-mentioned signals it is proposed to improve by making them lock signals. The pointsman at either end would have full control of the respective distant signals, but not so of the main signals. In working, should an engine or train approach one end of the signal line, and the pointsman, finding that it could not be let on (he not being in possession of the handle for opening the main signal) then in that case he would turn the distant signal to caution, and thereby permit the engine or train to draw in between the distant and main signals, the former being turned to danger so soon as the engine had past within it—in that way protecting the standing engine or train—and then so soon as the pointsman received the handle of the main signal (which could be carried along the single line either by the engine-driver or by the guard of a train, or by a pilot-engine) he would open it and permit the train or engine to proceed.

Travellers on the Midland Railway, passing Kegworth, may have observed at that place a new Signal, which is likely to cause a revolution in this class of work. It consists of a clock, with a face 4 ft. in diameter, placed on the top of a column 15 ft. high. Only a quarter of the clock is shown, which is formed of ground glass, with red figures 0.5.10.15., and has only one hand. Attached to the clock is a rod connected with a treadle about 16 ft. long, which lies along the inside of one of the rails. On the train passing over the treadle it is depressed slightly by the wheel flange, and the clock hand is set at liberty and is so adjusted by a counterpoise that it turns to the figure 0. Immediately the train has passed over the hand begins again to mark the time up to 15 minutes, when it is stopped, thus indicating to the next train exactly how long up to 15 minutes the preceding train has passed the signal. The same clock works two faces, one for the up and one for the down line. The signal is illuminated at night. The simplicity of this signal is such, that it is almost an impossibility for it to get out of order, and it is so arranged that a passing train takes off all pressure from the clock, so that the great difficulty hitherto experienced in self-working signals is successfully overcome. The Midland Railway Company, who have erected the one above described, have every reason to be satisfied with the result of the experiment. It is calculated that when adopted, double the number of night trains may be safely passed over the line that can be passed over now. There can be little doubt that it will prevent a great number of accidents from trains running into each other, and placed at mouths of tunnels, will be of great service. The inventor of this ingenious contrivance is Mr. John King, lace manufacturer, Heanor.—*Mechanics' Magazine.*

DISTRIBUTION OF RAILWAYS.

A CURIOUS paper has been submitted to the French Academy of Sciences, by M. Lalanne, showing that the apparently fortuitous distribution of Railways over the surface of a large country is in reality subject to certain laws, which may be stated as follows :—1. The meshes of a network of railways, as their number increases, tend to assume a triangular form. 2. These triangles have a tendency to form groups of six each round a certain point, which, therefore, is the nucleus of a hexagon. 3. When a pentagon happens to replace the hexagon, there generally is a heptagon somewhere, which makes up the deficiency, so that the number six really represents the average number of lines starting from each point. 4. There are certain exceptional points, such as the capital of the country, towards which more than six lines converge; in this case the number of lines does not exceed 12. 5. In those districts where the network is still incomplete, there are centres from which only three lines diverge, instead of six; in that case they make equal angles with each other, thus leaving space for the three remaining lines. This strange regularity, now observable in the networks of France, England, and North America, depends upon a primordial law which Buffon calls the reason of reciprocal obstacles. Rivers, mountains, forests, or even the mere inequality in the productive force of different soils, have contributed towards the formation of these regular meshes. Among the consequences which M. Lalanne deduces from this theory of his, there is this,—that the distance between two agglomerations of population of the same order and near each other, must be an exact multiple of the distance between two agglomerations of an inferior order. Thus, the average distance between two capitals of departments in France is 87 kilometres; that between two contiguous *chefs-lieux d'arrondissements* is 43½ kilometres; and between two contiguous cantons, 14½ kilometres; so that the difference between two prefectures is equal to twice the distance between two sub-prefectures, six times that between two cantons, and twenty-four times the average distance between two communes. — *Galignani's Messenger.*

RAILWAY ROLLING STOCK.

THE number of Locomotives possessed by English Railway Companies at the close of 1862 was 5140; of passenger carriages 12,584; of other vehicles attached to passenger trains, 4891; of waggons or trucks used for the conveyance of minerals, live stock, and general merchandize, 153,589; and of other carriages or waggons, 4270—making a total of 180,474. At the same date the number of locomotives at work on Scottish railways was 885; of passenger carriages, 1,854; of other vehicles attached to passenger trains, 623; of waggons or trucks used for the conveyance of minerals, live stock, and general merchandize, 27,952; and of other waggons, 188—making a total of 31,503. The railways of Ireland, again, possessed at the same date 373 locomotives, 927 passenger carriages, 423 other vehicles attached to passenger trains, 5513 waggons or trucks used for the conveyance of minerals, live stock, and general merchandize, and 309 other waggons—making a total of 7545. We thus arrive at a total for the United Kingdom of 6393 locomotives (which, at 2600*l.* each, would represent a capital of 16,634,800*l.*), 14,565 passenger carriages, and 197,758 vans, trucks, &c.—making a combined general total of 218,716. The value of this immense plant must be estimated at 40,000,000*l.* It may be added that each mile of railway in England possessed last year 22 vehicles of various kinds (including locomotives), while each mile in Scotland had only 18, and in Ireland barely 5. A comparison of this kind affords a valuable means of forming an estimate as to the relative productibility of English, Scotch, and Irish railways.

RAILWAY STATISTICS.

The traffic receipts of Railways in the United Kingdom amounted, for the week ending the 5th of December, 1863, on 11,028 miles, to 563,720*l.*, and for the corresponding week of the previous year, on 10,578 miles, to 517,950*l.*, showing an increase of 450 miles, and of 45,770*l.* in the receipts.—The cost of repairing and renewing the rolling stock of our different railways, is 1,243,714*l.* per annum, or about 8¾ per cent. of the total expenditure of the companies. This sum does not, in all cases, include the cost of repairing the locomotives. If we value the entire rolling stock at 27,000,000*l.*, and deduct (say) 10,000,000*l.* as the cost of the locomotive engines, the value of the wooden rolling stock will remain at 17,000,000*l.*; and upon this amount the annual depreciation is (say) 1,250,000*l.* It is not to our credit as machinists that foreigners have paid much more attention to these things than we have. On various parts of the Continent carriages are to be seen far more elegant in form and finish, and of very much less weight, than our heavy passenger vehicles. In America, passenger-carriages, mails, and goods-vans, are now very generally built of plates of corrugated and ridged iron, and such carriages ("metallic cars," as they call them) are said to be stronger, considerably lighter, cleaner, more comfortable at all seasons, more durable, and less affected by noise than wooden vehicles. The cost of iron in this country is so much below that in America, that anything that could be produced at a selling price on that side of the Atlantic might certainly be produced here at even a less rate. Iron-framed passenger-carriages have already been constructed in this country; it might be well if the principle were more largely tried.—*Builder.*

PNEUMATIC DISPATCH TUBES.

Of this new mode of transit we gave some details in the *Year-Book of Facts*, 1862, p. 72; and 1863, p. 59. In November last, the Company were about to lay down an enormous tube for the transmission of letters and parcels from their station in Holborn to a station to be established near the General Post-office, in St. Martin's-le-Grand. A tube of that kind already exists between the North-Western district post-office, in Eversholt-street, and the Euston terminus of the London and North-Western Railway, and the letters have been carried between those parts since the beginning of February, 1863. It was as above proposed to lay a tube from the Euston Station, through Woburn-place, Southampton-row, and King-street to Holborn, and thence along Holborn, Skinner-street, and Newgate-street, to the General Post-office. This tube is to be of cast iron, 4 ft. high and 4 ft. 6 in. wide, internally. At the city boundary it was to be 11 ft. 6 in. deep, and at Hatton-garden 18 ft. 6 in., from which point its depth decreases; the tube to pass over the Fleet sewer at a depth of 6 ft., and then under the London, Chatham and Dover Railway. At the west end of Newgate-street it was to be 25 ft. deep, and at the east end 14 ft.; its mean depth in St. Martin's-le-Grand being 12 ft. When completed, the transmission of all letters in bulk between the General Post-office and the North Western Railway will be effected by its agency, as will also large parcels of goods. This line of tubing, moreover, is understood to be but the commencement of a system which is to be eventually extended to the various metropolitan railway stations, and probably to connect all the district post-offices in London. The Pneumatic Dispatch Company have powers under their Act to lay down tubes within the city, subject to certain control or direction on the part of the Commissioners of Sewers.

SUBSTANCES FOR PREVENTING AND REMOVING BOILER INCRUSTATIONS.

THE following list of substances which have been used, with more or less success, in preventing and removing the incrustations which are formed by using hard water in boilers is given in the *Mechanics' Magazine*:—

Potatoes.—By using about one-fiftieth of potatoes to the weight of water in a boiler, scale will be prevented, but not removed. Their action is mechanical; they coat the calcareous particles in the water, and prevent them from adhering to the metal.

Extract of Tannin.—A mixture has been used of 12 parts chloride of sodium, 2½ parts caustic soda, ⅛ extract of oak bark, ¼ of potashes, for the boilers of stationary and locomotive engines. The principal agent in this appears to be the tannin of the extract of oak bark.

Pieces of Oak Wood, suspended in the boiler and renewed monthly, prevent all deposit, even from water containing a large quantity of lime. The action depends principally upon the tannic acid.

Ammonia.—The muriate of ammonia softens old incrustations. Its action is chemical; it decomposes the scale. In Holland it has been used with satisfaction in the boilers of locomotives. About 2 ounces placed in a boiler twice per week have kept it clean, without attacking the metal.

Fatty Oils.—It is stated that oils and tallow in a boiler prevent incrustations. A mixture, composed of 3 parts of blacklead and 18 parts tallow, applied hot, in coating the interior of a boiler, has given great satisfaction in preventing scale. It should be applied every few weeks.

Molasses—About 13 lb. of molasses, fed occasionally into a boiler of 8-horse power, have served to prevent incrustations for six months.

Sawdust.—Mahogany and oak sawdust have been used to prevent and remove scale; but care must be exercised not to allow it to choke up pipes leading to and from the boiler. Catechu contains tannic acid, and has also been used satisfactorily for boilers. A very small amount of free tannic acid will attack the iron; therefore, a very limited quantity of these substances should be employed.

Slippery Elm Bark.—This substance has also been used with some success in preventing and removing incrustations.

Soda.—The carbonate of soda has been recommended by Professors Kuhlman and Fresenius, of Germany, and Crace Calvert of England. It is now employed with satisfaction in the boilers of engines in Manchester.

Tin Salt.—The chloride of tin is equal to the muriate of ammonia; and is similar in its action in preventing scale.

The *Extract of Tobacco* and *Spent Tanners' Bark* have been employed with some degree of satisfaction. The sulphate (not the carbonate) of lime is the chief agent in forming incrustations. By frequent blowing off, incrustations from carbonate of lime in water will be in a great measure prevented.

Mr. Alexander Delrue, of Dunkirk, France, has patented compositions to prevent and remove incrustations. The compositions are composed entirely of vegetable matters, and are prepared by dissolving or infusing in hot water the bark of the oak and pine, as well as the leaves of the sumach-tree ground and reduced to the state of a coarse powder; this infusion is concentrated to a density of about 10 deg. Beaumé, and to it is added a quantity (say from 15 to 30 per cent.) of cream of tartar (bitartrate of potassa) and spirit of turpentine. In employing this liquid to prevent incrustation in steam boilers, a quantity of it is introduced from time to time into the steam boilers; the quantity of the liquid required varies according to the capacity of the boiler, three pints of the liquid being generally sufficient for every thousand pints of water in the boiler to prevent incrustation forming for about ten days.

STEAM-BOILER EXPLOSIONS.

DR. JOULE, has stated to the Philosophical Society of Manchester his belief that, in nearly every instance, rupture takes place simply because the iron, by wear or otherwise, has become unable to withstand the ordinary working pressure. Various hypotheses set up to account for explosions are worse than useless, because they divert attention from the real source of danger. He believes that one of these hypotheses—that which attributes explosions to the introduction of water into a boiler, the plates of which are heated in consequence of deficiency of water—is quite inadequate to account for the facts; although weak boilers may be exploded at the moment of starting the engine in consequence of the swelling of the water through renewed ebullition throwing hot water over the heated plates. The absolute necessity of employing the hydraulic test periodically has been pointed out so frequently that Dr. Joule considers that the neglect of it is highly criminal.

The destructive energy in steam-boiler explosions, in regard to its numerical expression and its comparison with that of gunpowder, is the subject of the leading paper, contributed by the Astronomer Royal, in the *Philosophical Magazine* for November. He premises that very little of the destructive effect of an explosion is due to the steam contained in the steam-chamber at the moment of explosion. The rupture of the boiler is effected by the expansive power common to the steam and the water, both at a temperature higher than the boiling point. "As soon as steam escapes, diminishing the compressive force upon the water, a new issue of steam takes place from the water, reducing its temperature; when this escapes and further diminishes the compressive force, another issue of steam of lower elastic force from the water takes place, again reducing its temperature, and so on, till at length the temperature of the water is reduced to the atmospheric boiling-point; and the pressure of the steam (or rather the excess of steam pressure over atmospheric pressure) is reduced to 0. It is the enormous quantity of steam, of gradually diminishing power, which Mr. Airy believes causes the disastrous effects of the explosion, the smaller volume of gas in the steam-chamber in ordinary boilers being wholly insignificant. In order to compare this energy with that of gunpowder, Mr. Airy obtained from Mr. G. A. Biddell, of the firm of Messrs. Ransomes and Sims, of Ipswich, as an experimental result on the quantity of water issuing from a high-pressure boiler in the form of steam when the valve is gradually opened, the sum of 2¾ cubic feet, or one-eighth of the whole. We cannot, of course, give the calculations on this point which were made for Mr. Airy by Professor W. H. Miller, of Cambridge, but subjoin the very interesting results. The destructive energy of one cubic foot of water at the temperature which produces the pressure of 68 lb. to the square inch, surrounded by hot iron, is precisely equal to that of two pounds of gunpowder as fired in a cannon. Mr. Airy, however, considers that the energy of the hot water when the effect of the hot iron is abstracted, is considerably less than the number used in this comparison, and would, therefore, state that the destructive energy of the water is equal to that of *one* pound of gunpowder.

NEW PORTABLE STEAM-PUMP.

M. Louvie, of Brussels, has invented a double-action Pump of great simplicity, which being at once self-acting and almost devoid of machinery, may prove useful in many situations where fuel is not expensive or facilities for repairs very accessible. It has no pistons, and is put in action by the alternate pressure and condensation of steam; drawing and discharging a continuous stream of water. The absence of mechanism points it out as being peculiarly adapted for feeding steam-boilers.

It consists of two sheet-iron cylinders, and a third vessel resembling them, which, serving as a reservoir for compressed air, is surmounted by a tube through which the water is discharged—this tube descending within the air-vessel; secondly, of two suction tubes uniting into one, and two tubes connected with the air-vessel—all four being provided with clack valves; and thirdly, of a small pipe placed between the two first-mentioned cylinders, and communicating alternately with each, in order to condense the steam by a jet of cold water, which, passing from the full cylinder into that containing steam, instantaneously produces a vacuum, and causes the ascent of the water. Between the pump-barrels is placed a small receiver, full of cold water, which serves to start the apparatus at first. This is evidently an improved model of Savary's engine, costing very little money, and, doubtless, capable of doing good service in many situations.—*Mechanics' Magazine.*

THE DUMMY ENGINE.

THE dummy, or noiseless steam-engine, has been thoroughly tested in North America, and has everywhere proved an unqualified success. In New Jersey, from Jersey City to Birgen Point, it has undergone the practical trial of several months' daily use, and has demonstrated these facts :—That one small engine, occupying no more space than a chest of drawers, in the front partition of the car, and entirely concealed from external view, will draw as many passengers as ten horses; that it will draw them two or three times faster than horses, if necessary; that the expense, including wear and tear, is less than that of horses; that the engine throws no sparks in the air, consumes its own smoke and makes no noise; that it can be stopped in less space than a horse can, removing thereby liability to accidents; that the roads are kept in a cleanlier state; and as the business of the road has been increased since the introduction of steam passenger cars, that passengers prefer them to horse cars. The greater cleanliness of the streets is a stronger reason for adopting this kind of car in cities than in less populous places, but is of little weight in comparison with the saving of horse-flesh and the consumption of feed which would result from the general introduction of these cars. The saving of the feed for horses now required for railroads, would cheapen the cost of feed.—*Philadelphia Ledger.*

NEW AIR-ENGINE.

MR. J. JAMIESON has described to the British Association a new form of Air-Engine of his invention, the arrangement of which it is impossible to explain without the aid of diagrams. Small engines, however, on this plan have been constructed, and are stated to give great promise of success; and larger engines are now in the course of construction. The advantages to be derived from these engines are stated to be a saving of fuel, freedom from risk of explosion, the engine not liable to derangement, insurance was not affected, and the compressed air might be applied in any situation, being laid on like gas. Power in this way might be supplied to a whole town at small expense.

THE HYDRAULIC PRESS.

AT an official trial of Messrs. Westwood, Baillie and Co.'s new 28-inch Hydraulic Press, erected in Woolwich dockyard, for Bending and Preparing Armour-Plates; the first test consisted of a trial of two 4½-inch armour-plates, made hot, forming a thickness of 9 inches of solid iron, which were placed in the press and bent to a curve of seven-eighths in the breadth of the plates in less than five minutes, at a pressure of 1000 tons on the whole surface of the piston, the pump making 130 revolutions per minute. In the second trial the plates were adjusted so as to bring the pressure near the centre of the plate. The pump was then worked up to 1539 tons by indicator, bending the two slabs of iron to a curve of one-half in their breadths. The third and last trial consisted of a simple test of the working of the pump and the strength of the press. The pump worked up to about 1600 tons, and exhibited no visible signs of weakness.

NEW WATER-PRESSURE ENGINE.

At the Water-works office, in Wolverhampton, according to the local *Chronicle*, a hydraulic engine is doing the work of a steam-engine in the most complete and satisfactory manner. It is the invention of Mr. Henry James Lewis, a practical engineer. Its mechanism in appearance is much the same as that of the steam-engine, with the exception that it has two globes or air-vessels upon the cylinder. The action is very simple. The water is supplied to the engine from the main by means of an ordinary pipe, and can be turned on or off by means of a common stopcock at pleasure. When the engine is about to be set to work the water is allowed to pass into a chest or nozzle, within which is a slide-valve, the same as is used in a steam-engine. The water, having filled the nozzle, rushes through the passage that is not covered by the slide-valve into the cylinder, forcing the piston along with it, at the same time compressing the air in one of the globes or air-vessels until the slide-valve shuts the passage; when the air that is now compressed in the one globe, by giving a certain amount of elasticity to the water acting on the piston, enables the crank to continue its motion. After the valve has covered the one passage, preparatory to opening the other passage for the return stroke of the engine, the same process is repeated. The rectilinear motion is converted into a rotary motion by means of a connecting rod and crank, and applied to the purpose for which it is required by ordinary pulley bands.—*Builder.*

NOVEL APPLICATION OF WATER-POWER.

Just forty years since, M. Fourneyron commenced a series of experiments in Water-Power, which resulted in his invention of the turbine or horizontal water-wheel. Since that period considerable improvements have been made in the turbine by different persons, the chief and most useful having been effected by Mr. Schiele, of Manchester, whose ingenious applications of mechanical curves seem to have been fully adapted by him for the production of this form of motive power. One form of his arrangement for supplying power we have recently seen (working the bellows of a powerful organ) at the residence of a citizen of Manchester, where the impression was given that, if all the results achieved by Mr. Schiele be equally successful, a new feature will be rapidly developed in applying water-power, especially in cases where a small amount of power may be required at irregular periods; as in the case of working the bellows of organs, driving small lathes, fans for ventilation, printing and other presses, sewing machines, washing machines, &c. In the house referred to, a water-wheel, 4 ft. in diameter, consuming 15 gallons of high-pressure water per minute, formerly employed to work the bellows of an organ in the drawing-room over the cellar wherein the water power was produced, has been replaced by a turbine only $1\frac{1}{4}$ in. in diameter, with a 3-in. case $1\frac{1}{4}$ in. wide, supplied by a $\frac{3}{8}$-in. pipe, and consuming less than a gallon of water per minute. An ingenious and yet very simple economical regulator, invented by Mr. Eccleston, organ builder, of Manchester, works in connexion with the apparatus just mentioned, by means of which the organist may easily supply his instrument with the required wind by simply turning a handle near the organ. By availing themselves of the ample supply of high-pressure water secured to the city by the Corporation, all persons using machines requiring a small amount of power appear now to have supplied to them, by this invention, the means of working their machines with no trouble, and at a trifling cost; while at the same time this kind of turbine appears to be equally well adapted for turning large mills and works, even when they require several hundreds of horses' power.—*Mechanics' Magazine.*

STEAM FIRE-ENGINES.

SOME important experiments to test the power of certain Steam Fire-Engines, have been made in the grounds of the Crystal Palace, at Sydenham. The following took place just inside the north water-tower, to test the engines as to their power in throwing a vertical jet high into the air. For this purpose the nozzles of the hose of the four competing machines were fixed upright side by side in a frame about 10 ft. high. The diameter of the hose pipe used by Mr. Merryweather was $\frac{26}{16}$ths of an inch, or more than an inch and a half. Messrs. Shand and Mason used a nozzle of $\frac{22}{16}$ths of an inch, the American engine one of $\frac{21}{16}$ths of an inch, and Mr. Roberts's engine one of $\frac{14}{16}$ths of an inch. The latter, for such a small engine (only 30 cwt.) threw a steady and high jet, at times quite as high as 140 ft. into the air. All, however, were eclipsed in height by the jets thrown by Mr. Merryweather's and Messrs. Shand and Mason's, that from the engine of the latter firm being the highest of all, reaching at times close upon 190 ft., if indeed it did not overtop even this great altitude. Mr. Merryweather's engine also threw a most magnificent column of the great diameter we have mentioned, and maintained the column steadily at a height varying between 160 and 170 ft. This was the most massive jet thrown, though Messrs. Shand and Mason, with their slightly thinner column, could always overreach it by 20 ft. or more. The American engine was literally nowhere, and, except during an occasional spurt, 50 ft. was about its maximum.

As the jets were kept close up, parallel with the tower, and only distant from it a couple of feet, it was quite easy, by a comparison with the storeys of the tower itself, each of which is 20 ft. high, to estimate almost to a foot the height each jet was thrown. The united efforts of all the nozzles of course came down in a perfect cataract of water. This last effort, which was exceedingly beautiful to witness, brought the trials to a close.

The following was the award of the prizes :—

To the patent steam fire-engine, the "Sutherland," by Messrs. Merryweather and Sons, Long-acre (large size), was awarded the first prize of 250*l*. The boiler of this engine is made of steel plates, a large heating surface being obtained by a quantity of vertical copper tubes, which also act as strong stays; the upper part of the boiler or steam-chest is fixed in wrought-iron valves for carrying off the smoke, and creating a draught. The outer water-jacket is also frequently stayed, so as to make it secure for the highest pressures. The internal arrangement of the boiler is such, that a perfect circulation of water is carried on, and it is fed by Clifford's patent injector. A prize of 100*l*. was awarded to Messrs Shand, Mason and Co., of Blackfriars-bridge, for the next best large engine. Both these engines are especially adapted for large towns and cities, but the small ones are what the committee of the Fire Brigade think will best suit the greater number of London fires. Among the small land steamers, the first prize of 250*l*. was awarded to Messrs. Shand, Mason and Co. The engine is of the class not exceeding 30 cwt. It has an upright tubular boiler, so that it can be easily taken to pieces to have the tubes repaired when necessary. It can also be refixed without injury, as it is joined by means of flanges, and fixed by bolts and nuts, instead of rivets. The steam cylinder is 7 in. in diameter, and is placed vertically over the pump. This part of the machine, with the connecting pieces, is entirely of gun-metal, and consists of a water cylinder, of 9 in. bore, with a plunger of $6\frac{5}{8}$ in diameter, the whole firmly connected to the boiler. This engine can be rapidly drawn to a fire by a pair of horses, and the working steam pressure can be raised to 160 lb. per square inch. Both these last-named engines are provided with means for carrying hose and implements, as well as the firemen to work the engine. The second 100*l*. prize was awarded to Lee's small engine, of which a full description has already appeared. The other competitors, having failed in the performance of their engines, received no prizes.

"The Sutherland" engine has been purchased for the Royal Dockyard, Devonport; it was tested in various ways for the purpose of instructing those now in charge of the engine in the best manner of working it. The engine was run about the dockyard by a few of the Metropolitan Police, who have charge of the fire arrangements there. On one occasion they ran the engine a distance of a quarter of a mile from the engine-house, and had a large quantity of hose attached, and four fine streams, each of 1 in. diameter, were playing in 20 minutes from the time of the alarm, the fire not being lit until its arrival.

ACCIDENTS BY FIRE.

THE frequency of terrible accidents by fire, lately induced Mr. Frank Buckland, Assistant-Surgeon 2nd Life Guards, to communicate to the *Times* his treatment of a woman at Windsor, who was fearfully burnt.

"I immediately," says Mr. Buckland, "gave her opiates, but soon perceived that stimulants were imperatively called for. Opiates are excellent things, and should be given for the sake of relieving pain, but the stimulants must not be forgotten. The shock of the burns depresses the whole system most terribly, and laudanum, though it relieves the pain, is also depressing in its effects. I would therefore (as in accidents of this kind time is most precious) recommend the following mixture to be given at once:—Laudanum, 30 drops; sulphuric æther, 40 drops; brandy, a tablespoonful, in a wine-glass full of warm water. This should be given directly, and repeated in an hour's time if the pain is not subdued. This treatment should be followed up by beef-tea and other concentrated forms of nourishment. Of course, the ever-present remedy of covering the burns freely with flour from a flour dredge, and applying cotton wool above the layer of flour, must not be neglected, and should be put in force till the medical man arrives."

In the 14 years 1848-61, 39,927 persons—about 8 a day—were burned alive in England, or were scalded to death; 1341 were infants under 1 year of age; 4500 were children of 1 and under 2 years of age: 9777 were between 2 and 4 years of age. Between the ages of 5 and 15, 6255 girls, but only 3750 boys, were burned to death in the 14 years. Subsequently, men are exposed to fires, and explosions in mines and works, and die by fire in much greater numbers than women, up to about 50 years of age, after which the men grow more cautious, or are partially withdrawn from danger, and the combustible dresses of women again turn the scale against them. 2122 old women (above sixty-five) in their feebleness were burned to death in the 14 years. The deaths by burning in England are ascribed to accident, but they are none the less dreadful on that account, particularly when it is considered that the victims are often as unnecessarily exposed as moths to the flames in which they perish. The time has assuredly come to endeavour to put a stop to these human sacrifices.—*Dr. Farr; Registrar-General's Report.*

UNINFLAMMABLE STUFFS.

On this important subject the French Academy of Sciences have received a report from MM. Payen, Velpeau, and Rayer, in which M. H. Chevalier's Paper sent in to the Academy on the 25th of January last, is discussed. From this report it appears that only three salts have hitherto been found that may be successfully applied to the purpose in question, viz., that of preventing ladies' dresses from catching fire. There are many other salts that would do the same, but not without spoiling the dye, or the gloss, or the texture of the stuff, &c. Of the three in question, the sulphate and phosphate of ammonia have the inconvenience of being decomposed by the heat of a smoothing-iron; but they are applicable in those manufactures where stuffs are stiffened by the action of hot air or cylinders heated by steam. They exercise no action upon either the thread or the colour of the stuff. The phosphate of ammonia may be mixed with half its weight of hydrochlorate of ammonia. To obtain an efficacious solution, 20 per cent. of this mixture must be dissolved in water. A solution of 7 per cent. of sulphate of ammonia produces the same effect, and is therefore the most economical salt that the trade can employ. But in those cases in which the smoothing-iron cannot be dispensed with, as in linen, for instance, a solution of 20 per cent. of tungstate of soda should be preferred. To obtain the desired effect, all these solutions must be applied to the stuffs after they have been stiffened and dried, because starch is always used in a weaker solution than that required for these salts. Acid tungstates destroy the thread of cotton stuffs, like borax, alum, and other substances previously recommended. The tungstate of soda is prepared in Cornwall, where the tin mines yield a large quantity of wolfram. It costs from 12*l.* to 18*l.* per ton. The sulphate of ammonia costs about 14*l.* per ton, and has hitherto been used for manure.—*Mechanics' Magazine.*

M. Sauvageon has announced to the French Academy of Sciences, that he has discovered that cotton cloth which had been exposed for a certain time to the vapour of burning sulphur, assumes such an amount of incombustibility that, although it will char and become brittle when held over the flame of a spirit lamp, it cannot be made to take fire, while under like conditions similar cloth, but unprepared in this way, inflamed immediately. The communication of M. Sauvageon *in extenso,* may be found in the *Comptes Rendu* for January 1863, and if its facts be borne out, the problem is solved, for the simplest domestic means may be devised for subjecting, after being washed, all white clothing to the vapour of sulphur, which will tend to make it still whiter.

THE NEWCASTLE-ON-TYNE GUN.

MR. JAMES MATHER, of South Shields, in a communication to the *Mechanics' Magazine*, thus describes this novelty:—The Committee of the River Tyne Commission had under consideration a suggestion that a time ball should be placed on the High Level Bridge, and a signal gun on the old Norman Keep of Newcastle, which was considered to be sufficient for the purpose of indicating Greenwich time to the upper reaches of the river, and that either a ball or gun near Whitehill Point, to command the docks and harbour, which sometimes contain more than twelve hundred ships, would be enough for the diffusion of this true knowledge. The brilliant and successful experiment performed by Professor Piazzi Smyth, at Newcastle, on the 17th of August, is sufficient proof of the easy adaptation of both ball and gun.

Mr. John Hewat, of Edinburgh, was the first to propound the advantage of a signal gun; and Professor Piazzi Smyth, with that penetration which distinguishes him, at once perceived its advantages, and, calling in the aid of Messrs. Ritchie and Sons, they proceeded with the *perfervidum ingenium Scotorum* which distinguishes their country, to effect its successful execution.

The Commissioners of the Tyne having obtained opportunities of examining the skilful arrangements at Edinburgh, they there found that, by the pendulum regulator of Mr. Jones, of Chester, the clock at the Castle of Edinburgh was made to pulsate with the astronomical clock of the Observatory at the Calton Hill, 4000 feet away. At the same time, by the ingenious clock-trigger of Messrs. Ritchie, the 24-pounder at the Castle was discharged at the same instant as the time-ball fell at Calton Hill, marking Government time. Daily the booming and flash of the time-telling gun from the castle-rock of Edinburgh thunders and gleams over that great city and across the broad waters of the Frith of Forth, amongst its deep bays, and for many miles throughout the surrounding country. When its instant flash cannot be observed, its sound is a true guide to mariners ; for by the law laid down by Herschel, that the velocity of sound, in a temperature of 62 deg., is 1125 ft. per second, and with 1·14 ft. difference for every degree of variance from 62 deg., adding for an increase, deducting for a decrease, the exact moment of discharge is fixed. This practical lesson cannot be lost upon the promoters of this great object on the Tyne. All that are required for those operations, with certain additions for the signal gun, are expressed by Professor Airy in his letters to the Tyne Commissioners, thus :—"The information given to you," states the Astronomer Royal, "is correct, that, at ten and at one time signals, equally accurate, are sent from Greenwich Observatory, with no interruption except that of a relay at Lothbury every day. From our best companies direct with Edinburgh, it appears that where the metallic circuit is complete, the whole time occupied in the passage between Greenwich and Edinburgh is less than the 1-20th of a second"—(the action of the relay cost, on one occasion, the 1-50th of a second). "If wires were always in good order and dry, there would be no difficulty in dropping the time signal by direct action at Greenwich. But, viewing the chance of failure of these saving circumstances, I should recommend that the Greenwich current should be used to give signals only to the telegraph office, by which the error of a clock, No. 1, stationed there, would be ascertained, and with this knowledge another clock, No. 2, would be adjusted, and this No. 2 clock would automatically drop the signal. You may take the hour or hours you like best. The usual hour (following the example of Greenwich, which was fixed by office convenience), is 1 o'clock p.m. You had better come here in the morning, to include 1 p.m. in your visit, and we will mention other points." To carry out these suggestions of Professor Airy, according to Mr. Latimer Clark, the experienced engineer of the Electric and International Telegraph Company, it would require to make a junction between the Greenwich Observatory and the selected sites or stations at Newcastle, and that near Whitehill Point, costing about 160*l.*; two time balls, costing each about 110*l.*, equal to 220*l.*; a very good clock at each station, each 25*l.* equal to 50*l.*; the maintenance of wires between Newcastle and Whitehill Point, 10*l.*; the charge for daily electric communication, per annum, 40*l.* ; total, 480*l.* After which, 100*l.* a year, or thereabouts, may be taken as the cost of keeping in repair and working these time signals for the Tyne.

JÖRNS' TIMEPIECES.

LETTERS patent have been granted to Heinrich Jorns, of Tessin, Mecklenburg, for improvements in clocks or Timepieces.

This invention is designed for obviating the necessity for winding up clocks or timepieces periodically, as at present practised. It is proposed to effect this through the agency of the variations in the temperature of the atmosphere, which is constantly taking place both inside and outside of dwelling-houses, and to employ the draught or current of air caused by such changes of temperature to set in motion certain mechanism to be connected to the ordinary mechanism of clocks, and by these means to produce a power sufficient to wind up a clock continuously, instead of having to wind it up by hand periodically, as at present practised. By this invention a great part of the weight at present necessary to keep the going parts of a clock in motion may be dispensed with; for example, a clock, which under ordinary circumstances would require four pounds to keep it going, may by this invention be kept going by the gravitating power of a weight of two ounces.—*Mechanics' Magazine.*

AERIAL LOCOMOTION.

On the subject of such movement by means of screw propellers, M. Babinet expresses himself as follows:—MM. Nadar and de la Landelle have constructed a little apparatus which receives its propulsion by means of springs, and which rises in the air, springs and all, without any other action. These little engines are therefore perfectly automotive, and find a fulcrum in the air. The form of the screw-propellers remains to be studied, as well as the nature of the steam-engine which is to provide the force of locomotion; but, as a large model is always, in a mechanical point of view, more advantageous than a small apparatus, we may here boldly say that if a mouse has been carried up into the air, it will be much more easy to transport an elephant. That is a question of money and technology. Hence we may warrant the success of aerial navigation within the limits of possibility; that is, we shall never be able to go against violent winds which the strongest birds cannot resist. As to the exclusion of air-balloons, which MM. Nadar and de la Landelle proscribe, natural philosophers have long considered the directing of balloons lighter than air as a problem which is not only insoluble, but absurd. As to screw-propellers, they should be possessed of great velocity, but a great many may be applied so as to work together. A spring will give the propellers a regular motion, and the steam-engine, made of thin metal, is only to keep the spring constantly tight. This spring will act as a fly for the motive power. As to the necessary velocity, I may say that on the Seine, a screw-steamer, the screw of which had a distance of a metre between the threads, and which might have performed a kilometre in 800 revolutions, only went 200 metres when it turned slowly, whereas it went 800 metres when turned fast. The advantageous effect of rapidity consists in this, that the air, obliged to yield to the impulse, has not time to escape from under the screw, and is strongly compressed. For this same reason a parachute descends slowly, because, to escape from under it, the air must fetch a considerable compass, which is effected at the expense of the descent."

NADAR'S GREAT BALLOON.

THE "Géant," now at the Crystal Palace, is by far the largest balloon ever yet made. Its entire height, including the "compensator"—a small balloon under the large one, containing a reserve of condensed gas—and the car, is close upon 200 ft., and when fully inflated it will contain 215,363 cubic ft. of gas. For greater security it has two skins, both of white silk—the outer coloured a yellowish white—of the finest quality, and of which more than 20,000 yards were consumed in the manufacture. All the gores are entirely hand-sewn, and the work occupied 300 men and women for more than a month. Perhaps we shall give the best idea of its magnitude to English readers by saying that it could not be got into one of Captain Fowke's great domes. It is easy to understand, too, how hard it must be to control this enormous body of gas so as to manage a safe descent; and novices in aeronautics may be permitted to doubt whether, until the valve machinery is improved, safe voyages can be performed by balloons of such a size. M. Nadar himself attributes the unfortunate issue of his last trip more to the deficiencies of the valves, which did not permit the gas to escape with sufficient rapidity, than to the failure of the anchors. The "Géant" is calculated to lift 4½ tons.

The car is a great curiosity in its way. In its outside appearance it is not unlike, on a small scale, one of the caravans to be met with by the side of a gipsy encampment. It is about 15 ft. long, by 12 wide, and is partitioned off into a captain's cabin with sleeping berth, four small cabins with berth, washing-room, and printing and photographic operating rooms. It is fitted with wheels on moveable axles, so that there may be no difficulty in the return, supposing a descent to be effected far from the ordinary means of transport. There are windows and doors on each side; but, after all, there does not seem much room for nine people to turn in comfortably. For those who prefer the open air there is the roof, with which a strong high bulwark running round makes a kind of airy terrace or quarter-deck.—*Mechanics' Magazine.*

NEW FLYING MACHINE.

THE New York papers describe the experiments made by a Mr. Solomon Andrews, of New Jersey, with a new Flying Machine. Its form is that of three cigars pointed at both ends, secured together at their longitudinal equators, covered by a net, and supporting by 120 cords a car 16 ft. below, under its centre. The car is 12 ft. long, made of basket-work, and is 16 in. wide at the bottom. The aerostat, or cylindroids, are made of varnished linen, like ordinary balloons. In his last experiment, he demonstrated the possibility of going against the wind, and of guiding her in any and every direction with a small rudder having only 17 square feet of surface. After a few short flights, to satisfy himself and a few friends that all was right, and that she would do all he had contemplated, he set her off in a spiral course upward, she going at the rate of not less than 120 miles per hour, and describing circles in the air of more than 1½ miles in circumference. She made twenty revolutions before she entered the upper strata of clouds and was lost to view. She passed through the first stratum of dense white clouds, about two miles high, scattering them as she entered in all directions. In her upward flight could be distinctly seen her rapid movement in a contrary direction to the moving clouds, and as she came before the wind passing by them with great celerity. As she was distinctly seen thus to move, both below and above the clouds on the clear blue sky at five o'clock p.m., with the sun shining clear upon her, there could be no mistake or optical delusion to the beholder.

COAL SUPPLY.

Mr. Robert Hunt, the Keeper of the Mining Records in the Museum of Practical Geology, London, has published a valuable series of Mining statistics, showing the extent and probable duration of the mineral resources of this country. Coals stand at the top of the table, as three-fourths by value of our mineral produce annually consists of this article, so indispensable to our manufacturing and maritime supremacy. We therefore learn, with something deeper than regret, that "the rate of exhaustion which is going on over our coal-fields still increases. From 3052 collieries, there was used and sold in 1861, 83,635,214 tons. Two millions and a half tons were wasted in the process of working and burned at surface on the collieries of Durham and Northumberland alone. The total waste must therefore have been very large, although information thereof could not be correctly obtained." There is also a large waste in the actual consumption of coal in this country for domestic purposes, not alluded to by Mr. Hunt, that is not likely to diminish so long as coals are cheap. At present, we probably burn much more fuel in warming our chimneys than our rooms; but if coals were to be permanently double the price they are now, ingenuity would soon find out the way to utilize that which we now squander. The year's produce from the principal coal-fields is shown by the following figures:—Tons in 1861—19,145,000 from Durham and Northumberland; 12,196,000 from Lancashire; 9,375,000 from Yorkshire; 7,254,000 from Stafford and Worcester; 6,691,000 from South Wales; 5,116,000 from Derby and Notts; 11,081,000 from all Scotland.—*Mechanics' Magazine.*

COAL-CUTTING BY MACHINERY.

An improved Coal-cutting Machine, invented by Messrs. Robert Ridley and Jones, has been completed at Mr. Middleton's factory, in Loman-street, and has been successfully tried upon a solid block of freestone. The size of the machine is about equal to that of a full-sized trunk, being about 3 ft. long, 1½ ft. wide, and 2 ft. high; it has flanged wheels, to run on the ordinary pit tramway, and weighs about ½ ton. Motion is given to it by a 6-inch cylinder high-pressure engine, the pick being connected with the end of the piston-rod; and by varying the mode of connecting, the blow may be given either right-handed or left-handed. There is an arrangement for regulating the depth and force of the blow, precisely similar to that used in the steam-hammer; and as the attendant has his hand constantly upon this regulator while the machine is at work, the precision obtained is fully equal to anything that could be obtained by hand-labour. Indeed, the collier directing the machine must use precisely the same amount of judgment as if he were using an ordinary pick; the principal difference being that he is enabled to strike five blows with the machine for one blow with the hand.

With respect to the efficiency of machines upon which this is considered to be an improvement, we cannot do better than state the results recorded by Messrs. Daglish and Wood, in their paper read before the North of England Institute of Engineers, as obtained in actual practice with Messrs. Donisthorpe, Firth, and Ridley's machine, at the West Ardsley Company's Balaclava Colliery, near Leeds. Working long wall, a kirving 35 yards long, and 37 in. deep, was made in 2 hours 45 minutes, including all stoppages; and in a subsequent experiment, a kirving 43½ yards long and 37½in. deep was made in 2 hours 37 minutes, so that at the mean practicable working speed it would appear that a yard can be cut in about 4 minutes. A kirving at the depth mentioned would be made at three cuts; the first going in about 16in., and the two subsequent cuts about 10 or 11 in. each. In these experiments the speed of the blows averaged about 40 per minute, but the machine just completed gave 15 in 10 seconds, so that it is probable 60 per minute could readily be given in the pit. As compressed air is used instead of steam, the difficulties which have prevented the success of several of the machines which have been introduced do not exist, whilst the price of the machine being considerably under 100*l.*, and its liability to get out of order is very small, it cannot fail to be very generally adopted as soon as the amount of economy which it effects becomes generally known.—*Mining Journal.*

SUBSTITUTE FOR COAL.

There is in Trinidad, only a mile from the coast, a basin of 99 acres filled with asphalte, yielding 70 gallons of crude oil per ton. There are also springs of asphaltic oil in the neighbourhood, and large pitch banks off the shore. It is estimated that the lake is capable of producing 300,000,000 gallons of oil, and 40 or 50 gallons are considered equal to a ton of coal. The *Trinidad Colonist* publishes a *mémoire* by Mr. Stollmeyer, of Port of Spain, proposing the use of this liquid fuel for oceanic steam navigation, and he states that he has been at various times for these three years suggesting this employment of a distillate from the pitch-lake of Trinidad. To oil a ship would not take above a tenth of the time it takes to coal her if pipes were employed, and the oil would not take above a fourth of the space occupied by coals. He recommends that it be applied at once as auxiliary to coal by throwing jets over the burning mass, but contemplates eventually upright tubular boilers, the liquid fuel to be supplied as fast as it can be converted into flame. Of course the North American oil-springs are another source of supply.

LIGHTING COAL-PITS.

A NEW method of illuminating fiery collieries has been proposed by MM. Dumas and Benoit, and which they say, so far as their experiments have gone, gives promise of success. In effect, the method consists in supplying each pitman with a "Geyseler Tube," in place of a Davy lamp. The light within the tube, which is of fluorescent (uranium) glass, is produced from a Rhumkorff's coil placed at a distance from the face of the workings. Insulated wires lead from this to each of the illuminated tubes, which can as easily be moved about as a Davy lamp, except, we may remark, that there will be always dangling from each the pair of wires; and as the tubes are hermetically sealed, and do not rise perceptibly in temperature, or, as the inventors express it, "*la lumière est froide*," so there is no possibility of ignition for the explosive gases. The light obtained, they admit, is feeble, but this they expect to improve upon.

A ruptured wire might, we submit, produce ignition at the instant of fracture, in this case; otherwise the apparatus is probably perfectly safe. We doubt its likelihood of success in a practical sense, however; although we feel perfectly certain that sooner or later all coal-pits and all mines will be illuminated by some form or other of electric light; and that the Davy lamp, beautiful and ingenious as its principle is, and with all the good service it has done, will come, before very many years shall have passed, to be deemed a thing of a comparatively barbarous and imperfect epoch of mining.—*Practical Mechanics' Journal.*

NEW SAFETY MINER'S LAMP.

ISAAC M. EVANS, a collier in North Wales, has invented a Lamp, with these advantages. The Davy has this objection, that the gauze covering or envelope renders the light obscure, and practical colliers say that they cannot fill so many trams in a week by its light, as by the light of a common candle.

Hence it has been known for colliers working in a dangerous stall, to open their lamps or put them aside and use a candle instead. Evans's lamp obviates this difficulty or defect. Around the light is a thin glass tube, purposely made thin so as to admit of expansion. Over this again is a stouter glass envelope, strong enough to bear being knocked about with impunity. At the top are two gauze cones, and at the base the air is admitted to the lamp by means of punctures. The point of the invention, it would appear, was to construct a lamp that should give equal light to that of a candle, that should warn the collier of the presence of gas, and, on the assumption that he with usual rashness would disregard the warning, should go out and leave him in the dark. These conditions are said to have been fulfilled.—*Mechanics' Magazine.*

LUCIFER MATCHES.

PROFESSOR ABEL has communicated to the British Association a paper "On some Results of Experiments on Lucifer Matches and others ignited by Friction." Having mentioned the components, chiefly consisting of ordinary phosphorus, and gum or glue as a binding material, he went on to notice the possible causes of accident in the transport of matches. The result of experiments proved that no degree of heat to which, under all ordinary circumstances, matches were likely to be exposed, in their transport or otherwise, would suffice to lead to their spontaneous ignition. It was quite within the range of possibility, however, that on board ship continuous concussion, combined with a degree of heat, might bring about accidental ignition of matches, while it might be granted, that the accidental ignition of one or two boxes in securely-closed cases might frequently occur almost without a possibility of fear of its spreading to other boxes. A knowledge of the causes of the accidental ignition of gunpowder and other explosives rendered it advisable that such precautionary measures as were obvious and easily observed should be attended to in the shipment of matches, with the view of reducing such occurrences to the minimum extent. Some of those steps he specified. The first was the appropriation of a place for the reception of such packages, distinct from all other merchandize. Secondly, the efficient ventilation of that part of the vessel in which matches were stowed. Thirdly, the enforcement of rules to prevent fire being brought by sailors within the vicinity of the matches. Fourthly, the carefully packing of the match-boxes into cases, so as to prevent any independent motion. And fifthly, the bestowal of more uniform attention on the production of stout and sufficiently stable match-boxes.

Dr. Paul believed a considerable proportion of the matches now used, were dipped with paraffin—a substitute for the sulphur that was originally used, and the resinous coating that had been applied to them. The effect was very advantageous. Paraffin matches ignited readily. There was no smell from them, and they were otherwise preferable.

ARTIFICIAL ILLUMINATION.

DR. FRANKLAND, in a lecture delivered by him at the Royal Institution, observes : "The use of animal and vegetable oils for illuminating purposes has received no new development the past ten years; but a new source of light of the greatest importance has been distilled by Nature herself. The native oil of the United States and Canada is obtained in immense quantities; from the latter country alone as much as 20,000,000 of gallons have been procured, which, it has been calculated, would give as much light as 180,000,000 of pounds of sperm candles. The importance of these oils could not be overrated. Some accidents had resulted from their use, apparently from careless manufacture, it being necessary to remove the lighter constituent oils before they could be used with perfect safety. The lecturer explained that it was necessary to burn these oils, as well as Young's paraffin oil, in lamps made of some badly-conducting material like glass, so that the oil in the reservoir might not become heated; and he showed the explosiveness of some oils, and non-explosiveness of others, when heated to 120 degs.

The following diagram exhibits the illuminating equivalents of various materials, showing the quantity of other substances required to give the same amount of light as would be obtained from one gallon of Young's paraffin oil :—

Young's paraffin oil	1·00 gallon
American rock oil (1)	1·26 ,,
,, ,, (2)	1.30 ,,
Paraffin candles	18·6 pounds
Sperm ,,	22·9 ,,
Wax ,,	26·4 ,,
Stearic ,,	27·6 ,,
Composites ,,	29·5 ,,
Tallow ,,	39·0 ,,

The comparative cost of light was shown in a diagram exhibiting the comparative cost of the light of twenty sperm candles, each burning ten hours, at the rate of 120 grains per hour:—

	s.	d.
Wax	7	2½
Spermaceti	6	8
Tallow	2	8
Sperm oil	1	10
Coal gas	0	4¼
Cannel gas	0	3
Paraffin candles	3	10
,, oil	0	6
Rock oil...	0	7¼

It was thus shown that paraffin and rock oils are the best sources of light for domestic purposes, inasmuch as they give the largest amount of light with the least development of heat.

In conclusion, Dr. Frankland alluded very briefly to the difficulties in the way of applying the discoveries of science to every-day purposes. It was thirty years ago that Riechenbach first made paraffin and paraffin oil in the laboratory, and twenty years elapsed before any practical use was made of them. It was thirty years since Dr. Faraday showed the magneto-electric spark. How long shall we have to wait for any development of thermo-electricity, or the direct transformation of heat into light by electricity? In the magneto-electric machine, the transformation was accomplished by the intermediate transformation of heat into mechanical force, by which there was experienced a loss of nine-tenths of the heat force. The man of science was rewarded by the truths which he discovered; it was not his function to apply these truths to useful purposes. That required quite different powers of mind.

IMPROVED LIGHTING.

Mr. J. B. Keeling has patented an improvement, to be applied to the lighting of halls, theatres, and other buildings, likewise to the diffusion of intense light, and to the prevention of shadows. The patentee takes an electric light, a lime light, or other source of intense light, and places it in some elevated spot above the space to be lighted. Under or before, or part under and part before this light, he suspends or fits a plain white, tinted, or coloured curtain or screen, and again in some instances he places under or before, or part under and part before, a ceiling of glass or other transparent medium. By these means he removes the obstacles that have hitherto prevented the successful application of the electric, lime, or other intense lights, to the lighting of the interior of large rooms and public edifices, and that also have all but confined these sources of light to the position of mere scientific curiosities. It is well known that the chief obstacles have been the intense brilliancy of the lights, their unpleasant white or ghastly hue, and the dense black shadows thrown by them. The first, however, gives so far a margin that the medium of the curtain absolutely utilizes the objection not by the sacrifice of brilliancy, but by the complete diffusion of the rays. The second obstacle is overcome by the tint or colour of the curtain or screen giving any hue most desirable to assimilate with any of the lights now usually employed, whether it be that of gas, of any description of oil lamp, of any wax or other candles. The relative use of the curtain or screen to the source of light is the same as that of the clouds to the sun.—*Mechanics' Magazine.*

VENTILATION OF APARTMENTS.

The French Academy of Sciences, have received a paper by General Morin, on the Ventilation produced in apartments by Fire-places. The room of the Director of the Conservatoire des Arts et Métiers was chosen by him for his experiments. This apartment may be heated at pleasure, either by a fire in the fire-place, or by a mouth of the calorifere of the establishment. Experiments were first instituted to ascertain the volume of air evacuated by the fireplace by the mere action of the difference of temperature of the outer and inner atmosphere. This natural ventilation was found to be on an average 400 cubic metres of air per hour, when the outer temperature was between 1·8 and 10 deg. centigrade (35·3 and 50 Fahr.), and the inner temperature was between 18 and 22 deg. centigrade (64·4 and 71·6 Fahr.). Hence this room is sufficiently ventilated by the mere aspiration of the chimney, even when, instead of one person, it contains, as it sometimes happens, ten or twelve. Direct experiments afterwards showed that the mouth of the calorifere introduced 150 cubic metres of air at 20 deg. centigrade per hour (68 Fahr.), when the temperature of the calorifere was between 70 and 100 deg. centigrade (158 and 212 Fahr.); but when the temperature of the calorifere was 45 deg., it only furnished 123 cubic metres. The quantity of air thus introduced through the interstices of two windows and two doors was found to be 246 cubic metres per hour. The fireplace drew from 1200 to 1300 cubic metres of air per hour, the amount of wood consumed being 8·26 kilogrammes per hour. The same quantity of air was drawn when the fire consisted of coal, the quantity burnt being 4 kilogrammes per hour. From these experiments it appears that nearly the whole of the warmth produced by combustibles in an apartment is carried off through the chimney, and the only useful part of it is obtained by radiation.

THE CHRONOTHERMAL STOVE.

MESSRS. LUCK, KENT and CUMMINGS, of Regent-street, Waterloo-place, have brought out a Stove, which is stated to be distinguished by the simplicity of its construction, and the admirable manner in which it effects the purpose it is intended to fulfil. It consists of a cylinder of cast-iron, about 20 in. long and 9 in. in diameter, pierced with several apertures at each end. This, which forms the external portion of the stove, is mounted on an ornamental base, fitted with a sliding register for regulating the draft through the fire, and surmounted by a suitable lid or top, of handsome design. An internal cylinder, one or two inches smaller than the external case, within which it is suspended, contains the circular grate on which the fuel rests. The fire, kindled at top, heats the metal with which it is in contact nearly red hot. The air contained in the space between the two cylinders is rarefied, and flows out into the apartment through the holes in the upper portion of the external case, while cold air rushes in through those beneath to make up the deficiency. The passage of the air over the heated plates is so rapid that the particles of dust in suspension cannot become ignited, and there is in consequence a complete absence of that peculiar scorched odour, so common in rooms heated by the ordinary stove. The products of combustion are conveyed away by a small pipe proceeding from the side of the stove into any convenient flue. The calorific powers of the apparatus are very considerable, 12lb. of Welsh coal sufficing to warm a large hall for an equal number of hours. The fire, once ignited, requires no further attention whatever during the day. When burned out, the inner cylinder is withdrawn by a suitable hook, and another filled with fresh fuel substituted, so that the operations of the stove can go on uninterruptedly for weeks together if necessary.

WELCH'S DOUBLE-ACTION PATENT REGISTER STOVE.

THIS invention is intended to warm one or two rooms, supplying them with fresh but heated air, by one and the same fire, while also promoting ventilation, and preventing draughts—purposes long striven for in various ways. The draught from the open fire, instead of flowing upwards and into the chimney, flows downwards (towards the feet), and into an iron box behind the fire; and from thence, through sheet-iron pipes, into the chimney. By this means, not only is a better open fire obtained, but a stream of fresh air is passed over the pipes in the air-chamber, and led into the room or into the bedroom above: thus obtaining more than double the warmth, it is estimated, of an ordinary fire, but capable of regulation at pleasure. If the ash-pan is drawn a little outwards the downward draught ceases, and the stove then acts like those in ordinary use. As regards ventilation, by supplying a room liberally with fresh warm air, the foul air from the combustion of gas, &c., and from exhalations from the lungs, is brought below the breathing level, and swept into the fire. A hollow fender, connected with the warming apparatus, is also a part of this invention, which may at will be filled with heat from the fire, and this warmth brought to the feet, corresponding with that of hot-water. This hollow feet-warming fender is not necessarily a part of the stove.—*Builder.*

UTILIZATION OF WASTE IN THE IRON MANUFACTURES.

CHEMICAL analysis has demonstrated that the thousands of tons of cinders drawn from the puddling and re-heating furnaces, which at most rolling-mills are thrown away as useless, contain invariably from 25 to 50 per cent of metallic iron, combined and mixed with sulphur, silica, lime, and alumina, forming a very peculiar brittle compound, defying the most ingenious devices of our ironmasters to separate. Professor Fleury, of Philadelphia, states that, near Troy and the Albany iron works, at Troy, New York, many thousand tons of this puddling-cinder are spread over the streets, every 100 lb. of which contains from 30 lb. to 55 lb. of good iron. After many unsuccessful attempts, he has finally succeeded in extracting good cast as well as wrought-iron, and has even been so fortunate as to produce from this refuse material a good quantity of cast steel. Two great difficulties had to be overcome. 1st. The oxides and metallic iron in these cinders are combined with silica and other substances in such a peculiar way that, by remelting the same in the puddling, cupola, or other furnace, very little of the metallic iron can be extracted; the combination withstands even the high heat in a steel crucible. 2nd. By re-working the cinder with lime alone, or with lime mixed with charcoal and clay, the product is red short, and often red and cold short. The sulphur, silicon, and phosphorus remain still combined with the iron; all attempts to extract good neutral iron from the puddling-cinder by dry admixture of lime are unsuccessful; no other means remain but to destroy or loosen the tenacious chemical combination of these substances before they were placed in the furnace. Unslacked burnt lime possesses the peculiar property of decomposing silicates during hydration, or slacking, as it is commonly called. Taking advantage of this fact, Professor Fleury mixed a proper percentage of powdered burnt lime with the fine-ground cinder, and, after wetting the whole with water, exposed the mixture to the drying influence of the atmosphere. The dry compound was then heated in a common puddling-furnace, and treated like pig iron. He obtained 50 per cent. of wrought-iron, which, however, retained still some traces of sulphur. To extract these last traces of sulphur he dissolved in the water which he used for slacking the lime a small percentage of a chlorine salt, and his expectations were thoroughly realized. The Professor states that the process is also applicable to the working of siliceous ores, and can be performed in the puddling, cupola, or blast furnace. The preparation of the cinder, cost of lime, salt, &c., does not exceed 2 dols. per ton; and, if properly worked, the result is invariably a good quality of iron.—*Illustrated London News.*

ENGLISH AND SWEDISH IRON.

Experiments of an important nature have been made at the fortress of Carlberg, in Sweden, upon the respective merits of armour-plates made in England, France, and Sweden. Messrs. John Brown and Co., of Sheffield, sent two plates, one 12 ft. by 2 ft. 6 in., and one 6 ft. by 3 ft. 8 in. Messrs. Petin, Gaudet, and Co., of Lyons, sent two plates, each of 7 ft. 6 in. by 3 ft. 3 in. The Montala Ironworks Company, of Sweden, sent two plates of 12 ft. by 2 ft. 6 in., and one 6 ft. by 3 ft. 8 in. All the plates were of 4½ inches thickness, and then bolted to a teak target backed with iron plating, and supported by a massive stone pier. The two upper plates in the target were the French, and each was secured by 11 bolts. The next plate below was the longest, Swedish, and this was secured by 29 bolts. Below this was a tier of two short plates, one Swedish and one English, each secured by 24 bolts, and the lowest place was a long English, secured, like the Swedish, by 29 bolts. Each plate received six shots from the ordinary 68-pounder naval gun. The French and Swedish plates broke to pieces, and the English plates remained uninjured and free from cracks. The shot used were of Swedish iron, and exhibited great toughness as compared with the shot used in the English service—the core or centre of the shot, after striking, being of double the weight of the core of the English shot.—*Army and Navy Gazette.*

PRESERVATION OF IRON AND STEEL.

CAVALIER NOVI, formerly Lieut.-Colonel of the Ordnance, has read at the Royal Institution of Naples a paper entitled "Substances for the Preservation of Iron, Cast Iron, and Steel." It was approved and inserted in the Reports of the Academy. After having enumerated the principal means for preserving iron adopted by the ancients, and still more recently down to modern times, he confines his attention to the three following compositions for coating iron works :—1. Varnish composed of resinous matter, such as essence of turpentine, galipot, resin, colophony, &c. 2. Varnish, in the composition of which there is quick essence of coal, tar, and dry pitch of the same tar. 3. Varnish, the composition of which is derived from asphalte and its quick essences, mixed with oxides and various colouring substances. He concludes by saying that the future preservation of iron depends on the positive use of asphalte and its results. The French Government have directed that experiments should be made on these compositions.

MANUFACTURE OF IRON AND STEEL.

MESSRS. WILLIAMSON, of Parliament-street, and Picard of Lyons, have provisionally specified an invention, the object of which is to run molten iron or steel directly from a converting vessel, capable of rotating motion. into moulds or receivers. For a large casting they pour into one mould, or into a receiver placed over it, the iron or steel produced in several converting vessels by means of conveying gutters, which gutters are in communication with the converting vessels. Sometimes they make the converting vessel portable, and remove several to the mould. —An invention which relates to ball, mill, and puddling furnaces employed in the Manufacture of Iron and Steel has been provisionally specified for Mr. Thos. Wright, of Coldbrook Ironworks, New Brunswick. The improvements consist in building such furnaces in pairs, with a stove formed in the neck, to receive the metal preparatory to its being passed forward into the body of the furnace, and in applying a blast of atmospheric air to such furnaces, either hot or cold, as required, whereby he obtains a more uniform heat, producing a better quality of the manufactured metal, with a larger yield also, effecting a saving in fuel, and a diminution of manual labour.—*Builder.*

NEW ANCHOR.

A NEW Anchor, invented by Mr. Martin, has been tested on the part of the Admiralty. This anchor weighed 24 cwt. 2 qrs. 12 lb. on being placed on the testing machine. The distance from the centre of the pin, which fastens the shackle to the shank, to a point near the extremity of one of the flukes, was measured, and was 5 feet 5 inches. Although subject to strains varying from 9 to a weight of 24 5-16 tons, its deflection was but one half-inch, and the shackle yielded only 1-16th of an inch. On being let down to 20 tons pressure, the deflection was decreased 1-16th of an inch; at 15 tons it was decreased by 3-16ths; at 9 tons the permanent set was $\frac{1}{8}$th less; and when all pressure was removed, the original dimension was regained. The Admiralty test was 24 5-16ths tons. The test was then pronounced satisfactory.

ANVIL-BLOCK CASTING.

MESSRS. STANLEY and Co., iron founders, Midland Works, Sheffield, have cast an Anvil Block weighing 100 tons. The operation of casting began about eight o'clock, and continued until three. The mould—to the uninitiated only an immense hole in the earth—was situate in the centre of a spacious casting-room, having on each side a powerful crane, by which the molten metal was conveyed in ponderous "ladles" from the furnaces to the mould. The metal was run from two large cupolæ and two air furnaces. The anvil block is intended for a 12½-ton Nasmyth's double-acting steam-hammer, resting on a foundation of oak blocks, 11 feet square by 4 feet deep, and 120 large piles driven 10 feet in the ground by steam-power. The hammer is for forging the homogeneous metal for the large Whitworth guns and projectiles, marine engine-cranks, and other shafts, weighing from 5 to 8 tons each.—*Builder*.

IMPROVED MANUFACTURE OF SCISSORS.

M. SIMMOLET has introduced into Sheffield a new process of manufacturing Scissors, which promises to revolutionize some departments of that trade:—

By the old process scissors are forged by hand. A flat narrow piece of steel of the requisite length and thickness for the size of scissor required is beaten on the anvil with a hand hammer into a rude approach to the shape required. The bow is made by punching a hole through the shank end, and hammering the steel thinner and wider until the requisite width is obtained. The ornamentation of the shank has to be produced by the hand-file—a long, laborious, and therefore expensive, process After all this labour has been expended upon the scissors, they are sent to the grinders to be put into shape Even the filer leaves the scissors very rough and uneven, and the grinding is consequently a laborious operation. By the new process, a great portion of the labour we have indicated is saved. Commencing with the narrow piece of steel, M Simmolet first chips slight pieces out of the shank by a single stroke of a machine. Another piece is struck out of the centre of the shank end, and by the simplest process possible—the introduction of a sort of wedge—the hole thus made is enlarged into the bow. Then comes the simple process by which the old plan of forging is superseded, filing is nearly done away with, and the grinders' labour is materially diminished. Dies of the precise size and shape of the scissor required are fixed in a steam hammer. The scissor is placed upon one die fixed on the anvil of the hammer, and is struck with a corresponding die fixed to the face of the hammer itself. By this simple and ingenious process scissor after scissor is forged almost by a single blow. The object of forging scissors is, by compressing the pores of the steel, to impart that hardness, tenacity, and elasticity—in one word, that "temper" on which the value of the scissors as a cutting implement depends. We are assured that this result is attained even more perfectly by M. Simmolet's steam-hammer and dies, than by the hand-hammer of the forger. The forger hammering first one part of the blade and then the other, often tempers one part better than the other; but by the use of the steam-hammer perfect uniformity of temper is obtained throughout. As a question of temper, the machine-made scissor is at least equal to the one made by hand from the same quality of steel. In every other respect it is superior. In the first place, the bows and shanks, as well as the blades, of machine-made scissors are perfectly uniform, and perfect uniformity cannot be secured by the hand-hammer, where the workman has to be guided by the eye. In the next place, the ornamentation of the bow is produced by the same stroke that forges the blade. However elaborate the ornamentation required, it has only to be inserted in the die, and is reproduced in perfection in the scissor. Thus the long and laborious operation of filing the straight or slightly curved bow into a highly ornamented one is not only saved, but improved upon. The scissor comes from the machine with a narrow flange on each edge. The greater part of the flange is cut off by machinery, and the hand-file is required only to round off the edges from which the flange has been cut. The steel, moreover, comes from the steam-hammer a smooth and perfect scissor as regards shape. There is no unevenness of surface to be ground down, only polish and edge is required, and therefore the work of a grinder is obviously much less than in hand-forged scissors Hand-made scissors have to be made in pairs, and require great care and labour in fitting. But scissors made by these machines are so perfectly uniform, that any two taken promiscuously from a heap, fit together as a pair, without the least adaptation, and M Simmolet's invention provides for the riveting by a process as simple as its predecessors. The total result is this:—The machine-made scissors are in bow, shank, and blade perfectly uniform; the bows are rounder and smoother inside than those of the hand-forged scissors, and are consequently much more agreeable to the fingers in use; the quality of the blade is equal to that of the hand-forged scissors, if the same quality of steel is used; moreover, scissors entirely devoid of ornamentation can be produced cheaper by machinery than by hand; and ornamented scissors can be produced at greatly reduced prices.—*Abridged from the Sheffield Independent; Mechanics' Magazine.*

CAST-IRON GIRDERS.

DR. PERCY, the eminent metallurgist, on visiting the remains of the German Bazaar, in Langham-place, after a destructive fire, remarked that several of the Cast-Iron Girders of the building were much bent, and the cast-iron columns distorted by the operation of the fire,—a circumstance of considerable importance with reference to the use of cast-iron for building purposes. The girders were 13 ft. long, and 13 in. deep in the middle, tapering off slightly towards each end, and flanged, as usual, at the bottom. Several had fallen to the ground, of which only a few were broken; and of those which remained entire two were bent laterally in a striking and nearly equal degree. The flexure was gradual from end to end; the deviation from a straight line at the ends was 32 in. No cracks could be anywhere detected. Many of the cast-iron columns, which were still upright, had been singularly twisted at the upper part, as though the metal there had been softened by heat, and yielded, without cracking, to the effect of pressure from above. As far as Dr. Percy and his friend, Mr. James Fergusson, could judge, there was no very decided evidence of fracture in either girders or columns from the injection of water upon them; and yet, from the fused glass and other objects which lay scattered about, it is certain that they must have been exposed to a pretty high temperature. Dr. Percy considers these results to deserve attention from engineers and architects, and that it would be desirable that specimens of these bent girders and twisted columns should be preserved in some public museum, where they might at all times be accessible for reference. A collection of objects in illustration of accidents, such as the bursting of boilers, breakage of railway axles and tires, railway collisions, &c., would be as interesting as it assuredly would be important in a practical point of view.

NEW MODE OF DRAWING METAL TUBES.

A POWERFUL hydraulic machine, embracing many constructive novelties, has undergone some severe tests at Johnstone, near Glasgow. The machine is for Drawing Tubes of cast steel and other metals from the cold bar, without join or weld, in the following manner:—A round bar of cast steel has a hole pierced up the centre, and one end tapped to the depth of about 1¼ in. The piece of steel thus prepared has the tapped end—which is bevelled back about 1½ in., to admit of its being passed through a wordle or draw-plate, having a hole 1-16th in. smaller than the piece of steel to be drawn—secured to the end of the draw-rod, which is secured to the flange of the piston; therefore, when the water is pumped into the cylinder, the piston is forced out, and in making its travel, draws the steel through the wordle; but were the drawing to take place from the surface alone, a considerable tensional strain would be thrown on the inner particles, but this is obviated by drawing over a mandril, having a bulb at the end, which not only eases the strain, but polishes the bore.

The machine, of some 30 tons weight, consists of a double cylinder and double pistons, the cylinders having flanges at each end about 5 ft. square by 9 in. thick, and having recesses at given distances, into which draw-plates, or wordles, and mandrils are fitted. The cylinders are placed at a distance of 10 ft. apart, and a piston 16½ in. diameter, gives motion to a cross-head or plate of the same size as the cylinder flange. Into these flanges steel draw-bars are secured. When the piston on the right-hand side is home, the two flanges are together—in other words, the cross-head plate and the cylinder cover are in close approximation. The steel to be drawn is screwed into the draw-bar, when the piston, on being forced out with the water, pulls the steel through the draw-plate; and this is continued until the tube is brought to the proper size, the steel being annealed several times during the process.

For large tubes the steel is cast hollow, thus saving the cost of boring and the waste of metal. The patentees are sanguine of being able to make tubes large enough for the bore of the Armstrong gun. Its power is equal to 600 tons pressure, and is the first of the kind constructed in Scotland, and for accuracy of workmanship and beauty of execution, reflects great credit on the maker, Mr. M'Arthur.—*Mechanics' Magazine and Glasgow Herald.*

AGRICULTURAL MACHINERY.

THE Exhibition of Implements by the Smithfield Club, at the Agricultural Hall, Islington, in December, 1863, was very fine. A mere list of articles which attracted attention would be of little value; but a few of the principal implement stands certainly call for a notice. Steam-tilling apparatus, for instance, formed a marked feature in the exhibition. Mr. Steeven's balance plough, with parallel motion for raising one set of shares out of work, while the other set is being lowered into the ground between the journeys, is worked by Messrs. Garrett's stationary engine and windlass on Messrs. Howard's principle. Messrs. J. and F. Howard have improved their steam ploughing implement, by placing it upon four wheels, by which the steerage is made easier and the plough steadier. To their cultivator they also attach ridge-ploughs, so constructed as to be double-acting, making a ridge whether travelling backward or forward. This firm is not only supplying a large home demand for steam cultivating apparatus, but has sent out these machines to Germany and France, to Italy, Spain, and has lately started two steam-ploughs near Lisbon; it has other "sets" in India, and is sending several sets to Egypt. While the Britannia Works at Bedford are thus turning out this novel species of agricultural machine, in addition to the horse-ploughs, harrows, and haymakers, for which they are famous, the steam-plough manufacturing is still more largely carried on at Leeds. Mr. John Fowler announces that his engines have broken ground (literally) in New Zealand, at the Cape of Good Hope, at Melbourne, in Antigua, Cuba, Barbadoes, Porto Rico, and Demerara, in the latter country having obtained a public premium of 1050*l.* as the most successful introduction of steam power to the cultivation of the soil, while reports already come across the Atlantic of greatly increased yields of sugar from the use of the new machine. Others of Mr. Fowler's steam-ploughs have gone into Austria and Prussia, and into the south of Russia. In India, some of these engines were preparing ground for cotton, tea, and indigo; and in Egypt, a large number of them (costly as they are) had been despatched and set to work, to cultivate for cotton, and take the place of the cattle destroyed by the great murrain. Mr. Fowler stated that he was then (Dec. 1863), turning out from his works no fewer than four engines per week, and that in February, the production will reach one per day, and these pieces of machinery, it should be remembered, are worth 800*l.* to more than 1000*l.* each.

The "traction-engine," or the farm-engine, made locomotive on common roads, is now largely used for hauling both heavy steam-plough machinery and threshing-machines from farm to farm;

and it is probable that much of the present labour of our teams in harvesting and manuring will ultimately be accomplished by the same engine that already ploughs and grubs. As an instance of the extent of our foreign trade in agricultural machinery, Messrs. Clayton and Shuttleworth, in 1862, sent 120 steam-engines with thrashing-machines, to their agency in Vienna, and these are now in use in Wallachia and Moldavia, and parts of Hungary. The trade with Russia is stopped by the war, and the unsettled condition of that country; but Italy is purchasing largely, and a great German trade is springing up. Egypt appears, just now, to be one of the best markets for agricultural machines.

Among the portable engines of Messrs. Tuxford and Sons, for steam-culture and thrashing, Appold's centrifugal pump was shown, proved by recent experiments to perform double the duty of the old scoop-wheel, in raising water for drainage or other purposes. Messrs. Tuxford have brought out a new windlass for steam-culture, in which frictional gearing is employed for avoiding breakages of the wire-rope, and the brakes are self-acting.—*Abridged from the Times' Report.*

SUBAQUEOUS APPARATUS.

At a late sitting of the French Academy of Sciences, a new apparatus for enabling persons to remain under water, or in places filled with deleterious gases, was described. The apparatus consists of a piece of wood having the form and dimensions of the human mouth when open. To this piece of wood two india-rubber tubes are fixed, of any length, according to the exigencies of the case. The man engaged in the operation is further provided with a nose pincher, or instrument for compressing the nostrils, so as to prevent the introduction of the deleterious gas or of water, as the case may be. The operator puts the piece of wood into his mouth, and puts on the nose pincher; he stops up one of the orifices with his tongue, and inhales pure air from the other; after which he shifts his tongue to the latter orifice, and exhales his breath through the other He continues thus regularly shifting his tongue from one orifice to the other, in the order of the inspirations and expirations; but even a mistake would be of little consequence.

BRIDGE-BUILDING.

Mr. Spencer has read to the British Association a paper (contributed by Mr. Page, the engineer of Westminster Bridge) "On the Foundation of Bridges," at the recent meeting of the British Association. After giving his own experience in such matters, he went on to describe the process of formation. The foundation, he said, might be described as a part of the structure which resisted the weight of the superstructure, and it was evi-

dent that the higher the horizontal place of the resisting mass was, the less was the weight of the superstructure upon it, and the better adapted as a foundation to resist its pressure. He then described the system he had pursued in the construction of four bridges over the Thames, and also of the pier at Greenock. He considered it important that the foundations of each pier should be one undivided structure, and should not be broken into separate parts, as it was in cases where cylinders were used; and that, besides the resistance due to the horizontal area of the foundation, it should embrace the additional resistance afforded by the friction due to the vertical surface of the pile, and this, short of founding on rock itself, would present the most solid resisting mass that could be found. The application of this system to harbours of refuge was a subject of great interest and importance at the present time, both for expedition in completing the works and for economy.

LIGHTHOUSES OF IRELAND.

THE Rev. Dr. Romney Robinson, Astronomer Royal, has addressed a letter to the Inspecting Committee of the Ballast Board on the Lighthouses of Ireland, which he has recently inspected. He bears testimony to the perfect cleanliness, order, and discipline which he found in all the thirty-six lighthouses which he visited, and in the dwellings attached to them. Dr. Robinson states in a note that, when leaving Gola Sound, though the gale was much abated, the waves were 20 ft. high, and of such power, that they made a clear sweep over the Stags of Aranmore, 45 ft. above the sea level. Referring to the object of these establishments, Dr. Robinson makes remarks, which may apply to lighthouses everywhere. He says:—

"With respect to the optical part of your lighthouses, I was glad to see how largely you use the dioptric system. I was not prepared to find it so extensively employed in the Irish lights, nor, I think, is the public. Of its superiority to the catoptric I have no doubt, and I have now got an additional evidence. At Rathlin, when asking the keepers about the visibility of the different lights around them, I found that 'they saw the Maiden's (distant 27 nautical miles) in very clear weather.' At the Maiden's they saw Rathlin habitually; 'it was a good and strong light' Both lights are first-class, but Rathlin is dioptric; yet, though the latter kind are so much more powerful, I think those which I have seen (with the exception of Rockabill) are still susceptible of improvement in the following matters.—In some of the earliest—for instance, Ballycotton, which in other respects is perfect—some of the reflecting prisms are of very green glass, and a few so full of *striæ* that they cannot add anything to the illumination, and ought to be replaced by good glass. In some cases, the prisms are not properly adjusted, and their light does not go where it is wanted. I was glad to hear that the commissioners are employing a competent person to set this to rights. When once properly adjusted, they are not likely to get out of position without much violence. The same may be said of the mirrors which are substitutes for prisms at St. John's Point, county of Down. These mirrors would be much improved if, instead of the amalgam of tin which coats them, they were silvered; but prisms would be preferable, especially as this light is red."

Dr. Robinson tells the Ballast Board that they are not properly appreciated, and he had himself but a very imperfect idea of the enormous amount of work they do, and do well.

LIGHTHOUSE CONSTRUCTION.

THE lantern for the Lighthouse of Aranmore, off the coast of Donegal, has been constructed by a Dublin firm,—Messrs. Edmundson and Co., of Capel-street. It is a huge sixteen-sided structure, covered with a copper dome, and surmounted by a ball, supplied with ventilators, and bearing a wind-vane representing an arrow. The height of the structure from its base to the ball is 30 feet, and its diameter is 15 feet. "At first sight," remarks the Dublin *News Letter* in describing it, "one would be inclined to believe that it was a large portable house. This lantern will stand on a solid mason-work tower of 55 feet high, which will make the elevation of the light nearly 85 feet. The floor of the lantern is composed of pieces of metal, weighing 16 tons, and all jointed together with the greatest precision. From this flooring rises a metal wall, presenting sixteen sides. From this wall the lantern springs, which is composed of forty-eight compartments, divided by bars of gun-metal, grooved to receive plate-glass three-eighths of an inch in thickness. The uprights sustaining the dome are of planed iron, jointed with gun-metal astragals. The lantern is entered by means of an air-tight door, which will open on the platform of the tower, into which the lantern will be built and bolted down. The metal walls are lined with polished mahogany, in which ventilators are inserted. A curved metal stairway leads to an open ironwork gallery surrounding the apartment at half its height. This gallery will be used for serving and tending the light, which will be a revolving one, and of the first order. Inside the dome, a circle of iron is introduced, from which the T-iron that will support the apparatus for sustaining the light will spring. This T-iron will rest on the wrought-iron cornice plates at the spring of the dome. Here will also be fixed the machinery and fixtures for the revolving gear, to which will be affixed a weight, which runs through a hollow metal column, having its base at the foundation of the tower. The weight is to be wound up on the principle of a clock. The whole work has been carried out under the immediate supervision of Mr. Wigham. It is the first of the kind ever manufactured in Ireland."

IMPROVED LEATHER-CLOTH.

MR. SZERELMEY, the chemist, who exhibited, in the Great Show at South Kensington, in 1862, some specimens of his Artificial Leather, or Leather-cloth, has greatly improved its manufacture, till it now promises to become a most important manufacturing discovery. While it possesses all the best attributes of leather in great strength and durability, it has other and special advantages of its own—namely, complete impermeability to water, a flexibility and softness equal to a woollen fabric, and a cheapness which makes its cost scarcely one-third that of real leather. Thus, a good calf-skin costs from 10*s.* to 14*s.*, and yields leather for three or three and a half pairs of boots, whereas six square feet of the calf-skin leather cloth yields materials for five or six pairs of boots, and costs only about 4*s.* 6*d.* The nucleus of a factory has been established at Clapham, where the leather is now made. The fabric used in the manufacture is entirely according to the kind of imitation leather wished to be turned out. Thus "moll"—a very thick, soft kind of cotton fabric made at Manchester—is preferred for calf-skin; fine calico or linen for waterproof material for mackintoshes, siphonias, &c., as perfectly waterproof as india-rubber itself; and alpaca, silk, cloth, or common cotton for boots and shoes, bookbindings, harness, carriage furniture, and all the thousand purposes to which real leather is applied. What the composition of the pigment is which in a few hours changes common cotton into a substance like enamelled leather, and only to be distinguished from the real article by its non-liability to crack and its greatly additional strength, is of course a strict trade secret.

The mode of manufacture is simple. The fabric to be converted into leather, silk, alpaca, or whatever it may be, of any length or width, is merely wound on rollers beneath a broad knife-blade, which by its weight presses in and equally distributes the pigment previously placed upon it. A hundred yards may thus be done in a single minute; and in this most simple application the whole manufacture begins and ends, except that three coats of the pigment are necessary to perfect the leather, and an interval of 24 hours must elapse between the application of each. During this period the sheets are carried to a drying-house heated to a temperature of 94 deg., and where they are hung like oilcloth, according to the order in which they arrive, the last comers displacing those which have completed their time and are ready for their second coat. Thus the manufacture never stops, and three days suffice to complete "hides" of any length or breadth to which fabrics can be woven. For imitations of morocco or other marked leathers the long sheets are simply passed, when finished, through iron rollers, which indent them in any pattern required. For enamelled leather, the enamel is applied after the third coat by hand-labour, which, though slower, of course, than that of machinery, is nevertheless rapid enough to cover the sheet in a very short time. The enamel, when dry, is infinitely superior to any description of patent leather. The pigment which transforms the cotton into leather is capable of being tinted to any shade that may be wanted of red, green, brown, black, blue, yellow, &c., and that whatever are the ingredients of the composition, no admixture of india-rubber or gutta-percha forms part of it, inasmuch as the leather-cloth when complete, even when left folded and exposed to considerable heat, is entirely free from the tendency to stickiness which has been the great objection to all waterproof material.—*Abridged from the Times.*

JEUNE'S SUBSTITUTE FOR LEATHER.

Mr. W. R. Jeune, of Bow, has patented a fabric to be used in lieu of leather for various purposes, which is described as follows:—

He takes a long sheet of fabric, felt, or paper, and spreads thereon a coating of india-rubber or gutta-percha, or such like solution, and when the solvent of the solution is evaporated, a thin film of rubber or gutta percha is evenly deposited on the fabric, felt, or paper; he next applies a similar coating of india-rubber or gutta-percha upon a number of skins or pieces of leather, and when the solvent is evaporated by the aid of iron rolls, he unites the skins or pieces of leather and fabric, felt, or paper, by passing them through the rolls with the rubber surface in contact. The fabric, felt, or paper, and skins or pieces of leather now united, are rolled upon a drum and placed upon a machine, in which, whilst the sheet is kept at the required tension, a knife, running at a quick speed, splits off as much of the skin or leather as may be required. The fabric, felt, or paper is now covered with a perfect sheet of leather; the remaining portion of the skins can again be treated in the same manner as before, so that the number of times he may split the skins depends upon the thickness of them, and the purposes for which the fabric is required. The precision of the splitting, which enables him to obtain several or many slices from the same skin or piece of leather, is only attained by the aid of the fabric, felt, or paper.

The fabric, felt, or paper, having a perfect surface of leather, may be dyed and embossed in the usual way, and a fabric is thus produced at a great reduction upon the price of solid leather, and which, as it contains a film of india-rubber or gutta-percha, is waterproof, and therefore fit for many purposes for which leather would not be suitable.

When a waterproof fabric is not required, other cementing materials may be employed in place of india-rubber or gutta-percha. He prefers, in producing the fabric above described, to employ not whole skins, but square pieces of leather, as these will fit together, so as to cover the whole surface of the fabric, felt, or paper, without waste, or the pieces of leather employed may be of other forms.—*Mechanics' Magazine.*

AUTO-TYPOGRAPHY.

Mr. George Wallis may fairly be said to have discovered this process, which was suggested by the nature-printing processes, but partakes more of the leaden seal process. He prepares a drawing on sheet gelatine, with a peculiar sort of ink, described in a patent which he has taken out, and containing various ingredients—such as gum-arabic, peroxides of tin and manganese, Indian or Venetian red, &c.; the purpose being to form, in drawing on the gelatine, a raised surface, which is transferred to a soft metal plate, on which the drawing leaves its impression.

The plate can then be worked from with printer's ink, in the usual way, so as to produce fac-similes of the artist's drawing. That it may produce the more copies without being exhausted, it may be coated with steel by Mr. Joubert's process. Several plates can be successively stamped or struck off from the original drawing without much damage to the drawing itself. Mr. Wallis has invented a special press for taking the metallic impressions, in which the pressure is regulated to a nicety: the plates are of Britannia metal.

WILKINSON'S ROTARY PRINTING PRESS.

Macniven and Cameron's Paper Trade Review describes this new printing-machine, which, it is stated, will print at least twice as fast as any now used. It will throw off with ease twenty thousand sheets an hour, printed on both sides, cut and folded, ready for immediate delivery. The process of printing with this machine may be described briefly as follows:—The paper being made of the proper width for the sheet intended to be printed, is wound upon a shaft in one continuous piece, in the same form as an ordinary roll of carpeting, and, at the same time, is damped so as to enable it to take a perfect impression. The type, which is slightly conical in form, is placed upon the surfaces of two cylinders, the circumferences of each of which is exactly equal to the length of the newspaper to be printed. Each type is made in the precise line of the radius of the cylinder on which it is placed, and a small projection on one side of the type, with a corresponding indentation on the other, furnishes a means of locking the type together on the surface of the cylinder, so that it is impossible to displace them by the most rapid rotary motion. The machine being set in motion by any ordinary power, the paper is unwound from its shaft by the action of an endless apron, by which it is carried forward and introduced between the first type cylinder and corresponding press roller, where the impression on one side the paper is made. After this first impression, the paper is still carried forward in a direct line, and immediately passes between the second type cylinder and press roller, by which the impression is made on the reverse side. The sheet being now printed on both sides, is still carried forward into the apparatus by which it is folded, and at the precise point when the folding process is completed, a heavy standing shears, by a single blow, separates it from its original roll, and it drops upon the floor a printed newspaper, ready for immediate distribution.

NEWSPAPER STEREOTYPING.

FEW persons would suppose, remembering the rapidity with which a daily paper is composed and printed, that the "forms" could be stereotyped. Yet, so it is, and for the sake of that very rapidity. The *Engineer* gives some particulars of the mode pursued in respect of the *Times*. The pages are set up with types in the ordinary manner, and from these a *paper* matrix is obtained by pressure. The paper intended to receive the indentation or intaglio of these forms is prepared as follows :—Beginning with a sheet of very thin and fine but strong paper, known variously as bank-post or silver tissue, a sheet of brown paper and two or more sheets of blotting paper are successively pasted one over the other upon one side of the tissue. The opposite or face side of the tissue is dusted with powdered French chalk. The form of type is first warmed in a steam oven ; and then, when taken out and laid flat, the plastic paper web, prepared for impression, and still damp with paste, is placed upon it, and the whole passed beneath a weighted roller. The impression is as perfect as if it had been made in the finest wax. The paper comes from the types without the least wrinkle, and without cutting or tearing at the edges of any one of the thousands of impressions with which it is covered. The sheet, too, is nearly dried, and is ready for the moulding-frame. As it is not so stiff but that it may be readily bent, the paper is now made to assume the curve corresponding to the cylinders, 64 in. in diameter, of the Applegath presses and those made upon Hoe's plan by Mr. Whitworth. The paper-mould is held between an iron back and a block of fire-clay, curved upon its face, and in this position the type metal may be poured, and a stereotype plate produced in a few seconds, and perfect, with the exception of trimming the edges and planing the back, which operations are accomplished in a few minutes more. The paper-mould is not burnt by the contact of the melted type metal, which fuses at a comparatively low temperature. A slight discoloration and the least smell of burning are the extent of the injury to the mould, which, indeed, is good for a dozen or more casts, and may then be filed, if required, and preserved for years to be again cast from at any time. The sixteen pages of the *Times*, including its double supplement, are thus stereotyped between four o'clock and 4·40 every morning, the average time of making and finishing each plate being two minutes and a-half. Instead of printing off a whole edition from a single form of type, as many like impressions may be obtained at one and the same time as there are presses for the work.

THE SEWING-MACHINE.

MR. E. P. ALEXANDER, in a paper read at the Society of Arts, states :—The Sewing-machine has since gone under a variety of patentees' names, from the accession of real or alleged improvements ; but hitherto it has been chiefly in America it has prospered ; and in this country and on the Continent even yet it is, comparatively speaking, in its infancy. Since 1860, however, when old patents expired, it has taken a start even here : during the last two years no less than 20,000 machines have been manufactured in this country alone. But in America it is estimated that there are 300,000 machines in use, 75,000 of these in private families for domestic sewing ; and the annual saving to the States is estimated at upwards of 29,000,000*l*. sterling ! "It has opened avenues to profitable and healthful industry for thousands of industrious females, to whom the labours of the needle had become wholly unremunerative and injurious in their effects. Like all automatic powers, it has enhanced the comforts of every class, by cheapening the process of manufacture of numerous articles of prime necessity, without permanently subtracting from the average means of support of any portion of the community."

Amongst the leading branches of industry which are giving employment to these machines in this country are the manufacture of shirts, collars, stays, mantles, dresses, underclothing of all kinds, coats, trousers, caps, trimmings, and boots and shoes. In this last-mentioned trade upwards of 3000 machines are now employed. Of these about 800 are working in Staffordshire, the town of Stafford alone employing from 450 to 500 machines. About 800 are in use in Northampton. In Leicester a trade entirely new to the town has been created through the instrumentality of the sewing-machine; about 300 machines being now employed there in the manufacture of boots and shoes. Bristol employs about 250 machines, distributed among five establishments. The towns of Norwich and Ipswich employ about 800 machines, and a new trade in "ready-made uppers" has been created.

The following comparison of times required to do different kinds of needlework, is the result of practical experiments instituted by a sewing-machine company in the United States. The fineness of the work must be presumed to be equal in the two processes. Whereas it took 14 hours and 26 minutes to complete a gentleman's shirt by hand, the same was finished by machine in 1 hour and 16 minutes. A frock-coat took 16 hours and 35 minutes by hand-labour, and 2 hours and 38 minutes by machine. A lady's chemise required 10 hours and a half to be produced by hand, and one minute over an hour for its production by the machine. A satin waistcoat was made in 7 hours and 19 minutes by hand, in 1 hour and 14 minutes by machine. A pair of cloth trousers required 5 hours and 10 minutes by hand; and only 51 minutes by machine. A lady's silk dress, which cost the labour of 8 hours and 27 minutes by hand, took 1 hour and 13 minutes by machine; in a merino dress the comparative gain in time was greater by 9 minutes. In smaller matters, a silk apron was produced by the machine in 15 minutes, which required 4 hours and 16 minutes by ordinary workmanship; while a plain apron was made in 9 minutes by machine, which consumed 1 hour and 26 minutes by hand. In all the above work, the machinery was driven by the treddle.—*Once a Week.*

BOOT-CLEANING MACHINE.

MR. POLSON has described to the Scottish Society of Arts a machine for Blacking and Brushing Boots and Shoes. The motive power is supplied in the same manner as in the ordinary turning-lathe. Brackets fixed to the frame support a double crank-shaft, from which the different brushes obtain their motion. At the operator's left hand is the dusting brush, a few moments' application to which is the first stage of the process. At the right hand is the blacking brush, which is fed from a small box, and by means of a connexion rod, worked from the front of the machine, the supply is presented or withdrawn. The boot or shoe, so prepared, is then placed under the polishing brushes, steadied upon a small self-adjusting platform. The brushes, which are hollowed to suit the rounded shape of the boot or shoe, move horizontally with great rapidity, closely imitating the action of the arm. The brushes give about 300 strokes per minute, being about five or six times the number produced by a strong hand and arm. They are, moreover, given with perfect equality and steadiness, and with a capability of sustaining the work for any length of time. The brushes, which are worked from the double crank-shaft by means of connecting rods, move in the grooves of a framework supported by brackets. The inventor then exhibited the machine in operation.

WOOD-SAWING MACHINERY.

MESSRS. EASTON AND AMOS, of the Grove, Southwark, have patented an invention of improved machinery for sawing wood. In order to secure the log from rising with the drag of the saw on its bed while being cut, the patentees keep it down by means of pressing rollers or bowles carried by vertical water cylinders, in which stationary pistons are inserted, their rods being pendant from a transverse beam of the saw-frame. The upper and lower ends of each cylinder are brought into communication by an outside pipe, which allows of the water which fills the cylinder to pass from one to the other side of the fixed pistons. The water forms an elastic packing between the piston and the lower ends of the cylinder, and serves to retain the bowles of the cylinders in contact with the timber when once lowered in contact therewith. As this machine would be required to operate upon balks or logs of varying thickness, the cylinders are fitted with a vertical rack in gear with pinions for raising and lowering the cylinders: by this means the position of the cylinders may be adjusted to suit varying sizes of timber. The *Mechanics' Magazine* of June 19, 1863, by aid of diagrams, describes various other peculiarities and advantages of this machinery.

A LARGE VAT.

THERE has been finished at the Vinegar Works of Messrs. Hill, Evans, and Co., in Worcester, a monster vat, which stands on a 2-ft. dwarf wall of nine bricks in thickness. Its height is 23 ft.; it is 102 ft. in circumference, 33 ft. in diameter, and in its construction 325 staves of Dantzic deal, each 3 in. thick, have been used. The staves are bound by twenty-three hoops of Staffordshire iron 3½ in. wide and ⅝ in. in thickness, and the vat will hold 114,643 gallons, or 3184½ barrels. The largest known vat next to this is said to be at the porter brewery of Messrs. Guinness, at Dublin, which holds about 80,000 gallons, so that the Worcester vat exceeds it by upwards of 35,000 gallons. The total weight of this mammoth, when full, is 570 tons. If circular tables were placed inside it while empty, 100 persons might conveniently dine round them, and a tolerably numerous school might assemble to tea within its walls. Standing near to it are two other vats, holding upwards of 80,000 gallons each; and there are others of 78,000, 50,000, and so on down to 1700, and making altogether 76. These vats have been built by Mr. J. Oxley, of Frome, Somerset.—*Builder.*

PRESERVATION AND ORNAMENTATION OF BUILDING MATERIALS.

M. KUHLMANN has laid before the French Academy of Sciences, and inserted in the *Comptes Rendus*, vol. lvii., a memoir, in which he treats of the very remarkable modifications of colour, hardness, and crystallization due to the action of certain elastic fluids—viz., oxygen, hydrogen, nitrogen, chlorine, ammonia, cyanogen, and their compounds. He enumerates the principal results obtained by directing currents of the gases on various substances placed in tubes of porcelain heated to various temperatures, but not sufficient to decompose them. By the action of oxygen, the marbles coloured by bituminous substances were decolorized: agates and yellow or green jaspers took a brown or lively red; and emeralds and sapphires became paler in tint. Red and yellow cornelians were decolorized, but the silex which constitutes them became a dead white. Chlorine also decolorizes precious stones; but the diamond, ruby, and sapphire resist its action. Marbles and agates coloured red by oxide of iron become black by the action of hydrogen, which reduces the oxide. Hydrogen also reduces malachite to the metallic state, blackens lapis-lazuli, &c. Ammonia blackens red granite, reduces malachite to the metallic state, &c. Several of M. Kuhlmann's experiments support the opinion that the colour of many of our precious stones is due to the presence of organic matters. "When we consider," says M. Kuhlmann, "the divers modifications which the metallic oxides undergo in silicious pastes and in marbles by the agency of oxidation, reduction, and sulphurization, we begin to recognise that these modifications are sometimes powerful causes in the disaggregation of stones, independently of the changes which result in coloration. In the same manner as water which has penetrated porous stones breaks them up by freezing, so also oxides, in peroxidizing themselves or changing into sulphurets, may in time disintegrate the very hardest stones. May the collecting these facts tend to the clearing-up many obscure points in this study of the numerous modifications which mineral substances undergo on the surface of the globe!"

M. Kuhlmann also states that the efficacy of silicates of potash, or water-glass, for the hardening of stone, &c., having been found incomplete when applied to old buildings under the influence of ammoniacal emanations and constant humidity, the inventor has tried, in the case of brick walls, a mixture of tar obtained from the distillation of coal, laid on as hot as possible, the wall having been previously heated by placing near it a portable coke fire. This having been found successful, he was induced to experiment with several combinations of coal tar with various mineral substances, such as oxide of iron, obtained from the combustion of iron pyrites; this latter, united with one-fourth of its weight of coal-tar, gives a plaster, which, when cold, possesses remarkable hardness and sonorousness. The application of silicious solutions is not suitable for moulded plaster, because, even at the moment of contact, there is an exchange of acids; and a gelatinous solution is produced, which forms on the surface of the plaster an impermeable layer, and thus prevents the silica from penetrating into the centre. In regard to the application of bituminous substances for the preservation of many public buildings and monuments from the injurious action of frost and damp by means of the combination of gas-tar with plaster and other substances, he thinks that the phenomena attending these combinations well deserve the study of geologists in relation to the histories of many of the transformations which have taken place on the crust of the earth.

NEW MATERIALS FOR PAPER-MAKING.

NEW ZEALAND FLAX has been tried and found admirably adapted for paper-making; and paper made from it is superior, both in strength and capability of finish, to that made from most of the rags now used. From experiments made by Mr. R. Cameron, of Edinburgh, he is convinced there is not a better material for the purposes of the paper-maker. The treatment it receives is as follows:—

The native flax (Phormium tenax) is found in almost every district to such an extent, that thousands upon thousands of acres of the most beautiful fibre possible, rot on the ground for the want of cutting and gathering; which if brought to this country would give unlimited employment to the labouring population. Mr. Cameron has directed his attention to this subject, and to make himself practically acquainted with the statement, he made a lengthened journey in several districts, both in the mountains and swampy places, to inspect and make himself well acquainted with the plant; and, for the benefit of others, gives the result of his investigation, as follows:—

"In the swampy grounds I found plantations of flax—as I have before stated, thousands of acres The plant grows from 6 to 12 feet high, and bears a beautiful flower. After a few months the leaves turn brown and decay, but, if cut, it will bear three fresh shoots in 12 months, so that the quantity of fibre on each acre of land might be calculated to be at least from six to ten tons or twenty times the produce of Irish flax. I may state that one-third part of this produce might be selected for good useful fibre, for ordinary purposes of manufacturing into cordage, sailcloth, sheeting, and such like, one-third into ropes, and the like, and the other third into material for making paper. I can speak from my own knowledge, that paper made from the New Zealand flax is superior in every respect to all other, so that here is an abundance of good useful material, well fitted for maritime purposes, growing to an unlimited extent, which only requires to be cut down and converted into useful and valuable fibre, without the cost of rent, taxes, manure, or even ploughing the land.

"With reference to the mountain flax, I must state, that in many districts it grows too far from water carriage to be collected so cheaply as the swampy-grown flax; but the quality is much finer in the fibre, conseqnently of greater value; even this might be brought to England at fully two-thirds less cost than Russian hemp, and it is of twice the strength."

"On boiling the leaf in a solution of soda for an hour or two, we found that the outer green covering came off very easily, leaving the fibres perfectly clean. Now, the great difficulty, apparently, s to get the plant home in a state to admit of this working; and (says Mr. Cameron) we see little difficulty in this, for I found that, although being allowed to dry in the warm room, the leaf became dry, woody, and crackly, yet on being boiled it became quite soft and flexible; and the fibre, after being cleared of the outer green cuticle and gum, resumed its toughness and strength. What, then, is to prevent this material from being shipped in sheaves of long leaves, which would come as stowage for the heavy portion of a ship's cargo at a low freight? Or, if some slight preparation were needed to make it more portable, the leaves could be squeezed by a hydraulic press, and packed in bales of 4 or 5 cwt. —taking care to keep the leaves laid out lengthwise and flat.

"On breaking up the leaf, after boiling and teasing it, we found it made a very fine cottony pulp; and treated with caustic and bleaching powder, it becomes fit in no ordinary degree for paper-making.

"There is at present little prospect of the plant being suitable for spinning, not only owing to the imperfect and very expensive manner of preparing it now known; but even if proper machinery were now invented, the fibre would be very dear in consequence of the loss in weight from waste in dressing. In the meantime, however, there can be no doubt of the perfect capability of the article for the purpose of paper-making."—*Letter in the Times.*

In a late Sydney newspaper (says the *Paper Trade Review*), mention is made of a peculiar vegetable substance, taken from the root of the *Zamia spiralis*, vulgarly known as the native palm. This plant, which flourishes luxuriantly over millions of acres of land in New South Wales and other Australian colonies, otherwise unproductive, seems to possess many other properties which would render it highly valuable as a plant of commerce. The substance is a soft sort of cotton, very short in the staple, but fine and soft, and it would appear preferable for this purpose to the refuse cotton of the manufactories of Lancashire, which is bought by the paper-makers at the rate of 6d. a pound. The specimen was collected at the Clyde River, near Bateman's Bay, and is described as forming a kind of external clothing to the fibrous root of the plant.

The plant also produces a fine gum (resin?) as pure as amber, which would doubtless be available for many purposes of commerce, although the gums exuding from the palm-trees of New South Wales have hitherto been found too brittle for ordinary use. The seed of the plant is commonly used by the aboriginal natives as food, and may be readily manufactured into the finest starch and farina, the latter property of the plant having been well known and acted on by settlers in the district for some time past.

METROPOLITAN MAIN DRAINAGE.

On July 18, 1863, the first step was taken towards utilizing the new gigantic system of subterranean tunnels which constitute the works of the Main Drainage, by lowering the contents of the high-level sewer, which collects the drainage of Hampstead, Highgate, and Holloway, Camden Town, Hackney, and Bethnal-green, for the first time into the river at Barking. This occasion was taken advantage of by a large party of members of both Houses of Parliament, members of the Board of Works, engineers, and scientific gentlemen, to pay a long visit of inspection to the drainage works now in various stages of progress on both sides of the river Thames.

This great plan may best be briefly described as consisting of three gigantic main tunnels or sewers on each side of the river. These completely divide underground London, from west to east; and cutting all existing sewers at right angles intercept their flow to the Thames, and carry every gallon of London sewage under certain conditions into the river on the north side below Barking, and on the south to near Erith. These main drains are called the High, Middle, and Low Level sewers, according to the height of the localities which each respectively drains. The High Level on the north side is about eight miles in length, and runs from Hampstead to Bow, being at its rise only 4 ft. 6 in. in diameter, and thence increasing in circumference, as the waters of the sewers it intercepts require a wider course, to 5 ft., 6 ft., 7 ft, 10 ft. 6 in., 11 ft. 6 in.; and at its termination, near Lea river, to 12 ft. 6 in. in diameter. This drain is entirely finished, and in full work. Its *minimum* fall is 2ft. in the mile; its *maximum* at the beginning nearly 50 ft. a mile. It is laid at a depth of from 20 to 26 feet below the ground, and drains an area of 14 square miles. The Middle Level, as being lower in the valley on the slope of which London is built, is laid at a greater depth, varying from 30 to 36 feet, and even more, below the surface; this extends from Kensal-green to Bow. The Low Level will extend from Cremorne to Abbey Mills, on the marshes near Stratford, the city portion to pass through the Thames Embankment. At Bow the Low Level waters will be raised by powerful engines at a pumping station to the junction of the High and Middle Level ducts, thence descending by their own gravity through three tunnels to the main reservoir and final outfall below Barking. These three tunnels are each 9ft. 6in. in diameter and nearly four miles long. Great engineering difficulties existed in the construction of these main arteries, as, from the height at which they all meet, it was necessary to take them above the level of the marshes leading to Barking. For a mile and a half the embankment which encloses the three tunnels is carried on brick arches, the piers going 18ft. below the surface, and being based on solid concrete. In the marshes at Barking the reservoir for the reception of the sewage of the north side is a mile and a half long by 100 ft. wide and 21 ft. deep. It is made of this great length in proportion to width, to allow of its being roofed with brick arches, which are again covered with earth to a considerable thickness, so that not the slightest smell or escape of miasma can take place. This reservoir is capable of containing more than three times the amount of sewage which can enter it while the pipes are shut; and thus, when all is complete, the works will not only be large enough to carry off all London's sewage now, but its sewage when London is double its present size.

While the sewage is in the reservoir we have spoken of, it will be completely deodorized by an admixture of lime. When the tide is at its height, the sluices which pass from the bottom of the reservoir far out into the bed of the river will be opened, and the whole allowed to flow away. It takes two hours thus to empty the reservoir, by which time the tide will be flowing down strongly, and will carry its very last gallon a distance of 13 miles below Barking, which, being itself 13 miles below London, will place the contents of the sewers, every 12 hours, 26 or more miles distant from the metropolis. It will all be carried away a distance of 13 miles, then deodorized, then suffered to escape into a body of water more than a hundred times greater than that into which it now crawls; and thus disinfected and diluted, so as to be without either taste or smell, swept still further down the stream, till every trace of it is lost.

On the south side the three great sewer arteries are constructed on similar plans — the High Level from Dulwich to Deptford; the Middle from Clapham to Deptford; and the Low Level from Putney to Deptford. At this point is a pumping station, which raises the water from the low to the high level, whence it flows away through a 10 ft. tunnel to Crossness Point. One part of this tunnel, passing under Woolwich, is a mile and a half in length, without a single break, and driven at a depth of 80 ft. from the surface. At the outfall will be another pumping station, to lift the water to the reservoir. The southern reservoir is only five acres in extent; that on the north is fourteen. In the reservoir the sewage will be deodorized and discharged in a similar way to that we have already described.

The visitors, on July 15, first inspected the channel for the overflow of storm-water; next the two culverts, as large almost as railway tunnels, which carry the sewage to the east and west pumping stations. Before the entrance to the pumps are massive iron strainers, which keep out all the coarse refuse brought down the sewer, and which is afterwards dredged up by the filth-hoist into the filth-chamber, which is flushed in the river at low water. The pumping stations will each consist of an engine-house, containing 10 boilers calculated to work up to 500-horse power nominal. This power working through eight pumps of 7 ft. diameter, and 4 ft. stroke, will daily raise 19,000,000 cubic ft. of sewage from 19 ft. below low water to the level of the outfall; but, in case of necessity, the pumps can raise 25,000,000 cubic ft. per day. The reservoir into which it will all flow, when roofed in with brick, will hold 20,000,000 gallons of sewage. The visitors were next taken across the river to the Barking outfall, where the works are larger, simpler, and much more advanced, for on the north the sewage is brought at such a level as to discharge into the reservoir by its own gravitation. The reservoir here is far advanced, a great deal of it being roofed in, so that all will be completed in a few months more. Close to the reservoir the contents of the High Level sewer were turned on into the river direct, and not, as they will in future flow, through the reservoir.

The total length of the three rows of intercepting sewers, the course of which we have sketched on each side of the river, will be 50 miles; and before all the works are completed, 800,000 cubic yards of concrete will be consumed, upwards of 300,000,000 of bricks, and 4,000,000 cubic yards of earthwork.

To appreciate the benefit which will result to the metropolis from this great work, it will be best to glance at the evils which it will avert. The Thames had been since 1849 the receptacle of all the cesspools of the metropolis, through 700 or 800 miles of new drains, by which some 200,000 additional gallons of sewage were daily contributed, at low water, containing no less than 300,000 tons of organic matter, or filth. Thus, year after year, the Thames was made the largest and dirtiest open sewer in Europe. The result, as a matter of course, was that in the summer months the stench from the river has occasionably been intolerable. In 1857 and 1858, great quantities of lime and chloride of lime were put in daily; and in 1859 the dose had been increased to 110 tons of lime and 12 tons of chloride of lime, costing some 1500*l*. per week. Even in a pecuniary point of view, however, this was not the only evil of the system. The Thames in this hot weather ran short of water, and when there was no rain the collections of refuse in the sewers had to be flushed into the river by artificial means. This flushing alone during summer cost 20,000*l*. a-year to get the poison into the Thames, where 20,000*l*. more was generally required to keep it from breeding a plague. The tide in summer carried off little or nothing. A marked object was set afloat in the river and watched, with a view of ascertaining this fact, and for three weeks it went backwards and forwards between Vauxhall and London bridges, without going much further either way. During the same period, of course, the sewage of the Thames, increased by its daily contribution, went backwards and forwards likewise under the summer sun, yet people profess to wonder why it smells so abominably. The magnitude and importance of this evil had long been known, and Mr. Bazalgette, the chief engineer of the Board of Works, fought long and assiduously to have the plan improved, and, strongly aided by public opinion, his fight has been successful. His main drainage scheme is nearly completed. In less than two years more it will be entirely completed, the Thames purified, and London effectually drained — *Abridged from the Times*, July 20, 1863.

THE WATER-SUPPLY OF LONDON.

THE analysis of Dr. R. Dundas Thompson, of the metropolitan waters in August, offer some points of special interest and importance. There was a slight increase upon the organic and total impurity of the preceding month, the most striking examples being illustrated by the Kent and Lambeth companies. Moreover, the Thames water at London Bridge at high water, was highly charged with impurities and sea-water, three experiments having yielded a mean of 232·67 deg. of total, and 26·38 deg. per gallon of organic impurity, while the amount of ammonia from the sewage was ·748 grains per gallon. One of the wells in St. Marylebone contained as much as 2·71 grains ammonia per gallon, an evidence of the large admixture of sewage with which it is contaminated. We give the Registrar-General's analysis:—

	Total Impurity per gallon.	Organic Impurity per gallon.
	Grains or Deg.	Grains or Deg.
Distilled Water	0·0	0·0
Loch Katrine Water, new supply to Glasgow	2·35	·605
Manchester Water Supply	3·33	·680
Upper Marylebone-street Well .	106·40	7·60
Thames at London Bridge	232·67	26·38
Thames Companies.		
Chelsea	17·08	1·40
Southwark	16·40	1·44
West Middlesex	16·72	1·36
Grand Junction .. .	16·64	1·60
Lambeth	17·20	1·72
Other Companies.		
East Londen	17·52	1·66
New River.	16·00	1·20
Kent	26·16	3·68

The table is read thus:—Loch Katrine water contains in the gallon 2·35 degrees or grains of foreign matter in solution, of which ·604 degrees or grains are of vegetable or animal origin.

THE SOUTH ESSEX WATERWORKS.

The South Essex Waterworks Company was formed for the purpose of turning to account a large and, indeed, almost unlimited supply of water at Grays, in Essex. During the process of excavating a series of chalk-pits on the estate of Mr. Meesom, which have been in working for upwards of fifty years, springs of water of large volume have been opened, capable of producing many millions of gallons daily; and hitherto this water has been simply wasted by being pumped into the Thames. The water springs in question are situated about a mile from the river, and when undisturbed they rise to a height varying from five to eight feet below high-water mark. The chalk had been worked out to the level of the springs, over an area of sixty acres, when attempts to go deeper led to the discovery of this water, which a careful scientific analysis showed to be entirely free from the presence of organic matter, in which respect it is far superior to any of the waters at present supplied to the metropolis, inasmuch as many of them contain at least three grains of organic matter to the gallon.

It became necessary, for the purposes of working the chalk-pits, to pump out the water, by which operation, the pumps working day and night, a quantity exceeding 2,100,000 gallons was obtained daily. In the course of weeks' pumping, the water was lowered about twelve feet, and it then became possible to excavate the chalk to that additional depth over a small space; but if the pumps ceased working the water speedily rose to its former height, and a day and a night were occupied in pumping so to reduce it as that the work might be resumed. When a space of thirty yards square had been excavated to a depth of about 12 ft., the pumps were overpowered by the increasing pressure of the water, and by going to a greater depth, namely, to about 31 ft. in a small well, an increased quantity of water was apparent. These operations had been carried on for many years; yet notwithstanding that so large a quantity of water was pumped daily into the Thames, no perceptible alteration took place in the quantity or quality of the water, and it was fairly presumed that an immense supply of very pure water might be obtained from these sources, provided the excavations were deepened and enlarged. With a view of turning such a valuable water supply to account, a company was formed, and obtained powers to distribute water to Brentwood, Romford, Ilford, Barking, and other places in Essex between Grays and the adjacent district, to the eastern suburbs of London. After providing for these districts, a very large surplus of water will remain, which it is proposed to carry to the metropolis.—*Illustrated London News.*

The following is a description of the pumping apparatus, &c., from particulars furnished to the *Mechanics' Magazine*, by Messrs. Easton and Amos, the engineers to the works. The steam-engine employed for raising the water from the chalk-pit to the reservoir at Warley, is constructed upon the principle known as Woolf's double cylinder, and is the most economical and convenient agent that can be employed for this purpose. The steam is first used at high-pressure in the small cylinder, where it is allowed to exert its full power throughout the entire stroke; from this it passes into a larger cylinder four times the capacity of the small one, so that it is then expanded to four times its first bulk, and consequently, its final pressure is reduced in a like proportion; it then passes into the condenser beneath the cylinders, where it is again converted into water, and in this process a vacuum is formed, which draws down the piston on the large cylinder, and then the whole power of the steam is made available. The water is raised by a pump, which is worked by a rod direct from the wrought-iron beam of the engine. The pump is double-acting, having both a bucket and plunger, and thus represents a combination of the common lift-pump, with a force-pump, similar to that used for feeding boilers. The bucket is twice the area of the plunger, and the consequence of this is—that it draws at the up stroke the full contents of the barrel, but only discharges one-half into the delivery pipe, the other half being displaced by the plunger at the down stroke. This causes a pretty uniform flow of water, and enables it to be forced, with the assistance of a large air-vessel, straight into the main, without the intervention of a stand-pipe. It is believed that this is the only instance of water being raised to a height of 400 ft. through a main 9½ miles in length.

Natural Philosophy.

THE ROYAL SOCIETY.

At the Anniversary Meeting, on St. Andrew's Day, the President, General Sabine, commenced his Address with a statement concerning the great Southern Telescope recommended by the Royal Society and the British Association so long ago as 1853 to be established by Her Majesty's Government; which representation was, however, allowed to remain until 1862, when the Royal Society reported to the Government upon the colony of Victoria as the site for such a telescope. The cost was estimated at 5000*l.*; the time of construction about eighteen months; and Mr. Grubb was designated as the constructor. It is understood that the colony of Victoria is willing to defray the cost of the instrument, so that in this instance there is no question of Government aid. If the Melbourne Board of Visitors adhere to their original intention, it will be a distinction of which the colonists may be proud; that the first reflecting telescope erected at public cost should have been set up by them in the southern hemisphere, and on a spot which thirty years ago was a wild solitude.

Since the Report was sent in to the Colonial Office, a few supplementary letters have been written, one of which is likely to influence the whole question. It is addressed to General Sabine by Mr. Lassell, and runs thus:—"On the occasion of my temporary visit to England, I have had the opportunity of looking into some of the correspondence respecting the proposed 4 ft. telescope for Melbourne; and, in consequence, I should be glad to be allowed to state that I do not intend to continue my observations with the telescope of this size now erected in Malta beyond the period of twelve or at most eighteen months from the present time (July, 1863); and that if this equatorial should meet the requirements of the Melbourne Committee, I shall then be glad to place it at their disposal." We have rarely seen so munificent a gift offered with so little ostentation. It forms a suitable *pendant* to the generous intentions of the colony of Victoria towards astronomical science. Mr. Lassell's offer will hardly be declined, unless his telescope be obviously insufficient for the proposed work. If accepted, the colonists will then have 5000*l.* available for some other scientific enterprise.—*Athenæum*, No. 1882.

The President then passed on to the pendulum experiments about to be made at the principal stations of the great Russian Arc, under the direction of M. Savitsch. This officer had been informed by General Sabine, that the invariable pendulums employed in the English experiments were now in the possession of the Royal Society, and would be readily lent, if applied for. The constants of these instruments, including the coefficient in the reduction to a vacuum, having been most carefully determined, they were ready, with the clocks and stands belonging to them, for immediate use; and would have the further advantage that experiments made with them in Russia would be at once brought into direct connexion with the British series, extending from 79° 50′ N. to 62° 56′ S. latitude. The communication was most courteously received and replied to. It appeared, however, that a detached invariable pendulum had been already ordered by the Russian Government from M. Repsold, of Hamburg, shorter than the English pendulums, for convenience in land transport, and with two knife-edges and two fixed lenses, symmetrical in size and shape, but one light and the other heavy, and so arranged that the times of vibration should be the same on either knife-edge in air of the same temperature and density. M. Savitsch expressed his desire to bring this pendulum in the first instance to Kew, and to secure thereby the connexion of his own with the English series; when he would have the opportunity of testing the exactness of the correction for buoyancy by vibrating his pendulum on both its knife-edges in the vacuum apparatus which is now established at Kew.

It is much to be desired, proceeds General Sabine, that a similar series of pendulum experiments to those about to be undertaken in Russia should be made at the principal points of the Great Indian Arc; and the steps which are understood to be in progress in providing new instruments for the verification of the astronomical and geodesical operations of the Trigonometrical Survey of India, and to give them a still greater extension, would seem to present a most favourable opportunity for the combination of pendulum experiments. In such case the pendulums of the Royal Society might be made available with excellent effect.

The proposed measurement of an arc in a high north latitude by the Swedish Government may fitly be taken in connexion with the above. A preliminary survey has been made at the recommendation of the Royal Academy of Sciences at Stockholm, to ascertain the practicability of the operations, and with encouraging results. From Ross Island, at the extreme north of Spitzbergen, to Hope Island, at the extreme south, suitable angular points for a triangulation have been examined and selected. These include about 1° 50′ of the proposed arc of 4½ degrees. In the summer of next year this preliminary survey is to be continued. "The northern portion," as stated in the report of the Swedish surveyors, "presents no impediments which may not be surmounted by courage and perseverance," and if present hopes be realized, it is probable that the measurement of the arc itself may be commenced in the coming year.

This subject was first brought before the Royal Society at one of their evening meetings last session by Dr. Otto Torell, of Stockholm, whose visit to this country will be remembered with sincere pleasure by those who had the good fortune to make his acquaintance. That it has a special interest for their President will appear from the following passage, which we give in General Sabine's own words.

"I may perhaps be permitted," he remarks, "to allude for a moment to the peculiar interest with which I must naturally regard the proposed undertaking. The measurement of an arc of the meridian at Spitzbergen is an enterprise which nearly forty years ago was a cherished project of my own, which I had planned the means of executing, and which I ardently desired to be permitted to carry out personally. I may well therefore feel a peculiar pleasure in now seeing it renewed under what I regard as yet more promising auspices :—while I cannot but be sensible of how little I could have anticipated that I should have had the opportunity, at this distance of time, and from this honourable chair, of congratulating the Swedish Government and Academy upon their undertaking; and of thanking Dr. Torell for having traced its origination to my early proposition."

Spectrum analysis next claims attention: in this instance in its astronomical applications. Attempts have been made to discover the chemical nature of the atmosphere of some of the fixed stars by a combination of the prisms of a spectroscope with a powerful telescope. It is a nice and difficult experiment, rendered more difficult by the movement of the star while under observation, and by the enormous distance through which the rays of light travel before they arrive at the instrument. The difficulty, however, is not insuperable, and we are glad to learn, on the authority of the President's address, that a distinguished chemist and an able astronomer have associated themselves for the investigation of this important question. The knowledge and experience of the one will be a check against drawing conclusions from delusive lines in the spectrum, while the practical skill of the other will insure that the drawings or photographs of the spectra shall be actual representations. The *Transactions* and *Proceedings* of the Royal Society already contain papers on this subject, and we may expect that important additions will be made before the next Anniversary.

Chemists and others who may devote themselves to this subject, would do well to study the Rev. Dr. Robinson's paper recently published in the *Philosophical Transactions*, in which certain questions are discussed, very important in spectrum analysis. These questions, as General Sabine states them, are —"Each elementary gas and each metal shows certain well-marked characteristic lines, from the presence or absence of which it is commonly assumed that the presence or absence of the element in question may be inferred. But the question may fairly be asked, Has it been established that these lines depend so absolutely on chemical character that none of them can be common to two or more different bodies? Has it been ascertained that, while the *chemical nature* of the bodies remains unchanged, the lines never vary if the circumstances of mass, density, &c., are changed? What evidence have we that spectra are superposed, so that we observe the full sum of the spectra which the electrodes and medium would produce separately?" Perusal of Dr. Robinson's experimental answers to these questions will save many an operator from erroneous conclusions.

The topic next treated of is gun-cotton; an explosive subject, on which, as General Sabine informed the meeting, a full Report by a Committee of the British Association is almost ready for publication. The Austrian Government, when applied to for information, responded in the most willing manner, and sent over General von Lenk with another officer to communicate with the Committee all that they had learned and discovered on the subject during a twelve years' course of rigorous experiments; and that it is demonstrated by these experiments that properly prepared gun-cotton is not "liable to spontaneous combustion: it can be transported from place to place with perfect security, or be stored for any length of time without danger of deterioration. It is not impaired by damp, and may be submerged without injury, its original qualities returning unchanged on its being dried in the open air and in ordinary temperatures." An officer from the Confederate States, who was present at the late meeting of the British Association at Newcastle, was so much struck by what he heard concerning gun-cotton, that he immediately sent off a report thereupon to his government; and we hear that gun-cotton is now one of the defensive appliances at Charleston.

This year, the Copley Medal and the two Royal Medals were awarded to Englishmen; the Copley Medal to the Rev. Adam Sedgwick, for his observations and discoveries in the Geology of the Palæozoic Series of Rocks, and more especially for his determination of the characters of the Devonian System, by observations of the order and superposition of the Killas Rocks and their Fossils in Devonshire.

The other awards were, a Royal Medal to the Rev. Miles Joseph Berkeley for his researches in Cryptogamic Botany, especially Mycology. Mr. Berkeley's labours as a cryptogamic botanist for upwards of thirty-five years, during which they have been more especially devoted to that extensive and most difficult order of plants the fungi, have rendered him, in the opinion of the botanical members of the Council, by far the most eminent living author in that department. These labours have consisted in large measure of the most arduous and delicate microscopic investigation. Next a Royal Medal was awarded to John Peter Gassiot, Esq., for his researches on the Voltaic Battery and Current, and on the Discharge of Electricity through Attenuated Media. These contributions are of high value, and in some respects peculiar. Their experimental part has been conducted on a scale of magnitude and power unmatched since the days of Davy and of Children, with apparatus of the highest perfection, and with consummate dexterity and skill; and the discussion and interpretation of the facts observed are characterized by sound theory and sober judgment.—*Abridged from the Athenæum Report.*

FRENCH ACADEMY OF SCIENCES.

At the public annual sitting of this body, under the presidency of M. Duhamel, the prizes for 1862 were thus awarded :— 1. That of statistics to M. Mantellier, Councillor to the Imperial Court of Orleans, for his paper on the value of the principal provisions and goods sold in the market of Orleans in the 14th, 15th, 16th, 17th, and 18th centuries. An honourable mention was awarded to M. Champion for a work entitled, "The History of Inundations in France from the 6th century to the Present Day." 2. Two Bordin prizes on the question "To determine by experiment the causes likely to influence the differences of position of the optical and photogenic foci," were awarded to MM. Felix Teynard, of St. Martin, near Grenoble, and Carl Miersch, of Dresden ; the former receiving a gold medal of the value of 2000f., the latter one of 1000f. 3. The prize of experimental physiology was divided between M. Balbiam, who received 1800f. for his labours on the sexual generation of infusoria, and MM. Chauveau and Marey, of the Veterinary School of Lyons, who received 1200f., together for their remarkable inquiries into the laws of cardial circulation. 4. The Alhumbert prize of 2500f. on the question of spontaneous generation, was unanimously awarded to M. Pasteur, just admitted a member of the Academy. 5. Another Alhumbert prize of 2500f. was divided between MM. Lereboulet and Dareste, for their labours on "the development of the embryo of a vertebrated animal by the action of exterior agents." 6. The late Dr. Jecker's prize for the advancement of organic chemistry, was awarded to Mr. Thomas Graham, on account of his researches on molecular diffusion as applied to chemical analysis. 7. The Barbier Prize was given to M. Cap, for his labours on glycerine. Many prizes proposed in the previous year were not awarded at all.—*Galignani.*

CONTACT BETWEEN SCIENCE AND ART.

At the Royal Institution, Cardinal Wiseman has delivered a lecture "On the Points of Contact between Science and Art." He considered the subject in its relations separately to painting, sculpture, and architecture, each of which department of art, he remarked, is intimately connected with the progress of science. The first representative man in whom science and art were combined in the greatest perfection was Leonardo da Vinci ; for, though little is generally known of that great artist's scientific acquirements, he wrote 13 folio volumes on matters relating to science, and he had brought that knowledge to bear in executing his works of art. The man of modern times who had done most to connect science with art, was the late Prince Consort, whom Cardinal Wiseman eulogized in high terms, and mentioned the many successful endeavours which had been made by the Prince to promote science in connexion with art. The relation between Scripture and science was illustrated by reference to the elliptical curves of which the form of the human body is composed ; and Dr. Wiseman pointed out an analogy between these elliptical curves and the orbits in which the planets revolve round the sun. The study of anatomy, also, had been of eminent service to the sculptor. The relation between architecture and science, he observed, is so intimate, that the operations of the architect are entirely founded on a knowledge of the principles of mathematics. To illustrate the importance of the application of science to architecture, the lecturer explained, in considerable detail, the manner in which the dome of St. Peter's, at Rome, had been repaired when in danger of falling.

DETERMINATION OF THE LONGITUDE.

M. Le Verrier has announced to the French Academy of Sciences, the termination of the operations carried on by means of electricity for the determination of the difference of longitude between the Observatories of Paris and Madrid. As the distance between them is 380 leagues, it has been thought necessary to establish an intermediate station at Biarritz. It was stated that the synchronism of the relays has left nothing to be desired, and the observations of the passage of the meridian are made simultaneously in the best condition possible. The station at Biarritz is the last of the network of the geodesy of France, and will shortly be connected with that of Spain. The determination of the longitude thus accomplished will then be submitted to a double control.

THE ORDNANCE SURVEY.

One of the first practical results arising from the completion of the Triangulation of the United Kingdom is, that we are now able to engrave the latitude and longitude on the marginal lines of the old sheets of the 1 in. map of England; and this is now being done at the Ordnance Map Office, at Southampton.

The equatorial diameter of the earth, as derived from the Ordnance Survey, is 7926·610 miles, or about one mile greater than that given by the Astronomer Royal in his *Figure of the Earth*. The ellipticity is $\frac{1}{299 \cdot 33}$. The mean specific gravity is 5·316. The elements of the spheroid most nearly representing the surface of Great Britain, are:—

Equatorial semi-diameter	3963·305 miles.
Polar	3950·064 ,,

Saturday Review.

VARIATIONS OF THE COMPASS.

In the *Revue Maritime et Coloniale*, has appeared a letter on the deviations to which the needle is liable in consequence of the substitution of iron for wood in ships. One of the latest contrivances for diminishing this serious inconvenience is the correcting Compass, which affords the means of taking the sun's position, whereby the deviation may be corrected. It has sometimes been supposed that fogs and certain other states of the atmosphere could influence the needle; but this has not been borne out by observation. Lightning alone exercises a decided influence on the needle by reversing its points, so that north becomes south, and conversely. When a vessel is nearing land, the needle is said to be affected; and certain rocks there are that exercise a decided magnetic influence on the compass, volcanic rocks especially, but this influence is not felt on board ships. But the action of the iron forming the ship's sides is far different; nothing, not even the interposition of a thick non-magnetic body, will stop its influence; far less, as some have believed, a copper coating or thick paint. But the real danger proceeds from another source; since the ship herself, under her weight of canvas, may increase the deviation of the needle. From experiments made on board an iron-built sailing vessel, provided with iron rigging and lower yards of steel, and with two binnacle compasses on her poops, and a third placed between the mizen and mainmasts, the lower part of which was all of iron,—the deviations of the needle were respectively 56 deg., 24 deg., and 35 deg. Without entering into further details on this matter, the writer of the article concludes with condemning the imprudence of those who freight an iron vessel before she has been at sea for a considerable time, in order to ascertain how her compass behaves. Moreover, a captain undertaking the command of an iron ship, should be called upon to show that he has previously been on board such a vessel on a long voyage, so that he may know how to deal with the deviations observable on board the vessel to be commanded.—*Galignani's Messenger*.

MAGNETIC MOUNTAIN.

A Magnetic Mountain has been discovered in Swedish Lapland. It is traversed by a vein of magnetic iron, several feet in thickness, and said to be the richest hitherto known. M. Berg, the owner of the mountain, has opened up the mine, with the hope of supplying all the world with loadstones of great power. One of these, weighing 68 Swedish pounds, has been already acquired by the eminent electrician, Professor Dove, of Berlin.

MAGNETIC ACTION ON CLOCKS.

In the *Philosophical Magazine*, Mr. Wm. Ellis, of the Greenwich Observatory, gives an account of some experiments made by him in order to ascertain whether it would be possible easily to change permanently the rate of a clock by the action of magnets, and thus avoid the necessity of touching the pendulum. The clock employed was one whose pendulum, vibrating seconds, consisted of a wooden rod fitted with a lenticular-shaped bob of lead. Near the lower end of the pendulum rod was fixed a permanent bar magnet in a vertical position. Above this, and supported by the clock case, was fixed another magnet, entirely similar, also in a vertical position, and so placed that when the pendulum rod was at rest, the lower end of the fixed magnet was precisely over the upper end of the pendulum magnet. The broad part of the magnets was towards the front. The clock rate having been found with the pendulum magnet only in position, the fixed magnet was then added, and the rate determined with this magnet placed at different distances above the pendulum magnet. The clock was rated with the poles of each magnet in reversed positions with respect to the other magnet, giving four sets of observations. Between each set, and again at the completion of the observations, the clock rate was determined with the pendulum magnet only in position. These determinations of the clock's normal rate were very satisfactory as respects steadiness of rate; the changes produced by the action of the magnets on each other may therefore be considered exact. When the adjacent poles of the two magnets were similar, the effect of the repulsion retarded the clock; when the adjacent poles were unlike, the effects of the attraction accelerated the clock. As respects change of rate, it appeared for a given distance of magnets that, when the adjacent poles were similar, the clock was not retarded to the same extent to which it was accelerated when the poles were unlike.

MAGNETIC DISTURBANCES.

MR. BALFOUR STEWART, F.R.S., of the Kew Observatory, has read to the Royal Institution a Paper "On the Nature of the Forces producing the greater Magnetic Disturbances." We can only give the chief points. When a bar of steel is magnetised it has acquired a tendency to assume a definite relation to our earth. Nothing in science is more mysterious than the cause of this. The earth (like a great magnet) acts upon a magnetised needle with merely a directive force. At the present moment a mariner's compass needle points in a direction of about 21½ deg. west of true north, termed a declination to that extent, and at the same time dips downwards, making an angle of about 68 deg. with the horizon. This declination and dip vary with time and place. But there are other changes which the magnet experiences when kept suspended in the same place —1, The secular change—viz., during a great many years; 2, the annual variation; 3, the daily variation; and 4, a change due to the moon. In addition to these are those curious and unaccountable changes termed magnetic disturbances, or storms. Atmospheric storms, even the greatest, are only local phenomena; but magnetic storms are cosmical, as has been shown by Gauss and Sabine, and occur almost at the same moment all over the world. Hence many colonial observatories have been established. Mr. Stewart having explained the methods of observation, and referred to diagrams giving results, showed that these magnetic disturbances are connected with the sun, inasmuch as they obey a daily law, and are, moreover, independent of the light of the sun. They have yet a still more mysterious relation with our luminary. Schwabe, of

Dessau, having for nearly forty years watched and recorded the spots on its disc, saw that these spots exhibit a maximum and a minimum nearly every ten years; and General Sabine, having discovered that magnetic disturbances have also a ten years' period, fortunately thought of comparing the two periods, and found that they were precisely the same, having the same years of maxima and minima. This brought us into the presence of some great cosmical bond, other than gravitation. On one occasion the sun was believed to be caught in the very act of causing a magnetic disturbance. On Sept. 1, 1859, Messrs. Carrington and Hodgson, independently, observed a bright sun-spot, and at the very same moment the magnets at Kew were found to be suddenly disturbed. It has also been proved that these disturbances are accompanied by the auroras, and also by electric earth-currents, in some case interfering with the telegraphic wires, both having a ten-yearly period. The nature of the bond by which these phenomena are allied is still a profound mystery. Mr. Stewart, however, with diagrams and models, endeavoured to elucidate it by the application of the laws of induced primary and secondary electric currents, demonstrated by Faraday. The earth, being considered as the iron core of an electro-magnet, is no doubt excited by some primary current (probably in the sun), and, having a conductor round it in the upper and moist crust of the earth, and another conductor in the upper and rarer strata of the atmosphere, has also an insulator in the lower and denser strata of the atmosphere. Mr. Stewart considers that every time a small but rapid change takes place in the magnetism of the earth it gives rise to a secondary or induced current in the two conductors; and this occasions the electric earth-currents and auroras, probably due to the inequality of the earth's surface. With regard to the spot in the sun's disc, Mr. Stewart suggests that, if that luminary, by causing magnetic disturbances, is capable of producing auroras in the earth's atmosphere, it can surely produce similar phenomena in its own.—*Illustrated London News.*

THE MASS OF THE EARTH.

ARCHDEACON PRATT, in the *Philosophical Magazine*, says: "The mass of the earth is arranged in nearly spherical strata around its centre." He then proceeds to show by calculation that if the outer surface be a spheroid of equilibrium, then all the strata are so also, however they acquired that form. He concludes by saying, in respect to his calculations, that "no more convincing argument, short of an absolute knowledge of the fact, can be produced to show that the earth's mass has derived its arrangement and form from having been in a fluid condition, especially as no other conceivable cause than rotation acting on a fluid mass, could have made the interior of the mass in every stratum bulge out towards the equator, and in every part by the precise quantity required by the fluid theory."

RIGIDITY OF THE EARTH.

PROF. W. THOMSON, F.R.S., has made to the Royal Society a communication upon this important inquiry. The author proves that unless the solid substance of the earth be on the whole of extremely rigid material, more rigid, for instance, than steel, it must yield under the tide-generating influence of sun and moon to such an extent as to very sensibly diminish the actual phenomena of the tides, and of precession and nutation. Results of a mathematical theory of the deformation of elastic spheroids, to be communicated to the Royal Society on an early occasion, are used to illustrate this subject. For instance, it is shown that a homogeneous incompressible elastic spheroid of the same mass and volume as the earth would, if of the same rigidity as glass, yield about 7-9ths, or if of the same rigidity as steel, about 2-5ths of the extent that a perfectly fluid globe of the same density would yield to the lunar and solar tide-generating influence. The actual phenomena of tides (that is, the relative motions of a comparatively light liquid flowing over the outer surface of the solid substance of the earth), and the amounts of precession and nutation, would in one case be only 2-9ths, and in the other 3-5ths of the amounts which a perfectly rigid spheroid of the same dimensions, the same figure, the same homogeneous density, would exhibit in the same circumstances. The close agreement with the results of observation presented by the theory of precession and nutation, always hitherto worked out on the supposition that the solid parts of the earth are perfectly rigid, renders it scarcely possible to admit that there can be any such discrepance between them as 3 to 5, and therefore almost necessary to conclude that the earth is on the whole much more rigid than steel. But to make an accurate comparison between theory and observation, as to precession, it is necessary to know the absolute amount of the moment of inertia about some diameter; and from this we are prevented by the ignorance in which we must always be as to the actual law of density in the interior. Hence the author anticipates that the actual deformation of the solid earth by the lunar and solar influence may be more decisively tested by observing the lunar fortnightly and the solar half-yearly tides.* These tides, it may be supposed, will follow very closely the "equilibrium theory" of Daniel Bernoulli for all oceanic stations, and the author suggests Iceland and Teneriffe as two stations well adapted for the differential observations that would be required.

The earth's upper crust is possibly on the whole as rigid as glass, more probably less than more. But even the imperfect data for judging referred to above, render it certain that the *earth as a whole must be far more rigid than glass,* and probably even more

* High tide, as far as the influence of either body is concerned, is produced at the poles, and low (average) water at the equator, when its declination, whether north or south, is greatest, and low water at the poles and high water at the equator, when the disturbing body crosses the plane of the equator.

rigid than steel. Hence the interior must be on the whole more rigid, probably many times more rigid, than the upper crust. This is just what, if the whole interior of the earth is solid, might be expected, when the enormous pressure in the interior is considered; but it is utterly inconsistent with the hypothesis held by so many geologists that the earth is a mass of melted matter enclosed in a solid shell of only from 30 to 100 miles thickness. Hence the investigations now brought forward confirm the conclusions arrived at by Mr. Hopkins, that the solid crust of the earth cannot be less than 800 miles thick. The author, indeed, believes it to be extremely improbable that any crust thinner than 2000 or 2500 miles could maintain its figure with sufficient rigidity against tide-generating forces of the sun and moon, to allow the phenomena of the ocean tides and of precession and nutation to be as they are.

MEAN DENSITY OF THE EARTH.

In a memoir on this subject by M. Faye, read at a meeting of the French Academy of Sciences, the following valuations, from pendulum experiments, are given:—4·39 by Carlini and Plana, at Mount Cénis; 4·71 by Maskelyne, Hutton, and Playfair, at Schehallien, in Scotland; H. James, at the same place; 5·44 by Reich, 5·43 by Cavendish, and 5·66 by Bailey, by means of the torsion-balance; and 6·55 by Airy, at the summit and bottom of a coal-mine.

TEMPERATURE OF THE EARTH'S CRUST.

It is hard to reconcile the different statements as to the rate of increase of Temperature in descending through the Earth's Crust.

Sir William Armstrong, in 1863, stated to the British Association the increase of temperature below the earth's surface to be one degree of Fahrenheit for every 60 feet in depth.

Sir John Herschel states it to be one degree of Fahrenheit for every 90 feet; while Dr. Edward Hitchcock, in his *Religion of Geology*, has the following passage:—"The mean rate of increase has been stated by the British Association to be one degree of Fahrenheit for every 45 feet."

The *Mining Journal* of November 24, 1860, records:—"At the Manchester Philosophical Society, Dr. Fairbairn made some observations respecting experiments conducted in the Dukinfield coalpit for the purpose of determining the increase of temperature below the earth's surface. He stated that from these experiments a mean increase of one degree Fahrenheit for every 71 feet had been arrived at."

On comparing these statements, a wide difference in the results will be observed, sufficient, almost, to lead one to conclude that the increase was really variable in the different districts where the experiments were tried.

A solution of the difficulty has, however, been attempted in the following communication to the *Times*:—

That this earth was once a fluid mass bears mathematical demonstration. The constitution, appearance, and position of the "unstratified" rocks indicate that this fluidity was due to intense heat, and we conclude that we now inhabit the cooled surface of a once molten globe. The fact that the temperature increases with the depth—as proved in Artesian wells and mines, coupled with volcanic phenomena and thermal springs—has induced the belief that the centre of the earth still remains in a state of fusion. If this be the case, and the rise of temperature in descending a mine be due to the approach to this molten matter—even allowing for the difference of conduction in the various strata in which the observations were made—such large differences as to the rate of increase ought not to appear.

But, in addition to this objection, there are many facts which militate against the "molten centre" theory.

In the Sandwich Islands there is a volcano—Mount Loa—10,000 feet high; 4000 feet from its base there is a lateral crater, Kilanea. It frequently happens that one crater is in active eruption while the other is quiescent. Now, it is clear that these craters cannot obtain their lava from the same reservoir, for the same pressure which forced the lava to the highest crater would also produce a jet 6000 feet high from Kilanea.

The density of the earth would be very much increased were the centre molten. It has been proposed, in order to evade this difficulty, that the temperature is so intense 150 miles beneath us, that all matter is in a gaseous state; but unless our notions as to the possibility of containing a gaseous sphere in a liquid envelope materially change, this supposition must be abandoned.

That this interior heat has no effect on the surface of the earth is inconceivable; for if a sphere of iron 12 inches in diameter, heated to 120 deg., be supposed to represent this molten centre, the crust on which we live will be but the thickness of writing paper, and what insulator can be found of such a thickness that it will be able entirely to repress even the low heat of 120 deg.?

But the supporters of the "molten centre" theory have a still more serious difficulty to contend with.

By means of the times of eclipses left us by Hipparchus 2000 years ago, we can prove that the earth has not cooled, or, in other words, that the day has not shortened; and can any one be found daring enough to assert that a ball of intensely heated matter, covered with a skin of by no means the highest insulating powers, of a thickness only 1-160th of its diameter, could float in a space which has a temperature of 220 deg. for 2000 years without cooling even a fraction of a degree?

Then how is the increase of temperature in descending mines to be accounted for, if the "molten centre" theory be abandoned? On examining tables of experiments in mines, it will be found that the temperature only increases when the mine is working.

The Oatfield engine-shaft, at a depth of 182 fathoms, had a temperature of 77 deg. so long as the mine was working; but, on being abandoned, in a few months it had cooled down to 66 deg., and in many months after it had reached its equilibrum, 54 deg.

The highest heat, given in a table by Mr. Moyle, was found in the Huel Abraham shaft, at a depth of 1400 feet, where the air was 90 deg. But since the construction of that table a lode was pierced in a Cornish mine which contained water of so high a temperature, that the miners were scalded; and it still retains the name of "Boiling Water Lode."

Of ten abandoned mines, only one was found in which the temperature at all varied, and probably in that mine the temperature had not time to become equilibriated. In the Herland shaft, for example, the temperature was 54 deg at a depth of 60 feet, and it did not vary the whole depth of the mine, 1150 feet.

We must therefore seek some other heating agent than the "molten centre," since the abandonment of a mine cannot possibly affect the radiation of heat from the "molten mass beneath." Chymical action seems to be one of the chief causes of the phenomenon (the oxidization of the substances newly exposed to the action of the air). The friction in extricating the ore, the presence of the miners, the heat of their candles, blasts, electric currents, &c., all aid to raise the temperature, and this temperature would naturally increase as the mine deepened, in consequence of the greater density of the air.

Seeing all these variable causes, the writer considers there to be no difficulty in accounting for the discrepancy in the results of the investigation of the *savans* above quoted.

RADIANT HEAT.

PROFESSOR TYNDALL has detailed to the Royal Institution his latest researches on Radiant Heat, which he defined as an explorer of the condition of the ultimate particles of matter, and in the investigation of which exceedingly delicate apparatus are indispensably requisite. The Professor employed as the source of heat a plate of copper heated by a gas flame, and compensated by a cube of copper containing boiling water. A brass tube was employed (having portions adapted to receive the gases and vapours to be examined), the tube being stopped air-tight at its two ends by plates of rock salt, and attached to an air-pump, by which it might be exhausted at pleasure. Former experiments were made with the same thicknesses of gas and vapours. The experiments the subject of the discourse had been made in order to compare the absorption of the rays of heat by different thicknesses of gas. In order to effect this, Mr. Becker constructed a fine piston apparatus, by which the absorption of the 100th of an inch of olefiant gas could be easily measured, and by which the absorption of half an inch of the gas was actually shown to the audience by means of a mirror attached to a delicate galvanometer. On the wall were exhibited the tabulated results obtained by experiments, showing the absorption of different thicknesses of carbonic oxide, carbonic acid, nitrous oxide, and olefiant gas in long brass tubes, divided into chambers of varying length. The absorption of the 100th part of an inch of olefiant gas was 0·99 ; of the 10th of an inch, 5·22 ; of 1 inch, 23·78 ; of 2 inches, 28·65. The results of investigations into the dynamic radiation of the above-mentioned gases were also shown in a table. In conclusion, Professor Tyndall described his experiments on the transmission of heat through liquids, in which he had operated with the obscure rays of a luminous source. The rate of transmission in bisulphide of carbon being 83 per cent. ; that of iodine in the bisulphide (an opaque liquid) was 81·50 ; the transmission in chloroform was 73 ; in alcohol, 30 ; and in brine only 26·44 per cent. He stated that the radiant power which belongs to the molecules in the gaseous state, adheres to it also in the liquid, and most probably, in the solid states.

HEAT CONSIDERED AS A MODE OF MOTION.

UNDER this title, Professor Tyndall has presented, not merely to the scientific world, but, as he trusts, to any person of ordinary intelligence and culture, the rudiments of a new philosophy, as laid before the Royal Institution, in a course of lectures, in 1862. The descriptions of the experiments are elucidated by engravings on wood; and the topics treated of in several lectures are still further enlarged on in appendixes, and a copious index adds very materially to the value of the book. As experimental contributors to the philosophy of heat, we have the names of Rumford, Davy, Faraday, and Joule; as theoretic writers, Clausius, Helmholtz, Kirchhoff, Mayer, Rankine, and Thomson.

FIRE FROM WOOD.

THE Indian method of making fire is described in the *Franklin Institute Journal* by Mr. George Davidson, who has in his possession, a pair of sticks used by the Indians on the north-west coast of the United States, which he has himself successfully employed. Each stick is 16 in. long, the thicker being 3 in. in circumference, and so cut that a section would give a rough ellipse with the largest diameter 1⅛ of an inch. The smaller stick is 1¾ in. in circumference. Both are crooked and whittled, so that a section shall give an irregular polygon. The smaller stick is of the same wood, but more compact in grain, and apparently of a slower growth. Both have been thoroughly roasted, and were carried carefully wrapped in skin, to prevent the absorption of moisture; accompanying them was carried a bunch of the inner bark of the cedar, picked very fine and dried. "To use them," says Mr. Davidson, "the larger has a shallow, circular hollow, less than 1⅛th of an inch in depth, made on its broad side, near one end, and a narrow groove or channel cut from this to the side; the smaller stick has one end made very slightly rounding. The Indian squats, holds the larger stick upon the ground with his bare feet, and places under the groove a small bunch of the bark-fibre. The smaller stick is then held upright, the rounded end placed in the hollow of the larger stick, and, with both hands at top and the stick between them, he commences to rapidly revolve it by rubbing the hands upon each other backward and forward, at the same time exerting pressure downward, by which his hands gradually slip down; he dexterously—and this is the point of success—runs his hands to the top and repeats the previous operation. A fine brown powder is soon produced by the attrition, and is carried along the side groove among the bark-fibre. This powder is finally ignited, and the burning transmitted along the groove to the bunch of bark-fibre, which is quickly seized by the operator and blown into a flame. With the sticks in my possession, I have seen them produce a flame in about a minute, and have frequently done so myself in three minutes." The Indians now use lucifer-matches, and the sticks are only used by Indians unacquainted with white men.—*Illustrated London News.*

ON SPECTRAL ANALYSIS.—BY PROF. PLUCKER.

It is generally admitted now, that every gaseous body rendered luminous by heat or electricity sends out a peculiar light, which, if examined by the prism, gives a well-defined and characteristic spectrum. By such a spectrum, by any one of its brilliant lines whose position has been measured, you may recognise the examined gas. This way of proceeding constitutes what is called spectral analysis, to which we owe, until this day, the discovery of three new elementary bodies. In order to give to spectral analysis a true and certain basis, you want the spectrum of each elementary substance. Most recently, some eminent philosophers, in examining such spectra, met with unexpected difficulties, and doubts arose in their minds against the new doctrine. These doubts are unfounded. The fact is, that the molecular constitution of gases is much more complicated than it has been generally admitted till now. The spectra, therefore, always indicating the molecular constitution of gases, ought to be more complicated also than it was thought at first. By these considerations, a new importance, a rather physical one, is given to spectral analysis. You may recognise, by the spectrum of a gas, not only the chemical nature of the gas, but you may also obtain indications of its more intimate molecular structure—quite a new branch of science.

Allow me now to select out of the results already obtained two instances. Let me try to give what I may call the history of the spectra of two elementary bodies—of sulphur and nitrogen. In order to analyze by the prism the beautiful light produced by the electric current, if it pass through a rarefied gas, I gave to the tube in which the gas is included such a form that its middle part was capillary. Thus I got within this part of the tube a brilliant film of light, extremely fitted to be examined by the prism. The date of my first paper on this subject is the 12th of March, 1858. After having provided myself with apparatus more suited to my purposes, I asked, about a year ago, my friend, Prof. Hittorf, of Munster, to join me in taking up my former researches. The very first results we obtained in operating on gases of a greater density opened to us an immense field of new investigation. We found that the very same elementary substance may have two, even three, absolutely different spectra, which only depend on temperature. In our experiments we made use of Ruhmkorff's induction coil, whose discharge was sent through our spectral tubes. In order to increase at other times the heating power of the discharge, we made use of a Leyden jar. Now, let us suppose a spectral tube, most highly exhausted by Geissler's mercury pump, contains a very small quantity of sulphur. The discharge of the coil will not pass through the tube if it do not meet with ponderable matter, either taken from the surface of the glass, or, if the discharge be very strong, by the chemical decomposition of the glass. In heating slowly the tube by means of a lamp, in order to transform a part of the sulphur into vapour, all accidental spectrum, if there be one, will disappear, and you will get a pure and beautiful spectrum of sulphur. I supposed the Leyden jar not to have been interposed. If you now interpose it, the spectrum just spoken of will suddenly be replaced by a quite different one. We were generally led to distinguish two quite different classes of spectra. Spectra of the first class consist in a certain number of bands, variously shadowed by dark traversal lines. Spectra of the second class consist in a great number of most brilliant lines on a dark ground. Accordingly, sulphur has one spectrum of the first class and another one of the second class. You may as often as you like obtain each of these two spectra. In operating on a spectral tube, containing nitrogen at a tension of about fifty millimètres, you will, without the Leyden jar, get a most beautiful spectrum of the first class. After interposing the jar, a splendid spectrum of the second class will be seen. But here the case is more complicated yet. The above-mentioned spectrum of the first class is not a simple one, but it is produced by the superposition of two spectra of the same class. Ignited nitrogen, at the lowest temperature, has a most beautiful colour of gold. When its temperature rises, its colour suddenly changes into blue. In the first case, the corresponding spectrum is formed by the less refracted bands extended towards the violet part; in the second case, it is formed by the more refracted band of the painting extended towards the red. Nitrogen, therefore, has two spectra of the first class, and one spectrum of the second.

The final conclusion, therefore, is that sulphur has two, nitrogen three, different allotropic states. It may appear very strange that a gaseous body may have different allotropic states—*i.e.* different states of molecular equilibrium. It may not appear, perhaps, more strange that a substance, hitherto supposed to be an elementary one, may really be decomposed at an extremely high temperature. From spectral analysis there cannot be taken any objection that sulphur and nitrogen may be decomposed. Chloride of zinc (or cadmium), for instance, exhibits two different spectra. If heated like sulphur, and then ignited by the discharge of Ruhmkorff's coil, you will get a beautiful spectrum either of chlorine or of the metal, if either the Leyden jar be not interposed or be interposed. There is, in this case, a dissociation of the elements of the composed body in the highest temperature, and recomposition again at a lower temperature. You may consider the dissociation as an allotropic state, and, therefore, I may make use of this term as long as the decomposition be not proved by the separated elements.—*Proceedings of the British Association*, 1863.

TRANSMUTATION OF SPECTRAL RAYS.

Dr. Akin in a communication to the British Association, proposed for simplicity of reference for his present purpose, to call the rays of the middle or luminous part of the solar spectrum "Newtonian," the least refrangible invisible rays of heat, after their discoverer, "Herschelian," and the most refrangible invisible portion, also after their discoverer, "Ritterian." This last portion of the spectrum Prof. Stokes has traced to an almost unlimited extent. The author then gives a sketch of Prof. Stokes's discoveries as to fluorescence, and the substances he has found capable of producing this effect; and observes upon it that the facts as yet noticed by Prof. Stokes only exhibit a degradation of the refrangibility of the rays, that is, from the Ritterian to the Newtonian, or from a higher part of the Newtonian, to the less refrangible part of it. Now, the author conceives that the action of carbon and lime rendering the strongest heat of burning hydrogen luminous are instances of the Herschelian rays being raised to the Newtonian, strongly illuminating part of the spectrum; and as Prof. Stokes has termed the other influence fluorescence, Dr. Akin proposes to term this calcescence, from the power of lime to turn heat into powerful illumination.

NEW FORM OF SPECTROSCOPE.

MESSRS. GRUNOW, of New York, have completed, at the suggestion of Dr. Gibbs, a Spectroscope involving a new principle, or one for the first time applied to instruments of this kind. In this instrument the prism of flint glass has a refracting angle of only 37 deg.; the rays which diverge from the slit being rendered parallel in the usual manner, by an achromatic lens having the slit in its principal focus. The bundle of rays then falls upon the first surface of the prism at a perpendicular incidence, and of course makes an angle of 37 deg. with the second surface Under these circumstances, the refraction takes place at an angle so near the limiting angle that the refracted rays emerge nearly parallel to the second surface of the prism. The amount of dispersion produced in this manner is very great, while the loss of light, occasioned by reflexion at the first surface in the prisms of 60 deg. placed in the position of least deviation, is avoided. The spectrum thus produced possesses remarkable intensity, and the dark lines are seen in countless numbers and with great distinctness. The instrument in this form is sufficient for all chemical purposes; but it is so constructed as to permit the use of a second prism, by which the length of the spectrum is of course greatly increased. Though the telescopes are only six inches in length, with a magnifying power of about 6, the spectrum compares very advantageously with that of a large apparatus with telescopes of eighteen inches focal length and one and a half inch aperature and a prism of 60 deg. It may be mentioned that the centre of the second surface of the prism lies in the vertical axis of the instrument, and also that in a prism of this kind the refracted rays diverge as if from a single radial point (which is not the case with prisms of the ordinary construction), the angular dispersion being at the same time much greater. So far as Dr. Gibbs has been able to find, this form of prism was first employed by Matthiessen. In a lithographed copy of Regnault's "Lectures on Optics" at the Collége de France in 1848, prisms on this principle, of various forms, are figured and described, together with the spectra produced. These last exhibit an extraordinary extension of the violet end of the spectrum. A Matthiessen prism of flint glass, in which the first surface is concave so as to admit the addition of a double convex lens of crown glass, appears to be preferable for the spectroscope, in consequence of the saving of light.—*Silliman's American Journal.*

COLOUR-BLINDNESS.

MR. JABEZ HOGG has communicated to the *Popular Science Review,* a very interesting paper upon the curious defect of Colour Blindness, illustrated with several remarkable cases. "The number of cases," says Mr. Hogg, "now upon record, of persons afflicted in this way are very considerable; though until within these late years it was supposed to be confined to a very few individuals. From the calculations of various authors, that *one* person out of every *fifteen* is colour-blind, and from the investigations of the late Dr. Wilson upon 1154 persons at Edinburgh made in 1852-53, we gather that—

1 in 55 confounded *red* with *green*,
1 in 60 confounded *brown* with *green*,
1 in 46 confounded *blue* with *green*;

hence, that *one* in nearly every *eighteen* had this imperfection. Professor Siebeck found five out of forty youths in the two upper classes in a school at Berlin colour-blind. Professor Prevost considers it occurs on an average in one out of twenty persons; and Wartmann, whose investigations almost exhaust the subject, thinks this estimate is not exaggerated. M. Lubeck rejects this conclusion as unsound, from the observations having been made in England and Germany, where blue is the prevailing colour of the eyes; and it is a question with him whether it occurs so frequently in persons the *irides*-colour of whose eyes are black or hazel. In answer to this, it seems the great majority of cases examined by Wartmann had black irides. This consideration, however, cannot be of much importance beyond the physiological correspondence observable with the ophthalmoscope between the colour of the iris and the fundus of the eye, by the relative determination of the *pigmentum nigrum* in persons of different complexions."

Mr. Hogg has published during the year the third edition of his *Manual of Ophthalmoscopic Surgery*, re-written and enlarged. In the preface he enumerates the important points already attained by means of the Ophthalmoscope; as the determination of the existence or non-existence of cataract; the approach of cataract; the physical causes of muscæ; cases indefinitely termed amaurosis; disclosure of retinal apoplexy, &c.

IMPROVED STEREOSCOPIC INSTRUMENT.

MR. CHORMANN has exhibited to the Franklin Institute, an improved Stereoscopic instrument. It consists of an outer and an inner casing, and a frame; the inner casing sliding within the outer one. To the front edge of the frame, which slides into the inner casing, are hinged two arms, each of which is provided with a ring for holding a lens. When the instrument is to be used, the frame is drawn from the inner casing as far as possible, without entirely removing it therefrom, and the arms turned out so as to be at right angles to the frame, the picture being secured to the outer case by a flat spring, which holds it against the same. The glasses may be applied to the eye as in the ordinary stereoscope, and the adjustment made by sliding the inner case back and forth within the outer one, until the proper focus is obtained. When not required for use, the arms holding the lenses may be folded together within the frame, and the latter pushed into the casing; the whole being thus condensed into a compact form of such dimensions as to be contained within the waistcoat-pocket without inconvenience to the wearer.

THE CHARIMORPHOSCOPE.

THIS new optical instrument, invented by Mr. H. Treppass, has been exhibited by him to the Royal Institution at a recent Friday evening meeting. This apparatus embodies improvements in the construction and application of the well-known kaleidoscope, the idea of Sir David Brewster, by whom it was perfected in 1817. In the latter, the beautiful forms produced are uncertain and temporary; but in the Charimorphoscope the effects are entirely under the control of the operator, who is thus enabled to produce, in relief, delicate and simple, or gorgeous and elaborate, patterns, as fancy may suggest. Mr. Treppass stated that his instrument may thus be advantageously employed in designing patterns for silks, carpets, architectural mouldings, jewellery, iron-work, &c.

THE STAR CHROMATOSCOPE.

MR. A. CLAUDET has described to the British Association this new instrument. The scintillation and change of colours observed in looking at the stars are so rapid that it is very difficult to judge of the separate lengths of their duration. If (says Mr. Claudet) we could increase on the retina the length of the sensations they produce, we should have the better means of examining them. This can be done by taking advantage of the power by which the retina can retain the sensation of light during a fraction of time which has been found to be one-third of a second--a phenomenon which is exemplified by the curious experiment of a piece of incandescent charcoal revolving round a centre, and forming a continual circle of light. It is obvious that if the incandescent charcoal during its revolution was evolving successively various rays, we could measure the length and duration of every ray by the angle each would subtend during its course. This is precisely what can be done with the light of the star. It can indeed be made to revolve like the incandescent charcoal, and form a complete circle on the retina. When we look at a star with a telescope we see it on a definite part of the field of the glass; but if with one hand we slightly move the telescope, the image of the star changes its position, and during that motion, on account of the persistence of sensation on the retina, instead of appearing like a spot, it assumes the shape of a continued line. Now if, instead of moving the telescope in a straight line, we endeavour to move it in a circular direction, the star appears like a circle, but very irregular, on account of the unsteadiness of the movement communicated by the hand. Such is the principle of the instrument employed by the author to communicate the perfect circular motion which it is impossible to impart by the hand. The instrument consists of a conical tube placed horizontally on a stand, and revolving on its own axis by means of wheels; inside this tube a telescope or an opera-glass is placed, by which, by means of two opposite screws, the end of the object-glass can be placed in an excentric position in various degrees according to the effect desired, while the eye-glass remains in the centre of the small end of the tube. Now, if we understand that when the machine makes the tube to revolve upon its axis, the telescope inside revolves in an excentric direction, during the revolution the star seen through it must appear like a circle. This circle exhibits on its periphery the various rays emitted by the star, all following each other in spaces corresponding with their duration, showing also blank spaces between two contiguous rays which must correspond with the black lines of the spectrum. The instrument, in fact, is a kind of spectroscope, by which we can analyze the light of any star, study the cause of the scintillation, and compare its intensity in various climates or seasons, and at different altitudes.

TENEBROSCOPE.

THE Abbé Moigno has exhibited and described to the British Association M Soleil's Tenebroscope for showing the invisibility of light. The instrument consists of a long tube, closed at one end, but with a short opening in the centre, in which is introduced a white ivory ball, capable of being placed and withdrawn at pleasure. The object of the instrument is to illustrate the principle that light is only the action of the illuminiferous medium by which bodies are made visible; and that neither the light itself nor the medium is visible. On looking through the glass, with the ball withdrawn, no light is seen; but immediately on the ball being replaced, it is distinctly seen at the end of the tube.

THE MICROSCOPE.

THE application of sunlight to the Microscope has been made by Mr. Wenham. He placed his microscope in full sunlight, receiving the rays upon a concave mirror, and thus enlightened the object placed in the focus of a large converging lens used as a condenser. To soften the excessive brilliancy, he placed the green and red glasses of his sextant (which gave a whitish neutral tint) over the eyeglass of his microscope. He states that the most delicate objects, such as the circulation of the sap in the anacharis, become visible and afford a charming spectacle.—*Les Mondes.*

SOLAR EYE-PIECES.

DR. LEE has described to the British Association the Rev. W. R. Dawes' Solar Eye-Piece. This eye-piece has been long known to astronomers, having been described in the *Monthly Notices of the Astronomical Society.* Its principle consists in reducing the pencil of light which enters the eye to a minimum; and for this purpose a wheel of diaphragms ranging from 0·5 to 0·0075-inch is placed in the solar focus, the great heat being kept to the metal diaphragm by the interposition of a non-conductor. Between the eye-lens and the eye a similar wheel of coloured glasses is introduced to reduce still more the evils which attend direct observation.

Professor Phillips described Cooke's Solar Eye-Piece, supplied by that eminent optician for observations of the sun. In this the light is reflected from the first surface of a prism placed within the solar focus, the surface being inclined at an angle of 45° to the axis of the telescope. Nearly all the heat, and fully 95 per cent. of the light, passes through the prism, which is one of small angle only, and made of prismatic form simply to direct the reflection from the second surface out of the field of the eye-piece. By this simple contrivance absolute safety and the utmost comfort is insured, and, by the addition of a slightly-coloured glass, the surface of the sun in all its minute detail can be studied as easily as can the surface of the moon. The great advantage of this method of research over the others which astronomers employ is, that the whole of the aperture of the object glass may be employed; and Professor Phillips insisted upon the great value of this method of research as evidenced especially by the Nasmythian and other discoveries made by its means.

A NEW DIALIZING MEDIUM.

A NEW Dializing Medium (viz. porous or unglazed earthenware, such as is used in the construction of porous cells for voltaic batteries) has been tried by M. E. Guignet, who found difficulty in the employment of parchment paper, in consequence of its being acted upon by some of the solutions. He states that he placed a porous vessel filled with pure water in a solution of gum and sugar, and that at the end of twenty-four hours a great part of the sugar had traversed the porous vessel and passed into the water, but no trace of the gum. He also placed a porous vessel of pure water in an ammonio-cupric solution of cotton: the water became blue, while the cotton remained in the outer liquid.—*Pharmaceutical Journal.*

NEW MICROMETER.

A NEW MICROMETER, by M. H. Soliel, has been exhibited and explained to the British Association by the Abbé Moigno. This consisted of two Ramsden's eye-pieces, one fixed near the object or image to be measured, the other movable to suit the vision of the observer, with a ruled glass micrometer plate placed between them. The magnifying power of this eye-piece being ascertained by a comparison of the object as seen directly, with the same object as seen through the micrometer, it then became applicable to the telescope, the microscope, and even to goniometry by a certain adjustment, and having the plate to which the objective eye-piece was attached graduated on its circumference.

A NEW CALCULATING MACHINE,

BY M. Wiberg, has been presented at the French Academy of Sciences. It was affirmed to possess advantages over all the preceding ones; it not only calculates but prints the numbers, and may be applied in the construction of tables of compound interest, &c.

INJECTOR OF SOLIDS.

THE Abbé Moigno has exhibited and explained to the British Association, on the part of MM. Bourdon and Salleron, an apparatus called an "Injector of Solids." The apparatus consisted of two communicating air-vessels—one of glass, the other the air-vessel of a small air-gun, the barrel of which was directed towards a valve in the metallic end of a glass receiver. Two small manometers, on the principle of the aneroid barometer, served to mark the state of condensation of the air in these receivers, and a cock between them enabled the operator to cut off the communication between them. On charging the air-pump receiver with only two atmospheres, but the glass receiver with even four atmospheres, the bullet driven by the first along the barrel of the air-gun was found to have acquired force sufficient to open the valve kept closed by four atmospheres and enter and show itself in the glass receiver. The Abbé stated that this little instrument exhibited, with a solid bullet, the principle on which water could be injected through a long pipe into, and feed, a boiler in which the steam had a considerably higher tension than that employed to project the water.

REPORT OF THE ASTRONOMER ROYAL.

AMONG the results of the year's labour at the Royal Observatory, are the following, dated June 6, 1863 —

"The meridional observations of Mars, in the autumn of 1862, have been compared with those made at the Observatory of Williamstown, near Melbourne, Australia, and they give for mean solar parallax, the value 8·932 sec., exceeding the received value by about 1-24th part."

"The mean magnetic declination for 1862 is about 22° 52′; the diminution in the year appears to be 13′. The mean dip for 1862 is about 68° 11′; at the present time it appears to be 68° 4′."

Considerable labour has been given to a numerical discussion of the Magnetic Storms, from 1841 to 1857. The reductions were not quite finished; but they had suggested to Professor Airy the idea, apparently confirmed by a separate deduction from the magnetic phenomena attending the splendid aurora seen December 14th, 1862, that—"the action of the earth-currents upon the magnet is in the same direction in which the earth-current flows, and not transverse to the current direction as is usual with galvanic currents." This result is certainly very remarkable. The Astronomer Royal adds:—"If this should be confirmed, then, viewing the rarity of disturbances in the vertical direction as produced by magnetic storms, and their great violence when they do occur in the vertical direction, I shall have no hesitation in suggesting, as a general theory of magnetic storms, that the idea of attraction is to be abandoned, and that they are to be referred to currents of a magnetic ether whose movements are closely analogous to that of air, the vertical movement of which occurs but in few places, but in these places is excessively violent. Much, however, must be done before such a theory can be established."

As regards chronometers and the communication of time, the Report proceeds to state:—

"The number of Chronometers on hand at this time is 132; of these, 82 are compared with a standard clock every day, and the others are compared on one day in every week. The standard clock is one of a series of galvanic clocks whose movements are necessarily synchronous with that of the motor clock; which is accurately adjusted to mean solar time by means of a galvanic action upon its pendulum, that can be used for any arbitrary length of time to accelerate or retard the clock by slow degrees during that time. Every chronometer, whatever be the reason of its lodgment at the Royal Observatory, is tried during some part of its stay in the heated chronometer oven.

"When it is necessary to decide on the merits of chronometers, either as affecting their price for purchase, or as deciding their place in the published order of merit, the decision is made by me. The repairs of chronometers the property of the Government are entirely managed by me.

"The drop of the time-signal-ball at Deal, by a galvanic current from this Observatory, which is automatically given by the corrected motor clock, is perfectly efficient, no failures occurring except from the defects of adjustment of the clock at the London-bridge station, which changes the connexion of wires. Time-signals are sent daily along the principal lines of railways, the most distant points (I believe) being Glasgow and Cardiff. I have also heard that the companies, through whose offices the wires pass, have begun to distribute branch signals to private factories.

"The clocks of the General Post Office are connected as formerly with the Observatory, each of four clocks being adjusted by current from our motor clock once every day, and reporting itself to us twice every day. The clock of Westminster Palace has also been brought into connexion, the attendant receiving a signal from us once every hour, and the clock reporting its state to us twice every day. As far as I have yet observed, the rate of this clock may be considered certain to much less than one second per week."

THE SUN'S DISTANCE FROM THE EARTH.

MR. J. R. HIND has communicated to the *Times* the results of the recent investigations of astronomers, which tend to show that the Sun is really about 4,000,000 of miles nearer the earth than is stated in the text-books, which give the distance as 95,298,260 miles, according to the observations of the transits of the planet Venus in 1761 and 1769, published by Professor Encke, of Berlin. These transits generally happen in pairs, and with an interval of eight years between each pair; a period of 105 or 122 years intervenes between the last of one pair and the first of the next. Within the last few years M. Le Verrier, the chief of the Imperial Observatory at Paris, has completed a most rigorous application of the theory of attraction of the motions of the earth, Venus and Mars, defined by observations at Greenwich and other observatories. The theory of the earth was published in 1858, and, Mr. Hind states, contains a result which shows a diminution of the assumed distance of the earth from the sun very nearly to the same amount assigned by M. Hansen's researches connected with the moon. The earth's mass, as referred to the sun's, would, from the same cause, require increasing to the extent of nearly a tenth part of the whole. Mr. Hind states that the next ensuing pair of the transits of Venus will take place on the 9th of December (civil reckoning), 1874, and on the 6th of December, 1882. No part of the transit of 1874 can be viewed in this country. The egress only will be visible in the south-east of Europe near sunrise, in Italy, Turkey, &c.; but the entire duration may be observed in Australia, New Zealand, British India, China, Tartary, and the islands of the Indian Ocean, including Madagascar. The entire duration of the second will be observable in the United States and British America. In conclusion, Mr. Hind says, "It is scarcely to be doubted, that every possible use will be made of the transits of 1874 and 1882, to improve our knowledge of the great astronomical unit, the measure of the sun's distance; and that all the resources of modern science, and all the facilities afforded by modern enterprise, will be combined for that purpose. No other opportunity of the kind will occur until the year 2004. —*Illustrated London News.*

CYCLONES.

MR. F. GALTON has communicated to the Royal Society "A Development of the Theory of Cyclones." As a limited area of very low barometer is a locus of light, ascending currents, which are indraughted from all sides in cyclonic spirals; so Mr. Galton maintains that a similar area of very high barometer is a locus of dense, descending currents, which disperse on all sides in *anti*-cyclonic curves. The curvature of the cyclone being retrograde in our hemisphere, that of the anti-cyclone is direct, owing to the same well-known fundamental causes, acting in a modified manner. The area of the cyclone is one of storm and rain, that of the anti-cyclone one of calms and fair weather. An anti-cyclone is enabled to feed a cyclone without abruptness, for the very reason that its curvature has an opposite character; just as a contrary rotation on the part of two wheels is a necessary condition of their moving in gear or in unison. The experience of simultaneous charts of the weather of Europe extending over ninety-three epochs of observation, compiled and shortly to be published by Mr. Galton, showed an almost invariable deflection of the wind-currents in the sense mentioned above, and occasional instances of exceedingly well-marked systems of anti-cyclones. The loci of highest and lowest barometer were separated in his charts by distances of from 1000 to 2000 miles; and Mr. Galton concludes that whenever there are limited areas of very high and very low barometers at distances not exceeding the above, a line drawn from the former to the latter will be cut in all cases by the winds coming from the left.

THE ATMOSPHERE.

PROF. PIAZZI SMYTH has read to the British Association a paper "On a Proof of the Dioptric and Actinic Quality of the Atmosphere at a High Elevation." The author commenced by observing, the chief object of the astronomical experiment of the Peak of Teneriffe in 1856 was to ascertain the degree of improvement of telescopic vision, when both telescope and observer were raised some two miles vertically in the air. Distinct accounts have, therefore, already been rendered as to the majority of clouds being found far below the observer at that height, and to the air there being dry, and in so steady a state and homogeneous a condition, that stars, when viewed in a powerful telescope with a high magnifying power, almost always presented clear and well-defined minute discs, surrounded with regularly-formed rings—a state of things which is the very rare exception at our observatories near the sea-level. Quite recently, however, the author has been engaged in magnifying some of the photographs which he took in Teneriffe in 1856, at various elevations, and he finds in them an effect depending on height, which adds a remarkably independent confirmation to his conclusions from direct telescopic observations. The nature of the proof is on this wise: at or near the sea-level a photograph could never be made to show the detail on the side of a distant hill, no matter how marked the detail might really be by rocks and cliffs illuminated by strong sunlight; even the application of a microscope brought out no other feature than one broad, faint, and nearly-uniform tint. But on applying the microscope to photographs of distant hills taken at a high level in the atmosphere, an abundance of minute detail appeared, and each little separate "retama" bush could be distinguished on a hill-side 4½ miles from the camera. Specimens of these photographs thus magnified have been introduced into the newly-published volume of the Edinburgh Astronomical Observations, four of them being silver-paper prints, and the fifth a press-print from a photographic plate, kindly prepared and presented by Mr. Fox Talbot.

FREE AIR BAROMETER AND THERMOMETER.

THIS instrument, devised by the Abbé Jeannon, has been exhibited and explained to the British Association by the Abbé Moigno. It consists of a syphon of about the bore of the tube of a maximum thermometer, one branch of the syphon open to the air, the other branch furnished with two bulbs, one at top for air, the other near the bend at the bottom, full of mercury, with a little glycerine oil, or other fluid not capable of acting on, or absorbing the air of the upper bulb, floating on the surface of the mercury. The two bulbs are so proportioned in capacity that the changes of the volume of the air in the upper bulb by changes of temperature are exactly compensated by the increased pressure of the mercury by the same cause, so that as far as temperature is concerned the surface of the mercury or glycerine between the bulbs shall remain perfectly fixed or unaffected. The branch then between the bulbs becomes a simple sympiesometer or pressure-barometer, while the open straight branch becomes a very sensitive thermometer.

BALLOON OBSERVATIONS.

THE Report of the Balloon Committee, read to the British Association by Col. Sykes, states that the Committee had meetings of a quorum on the 20th of February, 30th of May, 5th of June, 26th of June, 8th of July, and 28th of August; and under their instructions at these meetings, Balloon ascents took place on the 31st of March, 18th of April, 26th of June, 11th of July, and 21st of July. Three of these were to great altitudes and two to lower altitudes. A fourth high ascent was ordered to take place from Wolverhampton on any day between the 6th of July and the date of the report, but Mr. Coxwell's engagements and the unpropitious state of the weather have prevented the committee from carrying out their resolution. The required gas was specially prepared by the Wolverhampton Gas Company, and was kept at the disposal of the Committee. The observations made by Mr. Glaisher in the several ascents, together with the diagrams in illustration, accompany this Report for insertion in the annual volume of the Association. The British Association and Science owe a debt of gratitude to Mr. Glaisher for the ability, perseverance, and courage with which he has voluntarily undertaken the hazardous labour of recording meteorological phenomena in the several ascents. New physical conditions having been observed in the last two ascents, the Committee consider that it would extend our scientific knowledge were the Committee re-appointed, and the observations continued, with a grant of 200*l.* for the purpose. The Report on the ascents was then read by Mr. Glaisher.

At the close of the reading of Mr. Glaisher's paper, Professor Owen said he attended this meeting of the section chiefly in the hope of hearing from Mr. Glaisher something of the influences of these very high distances on the human frame, which was adapted, of course, to a very different medium. The fact which Mr. Glaisher mentioned as to his feeling a greater power of resisting the influence of very high temperatures was very interesting in physiology and in relation to the series of facts with which they were acquainted. They knew their lungs did adapt themselves to atmospheres of different degrees of gravity, so that there were people who lived habitually on high mountains, and felt no difficulty in breathing, such as was felt at once when the inhabitant of a plain or low country came up to these elevations. Now, that depended upon the greater proportion of the minute cells of the lungs which are open and receive an attenuated atmosphere, in proportion to the minute cells that are occupied by a quantity of mucus. Those on the plain did not make so large use of their breathing apparatus as those who lived at great altitudes. Hence more cells, occupied by mucus, would be taken up and opened to free course and play; and he had no doubt that was the solution of the interesting fact mentioned by Mr. Glaisher. Physiologists were all agreed that one condition of longevity was the capacity of the chest, and therefore he hoped that the increased breathing capacity acquired by Messrs. Glaisher and Coxwell would tend to the prolongation of their lives.

Mr. Glaisher, in a lecture delivered by him at the Royal Institution, gives, as the general results of eight ascents:—

1st. That the temperature of the air does not decrease uniformly with the height above the earth's surface, and consequently the theory of a decrease of 1 deg. of temperature for an increase of elevation of 300 ft. must be abandoned. In fact, more than 1 deg. declined in the first 100 ft. when the sky was clear, and not so much as 1 deg. in 1000 ft. a height exceeding 5 miles.

These experiments are the first to yield any definite information on the subject: more experiments are required to settle the law satisfactorily, but its effect on the laws of refraction will be great: all the elevations of the balloon are to a certain extent erroneous, for it has never happened that the mean of the extremities has given the mean of the whole column of air.

2nd. The degree of humidity decreased wonderfully with the height, till at above 5 miles there was scarcely any aqueous vapour at all.

3rd. That an aneroid barometer can be made to read correctly, to the first place of decimals certainly, and to the second place of decimals probably, to a pressure as low as 7 inches.

4th. That a dry-and-wet-bulb thermometer can be used effectively up to any height on the earth's surface where man may be located.

5th. That the balloon does afford a means of solving with advantage many delicate questions in physics.

CONSTRUCTION OF LIGHTNING CONDUCTORS. BY M. SACRE.

BEGINNING at the upper end of the Lightning Conductor we have first the platina point; it generally suffices to be made $1\frac{1}{4}$ in. high and $\frac{5}{8}$ in. diameter at its base; the base of the copper cone 11-16ths in., while the iron rod is $\frac{3}{4}$ in. diameter, copper being a better conductor than iron. It is preferable to make the rod of round, rather than of square iron. The rod should increase in diameter downwards, and should consist of 6 ft. lengths, each welded together—these lengths are screwed together with 1 in. gas thread sockets. If the ground string of the conductor is to be led overground, it ought to be 11-16ths of an inch, if underground, $\frac{3}{4}$ of an inch diameter, in either case to be made of bar iron, and not of wire cable. The copper cone is 11-16ths of an inch diameter screwed, and $1\frac{1}{4}$ in. long; the iron rod adjoining is screwed similarly; but one must have a left and the other a right-handed thread, joined by a corresponding screwed socket, the end of the rods abutting against each other. All the other joints to be made in the same way. The horizontal string of the conductor to be joined to the vertical by hard-soldering a ring welded from the former to the latter. The ground string terminates in a cast-iron pipe filled with charcoal, and with a hermetically closed cover, screwed at the part where the conductor passes through. The end of the conductor is screwed into a metallic disc. If it is led into a well, the disc should be of cast-iron of from $6\frac{1}{2}$ to $8\frac{1}{2}$ sq. ft. area, resting on the bottom of the well.

If it ends in the earth, however, the end should be a copper cylinder, of 10 to 20 sq. ft. superficial area, according to the moisture in the soil. The diffusion of the current is more effective, the larger the surface. If the ground string is made of wire cable, the end of the same should be soft-soldered into a piece of iron, whose other end is screwed. A screwed socket joins the same to the ring, or other part of the conductor. The mode of joining by screwed sockets is simple and cheap, and is very convenient in laying the ground string of the conductor when made of round bar iron, as recommended.—*Practical Mechanics' Journal.*

The fusion of the points of lightning conductors has been closely examined by M. Ch. Montigny, who has submitted the results to the Royal Academy of Belgium. Referring to the statistics of the subject published by M. Duprez, he states that in fourteen cases of partial or total fusion of the points, seven were of copper, three of iron, and four of platinum, these being the only ones out of 168 struck lightning conductors in which the metal is specified. It is necessary to remark that, of the 168, 55 were made on Sir Snow Harris's principle, without stem or points. Having regard to these and some other considerations, it seems to be proved that copper points are more liable to fusion by lightning than those of iron, although the former is a much better conductor of electricity. We have no space for the theoretical reasons adduced by M. Montigny for the phenomenon, which, he says, should in no way interfere with the use of copper, the efficacy of which has been fully demonstrated by Sir Snow Harris in the lightning conductors employed in the British Navy since 1850.

THE RED SEA.

THE Colouring Matter of the Red Sea is the subject of a paper by Mr. H. J. Carter, F.R.S., in the *Annals of Natural History*. To Ehrenberg is due the merit of having first described (in 1826) the nature of the organism from which this colouring matter is described. He found it in the Bay of Tor, and called it Trichodesmium Erythræum, which another writer, Montagne, advisedly changed to T. Ehrenbergii. "No one," says Mr. Carter, "who has read the memoir of M. Dareste on this subject, can doubt that this is not the only organism which colours the sea red in different parts of the world." In June, 1862, Mr. Carter himself had opportunity of seeing the colour of the Red Sea, on which he gives a few observations. When approaching Aden, on May 31, he passed through large areas of a yellowish-brown, oily-looking scum on the surface of the sea; and on June 2, when off the Arabian side of the first island sighted in the lower part of the Red Sea, after leaving Aden, it again appeared, and he frequently passed through large areas of it. Only once he saw a portion of brilliant red and one of intense green together in the midst of the yellow. The odour which came from this scum was like that of putrid chlorophyll, or like that from water in which green vegetables have been boiled. He drew up some of this scum, and found it to be composed of little short-cut bundles of filaments, like oscillatoria. On examining the specimens microscopically in January, 1863, he found the little bundles, which were still just visible to the naked eye, like so much fine sawdust. Their colour was still faint yellowish to the naked eye; but the filaments under the microscope were faintly green. After referring to the evidence of other observers, Mr. Carter considers that the occurrence of Trichodesmium Ehrenbergii in the Red Sea, the Gulf of Aden, the Indian Ocean, and the Sea of Onan is so far substantiated; and, as the yellow colour in all instances probably passes into red, we have apparently the explanation of the whole of these seas having been called by the Greeks erythræan (red). Next to the yellow colour, red is the most prevalent, and green least of all. Mr. Carter concludes by saying that much yet remains to complete the history of this little plant, which, unfortunately, can only be obtained by watching it long and narrowly.—*Illustrated London News.*

THE INUNDATION OF THE NILE.

THE source of the Nile and the cause of its annual Inundation have remained unknown even to the present time. In a paper on the subject by Mr. William Ferrel, in the *American Journal of Science*, he states his conviction that it is by no means certain that Lake Nyanza, discovered by Captain Speke, having its southern limit in lat. 2 deg. 30 min. S., and longitude 33 deg. 30 min. E., and said by the natives to extend three hundred miles in a northern direction, is the source of the Nile. Mr. Ferrel also dissents from Sir Roderick Murchison's theory, that the annual inundation is due to the abundant discharge of water from this lake in the rainy season. After alluding to the great watershed of the Oronoco and Amazon, due to a great rainy belt in South America, which is not stationary but vibrates with the seasons over nearly 1000 miles in latitude, he expresses his opinion that the inundation of the Nile may be caused in a similar manner. He considers that there is good ground to suppose the existence of a vibrating rainy belt in Africa, which would be between the parallels of 5 deg. and 7 deg. north latitude from May to November. The great watershed drained by the Blue Nile and its tributaries, embracing nearly all Abyssinia and also several important tributaries of the White Nile, is situated between these latitudes. Hence (he says) the immense amount of rain falling in this region during the rainy season must cause an inundation of the Nile, as it does of the Oronoco and Amazon. "The rainy belt, from November to May, is, perhaps, mostly south of the equator; and the source of the Nile or some of its tributaries must enter into this belt during this season, or the Nile, flowing more than 1000 miles through a rainless region, from which it does not receive a single tributary, however small, could not be supplied with water." This is an argument in favour of the hypothesis that the Nile has its source in Lake Nyanza. But Mr. Ferrel thinks "that the watershed of the lake would not be more than sufficient to supply the Nile at low water, and that, if ever the geography and meteorology of this region be well understood, the cause of the inundation of the Nile will be found in latitudes further north."—*Ibid.*

MOLECULAR MOTIONS.

IN 1827, the celebrated botanist, Robert Brown, observed a phenomenon which microscopists have since designated Brownian Motion. A very small drop of limpid dew holds in suspension grains of dust, or of impalpable organic remains, imperceptible to the naked eye, which the water of which the drop is composed conveys to the object (a leaf, flower, &c.) on which it is deposited. These particles of matter, when seen by the microscope, by their vibratory motion have the appearance of true animalcules. The opinion at first held that these movements were indications of a rudimentary life was soon abandoned. The phenomenon was afterwards attributed to currents, caused by the inequality of the temperature affecting different layers of the liquid, and by permanent evaporation. According to M. Wiener (in *Poggendorff's Annalender Physik*) we must seek the cause in the constant movements which take place in bodies in the liquid state. He undertook to show in a series of experiments that the vibratory motion in sand, white lead, &c., is due neither to a mechanical cause, attraction, or repulsion of the molecules, differences of temperature, nor to evaporation; and he affirmed that the greatness of the undulatory motion depended on the size of the molecules. The subject is one on which the minds of the philosophers are much exercised. We have only room for the résumé of Mr. Wiener's propositions, in which he thus expresses his views :—"In solid bodies the oscillation of the molecules has a direction opposed to that of the oscillation of the atoms, while in liquid bodies they have the same direction. The heat employed in making a solid body pass into the liquid state, the latent heat, serves to augment the force which, after the change of direction of the oscillations of the ethereal atoms and the material molecules, is necessary in order to maintain invariably the duration of the oscillations or the temperature."

THE ORGANIC CELL.

THE development of the Organic Cell is the subject of a memoir in the *Annals of Natural History* translated from the German of Professor H. Karsten. The development and life of the cell constitute the first problem to be solved in the sciences of anatomy and physiology, Schwann having declared that both animal and vegetable tissues consist of cells of like nature. Since the time that Robert Brown indicated the presence of a nucleus in several cells, Professor Karsten has demonstrated that the cell-wall, previously regarded as a single sac, in reality consists of several endogenous superimposed laminæ. In his later researches, the Professor's object has been to determine the physical and chemical changes of the histological elements of cells during their development and multiplication, and thus to establish the laws which govern the origin and growth of an organ and organism, and which collectively make up the phenomena of life. Kolliker, in his treatise on human histology, has given the following definitions :—1. The external wall of the cell serves only as a defence to its fluid contents, except so far as it takes part in those intrinsic vital processes which are shown to occur by changes in its chemical constitution; 2. The fluid cytoblastema pre-eminently constitutes the living portion of the cell; and, 3, The cell nucleus plays the most important part in cell formation. Karsten has investigated the development of the cell in various plants, especially in specimens of urtica, spirogyra, cladophora, &c., magnified representations of some of which are given in an engraving illustrating his paper. The very interesting examination of the cell in Urtica urens, showed that these hair-cells are occupied at a certain stage of their development by a tissue composed of non-nuclear cells (secretion cells), separated from each other not by a firm, but by a fluid intercellular substance. When such a hair-cell is moistened with water, imbibition takes place through the external wall, and the intercellular matter gets diffused, the more remote portions becoming intermingled with the more central. The process may be watched for hours, and the streams seen to set out, until at length the delicate diosmotic and assimilating membrane of the endogenous cell-wall becomes destroyed by excessive imbibition. Hence, says Professor Karsten, the physiologist might satisfy his problem of explaining the vital phenomena of the organism from its structure, and from the physical and chemical changes taking place in it, without being compelled to have recourse to an inherent contractility not referable to them. The rotation of the cell juices appears to be a mere phenomenon of diffusion. The cultivation of the Conferva spirogyra proved to him that this plant, when liberally supplied with organic nitrogenous matter, generates new cells profusely, but that, if this nourishment be withheld, growth is limited to the cell-wall. He concludes his paper with the remark, "Owing to the complicated structure of the tissue cells which enter into the composition of developed organisms, it is erroneous to speak of unicellular plants and animals. With as little reason can we imagine cells without membranes; such bodies, in my opinion, should be designated drops or granules."—*Illustrated London News.*

THE STOMACH.

A PAPER has been read to the Royal Society, "On the Immunity enjoyed by the Stomach from being digested by its own Secretion during Life," by Dr. Pavy. The author—after stating the "living principle" suggested by John Hunter as the protecting agency did not stand the test of experiment, for it had been shown that the tissues of living animals might be dissolved by the stomach secretion—said that the prevailing notion of the mucous lining of the organ serving as its source of protection by its susceptibility of constant renewal during life was equally untenable; for he had found by experiment that a patch of entire mucous membrane might be removed, and food would afterwards be digested in the stomach without the stomach itself presenting the slightest sign of attack. The view propounded by Dr. Pavy was one dependent on chemical principles. The existence of acidity was an absolutely essential condition for the accomplishment of the act of digestion. Now, the walls of the stomach being permeated so freely as they are during life by a current of alkaline blood, would render it impossible that their digestive solution could occur. After death,

but both brains, as compared with the European, have an infantile
however, the blood being stagnant. there would not be the resistance to the penetration of the digestive menstruum with the retention of its acid properties that existed during the occurrence of a circulation, and thus the stomach became attacked when death took place during the digestive process, notwithstanding it had previously been maintained in so perfect a state of security. Dr. Pavy, in advocating this view, brought forward experiments which showed that digestion of the stomach might be made to take place during life. Whenever the circumstances were such that an acid liquid in the stomach could retain its acid properties whilst tending to permeate the walls of the organ, gastric solution was observed. The question of result resolved itself into degree of power between acidity within the stomach and alkalinity around. It did not appear that the digestion of living frogs' legs, and the extremity of a living rabbit's ear introduced through a fistulous opening into the stomach offered any valid objection to his view. In the case of the frogs' legs, it might be fairly taken that the amount of blood possessed by the animal would be inadequate to furnish the required means of resistance. The vascularity of the rabbit's ear being so much less than that of the walls of the stomach, there was nothing unreasonable in conceiving that whilst the one received, the other might fail to receive protection from the circulating current.

THE HUMAN BRAIN.

THE brains of a bushwoman and of two idiots of European descent have been examined by Professor J. Marshall. From an abstract of his paper, given in the *Proceedings of the Royal Society*, we select the following notices:—The bushwoman was aged, and about five feet in height, and the form of her cranium is a long, narrow ovoid, less dolichocephalic (long-headed) than the negro skull. The actual weight of the preserved brain was 21·77 oz., which is estimated as less by 8·5 oz. than the average weight of the brains of European females of the same age. The general result of the inquiry showed that the fissures in the bushwoman's brain are rather more complex than in the brain of the Hottentot Venus, but much less so than in the European. They are rather more complex on the left than on the right side of the brain. They are widely separated from those of the ape's brain. Professor Marshall concludes—1. That all the convolutions proper to man are present; but, as compared with the European brain, are much more simple and less marked with secondary sulci. The greatest deficiency is in the occipital and orbital convolutions. 2. That the convolutions, taken generally, are rather more complex than those represented in Gratiolet's figure of the Hottentot Venus's brain, which may be partly due to the obliteration of details in the latter during its long period of preservation. 3 and 4. That the resemblance between the bushwoman's brain and the Hottentot Venus's brain is sufficient to justify the conclusion that the latter was not an idiot, or a defectively developed individual ;X / -simplicity, characteristic partly of sex but chiefly of race. 5. That the convolutions, being more simple, can be more easily traced and compared on the two sides than usual, but still show abundant evidences of the symmetry characteristic of man. 6. That there is a greater difference between the bushwoman's cerebrum and the highest ape's cerebrum than between it and the European cerebrum; but a less specific difference between it and the European than between the chimpanzee and the orang; and, of course, much less than between the highest and lowest quadrumanous brains. There is, however, less difference between the bushwoman and the highest ape than between the latter and the lowest quadrumanous animals. 7. The general results justify the expectation that characteristic differences of degree of cerebral development may hereafter be found in the several leading races of mankind. The idiots' brains examined were those of a woman, aged forty-two, and a boy, aged twelve. The former was able to walk, rather badly, dress a doll, and say a few words. The latter could neither walk, handle anything, nor articulate a single word. The following are some of the general conclusions arrived at :—1. The idiot's cerebra are not merely diminutive organs, having all the proper parts on a smaller scale, but these parts are fewer in number, less complex, and different in relative proportion and position. 2. Nevertheless, all the primary and connecting convolutions proper to the human cerebrum are represented in the idiots, but are very remarkably simplified.

COMA AND CHLOROFORM.

M. FLOURENS has read to the French Academy of Sciences a paper on the distinction between the state of Coma produced by a meningite, or inflammation of the membranes of the brain, and the Sleep caused by Chloroform. He remarked that in the former state the animal was under the influence of complete prostration, but did not sleep; that it kept its eyes shut, but would open them on the slightest occasion; that it could see, hear, and feel, and was constantly shivering. In its natural state the dog's pulse is between 100 and 120 per minute, and it breathes from 20 to 30 times per minute. During coma the pulse does not exceed 90, and it breathes 24 times. But the animal which is under the influence of chloroform really sleeps; it snores and does not open its eyes; it can neither see, hear, nor feel; the pulse is at 60, and it breathes 16 times per minute. The brain of the animal which has died of coma is all covered with red spots, a mark of congestion; the brain of the animal that dies of chloroform has no red spots, the vessels of the dura-mater alone being gorged with blood. Hence, in the case of coma, the congestion is intra-cerebral; in the case of chloroform extra-cerebral. "This should, therefore," M. Flourens concludes, "serve as a caution to those who apply chloroform, since from an extra-cerebral congestion to an intra-cerebral one there is but a step."

ON DEATH.

MR. W. S. SAVORY has delivered at the Royal Institution a series of lectures "On Life and Death," which has proved very attractive, partly through the lucid style of the lecturer, and the admirable selection and arrangement of his illustrative facts. We have only space to give an abstract of Mr. Savory's concluding lecture on the phenomena connected with Death, which he distinguished into general death and special or molecular death. The latter occurs some time after the last breath has been drawn, since several functions of the body, such as digestion, muscular contraction, and the circulation of the blood, may go on for some time after the change we term death has taken place. In this aspect the more important functions of animal life are suspended much sooner than those relating to our organic life. So also cold-blooded animals, and those with a very simple organization, such as polypes and worms, retain vitality of various degrees under circumstances fatal to such complex organisms as ours. In commenting on the various modes of dying, and the causes, whether arising from the suspension of the action of either of the three great organs termed the "tripods of life"—the heart, the lungs, and the brain—Mr. Savory expressed his own conviction that death was primarily occasioned by either the sudden or gradual stoppage of the supply of blood to the nervous centres. He also expressed his concurrence with the statement of the late Sir Benjamin Brodie that, in almost all cases, the point of death is free from physical suffering. He duly described and analysed the signs of death—viz., loss of heat, the muscular contraction termed "rigor mortis," the coagulation of the blood, and, finally, decomposition. The last, he said, is always going on in life, but is then accompanied by renewal; this ceases after death. The body then becomes subject to the chemical and physical forces, and is resolved into its component elements, to be taken up again for the constitution of new organisms. Death, then, is a condition of life.

SCIENTIFIC "GHOSTS."

MR. H. DIRCKS, the patentee of the apparatus invented by him for exhibiting the optical illusions which are popularly known as "Ghosts," described the same to the British Association, in 1858, as briefly recorded in the *Year-Book of Facts*, 1859, p. 125. It will now be interesting to give the subject more in detail. Mr. Dircks thus describes his optical arrangement :—

Two or more figures, for example, appear on a stage, and the spectators view them as two living actors, in all respects the one as well defined and obviously round and life like as the other, yet one shall be a material and the other only a visionary actor. We may suppose a theatre or apartment, arranged as customary when required for dioramic exhibitions, a stage being provided, and the spectators placed in a distant, darkened, and elevated portion of the building. The spectators, thus situated, may, for example, see on an illuminated stage two or more figures, but without being aware that one or more of them bears a visionary character. The peculiarity of this mode of exhibiting spectral appearances, it will be understood, consists in thus associating a living or solid figure with a merely visionary one, and yet the illusion to be so well sustained, that the spectator distinguishes no visible difference between the several actors when properly managed, until the circumstances of the dramatic scene require the visionary figure to fade away, or pass through the furniture and walls of the apartment, or play any similar spectral part.

Mr. Dircks then tells us that more than 20 years since, he invented a plane mirror of unsilvered glass, which, however, he laid aside until within the last two years. He accidentally observed a solid body in a peculiar situation, by which it was apparently rendered transparent. It was, in short, an effect illustrated by the plane unsilvered glass mirror in its principle. Mr. Dircks immediately saw that by means of this combination the singular 'appearance could be produced, of getting behind a mirror and communicating with its shadows. Here, then, a means was at once at hand for producing the best possible illustrations of all descriptions of spectral phenomena. For this purpose he arranged an oblong chamber into two equal portions, making the separation between the two by means of one vertical screen of thin glass, having a perfectly true surface. We may suppose each chamber to measure 12 feet square and 12 feet high. Now, let one of these be the stage in which the acting is to take place, its floor, and three of its walls are solid, and the fourth, or front of it, is one entire glass screen; the ceiling must be made to open at different parts to let in light, and have suitable blinds to regulate the light and shade, in which the actors perform. The chamber opposite, or facing the actors, is in reality a second stage for carrying out the spectral performances, and is differently constructed; the two sides may be large folding or sliding doors, or may be left quite open, or one side closed and the other open, but the ceiling must cover only that half of the top away from the glass screen or partition, thus leaving an open space in the ceiling of 6 feet by 12 ft. Through this space so left in the ceiling the spectators obtain a full view of stage, their seats being above the half-ceiling described, and thrown the rather backwards than forwards, the line of vision being at an angle of about 45 degrees with respect to the vertical glass screen or plane unsilvered crystal mirror. It will now be obvious that the actor on the stage beneath the seats of the spectators can only be seen by reflection, and the trained actor in the opposite stage, knowing the precise situations of the reflection as seen by the spectators, performs accordingly, so that, when really seeming to stand confronting the vision, the actor whose reflection is thus seen as a vision, is as far from the screen on one side as his reflection is cast in the other.

Some striking effects may be produced illustrative of the illusive properties of optical apparatus constructed on the principle described. Thus, a figure placed before a white screen is so strongly reflected that the spectator cannot divest his mind of there being the substance and not the shadow, which he observes, particularly as he contrasts them with an adjacent solid figure. By placing two figures of corresponding form equidistant, one on each side of the glass mirror or screen, they appear as one, until one is moved; and if they differ in colour, as one blue and one white, the effect seems more remarkable. If a cabinet, box, or the like, is placed one on each side of the mirror until the image of one exactly corresponds with the material figure of the other, then the spectator may see the visionary figure open a drawer or door and remove and replace anything therein, and afterwards the solid figure repeat the same acts. If the reflection of an actor is thrown on a transparent screen it is invisible, but by gradually decreasing the light the spectral appearance will be as gradually developed, until apparently it becomes a firm, solid figure in all its proper costume, and acting in perfect conformity to its designed character.

The arrangement of the apparatus is represented by engravings in the *Mechanics' Magazine*, Oct. 9, 1863.

Mr. Dircks has published a small volume, with engravings, popularly illustrating the marvellous illusions obtained by his apparatus, being a full account of its history, construction, and various adaptations.

EARTHQUAKE IN ENGLAND.

On the morning of Tuesday, October 6, 1863, at about half-past three, the central and western parts of England were shaken by an Earthquake. Comparing the various reports received from the districts over which the wave of agitation travelled, we gather that the shocks were as nearly as possible simultaneous from Milford Haven to Burton-on-Trent, and from the Mersey to Plymouth. The sky appears to have been clear and the air still, an observation quite consistent with the experience of travellers in countries where earthquakes are most frequent and violent. The shocks were in many if not in most places unaccompanied by any subterranean noise. In all, the effects were about the same—the furniture was shaken in houses, gates rattled, and high buildings oscillated alarmingly, but no actual damage was done. In the case of a vessel at sea, about twenty miles from Milford Haven, which felt the earthquake, the captain says that the ship reeled as if she had struck on a rock.

A zigzag line drawn from Liverpool through Derby, Wolverhampton, Birmingham, Worcester, Hereford, and Taunton, to Exeter, would seem to mark the course along which the main shock proceeded. The shock appeared to have been general throughout a large stretch of country, embracing South Staffordshire and parts of Warwick and Worcestershire.

Although no damage of any consequence was done, the sensation experienced was described by many persons as very peculiar, and in some cases awful; nevertheless, there is considerable discrepancy in the accounts. We have condensed them, as follows:—

One of the correspondents of a Birmingham paper says that at the time of the shock he was lying in bed awake, when he heard a sound as of the rushing of a very strong wind, which had scarcely subsided, when it was succeeded by a smothered rumbling, which caused his bedroom window to rattle. The sound, he adds, increased in intensity, and immediately he felt a swaying, rocking, or undulatory motion, inducing nausea. Another correspondent says the motion, which was very palpable, appeared more like an upheaving than an oscillating movement; while a third felt a rocking under his bed, and experienced a sensation as of standing upon the platform of a railway station while an express-train is passing. Others heard, as it were, the distant noise of kettle-drums—house bells ringing—and distant thunder

At Smallheath, one of the suburbs of Birmingham, was felt a sudden crash, followed without intermission by a slightly rolling motion, not unlike that of a railway train. The windows of the correspondent's bedroom rattled as though some person was violently shaking them.

At Wolverhampton, the alarm was universal, and the impression of many in that important manufacturing town was that a terrible boiler explosion had taken place.

In Walsall, Wednesbury, Darlaston, Cannock, and other districts within and bordering upon the "black country," the trembling of the earth was very distinctly felt. The same was the case at Stourbridge, where the shock caused a small fracture in the brickwork of a glass manufactory.

At Wordsley the Rev. R. B. Girdlestone writes that he was awakened about 3.15 by a shock which made the whole house quiver; the bed shook violently, the windows rattled, and all the furniture seemed to shiver. The effects of the first shock had hardly subsided, when a second followed it, with a sound as of a heavy explosion beneath the cellars, which made the house shake from the bottom to the top.

At Derby, Worcester, Hereford, and Gloucester the subterranean noises and the shakings of the earth were also comparatively severe. At Hereford several chimneys are said to have been thrown down.

At Monmouth a violent shock was felt at 3.30. Persons were rocked in their beds by the oscillations. This visitation was attended by a sudden and powerful detonation, resembling the booming of distant artillery.

On both sides of the Bristol Channel the shocks appear to have been felt with more or less distinctness. In Swansea noises were heard which were supposed to be the booming of guns, and the vibrations around Mumble Head lasted a considerable time, and created the utmost consternation. Throughout Swansea and Sketty, and all along the seacoast, numbers of individuals testify to the noises of the vibrations of the earthquake. At Haverfordwest several persons felt the shocks At Llanelly many persons were aroused from their beds by the sudden falling about of household furniture, glasses, &c.

At Taunton the utmost alarm was created by the earthquake, and the noise which accompanied it, and a large number of persons betook themselves to the streets and open spaces to escape being crushed by the fall of buildings which they dreaded.

The trembling of the earth and noises were felt with great intensity in Exeter and along the South Devon coast, causing everywhere considerable alarm.

Shocks were also felt in Leicester and Sheffield, but apparently with nothing like the severity observable elsewhere.

From Nottingham is described the rocking of the correspondent's bed and the shaking of the entire house

In London and the suburbs the shock was also felt.

Mr. Hind writes as follows from Mr Bishop's observatory, Twickenham :—"It appeared to me that the oscillatory motion was from E.N.E. to W S.W., lasting three seconds, or rather less. I heard no sound whatever after the shock; but cannot say positively whether any preceded it. The sky was partially clear at the time, and the air perfectly still. The sensation produced by the tremor was very peculiar, and different from that of ordinary vibration."

From the Beeston Observatory, near Nottingham, Mr Lowe thus writes :—"A smart shock of an earthquake was felt here this morning, at 3 30. Many persons awoke from the shaking of their beds and windows. At the time the sky was cloudless, the wind west, barometer stationary, and the temperature 31 deg. The motion of the earthquake pendulum at this observatory was from W.N.W. to E.S E., and the displacement of chalk by the 30 ft. rod was half an inch, the index-needle moving the chalk so as to leave an oval, or rather a lengthened-oval, hole. There must have been at least two shocks, as numerous letters describe the time as both 2·35 a.m. and 3 30 a.m. That the latter was the time of a severe lateral shock is certain, as the zero pencils on my atmospheric recorder marked the paper in a remarkable manner at that hour."

The Earthquake Pendulum employed by Mr. Lowe, at his Observatory at Beeston, is described by him to consist of a wooden rod, 30 ft. long, freely hung in a tube of 6 in. diameter, which extends from the summit to the base of his tower. At the base of the rod a solid brass ball, about the size of an ordinary orange, with a steel index below, is attached. The index ball was made by Negretti and Zambra, and its recent performance, after having been idle except for once, is exceedingly satisfactory. An earthquake, by moving the position of the tower, causes the index to plough up the chalk—the length of the chalk removed registering the displacement of the summit of the tower, while the line points out the direction of the shock.

Mr. Charles Dickens, at Gad's-hill-place, Kent, was awakened by a violent swaying of his bedstead from side to side, accompanied by a singular heaving motion. There was no noise. The air was very still, and much warmer than it had been in the earlier part of the night.

Most accounts describe the shaking as from east to west; a writer from Cheltenham, however, says it was from south to north. All accounts agree that the night was calm About ten years ago a shock was experienced in the same part of England, but it was of a upheaving, and not of a shaking, character, or accompanied with a noise.

THE EARTHQUAKE, AS OBSERVED FROM GREENWICH.

The Astronomer Royal has communicated to the *Athenæum* the following register of his observation :—

Royal Observatory, Greenwich, Oct. 13, 1863.

The earthquake-shock on the morning of October 6th was perceived at the Royal Observatory, Greenwich, but in such a way that it did not immediately excite attention. The first belief of myself and my assistants was that it had not been in any degree sensible; for, as soon as the rumour of an earthquake was received, the photographic traces of the three self-registering magnetometers, all in action and in the highest state of delicacy, were examined, but not the slightest displacement could be seen on any of them. It was not till October 8 that, upon carefully re-collecting the circumstances of an observation, and upon examining accurately into the time, the certainty of the shock having been perceived was established. As there can have been but few instances of actual sight of the earthquake-motion with the aid of a powerful telescopic instrument, the following register may be acceptable.

Mr. Ellis, an experienced assistant of the Royal Observatory, had, immediately before the earthquake, observed the places of the moon and a comparison-star with the altazimuth; and was completing the observation by determining the apparent instrumental position of the fixed mark of the collimator. The mark of the collimator is an extremely minute circular hole, most admirably defined; it is illuminated by a gaslight. The field of view of the altazimuth telescope, by which it is viewed, is intersected by a system of very close crossed wires; and the circumstances are in all respects most favourable for the observation of an apparent motion of the image of the mark among the wires. Mr. Ellis was preparing, by slow motion of the altazimuth-telescope, to place one of the horizontal wires upon the image of the collimator mark, when he found himself unable to make a satisfactory "bisection." Before he had actually moved the telescope, the image of the mark moved apparently downwards, remained stationary, or nearly stationary, for a short time, and then returned to its original position and had no further motion. The character of the motion was entirely different from any that the observer had seen before: there was nothing of quivering or tremor, but a steady motion like that of a double swing of a pendulum. The whole time occupied seems to have been a few seconds, but how many it is difficult to say. The whole extent of disturbance was 12″ or 15″, and this is pretty accurate. There was no horizontal motion.

The idea occurred to the observer, "the wall must be moving," but not so strongly as to return to his memory on the next day.

The time of the phenomenon is determined in this way. The Assistant observed the collimator twice, and it is not certain at which of these observations the shock was perceived; but the times of both observations are known by a reference to a star-observation which immediately preceded them. If the shock occurred at the earlier observation, its time was 15h. 23m. nearly; if at the second, it was 15h. 26m. nearly.

The azimuthal direction of the collimator from the altazimuth is very nearly north.

The altazimuth is upon the top of a rayed pillar of brickwork about 30 ft. high. The object-glass of the collimator is at nearly the same height in the wall of the building which surrounds the altazimuth, and the mark of the collimator is upon a wall of another building, somewhat lower.

It does not appear to me that the appearance recorded presents any evidence of vertical motion. I imagine that the effect seen is due to a horizontal shake of the earth, which, acting on the base of the lofty pillar, caused it to bend like a shaken tree; and thereby caused the telescope attached to its top to dip. The optical axis of the collimator might remain parallel to itself.

This being supposed, the apparent vertical motion of the mark is explained. The progress of the shock through the earth was probably in a direction very different from the north-and-south direction of the telescope in the observation. But upon resolving the shock movement into two parts, one north-and-south and the other east-and-west, it will be seen that the first would cause the telescope only to dip, and the second would carry the telescope parallel to itself and would produce no optical effect whatever.

I am informed by Lord Wrottesley, whose astronomical assistant, Mr. Hough, happened to be making a telescopic observation of a star at the same time, that no certain motion of the star was perceived, although the observer himself felt a movement as of rocking in a cradle (Lord Wrottesley's position, near Wolverhampton, was probably one of great disturbance). The quiescence of the telescope is probably due to the circumstance that the telescopic pier is little elevated, in comparison with that at Greenwich.—G. B. Airey.

EARTHQUAKE AT RHODES.

The following particulars of this sad calamity are given by a Correspondent of the *Temps*:—"On the 22nd of April, we felt the shock of an earthquake, such as had never been felt here before. Not a single building in Rhodes or in the villages escaped uninjured. The great tower of St. Michael's gave way, and the little that is left threatens every minute to fall into the port and block up the entrance. The lighthouse tower is ruined, as well as the Palace of the Grand Masters, recently converted into a prison;

the walls of the town are more or less damaged, besides all the churches. At Trianda only a dozen houses are left standing. Twelve other villages have been completely destroyed. There have been in all 300 persons killed, and an immense number wounded. Of all the villages Massari has suffered most. Out of 46 families only 35 persons have been saved. I was at Massari the second day after the catastrophe; 126 dead bodies had already been interred. Several families were still missing, but the positions their houses had occupied could no longer be recognised. The sight recalled to my memory the sad scenes of the explosion of 1856. Lindos has suffered but little. We continually feel the shocks, but they are steadily decreasing. To complete our misery, three days after the earthquake a deluge of rain came down, so that some provisions which the peasantry hoped to save have been utterly lost."

EARTHQUAKE IN NORTHERN ITALY.

On Nov. 18, at the Lake of Como, after much heavy rain and stormy wind, and the waves of the lake had beat violently on the shore, intelligence was received that the mountain at Molina had toppled over, and that the masses of stone had fallen upon four houses, and crushed 55 persons in the ruins. The earthquake was felt at Lugan Lake on the same day. Carate Laxio, in Lombardy, also suffered from its effects: the coffee-house of the Villa Sanguiliani was covered with the waves of the lake, garden walls were thrown down, and all the houses on the lake's shore were more or less injured.

EARTHQUAKE AT MANILLA.

On July 3, by an Earthquake at Manilla, great part of the town, and about a thousand lives were lost. The shocks did not last over half a minute. The first was from north to south, followed almost instantaneously by another from east to west. People at a distance from the noise of the ruins, said that it was accompanied by a loud rumbling under ground. Captains of ships lying in the harbour say that they saw a brilliant halo of what appeared to be phosphoric light over the city, and felt a shock which resembled the sensation caused by a ship striking the bottom. The strength of the shock was confined to Manilla. The number of lives lost was small in proportion to the destruction of buildings. The greatest destruction was in the churches, monasteries, hospitals, and government buildings; in the suburbs more houses were destroyed than in the city. The *Illustrated London News*, for August 29, contains three engravings—of the cathedral in ruins, the tower of Binondo Church, &c.

Electrical Science.

VELOCITY AND DURATION OF ELECTRICITY.

THE Velocity of Electricity and the Duration of the Spark have been made the subject of elaborate experiments by M. R. Felici, who has inserted some notes thereon in the *Annales de Chimie.* In his opinion, the best method of measuring the velocity of electricity is the observation of the sparks which arise at the interruption of an uncovered conducting-wire freely suspended in the air, and without an envelope of gutta-percha or silk, and traversed by the discharge of the Leyden jar. When we employ a battery and wires covered with gutta-percha, and in the very variable condition of telegraph wires, causes of error are introduced, as has been demonstrated, principally by Professor Faraday. M. Felici also expresses his doubts as to the propriety of employing for this purpose the galvanometer or the electro-magnet. In a memoir lately published, he stated that by his apparatus he had determined the velocity of electricity to be, in round numbers, about 260,000 kilometres a second. Since then he has had new and improved apparatus made, which he describes in detail. With regard to the duration of the spark, he observed in his experiments a phenomenon already noticed by Mr. Wheatstone and M. Feddersen — viz., that when the spark has a sensible duration it is composed of several sparks of an intensity successively more feeble and separated in themselves by infinitely small intervals of time. There is, consequently, one whole spark and some partial sparks of exceedingly small duration. According to M. Felici, the duration of the spark depends on the relation between the tension and the quantity of the charge. By augmenting the tension and diminishing the charge, the duration of the spark is also diminished. The duration of the spark (he says) also depends on the state of the surface of the metallic balls or points.—From the ably condensed "Scientific News ;" *Illustrated London News.*

ELECTRIC CONDUCTIBILITY.

M. DE LA RIVE has laid before the French Academy of Sciences a note on Professor W. Thomson's new method of measuring Electric Conductibility, and its application in respect to melting metals. Professor Thomson, by employing an arrangement of conductors of which one only is the seat of an electro-motive force, makes the intensity of the current depend on the wire of a galvanometer in regard to the two electric resistances desired to be compared. In this arrangement the two extremities of the wire of the galvanometer abut on two points of the conductors of the system, and these points are so determined as to divide in the same relation the total resistances of the two conductors. It thus appears that if the same relation exists between the two other resistances of the system (which are on the one hand, the unknown resistance, and on the other, that which serves as units) the intensity of the current in the galvanometer is null. The principle of the arrangement is the same as Wheatstone's ; and although rather more complicated, it admits of application to the measurement of smaller resistances. We must refer our readers to the *Comptes Rendus* (vol. lvii. No. 17) for details of the experiments, and merely give M. De la Rive's conclusions. In regard to melted tin, lead, bismuth, and antimony, he found that the resistance increased from the point of fusion to the highest limit that he could deal with. The total augmentation (corresponding to 500 deg. between 358 deg. and 860 deg., divided by the resistance to 358 deg.) is 0 32 for tin, 0·24 for lead, and 0·18 for bismuth, quantities notably different, and all smaller than that found for mercury by making use of its known co-efficient. For all the above-mentioned metals there was found to be a decided variation of resistance corre-pondin- to the change of state. For tin, lead, cadmium, and zinc, the re IN ce rose to nearly the double, for bismuth and antimony, the v of C on was inv pri greater for bismuth than antimony.—*Ibid.*

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The Spectrum Analys e masse Ele he has k produced in liquids and gases having been person Mes in ., he has reported the results to the French A n the sa ved in des. We give the chief points from the *Compte* m its ef Wheatsto spark obtained by means of Ruhmkorff's inducti ered wi nsible d s produced in sulphuric ether, sulphide of car and a cessiv , aniline, distilled water, and other liquids. The all employed were made of zinc, copper, pewter, cadmiu h, antimony, tin, lead, iron, aluminium, silver, platin UAI d various alloys. The spectra obtained, exhibited not onl characteristic rays of each metal, but also the spectrum of carbon, and the principal rays of hydrogen arising from all the liquids which contained those elements The red ray of hydrogen was always very brilliant The spectrum of carbon was not always complete · the violet rays were rarely visible ; but the red, yellow, green, and especially the blue rays, never failed. From the vapours of the above-mentioned liquids, M. Daniel obtained the same phenomena as from the liquids themselves, but the spectra were more brilliant. He generally distinguished the spectrum of the metal and the spectrum of the elements of the vapour. With regard to gases, he found by employing electrodes of copper, silver, and platinum, that the spectrum was more distinctly marked—viz.. In nitrogen, fine rays in the orange and yellow ; blue bands, and fluorescence. In hydrogen, the characteristic rays of the gas, and blue bands. In ammonia, the spectra of nitrogen and hydrogen, and fluorescence. M. Daniel derives the following conclusions from his researches — The constitution of the electric spark is always the same, whatever be the state of the medium in which it is produced, liquid or gaseous. There are generally—1. Volatilization of the polar and incandescent metal of the vapour produced; and, 2, incandescence of the elements of the medium traversed by the current. In certain cases, the medium alone, or even one of the elements, seems to become incandescent. In other cases it is especially the metallic vapour which becomes luminous. All simple bodies which have a great affinity for metals, whether free or in a compound easily decomposible by the spark, give intensity to the metallic spectrum. —*Ibid.*

ELECTRICAL AND MAGNETICAL RESEARCH

M. De la Rive has read to the French Academy of Sciences a résumé of his experiments on the propagation of Electricity across highly rarefied elastic fluids, more especially hydrogen and nitrogen, gases which are simple and unalterable, and inactive on the metals, yet possessing very different physical and chemical properties. In the *Comptes Rendus* will be found details. The results obtained, it is stated, are generally in accord with those given by other experimenters. With regard to the influence of magnetism on the above-mentioned phenomena, it is stated that at a certain degree of rarefaction, much more considerable when the gaseous medium is less conductive, the form of the luminous electric jet is changed into a thin sheet, when placed under magnetic influence. When the gas, instead of being dry, contains a little aqueous vapour, the jet is divided into several small perfectly distinct jets, equidistant, and revolving rapidly, like the spokes of a wheel, round the central magnetic pole.—*Ibid.*

ELECTRIC ACTION OF THE SOLAR RAYS.

M. Musset has reported to the French Academy of Sciences some additional facts in relation to this subject obtained by causing the rays of the solar spectrum to fall on a delicate Nobili's galvanometer. In the shade the needles remained perfectly immovable; but so soon as they were struck by the solar rays, whatever the hour or temperature might be, they performed oscillations the amplitude of which varied to the extent of 90 deg. When M. Musset caused the coloured rays of the spectrum to fall on the needles, he was led to consider that the violet rays excited the most action. He took great care to ascertain that the movements of the needles were not due to change of temperature or agitation of the air, and therefore does not hesitate to recognise in them an electric action. In conclusion, he says —"In reflecting on the important part which the sun plays in nature, is it not rational to admit its electric influence? In the shade the chlorophyl in plants disappears, the leaves of the mimosa sleep, chlorine and hydrogen remain together inert, and the needles of the galvanometer are unmoved But if the solar rays strike these bodies the plants become green, the leaves unfold, the two gases combine, and the needles oscillate. These diverse phenomena, taken together, have so much analogy that they may well legitimate an opinion which, by an ascending induction, attributes to electric influence the manifold and often mysterious actions of the sun upon nature."—*Ibid.*

ELECTRICITY OF THE CIRCULATION OF THE BLOOD.

M. SCOUTETTEN has reported to the French Academy of Sciences an account of some experiments made upon horses who were previously made insensible to pain. He found that the electric positive sign, indicating the direction of the current, was constantly from the red, or arterial, to the black, or venous, blood. He concludes his memoir by saying that since it is demonstrated that the red blood and the black blood, in their contact through the walls of the vessels, which act as true porous vases, give stated electric reactions to the galvanometer, we must admit, that as all the parts of our body are traversed by sanguineous fluids, there must necessarily be a constant disengagement of electricity in the most relaxed tissues of our bodies. Thus each organic molecule is incessantly stimulated by the electric fluid, and thus, under the influence of this excitement, all the functions of the body are performed. The oxygen contained in the red blood burns up the organic molecules with which it is in contact, and produces heat, without which life is impossible. Under the influence of electricity is effected, during digestion, the selection of the nutritive molecules and their assimilation. The same action takes place in respiration and in all the other functions. These facts perfectly agree with the electric phenomena of combustion. The carbon takes the negative electricity and the surrounding air the positive, or rather, the current is established between the carbon and the oxygen of the air. Now, the principal action of the red blood, by reason of the oxygen in it, is the producing a true combustion in our tissues.—*Ibid.*

ELECTRO-PHYSIOLOGY.

M. MATTEUCCI has forwarded to the French Academy of Sciences an analysis of his latest electric researches in relation to Physiology, undertaken with the view of explaining one of the most remarkable yet obscure laws of the science. He began by proving that the passage of an electric current in a non-metallic body, which is, however, a conductor of electricity on account of the liquid which it has imbibed, acquires the property termed secondary polarity. By virtue of this property, if it be touched by the homogeneous ends of the galvanometer, it is found that this body is traversed by an electric current, directed in a way opposite to the voltaic current which has excited the polarity. Such is the case with a cotton wick moistened with water, a vegetable stem, a membrane, and a nerve, independently of its vitality. Among these different bodies a nerve is remarkable by the rapidity with which it is polarized in all its points, and by the intensity of its polarity.—*Ibid.*

GALVANIC COPPER.

THE Abbé Moigno has communicated to the British Association a paper "On Galvanic Copper and its Applications." The Abbé commenced by complaining that the ironwork in England which was exposed to the weather and in public buildings was too often sadly neglected and allowed to decay. In Paris they either gilded or otherwise protected such ironwork. M. Oudry having been commanded by the Emperor to endeavour to protect some of the public monuments of France and *chefs-d'œuvre* of art by the electro-plating process, found insurmountable difficulties in depositing a uniform and brilliant coat of copper on iron, either malleable or cast; but having succeeded by mechanical means in reducing electrotype plates of copper to a completely impalpable powder, he used this as a paint, with a medium the basis of which was benzoin instead of linseed oil or any of the oils used with ordinary paints. He had completely succeeded in giving a surface of a very durable character and of a brilliant, bronzed appearance to iron, plaster, and other objects which it was desirable to protect with this substance. The Abbé exhibited several statuettes and busts in plaster covered with it, which had all the appearance of ancient bronzes. We understood that it was by the aid of a steam-hammer that the thin plates of copper deposited by the electrotype process were reduced to the very impalpable powder of copper exhibited by the Abbé Moigno.

NEW ELECTRIC PILE.

JACOBINI'S new Electric Pile had been employed by the Father Secchi for three months, when he stated that it is as efficient as when first constructed. It is composed of a glass vase, two metals, pulverized sulphate of copper, sand, and common water. The two metals are copper and zinc, the last in the same form as in Daniell's battery; the copper is in the cylindrical form, resembling a small porous vase, but open at the bottom. The lower part of the copper is pierced with holes to the height of five centimetres, and its lower edge is cut like a saw. The total height of the cylinder is thirteen centimetres, and the diameter four centimetres. The copper wire which forms the electrode is soldered to the upper part of the cylinder. To form the pile, a layer of sand a centimetre and a half in thickness is laid on the bottom of the vase; on this is put a disc of blotting-paper, with a hole in the centre of the size of the copper cylinder; the cylinder of copper is placed on the sand, and the cylinder of zinc on the blotting-paper. The sand is so placed that it shall touch the zinc cylinder within and without. The cylinder of copper is then filled with the powdered sulphate, pressing it down from time to time while pouring it in. This done, equal parts of water are poured into the sand and sulphate, in order that they may be equally penetrated. Several hours elapse before the pile becomes fully active. Its intensity goes on increasing till it attains its maximum on the fifth or sixth day, when it slowly descends to its constant power.

THE ELECTRIC THERMOMETER.

THIS new instrument has been recently employed by M. Becquerel in determining the temperature of the earth at great depths, and the details of his experiments are given in the *Comptes Rendus* of the French Academy. The Electric Thermometer in its simplest form is a closed circuit composed of an iron wire and a copper wire soldered at their points of junction, and in which is found either a galvanometer keeping zero perfectly, or, better still, a magnetometer solidly fixed, with divers accessories, such as apparatus for heating or cooling the free solder, thermometers, lenses, &c. When the temperature is the same at the two solderings, the magnetized needle rests at zero; when there is a change of temperature there is a deviation. If one of the solderings is placed in a spot where the temperature cannot be observed with a thermometer, then, by raising or lowering that of the other soldering, until the needle shall arrive at zero, the observer will be assured that this temperature is the same as that which was unknown. Thus, by giving to the metallic wires sufficient diameters, the temperature at great depths may be observed. Care must be taken that the temperatures given by the solderings are the same as those of the thermometers placed beside them. The operation requires a deep-bored well, a thermo-electric cable, a galvanometer, and other apparatus; in all which M. Becquerel was liberally aided by M. Rouland, the late French Minister of Public Instruction.

On examining the earth at Paris, M. Becquerel found—1, That, without going out of the tertiary basin of Paris, the invariable stratum is not of the same thickness; 2, That we can rigorously determine the march of the propagation of heat in the soil, and the position of the invariable stratum; and, 3, That at the Jardin des Plantes, from the depth of 26 to 36 metres, the temperature is constant, as it is also from 16 to 21 metres. He states, that in passing from one stratum to another, the temperature seemed to change, and thinks that, consequently, it will be possible to determine with great exactness the propagation of solar heat in the earth. Since this new mode of observation indicates changes of temperatures less than the tenth of a degree, M. Becquerel considers it to be highly desirable that experiments should be made at depths of 100 or even of 200 metres, in order to learn the nature of the strata, the infiltration of waters, chemical reactions, and other causes which influence the distribution of heat in the crust of the earth, and what are the modifications which it undergoes with the weather—a distribution, the effects of which may react on the temperature of the soil, and, consequently, on the climate. This is one of the grandest questions in terrestrial physics which a philosopher can propose to himself to solve, and well worthy of fixing his attention.—*Illustrated London News.*

NEW ELECTROMETER.

THIS new instrument by Professor W. Thomson, has been exhibited and explained to the British Association by Mr. F.

Jenkin. Hitherto most electrometers have been mere electroscopes, indicating, but not measuring, differences of electrical potential. Professor Thomson had now produced a measuring instrument fulfilling all the requisite conditions of portability, constancy, and delicacy. Some such instrument will soon be as generally in use for all meteorological observations as barometers now are. The principle of the instrument was explained, and it was shown that in practice, the observations could be made by any person accustomed to the usual meteorological instruments. By the use of this instrument, it is anticipated that in the balloon ascents contemplated in the next year, much valuable information as to the electrical condition of the atmosphere will be obtained.

THE BATHOREOMETER.

THIS electric apparatus for measuring the thickness of very thin substances, is described by its inventor, the Abbé Julien Giordano, a professor of the University of Naples, in a memoir recently laid before the French Academy, and which appears in *Les Mondes*, with an engraving on wood (required to make the description intelligible). By the bathoreometer, Professor Giordano has obtained the following among other measurements, in the decimals of the millimetre = 0·03937 inches. Common unsized paper of first quality, 0·278, the same after transformation into parchment by immersion in dilute sulphuric acid, 0·252; French gold leaf, 0·009; Neapolitan gold leaf, 0·006; hair of human adults, 0·045, 0·051; hair of a child ten days old, 0·009; and of a child four years, 0·067; the membrane of the wing of the praying mantis (*mantis oratoria*), 0·019; the scales of the dust of the wings of the vanessa atalanta, 0·007.

ENGRAVING BY ELECTRICITY.

A METHOD of Engraving by Electricity is described in *Les Mondes*, the process being due to M. Delouche, an engraver, and M. Fellmann, an artist. A well-polished plate of zinc is covered with a layer of white, similar to but not identical with that used by engravers on wood. On this white layer is drawn a portrait with a special ink, and the plate is then suspended to the negative pole of a voltaic battery in a bath of sulphate of copper, whereby the inked portion of the drawing is covered with a coating of copper. When this is sufficiently thick, the plate is removed and suspended to the positive pole, in acidulated water. The acid consumes and hollows out the parts not covered with copper, or the white parts of the design. The operation is complete in a few hours, and a plate obtained fit for printing from. Two specimens are given in the Number of *Les Mondes* from which these notes are extracted.

GUTTA-PERCHA AND INDIA-RUBBER.

MR. C. W. SIEMENS has read to the British Association a paper "On the Electrical Resistance and the Electrification of Gutta-

Percha and India-Rubber under varying Pressures, extending to 300 Atmospheres." The pressures were produced by a powerful hydraulic press. Mr. Siemens found by experiments the resistance of gutta-percha, or, in popular language, its insulating power, increased as the pressure increased, and the rate of increase was found to be greater the higher the pressure. At 300 atmospheres the resistance was nearly three times that observed at atmospheric pressure. When the pressure was removed, the resistance immediately fell to nearly its original amount, and after some time regained the original resistance exactly. The resistance of india-rubber, on the contrary, was found to decrease with an increase of pressure, but the rate of decrease tended to become constant; when the pressure was removed a kind of rebound occurred, for the resistance immediately rose to more than its original amount, but after some time again fell to its first condition. It might be thought that this effect in india-rubber was due to the introduction of water into its mass under high-pressure, whereas gutta-percha might be supposed to resist this kind of percolation. This view was, however, shown to be untenable; since, when a wire was first covered with india-rubber and then with gutta-percha, the change of resistance due to the increase of pressure was a mean between the results obtained with gutta-percha and india-rubber separately. The effect on the apparent resistance of the insulators by continued electrification, first published by Mr. Fleeming Jenkin at the Aberdeen Meeting of the Association, was next alluded to Mr Jenkin found that the decrease of the current passing through the gutta-percha, due to electrification, was constant at all temperatures, and independent of the change of resistance due to this cause. Mr. Siemens had found the same result with the change of resistance due to change of pressure.

GISBORNE'S ELECTRIC COMPASS.

THIS contrivance is nothing more than the ordinary ship's compass, with a battery in the box, and two insulated wires maintaining the electric currents round the needle. In the *Mechanics' Magazine* it is stated that the Liverpool Compass Committee, Mr. Evans, Mr. Smith, and the Astronomer Royal, obtained from Mr. Fairbairn 24 plates, each 16 in. long, 4 in. broad, and ¼ in. thick, to verify by experiment that the power of malleable iron for the reception and retention of subpermanent magnetism depends on the degree of heat at which the iron is passed through the rolls. "On collecting," he observes, "all the results (after repeated annihilations and reversions of magnetism) with the unlettered end downwards, the magnetism of the cold rolled longitudinal bars is greater than that of the other bars in the proportion of about 14 to 10; while those with the lettered end downwards give about 11 to 10." Here obviously we have a key to much that has been said as to good and bad iron for the construction of ships, the good iron being that which would lead to little compass variation, and the bad iron that which would lead to considerable or excessive compass variation. But the inquiries and deductions of the Astronomer Royal have been pushed much further. He goes so far as to recommend that iron ships should be built with the keel nearly north and south. The results of Mr. Smith's studies may be summed up in the one sentence that "the north end of the keel is attracted to that part of the iron hull which was furthest from the north in building." In other words, if the head of an iron ship is built towards the north, the needle will point towards the south; and if the head of an iron ship is built towards the south the needle will point towards the north; and so on—the general laws being disturbed and counteracted in endless ways. Mr. Evans again tells us that the *Warrior* was built head north 3 deg. east, and the armour put on head north-west; the *Black Prince* built head south, 20 deg. east, and the armour put on head south; and the *Defence* built head south, 47 deg. west, and the armour put on head south, 19 deg. east. He says, "The general law obtains in these ships that the point of the compass is drawn towards that part of the ship which was south in building" Mr. Evans has also told us the precise amount of compass variations: 1st, in sailing vessels, wood built; 2nd, in steam-vessels, wood built; 3rd, in vessels built partly of wood and iron; 4th, in steam and sailing vessels, iron built, and 5th, in iron-plated ships. In a wooden sailing ship the north end of the needle is drawn to the ship's head, and the amount is small; engines and boilers increase the amount; and, as observed before, if an iron ship is built north, so great is the variation that the needle will point south. The ill-fated *Royal Charter* had a large amount of variation. Last of all, Mr. Rundell, on behalf of the Liverpool Compass Committee, tells us many things. He says, "that many captains find the error of their compasses constantly vary with change of latitude, dispense with compensation of any kind, and trust entirely to constant celestial observation for determining the amount and direction of these errors."

Mr. Gisborne's Electric Compass was tried for three days on board the iron steamer *Resolute* in the Mersey. It was uninfluenced by the iron of the vessel, and worked correctly when placed over the engines and between the chimneys. Not so the ordinary compass of the *Resolute*, with the well-known magnetic adjustments; the variations being 1½ to 1¾ points. Piles of steel and iron shavings placed round the electric compass do not act upon the needle, and it is alike insensible to the presence of bars of iron on the top of the box. Tests such as these are demonstrations that currents of electricity restore the compass to the sailor as unvarying and trustworthy as when steam machinery, iron hulls, masts, and rigging were unknown. Gisborne is an eminent electrician, and having crossed the Atlantic frequently, it occurred to him to try electric currents as a means of checking compass variations.

LADD'S ELECTRO-MOTIVE MACHINE.

THIS machine, exhibited and described to the British Association by Mr. Ladd, consisted of two coils forming a powerful electro-magnet, revolving on an axis parallel to the axes of these coils, and at equal distances between them. On the stand, four pillars, forming coils, were planted in the circumference of a circle round the revolving electro-magnet, and at such a distance from it as to permit its free motion. By a simple contrivance, similar to the commutator, the electric current was so transmitted and reversed as to make each of the pillar coils a magnet, with the pole it presented to that of the revolving coil as it approached it, of the opposite name, south or north, but the instant it passed reversing it into one of the same name; thus, while advancing, it is attracted, but the instant it begins to retire, repelled, and so a constant motive force is applied to keep it revolving. The engine exhibited was mounted with bevel wheels, carrying an axle, on which a cord could wind up a weight of some pounds. It was also furnished with a friction brake, by which its power, which was, even with only two Grove's cells, considerable, could be exactly measured.

NEW MODE OF FIRING MINES BY ELECTRICITY.

THIS new fuse, invented by MM. Comte and Gaiffe, which will, it is hoped, render incalculable service in the working of mines and the excavation of tunnels, differs from those which have been employed hitherto, in a novel arrangement of the parts of which it consists, which permits of its manufacture in a very short space of time, and reduces the chances of fracture to a minimum. It consists, first, of an insulated wire, to which is affixed the usual fuse tube; secondly, of another wire, uninsulated, twisted round the first, with its extremity removed one centimetre from that of the insulated wire; and lastly, of a bag containing the explosive compound, within which are buried the extremities of both wires. When the induced current from a Ruhmkorff coil is passed through the wires, the spark, on account of the distance which separates them, passes through the powder contained in the bag. The thread of tin which is employed to complete the circuit in the first instance, is melted instantaneously, and a considerable space then exists between the insulated and uninsulated wires, through which the spark passes. By this arrangement, it is possible to affix upon two wires proceeding from the coil as many fuses as may be thought fit. The current having passed through the first, proceeds to the second; from that to the third, and so on; and because the sparks from Ruhmkorff's coil succeed one another with great velocity, a great number of mines can be exploded almost instantaneously. So far, the invention has been pronounced by the French press perfectly successful, the experiments which have been made leaving nothing to be desired.—*Mechanics' Magazine.*

THE MAGNETO-ELECTRIC LIGHT AT DUNGENESS.

SOME further Reports on the progress of this "magnificent" light, as a Committee of the Trinity House have called it, have been printed by order of the House of Commons. In one, dated 8th April, 1863, the Secretary says.—"The light has now been exhibited at Dungeness for a period of nine months, and during that time has, with some brief exceptions (generally attributable to want of care on the part of the attendants), been maintained without break or failure, showing a light of exceeding power and intensity, which Mr. Faraday, who took as his standard the revolving light at Grisnez, with which at equal distances it was of equal power, estimated to be eight times that of a first order fixed dioptric light (see his Report No. 1). Every part of the machines and engines has worked well, although one of the boilers has just required repair, causing a pressing demand from the engineer for the third spare boiler, which he has suggested as necessary. The lamps and lenses have been gradually improved until they may now be said to be perfectly satisfactory, and have been under the charge of the ordinary light-keepers, possessing no more than the usual ability of such persons. The engines and machines have been under the charge of two engineers." Various minor objections, however, to the light as it exists, are stated in these reports; but some of these are vitiated by the discovery that the chief engineer has had to be dismissed recently on account of intoxication. Professor Holmes replies satisfactorily to the objections in a separate pamphlet, and Professor Faraday also discusses some of them. The light seems to be visible at from twenty to thirty miles' distance, but occasionally not so far, a circumstance which Professor Faraday ascribes on certain occasions to local haze. The Trinity House authorities, however, admit the superior advantages of the light in respect to penetrative power and star-like brilliancy, although other first-class lights they regard as practically sufficient. —*Builder.*

ELECTRIC STEERING APPARATUS.

THE increase in the size of the ships of the Royal Navy, as well as of those in the mercantile marine, has rendered necessary many important changes and improvements in the construction and working of these vessels. In respect to Steering, Electricity is at last regarded as the only means of ensuring rapidity and accuracy. A new plan has been tested, it is said successfully, on the trial trip of the *Royal Oak*. The apparatus is the invention of Mr Gisborne, C.E. The communication between the captain and the helmsman and engineer is maintained by means of a coil of conducting wires. The wires are covered, by Messrs. Silver's process, with a thin coating of india-rubber, not thicker than the finest film of silk, but protected by tarred hempen cable. The motive power is a small galvanic battery, which, when charged, will remain permanently in action for twelve months. On the paddlebox, bridge, forecastle, or any other place convenient for the captain, there is fixed a circular dial-plate with a handle or knob fixed to a revolving arm, and upon the rim of the dial the words "port," "steady," "starboard," "hard." A small box is placed before the helmsman, upon the face of which are metal flaps corresponding in number, and covering the orders that may be transmitted by the apparatus. For the engine-room the arrangement is of a similar character, the words on the dial-plate being "stop," "ahead easy," "half speed," "full speed," "back half speed," "back full speed," and so on. To insure accuracy, the helmsman or engineer sends back a signal to the captain; and every order transmitted is registered, and remains permanently in sight until another order is sent.—*Mechanics' Magazine.*

GASEOUS FUEL.

MR. KEYWORTH, in a letter to the *Times*, states that the moving power of wind or water, costing nothing, is theoretically capable of conversion into Gaseous Fuel, from the decomposition of water by means of magneto-electricity, which he thus explains :—

"When an iron reel, having thread-covered copper wire wound round it, is passed endways near to the poles of a horse-shoe magnet, electricity appears in the wire. On this principle, however modified, magneto-electric machines are made for electric telegraphy, electro-plating, and the production of light. At the Dungeness Lighthouse numerous magnets are fixed, six together radially on a wheel, in three rows, between which two wheels, having the wire-covered reels fixed in the rims, revolve rapidly by means of a three-horse power steam-engine. The machinery being in the basement, the electricity is led by wires up to the lantern, where the slate-pencil-like carbon points forming the wick of the electric lamp are adjusted. These, when at a little distance apart, glow with insupportable brilliancy, producing a light which greatly excels others, and 'shines up and down the Channel and across into France.'

"Here, as in all such machines, motion is converted into electricity, and the cost of the electricity is the cost of the motive power.

"A magneto-electric machine moved by water, would be a very economical arrangement, and could a wick for the electric lamp be invented, as convenient and needing as little care as a gas jet, towns and districts having available water power might be lighted very cheaply, the wires being led from the electric factory to the streets and houses. In this way vast stores of coal used daily in gasworks would be saved.

"But magneto-electric machines will yield heat as well as light. Some years since unremunerative quantities of oxygen and hydrogen gases were obtained from the decomposition of water by this means, steam as the motive power being used. From these experiments it appears, that machines of 80-horse power, working

10 hours, would produce possibly 1500 cubic feet of gaseous fuel. It seems, therefore, well worth consideration, whether the boundless supplies of waste water power existing in the tides, the rivers, and lakes of Great Britain and Ireland, might not be economically converted into pure, smokeless, most intense gaseous fuel, made marketable by compression into wrought-iron vessels, as has been done with coal gas."

To this communication another Correspondent of the *Times* replies :—

"The electric current developed by electro-magnetic machines, machines such as have been manufactured since they were first applied to electro-plating in Birmingham, suffices to decompose water with what a laboratory chemist would term considerable rapidity. The motive power required to put these machines in action, it is recommended, might be derived from tides, rivers, and lakes. Tidal action, which was referred to as a source of power in the *Times*, September 25, 1862, might no doubt be made available for driving large magneto-electric machines, and, consequently, for the evolution of the gaseous fuel, hydrogen, from water. Your correspondent informs us, that 'machines of 80 horse-power working ten hours would probably produce 1500 cubic feet of gaseous fuel'—that is, of hydrogen Now, estimating the weight of 100 cubic inches of hydrogen at 2 14 grains, a cubic foot will weigh 36·97, say 37 grains, and 1500 cubic feet will weigh 55,500 grains, or 7 9, say 8 lb. avoirdupois. One part by weight of hydrogen will, on perfect combustion by oxygen, raise the temperature of 34,000 parts by weight of water 1 deg centigrade, or, what is equivalent, will just raise 340 parts by weight of water from 0 deg centigrade (the freezing point) to the boiling point. Hence 8 lb of hydrogen will, on perfect combustion, providing there is not the slightest loss of heat by radiation, conduction, or otherwise, suffice to raise the temperature of 2720 lb or 272 gallons of water from the freezing to the boiling point. We need not pursue the calculation further The conclusion from the data of your correspondent is that in order to boil 270 teakettlefuls of water it is necessary to employ an engine of 80 horse power during ten hours. But engines cost money, require attention, and are subject to wear and tear Your readers may form their own judgment whether the investment in magneto-electric machinery, driven even by tidal action, is likely to prove remunerative"

A third Correspondent, Mr. Bower, of St Neots, replied :—

"The suggestion of Mr. Keyworth to produce 1500 cubic feet of gaseous fuel by the expenditure of a power equivalent to 80 horses working for 10 hours is certainly not a move in the right direction.

"The power which this fuel so raised represents, is not greater than that which can be obtained from 1 cwt. of coal.

"If there be such a plentiful supply of waste power in the tides and winds, let it be used in a direct manner, not wasted in the production of that which can only be made to give off one-twentieth of the power expended in its creation.

"The suggestion of compressing the gas into cylinders (say equal to 10 atmospheres) would be a still further loss; the power required for this purpose being more than could be obtained out of the 1500 cubic feet."

SUBMARINE CABLES.

THE practicability of Ocean Telegraphy is once again to be tested on a considerable scale. Four undertakings of this description—two being enterprises of world-wide importance—are in various stages of progress, and will, it is hoped, become established facts in the course of the approaching year. By their success or failure, the progress of this branch of science will very probably be influenced very materially. We propose, therefore, to glance at the means about to be adopted for carrying out each of them.*

The French line may be first mentioned. This Cable has been undertaken for the Imperial Government by Messrs. Siemens, Halske, and Co., and is shortly to be laid between Oran, in Algiers, and Carthagena, in Spain—a distance of some 250 miles; the communication being continued from the latter place by means of land wires through the Spanish territory into France. The cable is on the plan which has been patented by Messrs. Siemens and Co., and of which specimens were shown in the Exhibition of 1862—with the exception that the insulation of the present cable is entirely of gutta-percha, instead of part gutta-percha and part india-rubber, as originally recommended by the inventors. The conductor is a strand of 3 No 22 copper wires laid together spirally; and the diameter of the core, consisting of the insulator and the conductor, is about 3-10ths of an inch—this is surrounded by a pad consisting of a double layer of hemp strings running spirally in opposite directions. Around these hempen strings is laid the final metallic sheath, which is made of phosphuretted copper rolled into ribbon about a quarter of an inch in breadth and the 20th of an inch in thickness. The ribbon so made is laid in a short spiral, every turn overlapping the one preceding it after the fashion of ancient scale armour. The diameter of the entire cable does not exceed 4-10ths of an inch, and the specific gravity is low, but the policy of employing so small a conductor, and an insulation so slight, may fairly be doubted, as also may the weakness of the completed cable under strain.

A more extensive undertaking than this, will be the Cable shipped by Mr. W. T. Henley, of North Woolwich, for the Indian Government, and the laying of which has been entrusted to Messrs. Bright and Clark, under whose specification and superintendence it has been manufactured by Mr. Henley. The core consists of a copper conductor, which, though presenting a solid appearance, consists, in fact, of several segments drawn out together and firmly encased in a surrounding tube. This arrangement is supposed to secure all the advantages to be derived from solid copper, without the danger of internal and unperceived fracture of the conductor, on account of its liability to which, that form of the latter has long been laid aside in favour of conductors worked into a strand. A conductor so constructed may escape severance in shallow water, like that of the Persian Gulf; but for deep sea cables, a conductor of that class would be a very dangerous experiment.

The conductor of the Persian Gulf line weighs 225 lb. to the nautical mile, and is surrounded by 285 lb. of gutta-percha per

* This able *résumé* is from the *Mechanics' Magazine*, November 16, 1863.

mile for its insulation. The core thus formed is padded with a spiral ribbon of hemp saturated in tar-mixture, the hemp in turn being surrounded spirally by 10 No. 7 iron wires. Finally, the entire cable so constructed is lapped with yarn over its external circumference and served with a composition of pitch, tar, and silica, laid on at a heat of 300 deg. Fahr., for the purpose of preserving the outer iron wires from oxidation. The cable was to be taken out to the Persian Gulf in five sailing vessels, to be towed by means of steamers during the paying out, the depth being scarcely anywhere more than 50 fathoms. The cable will be laid in several sections, commencing at Bussora at the head of the Gulf, and completing the work at Gwaddell, on the coast of Belochistan, whence the wires are continued to Kurrachee, Bombay, and the most important centres in India.

The third Cable is a sort of adjunct to the last mentioned, and will be similar in construction. Its importance consists in the fact, that it forms a link of about 60 miles in the communication with the East, which it connects with the direct European lines going west and north from the coast of Italy.

But the circumstance to which the chief importance attaches in the present history of submarine telegraphs, is the resuscitation of the original Atlantic Telegraph company. They have now provided the means for purchasing a new cable, and the attempt will be made to restore communication with America during the summer of 1864. On the present occasion, the Board have committed their scientific affairs and the judgment of the tenders sent in reply to their advertisement, to a Scientific Committee, composed of Mr. William Fairbairn, Mr. Joseph Whitworth, Captain Douglas Galton, Professor Wheatstone, and Professor William Thomson.

These gentlemen decided in favour of Glass, Elliot, and Company's offer, but required, as regards the external armour of the cable, that they themselves should institute certain experiments and finally determine how it was to be constructed.

As regards the core, it has been generally conceded that the one fixed on is suitable. It will be made up of a conductor having seven wires laid spirally into a strand containing 300 lb. of copper to the nautical mile. The insulator will be of gutta-percha, laid on in four layers, alternately with four layers of Chatterton's compound. The entire insulator weighs 400 lb., and the entire core 700 lb. per knot.

As to the external covering, the problem now being worked out at Greenwich, and at the works of Messrs. Fairbairn, is to obtain for the whole cable completed, a specific gravity of about 1·8, with a breaking strain of about 9 tons, giving thereby a cable capable of bearing about 13 miles of its own length perpendicularly suspended in water.

As the greatest depth of the route between Newfoundland and Ireland is only 2½ miles, it is thought that this will leave an ample margin; and as it is stated that a cable of this description can be constructed by means of a combination of hemp and the best charcoal or homogeneous iron without any unattainable increase of expense, it is most probable that these materials, in proportions now being ascertained by actual experiment, will constitute the external coat of the future Atlantic cable.

Glass, Elliot, and Company have undertaken the entire work of manufacturing and laying the cable.

We add from an article in the *Times* the details of the manufacture of Henley's Cable.

Experience has taught electricians the value of moderating the power used in working lines, and above all has pointed out the imperative necessity of having no single section of a submarine line of more than 600 miles in length. To lay long submarine cables in a continuous length without intermediate stations has been found to answer no other purpose than that of greatly diminishing the speed of working and multiplying every imaginable risk both of manufacture and submersion The Indian Government, acting under the judicious counsel of their scientific advisers, have wisely determined to divide the Persian Gulf cable into three sections.

The faults which led to the destruction of the Red Sea line were of another character. Though it was manufactured and tested with a care greatly superior to that taken with the Atlantic cable, it was submerged in a way which rendered its ceasing to work a question of a few weeks more or less. Sheathed in a covering of small wires, quite unprotected from corrosion, it was laid without any allowance for "slack" cable to fall into the irregularity of the bottom of the sea. It consequently lay strained across the points of the inequalities, with a tension of several thousand pounds As the unprotected wires rusted away, and the suspended portions of the line became loaded with coral and barnacles, the whole line crumbled into hundreds of pieces by its own weight. This is no mere hypothetical opinion, but a fact which was amply proved by the expedition to the Red Sea in 1861, under Mr. Latimer Clark. There can be little doubt that the same cause led to the temporary failure of the Malta and Alexandria line, as well as that laid for the French Government between Toulon and Algiers.

To obviate this cause of danger, which in the above-mentioned lines has probably occasioned a loss of property to the value of over a million sterling, the Persian Gulf line is cased in twelve No. 7 gauge hard-drawn iron wires, thickly galvanized, so as effectually to prevent their corrosion. But, in order to secure more effectually the permanent stability of the line, the whole finished cable is thickly coated with two servings of tarred hemp yarn, overlaid with two coatings of a patent composition invented by Sir Charles Bright and Mr. Latimer Clark. The composition consists of mineral pitch or asphalte, Stockholm tar, and powdered silica, mixed in certain proportions, and laid on in a melted state. While yet warm it is passed between circular rollers, which give it a round, smooth surface. When quite cold this forms a massive covering of great strength and perfect flexibility, totally impervious to water, and incapable of being destroyed by the minute animalculæ which exist in such abundance in warm latitudes, and which, when the cable is not protected against their attacks, eat every atom of the hemp, as in the case of the cable laid between Toulon and Algiers. Galvanizing the wire is in itself an almost perfect protection from rust—certainly for many years, as the good condition of the cable picked up off the Kooria Mooria Islands, a part of which was galvanized, showed, as far as the galvanizing was concerned. But, with the final protection both from rust and animalculæ which Bright and Clark's compound affords, there appears to be no reason why this cable, when once laid in shallow or deep waters, should not remain good for a hundred years to come. The copper conducting wire is composed of four segments, drawn into a hollow tube in such a manner as to appear like a solid wire. By this means, all the advantages of a strand wire are combined with the condensed bulk and small surface of a solid one. The copper from which the wire is drawn is especially selected by the engineers for its high capacity for conducting electricity. It is, perhaps, not generally known that different samples of copper vary as much as 50 or 60 per cent. in this respect—that is, some specimens of copper wire will conduct electricity with greater facility than other specimens of double the thickness, though physically there may not be the slightest difference by which you can distinguish one from the other. This wire, which is nearly one-eighth of an inch in diameter, is then covered by the Gutta-Percha Company with four distinct coats of gutta-percha, and four coats of Chatterton's compound, laid on alternately. This "core," as it is termed, is then tested in cold water, at a temperature of 90 deg. and then under a pressure of 600 lb to the square inch. After passing through all these ordeals, the loss by leakage through the gutta-percha covering does not exceed one hundred-millionth part of the current of electricity passing through the conducting wire in every nautical mile To such minute perfection has the system of testing adopted by the engineers been carried, that the loss of one thousand-millionth part of the current by leakage could be detected and estimated on the instruments In the present state of the insulation of the cable the loss by leakage in working each section of the line will not exceed one four-hundredth part of the electric current sent through the conductor—a condition of insulation which we believe has never been equalled by any cable hitherto manufactured.

Before being sheathed at Mr Henley's works the coils of gutta-percha core, which are in three mile lengths, are again tested under water for insulation and for resistance of conductor, therefore if any injury should have occurred to the fragile gutta-percha covering of the wire during its transit from the Wharf Road to North Woolwich, it is detected before the cable is made up, and then the process of sheathing them in their outer covering is commenced. The first coating outside the gutta-percha is 12 thick strands of wet hemp, and over these again come 12 solid No. 7 gauge wires, which have been most carefully galvanized by Mr. Henley. The outer covering of iron wire is generally the last which a cable receives, but in this instance, as the line is to be laid in comparatively shallow water, the wires themselves, though galvanized, are still to be further protected from their most formidable enemy, rust, which is done by the coverings of Bright and Clark's composition already described

During the whole time the cable is at Mr. Henley's the current is kept always through it, so that the slightest possible defect in the wire can be detected In addition to this, the very able electrical staff test every portion regularly twice a day for insulation and resistance of conductor. When everything has been done which the most jealous care and the most fastidious scientific skill can suggest, it is passed out on the river side of Mr. Henley's factory, and coiled away in tanks filled with water; and, even here, perpetually watched and tested. There are upwards of 900 nautical miles of it thus manufactured, lying at Mr. Henley's works—huge coils of thick black-looking rope, nearly 1¼ in in diameter, weighing nearly 4 tons to the mile, and 2½ tons in water, and costing as nearly as possible 200*l* per mile—the cheapest, strongest, and, electrically speaking, the most perfect cable that has ever yet been made. Three hundred and fifty miles more of the same kind have yet to be manufactured

At all the breaks or stations in the Persian Gulf the extreme shore ends will be very massive, coated with galvanized iron-wire of almost tenfold strength, and weighing as much as 8 tons a mile. In certain portions of the route near Bussorah, where there is any danger to be apprehended from small coasters anchoring, the weight of the line will also be increased by the extra thickness of its wires, to nearly 9 tons a mile—enough to shield it from any risk from the little anchors of the native boats which are likely to come there.

The total length of Cable taken out for this line amounts to 1250 miles, and weighs upwards of 5000 tons, being an excess of 2000 tons over that of the Red Sea, Malta, and Alexandria, or the Atlantic. The wire alone of the present cable weighs 1000 tons. When completed London and Calcutta will be in telegraphic communication, by which a correspondence may be conveyed from one hemisphere to the other in the course of a very few hours.

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PRINTING TELEGRAPHS.

PROF. HUGHES has read to the British Association a paper on his system, which depends for its correct action on the subdivision of time between each signal or letter, and the contact for each wave of electricity of the same duration. All other systems depend either upon the number and duration of different signals to produce the letter intended, or upon a certain number of signals indicating a certain letter. In order to obtain the results, we must secure, 1st, the perfect synchronism, or time-keeping, of two or more instruments; 2nd, the sending of the currents should be perfect as regards intervals of time and duration of contact; 3rd, the arrival of the current should be perfectly recorded, both as regards the intervals of time and the signals obtained. The instrument is driven by a weight acting upon a train of wheels, and its speed is governed by a vibrating rod. The type-wheel revolves continuously, and carries, by means of bevel wheels, a contact-making arm, which travels around a disc of pins acted upon by the finger-keys. Whenever any one of these keys is pressed down, the corresponding pin comes in contact with the revolving arm at the time wished for. The current is thus sent on the line, passing through the electric magnet, detaching the armature, which, in its rapid upward motion, comes in contact with a detent, which locks at will a small shaft to the train in motion. A cam on this shaft raises the paper against the type-wheel, causing the impression of the letter intended on the paper. At the receiving station the current acts in the same way as in transmission, detaching the armature, thus permitting the printing shaft to make one revolution, and to take the impression of the intended letter once for each current received. The transmitting and receiving instruments are brought into unison by a detent on each, which, on being pressed, stops both type-wheels at a given point, and on being released by the electrical wave, starts them both at the same instant of time. After a detailed description of the mechanical arrangements of the instrument, the methods of obtaining the results, &c., the paper supplied the following particulars as to the special merits of this invention over others:—It will be seen, from a careful study of this instrument, that it possesses special merits not only for land lines, but for long submarine lines, from the fact of its requiring but one wave to each letter, and the sensitiveness and simplicity of the electrical arrangements. Theoretically its speed is three times greater than the Morse; and this has been fully borne out in the numerous practical trials the instrument has had. The following rates of speed were obtained in different lengths of cables:—

Atlantic cable	......	2500 miles	4	words per minute.
Red Sea ,,	......	2000 ,,	6	,,
,, ,,	......	1000 ,,	10	,,
,, ,,	......	500 ,,	24	,,
Denmark ,,	.....	300 ,,	22	,,
Tasmania ,,	.....	240 ,,	30	,,

On aerial lines the average speed of good operators is 40 words per minute. Having stated the special merits of this instrument with regard to the velocity of transmission through submarine cables, and given various tables and particulars as to the force and time of currents, the paper proceeded :—The electric magnet of this instrument has been also used as a measure of the force of different electrical forces. The adjusting screw on armature when graduated shows the amount of the electric magnetic force that has detached the armature The same arrangement has been used as a measure of force under different speeds of transmission. The results of experiments in relation to these points were given. The patents for this instrument have been purchased by the Governments of France and Italy, after a series of practical trials of one year's duration, and it is now in daily use on their most important lines. In the United States it has been purchased by the American Telegraph Company, and has been in operation there since 1855. The United Kingdom Telegraph Company possess the sole right for Great Britain, and it is in operation upon their lines between Liverpool, Manchester, and London.

THE NEW TELEGRAPH ACT.

An Act has been passed to regulate the exercise of powers under special Acts for the construction and maintenance of telegraphs. Before a company proceeds to place a telegraph over, along, or across a street, not being a street in the metropolis or in a city, or a public road, or to place posts, they are to publish a notice that they have got the consent of the body having the control of the street, and leave notice at the dwelling-houses, and are not to place the telegraph until after 21 days' notice, during which time objections can be made to the Board of Trade. If any person in the employ of a company wilfully or negligently omits or delays to transmit or deliver any message, or by any wilful or negligent act or omission prevents or delays the transmission or delivery of any message, or improperly divulges to any person the purport of any message, he may for every such offence be liable to a penalty not exceeding 20*l*. All messages on Her Majesty's service are to have priority, and on the request of the Board of Trade a telegraph is by a company to be placed for the exclusive use of Her Majesty. The Act further provides that in case of an emergency telegraphs may be taken possession of for Her Majesty's service by a warrant from the Secretary of State. The warrant is only to be in force one week ; but successive warrants may be issued. The Treasury in such case is to pay the company for the loss sustained. A company may be proceeded against by the law officers of the Crown on a certificate from the Board of Trade that any provision of the Act has not been complied with, or that compliance would be for the public advantage.

Chemical Science.

CORRELATION OF MECHANICAL AND CHEMICAL FORCES.

MR. SORBY has read to the Royal Institution a paper "On the Direct Correlation of Mechanical and Chemical Forces," which, says the *Athenæum*, is a pregnant indication of the theory therein developed. It clears away difficulties, and throws light on phenomena hitherto inexplicable; those, for instance, in which mechanics and chemistry appear to have an equal share. It has long been known that pressure has an important effect on the solubility of salts. Mr. Sorby, by filling the tubes with which he experiments at a very low temperature, and placing them afterwards in proper situations, is enabled to keep the solutions which they contain, under a pressure of from 2000 to 3000 lb. to the square inch, for weeks or months continuously, and to watch the results. The pressure is measured and indicated by a capillary tube enclosed within the principal one. The researches of Mr. Hopkins and Prof. W. Thomson have made us acquainted with the effects of pressure on fusion and freezing, and there appears to be an intimate connexion between them and the experiments here under notice. Mr. Sorby has proved that if a salt *contract* in dissolving it is *more* soluble under pressure, and that if it *expand* it is *less* soluble. The law, as might be anticipated, varies with the nature of the salt. For common salt it may be stated thus: the extra quantity dissolved varies directly and simply as the pressure. On comparing sulphate of copper with ferridcyanide of potassium under the same pressure, it is found that one quantity dissolved of the former is ten times that of the latter; and there is a still greater variation of the mechanical equivalents. Reasoning upon the interesting facts brought out by this investigation, Mr. Sorby concludes that the experiments "indicate that in some cases pressure causes a slower and in others a quicker chemical action. And I think it probable," he continues, "that further research will show that pressure weakens or strengthens chemical affinity according as it acts in opposition to or in favour of the change in volume, as though chemical action were directly convertible into mechanical force, or mechanical force into chemical action, in definite equivalents, according to well-defined general laws, without its being necessary that they should be connected by means of heat or electricity." Apply these principles, and it seems easy to explain peculiarities in the structure of metamorphic rocks—to account for slaty cleavage—for some of the phenomena of crystallization, that is, the direction in which the crystals are formed, and for the impressions made by one limestone-pebble in another, as seen in the "Nagelflue"—the latter a much-debated question amongst the geologists of Switzerland, Germany, and France. In due time we shall have to record a further development of the theory, of which, as Mr. Sorby remarks, his present paper is to be regarded as a preliminary notice only.

CHEMICAL CATALYSIS.

WITH regard to the power possessed by certain substances of developing catalytic phenomena (said to occur through the mere presence of a substance such as the combination of oxygen and hydrogen when a piece of spongy platinum is introduced), M. Schonbein says that this power is almost universal, both in the vegetable and animal kingdoms. He asserts that the seeds and roots of all plants contain catalyzing substances; and he thinks that germination is intimately connected with the presence of a substance of this nature, and that everything which annuls the catalytic activity of a substance at the same time destroys its germinating power.

ELECTRO-CHEMICAL DECOMPOSITION OF INSOLUBLE SUBSTANCES.

SINCE the decomposition of water by the galvanic pile or battery, about 1800, philosophers have not ceased to employ the chemical action of electricity, which in the hands of Davy became the point of departure of so many brilliant discoveries. In his remarkable memoir of 1806 he demonstrated that, with a pile of 150 elements, we can obtain from insoluble substances, by the intermediation of distilled water and two plates of platinum or gold as electrodes, the acid, alkaline, or earthy elements, which enter into their composition, or which are found there in a state of mixture. Thus he succeeded in obtaining from glass and a number of other bodies the chloride of sodium they contained; and thereby he concluded that the most part of the minerals have been emerged in sea water. In M. Becquerel's recent researches on this subject his method has been to plunge into water the insoluble body to be decomposed by means of the voltaic battery, and observe the evolution of oxygen and hydrogen. The insoluble body is then brought into contact with the electric current, and dissolved. He has also occupied himself with silica, alumina, and the sesquioxide of iron, soluble in water, which Mr. Graham obtained by his beautiful experiments on dialysis. With the view of ascertaining the condition of these bases, he submitted these solutions to the action of ten elements. He observed on the negative wire silex, alumina, and sesquioxide of iron as a jelly, which could not occur if these bases form soluble hydrates. In electrolyzation the water which plays the part of the acid went to the positive pole, where it was decomposed, and the base went to the negative pole. During the experiment a quantity of hydrochloric acid was disengaged abundantly, which proved that the solutions, though neutral, still contained chlorine. In seeking to oxidize silicium at the positive pole in distilled water with a pile of eighty elements containing sulphate of copper, M. Becquerel recognised that this metalloid is not a non-conducting body, as generally believed, but possesses a sufficient amount of conductibility to produce remarkable effects of heat when it is traversed by an electric current, by reason of the great resistance which it undergoes. For further details we must refer to the memoir in the *Comptes Rendus* of the Academy of Sciences, and give only the conclusion :—The facts stated in evidence show the influence of the contact of the electrodes with insoluble matters in producing decomposition (employing for the purpose a battery of medium intensity), not by the direct action of electricity, but by the effect of secondary actions which nature so frequently employs.—*Illustrated London News.*

SULPHUR.

A NEW form of Sulphur has been shown at the French Academy of Sciences by M. H. St. Claire Deville, who had received it from a young German chemist, M. Dissenbacher. By adding to pure sulphur a four-hundredth or even a few thousand parts of chlorine or iodine, the sulphur was made perfectly soft, so that it might be spread in thin leaves, as flexible as leaves of wax. This fact may, perhaps, tend to explain the sulphurization of india-rubber. When pressed in the hand, the modified sulphur acquired a certain degree of hardness.

SPECIFIC WEIGHT.

A NEW apparatus for determining Specific Weights, made by M. Lenoir, after the idea of M. Tschermak, has been described by the latter in a note read at a meeting of the Academy of Sciences at Vienna. It consists of the beam of a balance, made of yellow copper, suspended by the centre, and divided in the direction of its length into two equal parts of some absolute value. At one side is placed at the point of suspension a current weight, at the other a small basket of metallic wire, both ends being provided with steel hooks which may be attached to the beam, and easily moved in the direction of its length. The object, the relative density of which is required, is placed in the basket. It is weighed first in air and then in water, displacing, in the last case, the current weight, till the equilibrium be re-established. The two distances of the current weight at the point of suspension of the beam furnish the results for the calculation of the specific density. M. Tschermak states that this simple apparatus, placed in a flat box 13 centimetres long, will give results differing only 0·05 from those obtained by a sensitive hydrostatic balance.

MUCEDINES.

THE development of the Mucedines, especially of the Ascophora nigrans, in artificial media, has been made the subject of rigid experiment by M. Raulin, a pupil of M. Pasteur, who has laid the results before the French Academy of Sciences. M. Raulin has shown that, by a suitable choice of minerals, the development of this plant may be rendered as rapid in an artificial medium as in its most appropriate liquids; the most useful substances being phosphorus, potassium, magnesium, sulphur, and manganese, in the forms of sulphate and phosphate of ammonia and carbonates of potash; magnesia and manganese and other elements intervene, but in small proportions. The respective weights of the elements which suffice for the development of the Ascophora nigrans, are of different degrees; considerable for some, such as carbon, hydrogen, and oxygen; hardly appreciable for others, which are, no doubt, equally necessary. After very careful experiment, M. Raulin was led to conclude that free nitrogen was not absorbed by the plant in any case.

FULMINOSE AND FULMINAM.

In a memoir on the formation of humus vegetable soil and nitre, read at a meeting of the French Academy of Sciences, the author, M. Blondeau, states that twenty years ago, when studying the action of acids on cellulose, he observed the remarkable fact that, before combining with cellulose, sulphuric acid transformed it into an isomeric substance having remarkable properties, which he designated "Fulminose," because, when raised to the temperature of 140 deg cent, it spontaneously decomposed into carbon and aqueous vapour. Fulminose possesses not only the property of combining with nitric acid, and forming gun-cotton, but is also capable of actively absorbing certain gases, especially ammonia, hydrochloric acid, and sulphuretted hydrogen; this absorption being accompanied with the evolution of heat, and the combination of the gas or its elements with the fulminose. After noticing other properties of fulminose, M. Blondeau states that, when dead wood is placed in suitable conditions of temperature and moisture, it is soon attacked by one or two specimens of Mycoderms; and that, after they have drawn from the wood the nitrogenous matters necessary for their development, they leave behind a substance closely resembling fulminose. When a fragment of dead wood of a linden-tree was treated with an alkaline solution of potash, by dilute hydrochloric acid, and finally by boiling water, M. Blondeau obtained as residue a friable white substance, which when analysed, presented the composition of cellulose, and possessed all the properties of fulminose. These facts, he believes, throw light on the formation of humus, and the part which it plays in nitrification. Fulminose possesses the property of absorbing gases, especially ammonia, which, reacting on the remains of sclerogen, colours them black, and forms a species of combination which, being soluble, penetrates into the pores of the substance, giving it the black tint characteristic of humus. Ammonia and oxygen are condensed by the humus, whereby a quantity of heat is generated, sufficient to determine the combustion of the ammonia, and its transformation into water and nitric acid; hence arises the production of nitrate of ammonia, which may change its base with potash, soda and lime, and thus form the different nitrates which so powerfully aid vegetation. M. Blondeau thus sums up the facts contained in his memoir:—"1, The transformation of wood into fulminose under the influence of mycodermic vegetation; 2, The absorbing power of fulminose in regard to gases, especially ammonia; 3, The combustion of ammonia in the pores of the fulminose, and the transformation of the elements into water and nitric acid—a combustion rendered manifest by the light which dead wood affords in darkness; 4, The identity of humus and fulminose." M. Blondeau states that, although all the foregoing facts are not entirely new, the most part having been previously observed, yet that no one has hitherto precisely determined the nature of the substance which enjoys these curious properties, which he thinks constitute the simplest interpretation of nitrification hitherto obtained.

In relation to the foregoing observations on the remarkable compound termed Fulminose, we give some notes from a paper by M. Blondeau in the *Annales de Chimie*, on an analogous body, termed by him Fulminam. In treating starch with a mixture of sulphuric and nitric acids, and then adding water to the produce of this reaction, we obtain a white pulverulent substance similar in its constitution to the powder-cotton, named by Braconnot, "xiloidine." The analogy of composition which exists between cellulose and starch fecula having led M. Blondeau to think that starch, before combining with nitric acid, must undergo some modification similar to that which cellulose undergoes when under the influence of sulphuric acid, he was induced to ascertain whether this substance existed naturally, and whether it were possible to obtain it by means of a process similar to that by which he obtained fulminose. Accordingly, after having placed some starch in a mortar and moistened it with sulphuric acid, he made of it a firm and consistent paste, which when thrown into water was completely dissolved. When a little alcohol was added to the solution, he obtained a white amorphous precipitate, differing from starch by its appearance and its solubility in water. After several solutions of this precipitate, and successive precipitations, he found on examination not a trace of sulphuric acid in its composition. When submitted to the action of heat it began to puff up, and at about 96 deg. Fahr. it was decomposed, disengaging steam and leaving a residuum of voluminous very inflammable charcoal. The property which this soluble starch possesses of suddenly decomposing at a temperature little elevated led M. Blondeau to name it "fulminam." It is very soluble in water, but is insoluble when a small quantity of alcohol is added. When dried in vacuo it presents the appearance of a dry, brittle gum. Its solution is coloured blue by iodine; the colour disappearing when heated. Its analysis shows a composition identical with starch. Carbon, 44·20; hydrogen 6·07; oxygen, 49·73.—*From the Illustrated London News.*

ACTION OF SULPHURIC ACID ON LEAD.

AT the French Academy of Sciences, M. Frémy has read a note from Messrs. Calvert and Johnson, of London, which stated that this acid is found to attack pure lead much more actively than impure—an unexpected peculiarity. The reverse of this fact occurs with zinc and nitric acid (aqua fortis), which latter attacks impure zinc much more readily than pure. M. Frémy justly remarked on the importance of the former fact noted by the English chemists, stating that it ought to be borne in mind in the construction of leaden chambers for the manufacture of sulphuric acid.

OXALIC ACID FROM SAWDUST.

DR. MURRAY THOMSON has described to the Pharmaceutical Society Mr. Dale's new patent process for the manufacture of Oxalic Acid from Sawdust, acted upon by alkali, lime, &c. It appeared from the statement in the paper that, by proper manipulation, 2 lb. of sawdust were made to yield 1 lb. of oxalic acid, and that during one part of the process most of the alkali employed was recovered, and used again in succeeding manufactures. The produce in Mr. Dale's establishment was weekly about nine tons' weight—an amount more than half of the oxalic acid believed to be used all over the world.

NEW PYROMETER.

A COAL-OIL PYROMETER, invented by Mr G. Tagliabue, has been exhibited at the Franklin Institute, Philadelphia. The vessel containing the coal-oil, the quality of which is to be tested, is placed in a reservoir of water which is heated by a small spirit-lamp. A thermometer, the bulb of which is immersed in the oil, indicates the temperature. Openings in the lid of the vessel containing the oil are provided with lids, which are removed at a proper time to admit atmospheric air, which, combining with the gas generated with the oil, forms an explosive mixture. A taper is introduced from time to time into a tube projecting from the top of the vessel, and when the gas and air have combined in the proportion, the mixture is ignited by the taper and explodes, the height of the thermometer at the moment of the explosion indicating the quality of the oil.

ALLOTROPIC PHOSPHORUS.

THE discovery of Allotropic Phosphorus is generally attributed to M Schrotter, of Vienna, about 1845. We now learn from M. Nicklès, in the new scientific periodical *Les Mondes*, that M. Kopp stated, in 1844, in the *Comptes Rendus* of the French Academy of Sciences, "that in preparing the hydrated ether of iodine—by means of alcohol, phosphorus, and iodine—there remained an inert residuum in the form of a red powder. When well washed, this substance was insipid, inodorous, and readily acted on by the oxygen of the atmosphere. It was a red modification of phosphorus. It could be dried in the sand-bath without sensibly oxydizing, but was with difficulty freed from the last traces of humidity. When submitted to dry distillation it was transformed into ordinary phosphorus." In 1845, Berzelius confirmed M. Kopp's experiments. This was doubtless the "amorphous" phosphorus of Schrotter; but M. Kopp did not then see that this form of phosphorus could be obtained by M. Schrotter's method—viz., by submitting ordinary phosphorus to a higher determinate temperature, and that, when so obtained, it was not poisonous, and could therefore be successfully employed in the manufacture of the safe lucifer-matches.—*Illustrated London News.*

COMPOSITION OF LUCIFER-MATCHES.

In the *Répertoire de Chimie* is a memoir by M. Wiederhold, giving an account of a series of experiments on substances suitable to be employed in this important manufacture. He states, in conclusion, that the mixtures composed of chloride of potash and hyposulphite of lead give the best results; those which contain some chlorate, tersulphuret of antimony, and nitrate of lead, take fire very readily also, but are hygroscopic, and are therefore inferior to the former. The matches prepared with hyposulphite of lead present the advantages of being devoid of phosphorus and of being very economically prepared. (See p. 78 of the present volume.)

THE HYDRO-OXYGEN OR DRUMMOND LIGHT.

This was called "Drummond-light" from having been used by Captain Drummond when making the Ordnance surveys. It is produced by the ignition of the hydrogen and oxygen gases on lime, and gives so brilliant a light that Captain Drummond was enabled to take bearings of altitudes at from 60 to 90 miles distant. It was considered desirable that such a light should be brought into practical use, and particularly so for lighthouses; but the difficulties to be overcome were many, and have caused much expense and time in experimenting on them.* The insuperable desideratum was that the light should be continuous, or able to be burnt for many consecutive hours without any intermission. Then the production of pure hydrogen and oxygen gases in sufficient quantities presented difficulties, nor was the highly inflammable nature of a mixture of these gases to be overlooked. A lamp was at length produced by Mr. Prosser, with its necessary apparatus, which he asserted possessed all these requirements; but this fact was much doubted, and particularly as to the possibility of burning it for the number of hours required—viz., from

* The main difficulty, as we were informed by Captain Drummond, lay in the finding of persons of sufficient intelligence to manage the apparatus, who could bear the solitariness of lighthouse duties.

12 to 15, with equal intensity and without intermission. To test this, the Trinity Board consented that the light should be tried at the South Foreland Lighthouse, under the inspection of their officers; but of course at so important a station it was allowed only to be placed in the apparatus of the oil lamp, so that in case of failure the oil lamp might be immediately replaced, which could be done in a few minutes. The glass apparatus of the oil lamp was out of focus for the lime lamp; however, the principal point to be decided was as to the continuous light; it was therefore submitted to this ordeal; it could not be shown in any other manner. The lime lamp was burnt for 12 weeks, during September, October, and November, 1861. At the end of that time the following certificates speak as to its success. First, from the principal lightkeeper:—"I beg to state that the patent lime light lamp has been burning in this lighthouse 12 weeks, from sunset to sunrise; during this period it has been carefully noticed by me and the other lighthouse keepers, and we have found the light to be steady, continuous, and brilliant, and it has burnt without any defect or intermission." Second, from the captains of the English and French packets.—"We, the undersigned commanders of the Royal Mail Packet Service on the Ostend and Calais stations, beg to certify that we consider the lime light which has for some time past been exhibited in the South Foreland Lighthouse superior in power to the old one with oil. We have always observed the lime light at a greater distance than the other, and particularly in hazy weather, when the other could not be seen." Then comes a certificate, unasked for, in the May following, signed by master mariners, mates, the Coast Guard, and 30 Channel pilots, stating that "The light burnt steadily and continuously, and that its power very far exceeded the brilliancy of any oil lamp previously or since exhibited (a new oil lamp had been exhibited after the removal of the lime light lamp), and would doubtless be a valuable addition to the protection of life and property on this coast."—*The Times.*

STORAGE OF PETROLEUM.

One of the immediate practical results of the important experiments on petroleum made at Hamburg by the authorities of that city is the publication of a decree of the Senate considerably relaxing the stringent measures hitherto in force with regard to warehousing petroleum in private stores. The decree ordains that crude petroleum, petroleum-naphtha, and petroleum that evaporates into gas at a lower temperature than 30 deg. Réaumur (99½ deg. F.) must be, as heretofore, warehoused exclusively in the public stores on the island in the Elbe. Refined petroleum, however, from which no inflammable gases emanate at a temperature under 30 deg. Réaumur, may, as is the case with oil of turpentine, be warehoused in the private stores of retailers to the extent of 1600 lb., and may be shipped without requiring the presence of a police guard. The quantity of refined petroleum allowed to be kept in a shop or other place of sale by retail is extended to 300 lb. The private warehouses for storing refined petroleum must first be examined by the police, and found unexceptionable; they must have no vent towards the canals, streets, or courts, by which the liquid can escape, and the doors must be furnished with a sill at least six inches high. Importers and owners of refined petroleum are bound to submit samples of their goods to one of the local sworn chymists, who will analyse them, and furnish a certificate of the examination. All petroleum not accompanied by such a certificate will be considered inflammable and dangerous, and cannot be admitted into private warehouses, but must be sent to the public stores.—*The Grocer and Oil Trade Review.*

LATEST USE FOR PETROLEUM.

AN assistant-surgeon, writing from Gettysburg, attests the use of coal oil in suppurating wounds. As volunteer assistant he received permission from the surgeons to use it in the most offensive cases. By its manifest utility and the solicitations of the wounded, he was induced to enlarge its use, until he became satisfied that what cold water is to a wound in its inflamed state, coal oil is to it in its suppurating state,—dispelling flies, expelling vermin, sweetening the wound, and promoting healthy granulations. It can be used by an assistant of ordinary judgment with perfect safety, and to the great comfort of the patient.—*Missouri Democrat.*

SOLAR RAYS.

THE chemical action of the Solar Rays has been measured by a new method, invented by Dr. T. L. Phipson. Having observed that a solution of the sulphate of molybdic acid, placed on one of the shelves of his laboratory, where it received the direct rays of the sun for three hours a day, became bluish-green in the daytime and colourless at night, he made several experiments, and always found that the saline solution was reduced when exposed to the sun, but lost the colour by oxydation when placed in the shade. He believes that during insolation a certain quantity of molybdic acid loses one atom of oxygen, which combines with the water, forming binoxide of hydrogen, and that, during the night, the latter gives up the equivalent of oxygen to the oxide of molybdenum produced; consequently no disengagement of gas takes place. Dr. Phipson has constructed an apparatus for measuring this action, which is not due to heat, as he has boiled the solution without observing any coloration. A weak solution of permanganate of potash destroys the bluish-green colour, and the quantity (volume) of this solution employed indicates the relative daily amount of actinism.

ACTION OF HEAT ON LIQUIDS.

SOME researches of Professor Donny, of Ghent, on this subject induced Mr. W. R. Grove, F.R.S., to investigate the question; and, in consequence, give a lecture to the Chemical Society, describing his experiments, of which we give a few notes. Water, it is well known, boils quietly in an open saucepan; but it was found to behave very differently when heated in a long glass tube drawn out to a fine point, which, permitting the escape of steam, did not allow the water again to absorb the gases of the atmosphere; under these circumstances the "bumping" or concussions, which are also to be noticed in the distillation of sulphuric acid, were observed. When, further, the air-pump is employed to facilitate the extraction of the air from the water, and the upper portion of the glass tube cut off with a file, it may happen that the renewed application of heat will induce a sudden and violent escape of vapour, amounting almost to explosion. Again, a flask containing a little hot water was placed under the receiver of an air-pump in connexion with a platinum wire, which could be heated to a tolerably constant temperature beneath the surface of the water, by means of an external galvanic battery. On exhausting the air, it was found that the ebullition occurred only at intervals; often a minute would elapse, and then a burst of vapour would almost eject the contents of the flask; but, this over, the water again became perfectly tranquil, and remained so for another minute, when another tumultuous ebullition occurred, to be succeeded by a period of rest. The same phenomenon was repeated at such regular intervals that the apparatus might almost have served as an indicator of time.

In Mr. Grove's opinion, there was a parallel between the ebullition here noticed and that observed in the boiling springs of Iceland. In both cases, a column of water, partially deprived of air, was exposed to an external source of heat, and an uninterrupted kind of ebullition induced in consequence. In proof of the extreme difficulty of expelling air or dissolved gas from water, Mr. Grove described the following experiment:—A long glass tube, closed at one extremity, was bent in the middle nearly to a right angle; the closed limb was then half filled with water, from which by long boiling, the air was supposed to have been expelled; the remaining space in the tube was then completely filled with olive oil, and the opened extremity dipped into a basin of the same. Heat was then applied to the tube until the water boiled, and this temperature maintained for a considerable time. Each bubble of steam which left the surface of the water, passed through the column of oil, becoming smaller and smaller during its ascent; but never did it condense without leaving a microscopic bubble of gas, which at length accumulated so that it could be examined. This bubble was found to be pure nitrogen. Similar experiments were made with bromine, chloride of iodine, &c. The general conclusion Mr. Grove derived from his experiments was to the effect, that water had a very powerful affinity for the gases of the atmosphere; that by several processes, the oxygen could be eliminated, but that the nitrogen resisted all attempts to expel it from solution—so much so, that it might be doubted whether chemically pure water (a compound of two elements only) had ever been prepared; and further, that ebullition (as applied to water) under all circumstances, consisted merely in the production and disengagement of bubbles of aqueous vapour formed upon a nucleus of permanent gas.—*Illustrated London News.*

WOOD CHARRED BY STEAM HEAT.

MR. T. HYDE HILLS has presented to the Royal Institution some charred wood which he stated was found in repairing the case of a tin pan used for pharmaceutical purposes, and heated by steam at a temperature not exceeding 250 deg. Fahr., generally working from 5 lb. to 15 lb. to the square inch. This fact may probably throw a light on some of the fires not yet accounted for. The charred wood was exhibited at a recent evening meeting of the members of the Royal Institution.

BEEKITES.

BEEKITES are remarkable siliceous substances, interesting alike to the geologist, palæontologist, and chemist. They derive their name from the Rev. Dr. Beeke, Dean of Bristol, by whom they were first publicly noticed. They are abundantly found in the conglomerates of the neighbourhood of Torbay, and in various other formations in this country, Spain, India, and Australia, and form the homologues of the flints and potstones of the chalk. They are, in fact, not merely minerals, but fossils which have been more or less mineralized in a way not very easy to comprehend. This has given rise to much investigation, especially by Mr A. H. Church, the chemist, who recently exhibited some interesting specimens of beekite in the library of the Royal Institution. Beekites vary in diameter, from half an inch to a foot. Their surfaces are composed of chalcedony, generally arranged in tubercles, varying in size from a pin's head to a pea, each of which is not unfrequently surrounded by one or more rings. When broken, the interior is mostly found to be calcareous, and in a decomposing state, apparently caused by the infiltration of water holding carbonic acid and silica together in solution, as Mr. Church thinks. Sometimes the nucleus has entirely decomposed, in which case only a few grains of matter remain within the crust, and the beekite will float in water. The specimens exhibited showed beekite in various stages of formation — coral in the interior, mammillations, the gradual silicification, &c.—*Illustrated London News.*

INFLUENCE OF PRESSURE ON THE SOLUBILITY OF SALTS.

THIS result is full of interest, not only in respect to physics and chemistry, but also in regard to geology and mineralogy. In fact rocks and minerals must, in many cases, have been formed under high pressure, and it is important to know how much this has modified the phenomena which presided in the formation of the crust of the earth. To add to our information on this point has been the object of the researches of M. K. Mœller, a short account of which appears in the *Bibliotheque Universelle de Genève*. He finds that the solubility of chloride of sodium (common salt) and sulphate of potash is considerably increased under pressure; but that the solubility of the hydrated sulphate of soda increases with pressure at the temperature of 0 deg. cent., and diminishes considerably at 15 deg. cent. when the pressure is increased. The sulphate of lime (gypsum), very interesting in a geological point of view, undergoes a considerable influence in its solubility by pressure. At 15 deg. 100 parts of water dissolve 0·207 of gypsum under a pressure of one atmosphere, and 0·230 under twenty atmospheres. If we place a solution of sulphate of soda in a receiver, one part of which is heated while the other remains cold, the proportion of the salt increases in the heated part at the expense of the cold part. This fact is explained by the greater affinity of the water for this substance, at a higher than at a lower temperature. M. Mœller on this remarks that, since pressure, like heat, exalts the affinity of water for salts, we may thus explain the fact that the deeper water of the sea contains a larger quantity of salts than the water at the surface does.—*Illustrated London News.*

CHEMICAL REPORT UPON GUN-COTTON.

DR. GLADSTONE has read to the Chemical Section of the British Association the chemical portion of the Report upon gun-cotton. Of the more important points the following is a summary:—As to the chemical nature of the material, Von Lenk's gun-cotton differs from the gun-cotton generally made, in its complete conversion into a uniform chemical compound. It is well known to chemists that, when cotton is treated with mixtures of strong nitric and sulphuric acids, compounds may be obtained varying considerably in composition, though they all contain elements of the nitric acid and are all explosive. The most complete combination (or product of substitution) is that described by M. Hadon as $C_{36}\ H_{21}\ (9\ NO_4)\ O_{30}$, which is identical with that termed by the Austrian chemists Trinitrocellulose, $C_{12}\ H_7\ (3\ NO_4)\ O_{10}$. This is of no use whatever for the making of collodion; but it is Von Lenk's gun-cotton, and he secures its production by several precautions, of which the most important are the cleansing and perfect desiccation of the cotton as a preliminary to its immersion in the acids—the employment of the strongest acids attainable in commerce—the steeping of the cotton in a fresh strong mixture of the acids after its first immersion and consequent imperfect conversion into gun-cotton—the continuance of this steeping for forty-eight hours. Equally necessry is the thorough purification of the gun-cotton so produced frm every trace of free acid. This is secured exclusively by its being washed in a stream of water for several weeks. These prolonged processes are absolutely necessary. It seems mainly from the want of these precautions that the French were not successful. From the evidence before the committee it appears that this nitro compound, when thoroughly free from acid, is not liable to some of the objections which have been urged against that compound usually experimented upon as gun-cotton. It seems to have a marked advantage in stability over all other forms of gun-cotton that have been proposed. It has been kept unaltered for fifteen years; it does not become ignited till raised to a temperature of 136° C. (277° Fahr.); it is but slightly hygroscopic, and when exploded in a confined space, is almost entirely free from ash.

There is one part of the process not yet alluded to, and the value of which is more open to doubt—the treatment of the gun-cotton with a solution of silicate of potash commonly called water-glass. Prof. Abel and the Austrian chemists think lightly of it; but Von Lenk considers that the amount of silica set free on the cotton by the carbonic acid of the atmosphere is really of service in retarding the combustion. He adds, that some of the gun-cotton made at the Imperial factory has not been silicated at all, and some imperfectly; but when the process has been thoroughly performed, he finds that the gun-cotton has increased permanently about 3 per cent. in weight. Much apprehension has been felt about the effect of the gases produced by the explosion of gun-cotton upon those exposed to its action. It has been stated that both nitrous fumes and prussic acid are among these gases, and that the one would corrode the gun and the other poison the artilleryman. Now, though it is true that from some kinds of gun-cotton, or by some methods of decomposition, one or both of these gases may be produced, the results of the explosion of the Austrian gun-cotton without access of air, are found by Karolys to contain neither of them, but to consist of nitrogen, carbonic acid, carbonic oxide, water, and a little hydrogen and light carburetted hydrogen. These are comparatively innocuous: and it is distinctly in evidence that, practically, the gun is less injured by repeated charges of gun-cotton than of gunpowder, and that the men in casemates suffer less from its fumes. It seems a disadvantage of this material as compared with gunpowder, that it explodes at a temperature of 277° Fahr.; but against the greater liability to accidents from this cause may be set the almost impossibility of explosion during the process of manufacture, since the gun-cotton is always immersed in liquid, except in the final drying. Again, if it should be considered advisable at any time, it may be stored in water, and only dried in small quantities as required for use. The fact that gun-cotton is not injured by damp, like gunpowder, is, indeed, one of its recommendations, while a still more important chemical advantage which it possesses arises from its being perfectly resolved into gases on explosion; so that there is no smoke to obscure the sight of the soldier who is firing, or to point out his position to the enemy, and no residuum left in the gun to be got rid of before another charge can be introduced.

The Mechanical Report on Gun-cotton will be found at pp. 22—26 of the present volume.

HEATING AND COOLING OF METALS.

A REMARKABLE change of form in metals, caused by excessive heating and cooling, is the subject of a paper in the new number of the *Proceedings of the Royal Society* by Lieutenant-Colonel H. Clerk, who was led to experiment on the subject in consequence of the following circumstance:—When, a short time ago, the workmen at the Royal Arsenal, Woolwich, were about to shoe a wheel with a hooptire, to which it was necessary to give a bevel of about three-eighths of an inch, one of the men suggested that the bevel could be given by heating the tire red hot and then immersing it one half its depth in cold water. This was tried and found to answer perfectly; that portion of the tire which was out of the water being reduced in diameter. The tire was 3 in. wide, ½ in. thick, and 1 ft. 2 in. in diameter. As this result was curious and not generally known, Colonel Clerk considered it desirable to institute some further experiments, in order to try how far, by successive heatings and coolings, this change of form could be augmented, and also whether the same effect could be produced on other metals than wrought-iron. The experiments were made on cylinders of wrought-iron of different dimensions, both hollow and solid—immersed, some to one half of their depth, others to two-thirds; also on similar cylinders of cast-iron, steel, tin, zinc, and gun metal. With wrought-iron the heatings and castings could be repeated from fifteen to twenty times before the metal showed any signs of separation; but with cast-iron, after the fifth heating the metal was cracked; and the hollow cylinder separated all round just below the water-line after the second heating. Cast steel stood twenty heatings, but was very much cracked all over its surface. As respects the change of form of cast-iron and steel, the result was similar to that in wrought-iron, but not nearly so large in amount. The cast-iron did not return to its original dimensions; but the smallest diameter was about 1 in. above the water-line. Tin showed no change of form. there being apparently no intermediate state between the melting point and absolute solidity. Brass, gun metal and zinc showed the effect slightly; but, instead of a contraction just above the water-line, there was an expansion or bulging. The remarkable forms assumed by the metals are shown in wood engravings.

THE AFFINITY OF NITROGEN FOR METALS

Has been shown by some researches of MM Briegleb and Geuther, which show that nitrogen combines with magnesium, forming a stable compound containing 28 per cent. of nitrogen. They obtained it by heating magnesium to redness in a current of ammoniacal gas. Zinc heated to a dull red in a current of nitrogen is covered with a grey coating which shows traces of ammonia when heated with caustic potash ; iron powder, reduced by hydrogen, takes up a little nitrogen when heated in a current of that gas ; aluminium, in a similar position, takes up about 2·16 per cent., and chromium absorbs 18 7 per cent of nitrogen. The above-mentioned chemists have experimented with tungsten and molybdenum, and found that these bodies did not combine directly with nitrogen at a red heat.

THE COMPOSITION OF ANCIENT ROMAN COINS AND MEDALS

Has been examined by M. A. Commaille, who has published a memoir on the subject, giving the composition of thirty-seven different medals, in the *Journal de Pharmacie*. The basis of the metal employed by the Romans was pure copper, alloyed with different proportions of tin, lead, zinc, silver, &c. Formerly numismatists were agreed in believing that the ancients never employed pure copper in the manufacture of their coins, and Mongez asserts that no antique coin of pure copper has ever been found ; but Pelouze now states that he has not only met with Roman medals with very small quantities of a foreign metal combined with copper, but that he has analysed several coins of copper so pure that the reagents could not reveal the smallest trace of another metal. M. Commaille gives the description and analysis of the following among other Roman coins found in Algeria :— Augustus—copper, with traces of tin and lead ; another—pure copper ; Caludius I.—pure copper : Vespasian and Marcus Aurelius—copper, with traces of tin, Titus—copper 96·6 zinc 2 71, iron 0·85, traces of antimony ; the Roman *as*,—copper 69·65, lead 24·37, tin 5·98 ; a coin of Constantine—copper 83·55, lead 14·76, tin 1·42, iron 0·27, traces of cobalt. The comparison of the analyses of M. Commaille shows that the metal employed varied from pure copper to ten per cent. of tin, and nearly twenty-eight per cent. of lead. In twenty-eight coins the three metals were found combined. In some the lead and tin were certainly present by accident. M. Pelouze found cadmium in some medals, and M. Commaille found gold in the medals of two Princes, who occupied the Imperial throne nearly about the same time. In one coin he found traces of cobalt, in another of antimony, and in a third of a metal which he believed to be bismuth.—*Illustrated London News*.

NEW METALS.

INDIUM and Wasium are the names of two new chemical elementary bodies. The former metal, discovered by MM. Reich and Richter in the arsenical pyrites of Freyberg, received its name because its spectrum does not present any green ray, but gives an indigo-blue ray not hitherto remarked, which is very brilliant, clearly defined, persistent, and with a refrangibility sensibly greater than the blue ray of strontium. They have succeeded in isolating the new body in very small quantity, in the forms of chloride and hydrate-oxide, and even in the metallic state. The latter metal, Wasium, was discovered by M. Bahr, a Swedish chemist, who has named it after the illustrious house of Wasa or Vasa. It was found in wasite, a mineral resembling orthite, found in the isle of Roensholm. The oxide of wasium has a rosy white colour. When converted into a nitrate, precipitated, and re-washed, it assumes the form of a yellowish-brown gummy powder, which disengages reddish vapours when exposed to a high temperature. The density of the oxide is 3·726. It does not appear to give rise to any characteristic spectral rays.

Wasium is stated by M. Nicklès to be a compound body; his analyses proved it to be yttrium combined with didymium and terbium. The question will have to be determined by the chemical world.

RUBIDIUM.

M. DUMAS has communicated to the French Academy of Sciences a note on the preparation and properties of this new alkaline metal; and showed a specimen sent by the discoverer, M. R. Bunsen, who detected its presence by means of the spectrum analysis The first matter which led to these researches was extracted from the residue of lepidolithe from the manufacture of lithine, by Dr. Struve, of Leipsic. In order to separate the carbonate of cæsium from the corresponding salt of rubidium, use was made of the great difference of solubility which exists between the neutral tartrate (deliquescent) of cæsium and the bitartrate of rubidium (very slightly soluble). The reduction of the carbonate of rubidium by charcoal is more difficult than that of sodium, and more easy than that of potassium. The mixture treated by heat in a potassium furnace was as follows:—Bitartrate of rubidium, 89·55; neutral tartrate of lime, 8·46; soot of the essence of turpentine, 1·99—total, 100 10. The metal was collected in a receiver containing oil of naphtha; 75 grammes of the bitartrate gave 5 grammes of metal. The metal melts at 38·5 cent.; its density is equal at 1·516. Sodium melts at 95·6; potassium at 62·5; and lithium at 180 cent., according to the new determinations made at the laboratory of Heidelberg. Rubidium burns in water like potassium, and presents, by its other properties, great analogies with that metal. M. Bunsen has not yet reduced cæsium, having been able to acquire only a few grammes of the salts of that metal from 15,000 litres of the water of Murquelle, at Baden.

THE NEW METAL THALLIUM.

IT may be truly affirmed that we live in a world pre-eminently metallic. The ground on which we tread is, to a large extent, compounded of metals; and the water which covers three-fourths of the earth's surface contains an element, hydrogen, which has all chymical relations of a metal. The number of elementary bodies with which we are now acquainted exceeds 60, and these, for the most part, are metals. In the present century 27 additional metals have been discovered, and a few others have been announced on evidence which is still regarded as inconclusive. In this branch of research our own countrymen have laboured successfully. Thus, palladium and rhodium were discovered by Wollaston in 1803; iridium and osmium by Tennant, also in 1803; potassium, sodium, barium, strontium, and calcium by Davy in 1807; and, lastly, thallium, the subject of this article, by Crookes in 1861.

There are few educated persons who have not heard of the remarkable application of optical science to chymistry, for which the world is indebted to the joint labours of a chymist and a physicist, each of the highest eminence—namely, Bunsen and Kirchhoff. Every one knows that when a ray of solar light falls upon a prism of transparent glass a spectrum is produced, which consists of a series of colours, termed prismatic, arranged in the following order of irrefrangibility—red, orange, yellow, green, blue, indigo, violet. Now, if the light evolved by the combustion of certain metals, instead of solar light, be allowed to fall upon a similar prism, strikingly different spectra will be formed, each metal yielding one peculiar to itself. The peculiarity consists in the suppression of certain parts of the ordinary spectrum in a greater or less degree, and the consequent development of luminous bands of different colours. Only an infinitesimal amount of a metal suffices to give a characteristic spectrum. Indeed, this means of detection by what is now termed spectrum analysis very far exceeds in refinement the most delicate chymical tests. By applying it to the light of the sun, it has been demonstrated that the solar atmosphere contains metals in the state of vapour, such as iron, nickel, chromium, potassium, sodium, calcium, magnesium, &c. The spectra of the stars have been found to differ greatly from that of the sun; but this line of inquiry is as yet very imperfectly explored.

In 1861 Mr. Crookes, of London, was occupied in examining a seleniferous deposit from a sulphuric acid chamber at Tilkerode, in the Harz mountains; and, availing himself of the new method of spectrum analysis, he found that this matter contained something which gave a totally distinct spectrum from any then known, and he consequently inferred the presence of a new element. He had only a very small quantity of material to operate on, and yet, by the exercise of skill and perseverance, he succeeded in extracting from it a metal hitherto unknown, which he exhibited at the International Exhibition last year, labelled as follows:—"Thallium, a new metallic element, discovered by means of spectrum analysis." Of the metal itself there was about five or six grains in the state of powder; but various compounds of it were also exhibited. At first Mr. Crookes was doubtful whether it belonged to the metals proper; but in September, 1861, he had become convinced of its metallic nature, and showed it to several persons as a new metal. The first publication of this fact was at the opening of the Exhibition, May 1. Of that there is no doubt. It is proper to state that two other new metals, rubidium and cæsium, had been previously detected by Bunsen and Kirchhoff by the same method of examination.

On the 16th of May, 1862, M. Lamy exhibited to a society at Lisle, in Belgium, a specimen of thallium in the form of a small fused ingot, weighing about 70 or 80 grains. M. Lamy, who is son-in-law of the well-known chymist and chymical manufacturer Kuhlmann, had at his disposal ample means of investigation and a copious supply of raw material from the sulphuric acid chambers of his father-in-law, and he availed himself of these opportunities in a manner very creditable to himself. He adopted Mr. Crookes's original name of thallium, and thus acknowledged the claim of that gentleman as the discoverer.

Thallium receives its name from the Greek word θαλλὸς, (a green leaf), as it produces a remarkable green band on the spectrum, suggestive of the colour of young vegetation. It has a bright metallic lustre, which it speedily loses in the atmosphere from oxidation. In colour it closely resembles cadmium, and it produces a fleeting mark on paper similar in appearance to that of black lead. It is much softer than lead, and is, indeed, the softest heavy metallic body yet discovered. It may be easily cut with a knife, and even indented with the finger-nail It melts at a somewhat lower temperature than lead. It is volatile at a bright red heat, and burns with an intensely brilliant green light. Its specific gravity is 11·9, or a little higher than that of lead. Its atomic weight is about 203, or nearly double that of lead It is one of the most diamagnetic bodies known. In electric conductivity it is a little inferior to lead. It readily oxidizes by exposure to the air, but not in water deprived of air. It forms two, and perhaps three, basic oxides and an acid oxide. The protoxide is yellowish, easily fusible, volatile, soluble in water, and strongly alkaline to test paper. Many of its salts are beautifully crystallized, especially sesquichloride, sulphate, nitrate, and chlorate. Mr. Crookes maintains that thallium belongs to the lead and silver group of metals, whereas Lamy regards it as one of the alkaline metals. This metal appears to be very widely distributed over the world, though in relatively small proportion. It chiefly occurs in the common mineral, iron-pyrites, and in no ore has Mr. Crookes succeeded in finding more than ten ounces to the ton. It has been also met with in native sulphur, and in certain sulphuretted ores of mercury, zinc, cadmium, and bismuth. Many specimens of commercial copper contain it in very sensible quantity; and this is a point well deserving the attention of our great copper smelters, as thallium renders the copper brittle and otherwise deteriorates its quality.—*From the Times.*

An ingot of this new metal, weighing 5963 grains, has been exhibited at the Royal Institution, by Mr I. Lowthian Bell, of Newcastle. It was produced at his chemical works at Washington, near Durham, and is the largest piece yet shown of this metal.

THALLIUM KNOWN TO THE ANCIENT MEXICANS.

IT is reported upon good authority, that a distinguished German chemist has just made an important discovery in connexion with the alloy now generally designated thallium. It appears that among the most ancient records of the ancient Mexicans an account is given of the mode of preparing the alloy used for producing the brilliant green fire which was freely burnt during the sacrificial ceremonies in honour of Vitzliputzli, one of their principal deities, and that in the attempt to prepare a similar alloy, from the details given, a discovery opening up an entirely new field of chemical science has been made. By the peculiar treatment of certain proportions of silver, lead, and selenium a black powder was produced, so much resembling that designated thallium by Mr. Crookes that the experimenter was induced to test it. The weight of alloy was precisely equal to that of the metals used; yet the whole of the reactions of thallium were obtained, and salts, bases, and acids of the alloy were produced, precisely as if the alloy had been a perfect metal. Even in the spectroscope the well-known green line was produced. The fact of selenium entering so largely into the alloy is considered to account for Mr. Crookes supposing the so-called thallium to belong to the sulphur group, until M. Lamy showed him the alloy in its metallic state, and proved it to be nearer to silver and lead. Whether the whole of the powders hitherto considered to be pure metals in the pulverulent state are simply alloys has yet to be ascertained. It will be an interesting subject for research whether chemistry or electricity gives an alloy these peculiar qualities.—*Mining Journal.*

COMPOUNDS OF THALLIUM POISONOUS.

M. LAMY has informed the French Academy of Sciences of certain injurious consequences which he experienced after working on compounds of the new metal — extreme lassitude and pains in the lower extremities. Since then he has administered a compound of the metal to eleven animals—two fowls, six ducks, two young dogs, and a bitch of middling size succumbed to the action of five grammes of sulphate of thallium. A fowl languished three days under the effect of the poison. When then killed, M. Lamy was able to affirm the presence of thallium in the intestines in very small quantity; but no traces were found in the other organs. In order to be still further convinced of the energy of the poison he gave one decigramme only of the sulphate to a young dog, which died forty hours after taking the poison. Bearing in mind

* At the late Meeting of the British Association at Newcastle-upon-Tyne, Mr. Bell read a paper upon Thallium; where also Mr. Crookes detailed "The Extraction of Thallium on a large scale from the Fine Dust of Pyrite Burners."

that thallium itself was discovered by means of the spectrum analysis, it becomes sufficiently obvious that this method may eventually become extremely valuable, both in physiology and in medical jurisprudence.

ALUMINIUM BRONZE.

ALUMINIUM BRONZE, as many of our readers know, is an alloy of aluminium and copper, now manufactured by Messrs. Bell Brothers, of Newcastle, under a licence from M. Deville, of Paris, the inventor of the process These gentlemen sent to the International Exhibition of 1862 various articles made of it, which attracted much attention, especially some watchcases made by Messrs. Reid, of Newcastle, which so closely resemble gold as not to be distinguished from it by experienced persons. In the *Proceedings of the Royal Astronomical Society* is a paper by Lieutenant-Colonel Strange, recommending the use of aluminium bronze as a material for the construction of astronomical and other philosophical instruments. He gives an account of a series of test-experiments on this alloy made at his request by Mr. Anderson, at the Royal Gun Factory, Woolwich, and by Messrs. Simms, mathematical instrument-makers. The results with regard to its tensile strength compared with gun-metal, gave a ratio of rather more than two to one in favour of aluminium bronze; and in respect to transverse strength, it appeared to be three times more rigid than gun-metal, and 44 times more rigid than brass. It shows excellent casting qualities, behaves well under files and cutting-tools, has much less inclination to oxidize than the metals usually employed for philosophical apparatus, and receives the marks for graduation well, bearing extremely fine divisions It is easily made into tubes, admitting every process necessary for this purpose. It can be soldered with either brass or silver solder; can be rolled into sheet metal, and can be hammered and drawn. Hitherto telescope-tubes, cones of transit axes, &c., have been made almost exclusively of yellow brass, a metal very deficient in rigidity. Gun-metal does not admit of being rolled, and has therefore never been used for the tubular parts of instruments, for which the new alloy seems pre-eminently suitable. The specific gravity of the alloys of aluminium and copper made by Messrs. Bell varies from 8·691 to 7·689, as from 3 to 10 per cent. of aluminium is used. Very pure copper must be employed. That deposited by electricity is the best, but is very expensive; the next best is that from Lake Superior. Ordinary coppers usually fail, from the presence of iron, which seems to be specially prejudicial. Colonel Strange recommends this alloy as a material to be employed in constructing the new great theodolite for the service of the trigonometrical survey of India.

ALUMINIUM AND PLATINUM.

AT the Royal Institution the eminent metallurgists, Johnson and Matthey, have exhibited two very remarkable specimens :—1. An alloy of Aluminium and nickel (containing one-and-a-half per cent. of the latter), which had been tried with hydraulic pressure against copper sheet of the same dimensions, when the alloyed aluminium endured a pressure of 476 lb. to the square inch. 2. A specimen of autogenous soldering in Platinum, with tubes of the same, having cast-iron and leaden screw joints — for use with sulphuric acid at high temperatures.

POROSITY OF PLATINUM.

DURING their researches at high temperature, chemists are continually checked by the difficulty of finding suitable vessels. Platinum vases at first appeared irreproachable ; but they are now rejected on account of the mistrust occasioned by a metal to which is attributed the faculty of condensing on its surface the gases with which it is brought into contact. A recent memoir of M. E. Becquerel has suggested to MM. Ste.-Claire, Deville, and Troost, a series of experiments by which they consider that they have found out the true cause why platinum presents no security when experiments are made with gases and high vapours. We must refer our readers to the *Comptes Rendus* for the details of the researches which have led these able chemists to the decision that at high temperatures platinum conducts itself like those porous vases which were so well employed by M. Jamin in his beautiful experiments relative to the endosmoses of gases. This porosity of platinum MM. Deville and Troost consider to be in perfect harmony with the catalytic actions and feeble conducting power for heat and electricity possessed by that metal. MM. Deville and Troost especially commend a remarkable platinum tube made for their use by Johnson and Matthey. This tube, of cast platinum, weighs 1070 grammes, and is 60 centimetres long and about 2 millimetres thick.

MAGNESIUM.

PROFESSOR FARADAY has exhibited at the Royal Institution a fine piece of this metal, which he had received from Mr. Tegetmeier, and which was the largest that had been seen hitherto. It had been obtained by Mr. E. Sonstadt's patented process, which, it is supposed, will be applicable on a manufacturing scale, and which is based upon the two following main facts :—1. That when a mixed solution of the chlorides of magnesium and of sodium is evaporated to dryness and then heated to redness, a fused mass remains, which, heated with sodium, gives magnesium ; and, 2. That magnesium does not sensibly act upon iron when air is excluded, and the heat is not raised excessively high. Hence it follows that iron vessels may be used in which to effect the reaction of sodium upon the "material" or fused mass obtained as described. The metal magnesium, which was first obtained from the earth magnesia in 1807, by Sir Humphry Davy, by the agency of the voltaic battery, is a pure white, silver-like metal, permanent in the air, but inflammable at high temperatures, as was shown by Mr. Faraday burning a piece in the flame of a candle, and also in the electric light. Like lead, a thin film is formed on its surface by the action of the air, which preserves it from further oxidation. Its specific gravity is less than twice that of water.

CHEMISTRY OF STEEL.

A PAPER on this subject, by M. H. Caron, has been laid before the French Academy of Sciences. Karsten, it is said, remarked that when untempered steel is acted on by acids a substance resembling graphite remains, which is not present when tempered steel is substituted. This substance, he stated, was a compound of six atoms of carbon and one of iron. Berthier, also, by treating cast-steel with iodine, which did not completely dissolve it, separated another carburet of iron. M. Caron states that, after numerous experiments, he has not been able to obtain this carburet of iron, and hence is compelled to conclude that it was probably only a mixture of carbon and metal, in which the latter was mechanically protected by the former against the dissolving action. Nevertheless, he hopes that his experiments have produced another element to be considered in the determination of the true state of the carbon in steel of different qualities. He subjected, 1st, steel in its original state; 2nd, steel which had been submitted to prolonged hammering, and, 3rd, tempered steel—to the action of hydrochloric acid and heat, drying the residuum in hydrogen. The graphitous substance, when taken from the acid, was washed, dried in a stove, and weighed In 100 grammes of dissolved steel of each kind he found the following residuum :—

	1st.	2nd.	3rd.
Carbon ...	0·825	0·560	traces
Iron .	0·557	0·445	traces
Silica	0·212	0·238	0·240
	1·624	1·243	0·240

Thus, the effect produced in a complete manner by tempering is found to be partially realized by hammering, and the qualities which constitute steel seem to increase as the proportion of carbon which combines intimately with the iron increases. M. Caron states this on account of the opinion generally entertained that the larger the amount of carbon separated by the acid, the less intimate is its combination with the metal. For further details on the subject we must refer our readers to the *Comptes Rendus* of the Academy.

M Caron, in a continuation of his elaborate studies, treats especially on the expulsion of phosphorus from steel It has been found that the castings which contain sulphur or phosphorus afford steel brittle when either hot or cold ; and that by forming a mixture of the two kinds a metal is obtained in which these defects are much less sensible ; and it has therefore been concluded that sulphur and phosphorus either mutually destroy each other, or rather form a solid or gaseous combination (either with the scoria or the gases of the furnaces). M. Caron was led to study this question analytically, with the view of ascertaining if there really existed a method of expelling phosphorus from the castings of steel. Details of his experiments will be found in the *Comptes Rendus*. They proved to him that in the mixtures in question neither the sulphur nor phosphorus disappears. The operation has no other effect but that of disseminating the injurious metalloids in a larger quantity of metal, which consequently possesses the defect of brittleness in a less degree The mixture, therefore, possesses advantages available in the manufacture of steel for industrial purposes.

M. Caron, in concluding his researches, after having several times treated ores completely free from phosphorus with wood charcoal, phosphate of lime, and silica, has constantly found in the casting thus produced nearly all the phosphorus which he had placed in the crucible in the state of phosphate. Since, then, says M. Caron, there does not seem to be any method of taking away from the steel castings the phosphorus they contain, as they never fail to combine with that body wherever they meet with it, it is of the utmost importance that the causes that contribute to the presence of this injurious metalloid should be removed, and the chemical composition of the combustible vegetable employed attentively considered. Nearly all woods contain phosphorus ; thus the cast-steel made by wood from ores which have no phosphorus, according to Karsten, contains at least two per cent. In this proportion phosphorus is not injurious, and even at five per cent. is inoffensive ; but at seven per cent. the steel obtained breaks with percussion, although it may be bent to a right angle. Wood which will give this last percentage ought, then, never to be employed ; since the different elements of wood contain different quantities of phosphorus, not only according to the nature of the soil on which they grow, but also in the same soil, according to their species. M. Caron refers to the analyses of Berthier, which show that some wood ashes contain only 0·008 of phosphoric acid, while others have as much as 0·9, 0·1, and even 1 per cent. The latter would certainly produce castings of bad quality.

M. Charles Sainte-Claire Deville, commenting on the researches of M. Caron, says that the latter confirms the important remark due to Karsten, that in attacking, by acids, steel not tempered, we obtain as a residuum a graphitous matter, which does not appear in the case of tempered steel. He also confirms, on the other hand, the experiments of M. Regnault, which establish that non-tempered steel possesses a density considerably greater than that of tempered steel. This double conclusion is in perfect concordance with the results of numerous experiments, published by M. Deville himself, which had for their object the study of the peculiar physical and chemical properties which may determine in a body an abrupt cooling or the abnormal proportion of latent heat which results from them. Amongst other facts, M. Deville had shown that different bodies in this respect appear to form two clearly distinct categories, some, such as sulphur, selenium, silicium (or rather its compounds, silica and the silicates, and the experiments of M. Jacquelain, in accordance with those of Lavoisier and Silliman, authorize in the highest degree the addition of carbon), are subfusible and susceptible of acquiring by tempering the vitreous and amorphous state. Other substances, such as lead, tin, bismuth, and probably the metals in general, present after a slow or abrupt cooling the same molecular state, characterized by a density sensibly constant. "Now," says M Deville, "if I do not deceive myself, the results obtained by M. Caron may be explained by considering the iron and carbon as belonging respectively to these two categories."—*Illustrated London News; abd.*

NEW METAL.—SIDERIUM.

In the development of his invention for the production, on a commercial scale, of the metal magnesium, Mr. E. Sonstadt, of Loughborough, has discovered a new metal in the "carcasse" remaining when the chloride of magnesium is obtained by evaporating and igniting the chlorides of magnesium and sodium. In many of its reactions, this new metal corresponds almost precisely with iron, for which metal it has probably hitherto been mistaken. The new metal appears, at present, to occur invariably in connexion with magnesium, which cannot be entirely freed from it.

ADHESION OF LIQUIDS TO MERCURY.

Mr. Gore has reported in the *Philosophical Magazine* some experiments on this phenomenon. If a drop of Nordhausen sulphuric acid (about one-tenth of an inch in diameter) be carefully placed by means of a glass rod upon the centre of a clean globule of pure mercury about eighty grains in weight, it instantly diffuses itself in a thin film over the surface of the metal, and the mercury becomes flattened, and exhibits vortical movements all over its surface; but if the experiment be made with a strong aqueous solution of ammonia, or of caustic potash, no such results occur; the alkaline solution contracts itself into a spherical form, and persistently floats to the side of the mercury without spreading itself over the surface, especially if the mercurial globule weigh less than sixty grains. Mr. Gore made arrangements to ascertain the order in which various liquids stood with regard to this particular behaviour with mercury. He made use of a uniform weight of eighty grains of pure mercury in a clean watch-glass; a small drop of liquid, as nearly as possible of uniform size, was carefully placed upon it, and the degree of rapidity with which it spread and the diameter it attained were repeatedly noted. Mr. Gore gives a list of the liquids tried, which shows that with regard to this phenomenon, acids are at one extreme and alkalies at the other—water and solutions of neutral salts being intermediate.

SILVERING GLASS.

A NEW method of Silvering Glass has been invented by M. A. Martin, and laid before the French Academy of Sciences by M. Le Verrier. The details are thus given in the *Illustrated London News*:—

M. Martin states that, after having carefully studied and experimented upon all the known methods of silvering (in which aldehyde, sugar of milk, glucosate of lime, &c., are employed), he has obtained a process which seems to him to possess all the requisite conditions in its easiness of application and in the adhesion and durability of the layer of silver deposited. M Martin begins by preparing—1, A solution of 10 grammes of nitrate of silver in 100 grammes of distilled water; 2, an aqueous solution of pure ammonia, marking 13 degs to the aerometer of Cartier; 3, a solution of 20 grammes of pure caustic soda in 500 grammes of distilled water; and 4, a solution of 25 grammes of ordinary white sugar in 200 grammes of distilled water; pouring into it 1 cubic centimetre of nitric acid (at 36 degs), and causing it to boil twenty minutes in order to complete the process The volume is raised to 500 cubic centimetres by the addition of distilled water and 50 cubic centimetres of alcohol (at 36 degs) Having obtained these solutions, M Martin proceeds to the preparation of the silvering liquid He pours into a flask 12 cubic centimetres of the solution of nitrate of silver; then 8 cubic centimetres of ammonia (at 13 degs); next 20 cubic centimetres of the solution of soda; completing the volume of 100 cubic centimetres by adding 60 cubic centimetres of distilled water. If these proportions have been well observed, M. Martin states that the liquid will remain limpid, and a drop of solution of nitrate of silver in it will produce a permanent precipitate. However, the liquid should be permitted to stand twenty-four hours, after which it may be used with perfect security. The surface to be silvered should be well cleansed with a lump of cotton impregnated with some drops of nitric acid (at 36 degs.), then washed with distilled water, and afterwards drained and placed on wedges on the surface of a bath comprised of the silvering liquor described above, to which from a tenth to a twelfth part of the preparation of sugar has been added Under the influence of diffused light, the liquid in which the surface to be silvered is bathed will become yellow, then brown, and at the expiration of from two to five minutes the silver will invade the whole of the surface of the glass After ten to fifteen minutes the layer will have attained the thickness desired, and the glass may then be washed—first, with common water, and next with distilled water, and, finally, be placed in the open air to dry The dried surface will be perfectly polished, but covered with a light, whitish veil. At the slightest rubbing of a ball of chamois leather powdered with polishing rouge the veil will disappear, leaving on the glass a brilliant surface, the physical constitution of which renders it eminently suitable for the optical purposes for which it is destined.

POROSITY OF CAST-IRON.

IN reference to the experiments of MM. Deville and Frost, M. Barreswil, in the *Répertoire de Chimie*, states that he once, during an experiment of Thilorier, made with the view of liquefying oxygen by enormous pressure, observed that the mercury in the receiver was forced through and oozed out of the pores of the very thick mass of the cast-iron envelope. A paper placed beneath the receiver assumed an ash-grey colour, which microscopical examination proved to be due to the presence of finely-divided mercury.

COMBINATIONS OF ARSENIC.

WHEN acids, more or less diluted, disengage hydrogen from the water in the presence of zinc or iron, and the gas be brought into contact with a soluble compound of arsenic, a gaseous hydrate is produced. Dr. Blondlot, of Nancy, in the *Annales de Chimie*, points out a remarkable exception to this rule, and which he believes unique and important in relation to toxicology; it is this —that when nitric acid and its derivatives are used, as indicated above, a solid hydrate is formed, which is precipitated on the zinc in the form of brown floccules. The writer gives details of cases of poisoning, and considers that the knowledge of this fact may throw much light on the investigation of the phenomena.

USE OF ARSENIC AS A COLOURING MEDIUM.

A CORRESPONDENT of the *Times* writes.—"Four maidservants in my family were recently attacked, while working up articles of dress in green tarlatan, with nausea, bleeding at the nose, irritation about the eyes, and other threatening symptoms, which caused the work to be stopped, and, on chemical examination, the stuff was found to be loaded with arsenite of copper to such an extent, that the 'handling and wearing of such an article are fraught with danger.' Now, the tarlatan was supplied by two London houses of the first respectability. The members of the first have assured me that they had no idea the wearing of such an article was fraught with danger, or they would have warned the lady who purchased the goods; and to a similar assurance the second add that the manufacturer who supplies them, supplies also nearly all the first establishments in London as well as France."

ARSENICAL PAPERHANGINGS.

DR. ORTON (Limehouse) has adduced several facts, detailing the evils resulting from inhabiting rooms papered with the common light-green paper, as brought out in evidence before coroners' juries, especially in regard to the deaths of children; and birds also had been known to have died from a like cause. A gentleman present at the discussion of this subject remarked that the evils, in his opinion, were rather of a mechanical than chemical character; or, in other words, that, unless the pigment was scratched or rubbed off, or otherwise inhaled from actual contact with the arsenical substance, no evil would ensue. Dr. Challice (Bermondsey) opposed that theory; for, if arsenic entered largely into the composition of paper on walls, harm must result, though not detectable by a practical chemist. He believed many cases of death attributed to diphtheria were the consequences of arsenic absorbed into the system from the presence of arsenical paper, independent of direct contact therewith. Dr. Liddle (Whitechapel) believed the best green paper had no arsenic, and if there were so much arsenic in paper as stated, or that it was such an evil in that form as alleged, they would hear more of its effects. Dr. Aldis (Belgravia) introduced Mr. Turner, a manufacturer, who exhibited specimens of beautiful light-green paper, destitute of arsenic, which could be produced as cheaply and in as great beauty and variety as the arsenical papers. Dr. Druitt (Mayfair) mentioned the case of a child's death which had been caused or accelerated by having its cot near a wall, the child having picked off the paper and put it into that universal receptacle, the mouth. Dr. Orton mentioned a proved case of twelve birds having died in a week from contact with arsenical papers. Dr. Thomson would recommend persons to have nothing to do with such papers. He had none in his own house, and believed the dark-green contained no arsenic.—*Builder*.

CHROMATE OF LEAD IN BUTTER.

THE Conseil d'Hygiène of Paris lately charged M. Poggiale with the chemical examination of a specimen of paste which had been seized in the shop of a butter-merchant, and which was intended for giving a good appearance to bad butter. When calcined in a platinum capsule, it left considerable residuum. The fatty matter was separated by means of ether; and, after filtering the etherated liquor, a yellow substance was found, composed of chromate of lead and a vegetable colouring matter, presenting all the characteristics of turmeric. The presence of the chromate of lead was proved by suitable reactions. The paste was finally shown to consist of rancid butter, chromate of lead, turmeric, chloride of sodium, and all the saline matters found in sea-salt. As the chromate, like all the salts of lead, is poisonous, its introduction into butter is highly culpable, and should be repressed with severity. If it be true, as the maker of the paste asserted, that he did not use the chromate, the turmeric itself must have been adulterated with it.

INJURIOUS ACTION OF LEAD PIPES ON WATER.

THE importance of discovering a really efficient means of preventing the injurious action of lead pipes on water is universally acknowledged, and the experiments of Dr. Crace-Calvert have proved beyond question that no proposition hitherto brought forward has been calculated to remedy the evil complained of. A discovery, however, has now been made through which the water supplied by leaden pipes may be obtained by the consumer as pure as from the original source. Dr. H. Schwartz, of Breslau, has discovered a means by which the portion of the lead forming the interior surface of the pipe may be converted into an insoluble sulphide, the natural consequence being that the water passing through will be as free from contamination as if glass were used. The means by which Dr. Schwartz effects this conversion are extremely simple. He simply passes a strong solution of the sulphide of an alkali through the pipe to be acted upon, and the process is completed. This solution, which is either a sulphide of potassium or of sodium, is used at a temperature of about 212 deg. Fahrenheit, and is allowed to act upon the metal for from 10 to 15 minutes. It is stated that, in practice, the boiling solution of caustic soda and sulphur is found to answer every purpose.—*Mining Journal.*

PAINTING ON GLASS.

M. Chevreul has laid before the French Academy of Sciences a memoir on ecclesiastical Painting on Glass, considered in four categories:—1. The different kinds of glass employed; 2, the nature of the solid layer which the atmosphere deposits on their external surface; 3, the means of removing this layer without causing injury; and 4, the causes of the fine effects of the ancient paintings on glass.

M. Chevreul gave a vivâ voce analysis of this paper. He began by stating that, twenty years ago, a very honourable person, charged with the restoration of the painted glass of some of the ancient cathedrals, consulted him on the means of restoring transparency to glass which had become absolutely opaque through long exposure to the atmosphere. He was successful, but did not publish the process, because an archæological committee, to which specimens of the restored glass were shown, rather hastily concluded that it might lead to fraudulent imitations. Eventually, however, the process was communicated to M. Prosper Lafaye, who at once put it in practice on the glass of St. Gervais The glasses used by the ancients were of three kinds—1, Glass coloured by extension on the exterior or interior surface by a thin layer of a coloured glass; 2, glasses coloured purple, green, &c, in their mass, in the act of fabrication, and 3, glasses simply painted on their surface with vitrifiable colours The layer on the glass which renders it opaque contains sulphate of lime in large quantities, some subcarbonate of lead, various calcareous salts, chloride of sodium crystallized in three forms; divers organic matters to which no name can be given, a nitro-sulphuret, and a fatty substance insoluble in alcohol, an inflammable carbonaceous matter resembling lampblack, containing hydrogen ferruginous and siliceous matters, &c. M. Chevreul's process consists in—1, washing the glass in plenty of water, 2, plunging it for ten or twelve days in a bath of subcarbonate of soda, 3, well washing it again in water, 4, plunging it into a solution of hydrochloric acid, to dissolve the carbonate of lime, and 5, leaving it for some time in plenty of water. M. Chevreul attributes the superiority of the coloured glass of the ancients to the extreme care taken to attain as distinct vision as possible by various methods; and the modern cases of failure to neglecting the means of attaining this object. Further details will be found in the *Comptes Rendus*, vol. 51, No 17.

With regard to the cleansing of ancient painted glass and M. Chevreul's process, M. Bontemps has written to the Academy of Sciences a warning letter, stating that great care must be taken in dealing with this glass, since, although the black characters traced on the glass of the twelfth and thirteenth centuries are generally well enough vitrified, yet sometimes they have so little undergone the action of fire as to be easily rubbed off with the finger-nail. It would, then, be highly dangerous to wash them with muriatic acid. In respect to the *chef-d'œuvres* of the fifteenth and sixteenth centuries, he denies that the beautiful effects are due to chance and to the accidental rugosities in the glass, &c., and asserts that they are to be attributed to the intuitive knowledge which the artists possessed of the laws of the contrast of colours so ably enunciated by M. Chevreul in our day.

SOILS OF ENGLAND.

Professor Voelcker, of the Royal Agricultural College, Cirencester, has read to the Royal Institution a paper on "The Chemical Properties and Productive Powers of the Soils of England." After referring to the soil constituents essential to the life of plants, especially lime, magnesia, silica, and phosphoric acid, and stating that to Liebig was due the credit of introducing and defending the "mineral theory," and thus giving the death-blow to the "humus theory," the Professor proceeded to insist on the danger of looking too much at the mere chemical properties of soils, and consequently thinking it sufficient to merely replace in them what had been taken out by plants, according to a somewhat mechanical process. He gave an account of experiments made by Messrs. Way, Townsend, and Huxtable, and himself with various manures on different soils, which showed that soils not only possess the power of selecting from the manure the constituents they need, but also of giving off what is injurious to them, a real power of extraction, absorption, and rejection; this physico-chemical power varying exceedingly according to the nature of the soil, whether light or heavy, sand or clay. The results of these experiments were duly set forth on diagrams, and tend to show the great importance of further research into soils with the view of determining their essential properties, and thereby acquiring the power of manuring them with more discrimination than has hitherto been done. With regard to the continuance of the productive powers of the soil of England, the professor expressed his conviction that there was not the slightest ground for anxiety. By means of improved methods of cultivation, and the application of fossil and other manures, now so abundant, the fertility of our country may be considered as inexhaustible.

THE USES OF GUANO.

Mr. Mark Fothergill, the first seller of guano (1839), has addressed to the *Times* the following letter, first noticing a letter from Mr. Sussex, Milbank, which he cannot help thinking has refuted the proposition that artificial manures are not only unnecessary but in fact, as mere stimulants, detrimental.

Mr. Fothergill proceeds :—"I willingly admit, and have done so from the outset, when guano sold at 24*l.* per ton, that the dungcart could not be dispensed with ; but, I ask, what could the man entering a farm have done without guano? What can the farmers of poor land in Oxon, Gloucester, Sussex, Hants, Surrey, Wales, and adjoining counties do without it now?

"I acknowledge readily Mr. C. Lawrence's ability as an agriculturist, but when he somewhat grudgingly admits the value of bone, I should like to know whether he has not got such capital root crops as enabled him to get heavier corn crops, for I cannot think he applies all the bone he purchases to grass. It is not every farmer who can afford to feed cattle on cake for the sake of manure; but I find that the large farmers in Norfolk—say Castle Acre, Burnham, and many others in that and the adjoining counties—let cake, guano, dissolved bone, and foldyard manure act as auxiliaries to each other.

"Referring to Mr. Alderman Mechi's letter, I must say that I have long admired his patriotism and generous farming; but I would ask whether the use of liquid manure, applied at a great cost, in addition to the accumulation of manure from use of cake, is not a much more expensive artificial dress than 3 cwt. to 4 cwt. of guano at, say, 12*l* to 13*l*. per ton?

"A great deal has been said and written, and a great deal of twaddle talked before committees of the House of Commons and elsewhere, about sewage. I do not hesitate to say that the realization of a solid manure from it is, commercially, impracticable; for by the process of filtration the valuable salts run off in solution, and the deposit, which ought to fetch 4*l* per ton, is intrinsically worth only 30*s*. per ton, and the application in a liquid state is much too expensive and complex."

YELLOW AMBER.

A PIECE of this substance about 3 in. long and 2 in. broad, of an elongated oval form, with an exterior of the colour of honey-yellow, and yellowish white, pellucid, and perfectly homogeneous in the interior, has been found at the depth of three toises in the soil in the tertiary sands of Polnisch Ostran, Austrian Silesia. It is remarkable that this piece, which is perfectly hard on the surface, has preserved in its interior the soft plastic consistence proper to resinous substances.

PROCESS FOR BLEACHING GUTTA-PERCHA.

DISSOLVE it in twenty times its weight of boiling benzoin, and add to the solution some plaster of very good quality, stirring the mixture from time to time. At the expiration of several days the plaster is precipitated, having drawn down with it all the insoluble impurities in the benzoin. The limpid liquor is then decanted and introduced by small portions into a vase containing twice its volume of alcohol at 90 deg. cent., and continually agitated. During this operation the gutta-percha is precipitated in the form of a pasty mass, perfectly white. Its desiccation, thus purified, requires several weeks' exposure to the air; but it may be much accelerated by trituration in a mortar, and removing the water thus separated.

RAPID TANNING.

AT the Franklin Institute, Pennsylvania, Mr. Howson has exhibited a calfskin tanned in accordance with a patent granted to Mr. H. G. Johnson, improved by Mr. S. Dunseith. The principal ingredient employed is a decoction of the wild chamomile, It was stated that, by this process, an ordinary calfskin can be tanned in fourteen days, and a cowhide in twenty-one days.

SUGAR FROM SERPENTS' SKINS!

IN 1861, M. De Luca made some experiments from which it appeared that the skins cast off by silkworms might be transformed into sugar. The same chemist has now sent in a paper to the Academy of Sciences, in which he describes a similar process for changing Serpents' skins into Sugar. These skins contain a small quantity of a substance resembling the cellulose of plants, soluble in ammoniuret of copper, and transformable into glucose, which reduces the tartrate of copper and potash, and ferments under the influence of yeast, yielding thereby carbonic acid and alcohol. Concentrated sulphuric acid and a solution of potash are the best reagents for depriving serpents' skins of their nitrogenous matter; the residue, although very refractory to chemical agents, may nevertheless be transformed into fermentable glucose, recognisable from its property of reducing the tartrate of copper and potash. Thus, M. De Luca boiled 50 grammes of serpents' skins in a litre of water containing 40 grammes of caustic potash, the skins having been previously treated with concentrated sulphuric acid. The liquid having been allowed to cool, a great deal of water was added, and the undissolved residue was several times washed by decantation; it was then treated with ammoniuret of copper, whereby an alkaline solution was obtained, which on being neutralized by hydrochloric acid, yielded a white precipitate; this, heated in slightly acidulated water, reduced the tartrate of copper and potash, thereby showing that it was glucose, or the base of sugar. In another somewhat similar operation glucose was obtained which fermented in contact with yeast, producing carbonic acid and alcohol. The former was completely absorbed by caustic potash; the alcohol extracted from the solution by distillation, and insulated by means of crystallized carbonate of potash, was nearly pure, since it would burn without leaving any residue; rubbed between the hands it evaporated, emitting an agreeable smell, though still partaking of that of animal matter. From all this it may be concluded that serpents' skins contain a very small quantity of sugary matter or glucose.—*Galignani's Messenger.*

FORMATION OF THE FATTY MATTER IN OLIVES.

M. DE LUCA has reported to the French Academy of Sciences the results of his elaborate researches on this subject, to which we adverted about two years ago. From the figures given in his table of observations, ranging from June to December, it appears that the weight of the Olive increases with the progress of vegetation until the month of November; but that the stone is the first to be developed, the growth of which takes place in the early part of vegetation during the months of July and August, after which it remains stationary; there being, in fact, in successive months, no sensible variation of its weight. The pulp, on the contrary, increases in weight continually until the complete maturity of the fruit. The quantity of water found in olives diminishes progressively at their maturity. Thus it is about 60 or 70 per cent. in the first phases of vegetation, while it is only about 25 per cent. at the last period of the growth and maturity of the fruit. The sulphuret of carbon takes from olives several substances of a different nature; among which are colouring matters, especially chlorophyll, which gradually diminishes as the fruit approaches maturity. The fatty matter, on the contrary, which is found only in small quantity at the beginning of vegetation, increases as the plant grows, and is at its maximum when the olives are ripe and have completely lost all trace of their greenish tint. It is also remarkable that when the stone ceases to increase in weight the fatty matter in the fruit accumulates in greater proportion.—*Illustrated London News.*

ANALYSIS OF BREAD DISCOVERED AT POMPEII.

DURING the excavations made on Aug. 9, 1862, under the direction of M. Fiorelli, a baker's shop was discovered. In the interior of the oven were found eighty-one loaves of bread, of which seventy-six weighed from 500 to 600 grammes; four weighed from 700 to 800 grammes; and one weighed 1204 grammes (100 grammes=about 3½oz. avoirdupois). All were nearly of the same form, but some had a depression in the centre, which appeared to have been a sort of trade-mark. Their edges were raised and rounded, and separated by eight lines proceeding to the centre, so that the upper part of the loaf could be divided into eight parts. The largest loaf appeared to have been destined for division into four parts. All the loaves measured at the raised part from 6 to 7 centimetres, and the central depressed part of some was between 3 to 4 centimetres (centimetre=0·39371 in.). The shape of these loaves is that to be seen in the bread used at Palermo, Catania, and the interior of Sicily. The analysis of the above-mentioned loaves was made by M. De Luca, who has presented a memoir on the subject to the Academy of Sciences at Paris. He states that all the loaves have a blackish brown exterior, which tint becomes weaker in the central parts. The crust is hard and compact, while the crumb is porous, having cavities like our own bread. The bread contains moisture, unequally distributed, which it gives up at 110 to 120 deg. cent. The nitrogen is unequally distributed in it. The following table shows the variability of the composition of five of the loaves analysed:—

Water	20·3	23·0	21·1	—	19·6
Carbon	34·3	27·2	39·0	—	—
Hydrogen	8·4	6·5	4·3	—	—
Nitrogen	2·6	2·8	2·8	—	—
Oxygen	2·4	30·0	10·2	—	—
Ashes	7·2	13·2	16·6	16·9	11·8

with a small quantity of matters soluble in water and alcohol.

NEW REAGENT.

A NEW vegetable reagent of great delicacy has been discovered by M. Goppelsroeder, of Basle, who states that paper tinted with the extract of the petals of the mallow, may be used in the same manner as litmus or carcuma. The alkaline bases render this paper violet when the solutions are diluted, and green when they are more concentrated. The presence of one ten-millionth part of caustic soda suffices to colour the reagent violet, and the alkaline nitrates furnish the same result.—From *The Reader*, an ably conducted, new critical journal, in which special attention is paid to scientific subjects.

AZULENE.

THIS is the name given by Mr. Septimus Piesse to a new body discovered by him to exist in several essential oils. Mr. Piesse states, in a paper read before the Chemical Society, that though this substance was first observed by him as a product derived from the fractional distillation of otto of patchouli, he has since found it to exist generally in essential oils as an integral part of their proximate constitution, giving, in fact, the colour by which each oil is distinguished. Pure azulene has a beautiful blue colour, and it is to the presence of a small quantity of azulene that blue oil of chamomile owes its azure tint; and hence the name given to the new body. It is now ascertained that brown-green, yellow-green, and green oils owe their colour to a portion of azulene and a yellow resin, varying in proportion, as optically indicated. At the meeting Dr. Hofmann objected to the name, as likely to be confounded with azuline, a blue colouring matter obtained from coal-tar. Dr. Gladstone stated that he himself had separated the blue produce from otto of patchouli, but was not yet satisfied with its purity. He proposed the name cæruleine, and stated that in a short time he would be prepared to read a paper on the subject. The editor of the *Chemical News* says that the name cæruleum has been appropriated to a new mineral blue.—*Illustrated London News*.

MAUVEINE.

THIS is the name given to a chemical base by Mr. W. H. Perkins, the discoverer of the aniline purple. He states in the *Proceedings of the Royal Society*, No. 57, that on adding a solution of hydrate of potassium to a boiling solution of commercial crystallized mauve, it immediately changed in colour from purple to a blue violet, and, on standing, deposited a crystalline body, which, after being washed with alcohol and then with water, presents itself as a nearly black glistening body, not unlike pulverized specular iron ore. It dissolved in alcohol, forming a violet solution, which immediately assumes a purple colour on the addition of acids. It is insoluble, or nearly so, in ether and benzole. It is also a very stable body, and decomposes ammoniacal salts readily. When heated strongly it decomposes, yielding a basic oil.

ANILINE.

The blue of aniline* is the subject of a communication from Dr. Hofmann, of London, to the French Academy of Sciences, in which he gives the full details of the chemical processes employed in the production of this colour. The transformation of the red of aniline into blue opens up varied and interesting points of view. Dr. Hofmann hopes shortly to submit to the Academy the results furnished by the examination of two more colouring matters derived from rosaniline—viz., the green and the violet of aniline, as well as the blue colouring matter known as azuline, the general properties of which present a striking analogy with triphenylic rosaniline. With regard to the progress of research in this department of chemistry, Dr. Hofmann refers to the following passage, written about two years ago by M. E. Kopp in a memoir on the red of aniline:—"As hydrogen may be equally replaced by methyl, amyl, phenyl, &c., we may easily foresee the existence of a series of very numerous compounds, all belonging to the same type, and all capable of being constituted colouring matters—red, violet, or blue." This prophecy is undoubtedly in rapid course of fulfilment.—*Illustrated London News.*

COLOURLESS LILAC-FLOWERS

Were produced for ornamental purposes in winter in Paris above forty years ago by amateur horticulturists by the aid of manure in their greenhouses. More recently, improved methods have been devised for obtaining them by ingenious professional gardeners. Some of these methods are described by M. Duchartre, in the *Répertoire de Chimie*, he having made many experiments with the view of ascertaining the cause of the loss of colour. He concludes by saying that his experiments prove "that the absence of the colouring matter is due neither to the heat, the enfeebling effect of the hot manure, nor to the separation of the branch from the parent stem. Perhaps the rapidity of the development of the flowers may be an efficient cause of the phenomenon; yet I confess that I cannot conceive the possibility of this action. In my last analysis I was led to seek the explanation of the fact in the influence of ozonized oxygen, a decolorizing principle, through the oxydation of organic matters, which, in accordance with different observations, especially those of M. Kosmann, must exhibit in much larger proportion in greenhouses filled with plants than in the free atmosphere." M. Barreswil doubts this supposed action of ozone, and is inclined to attribute the decolorization to chemical action in the colouring matters of the plant. Whatever be the explanation, the facts certainly open up a new field of observation for naturalists and chemists.—*Ibid.*

MILK.

THE nature and properties of milk is the subject of a long article, by Professor Voelcker, in the new number of the *Journal of the Royal Agricultural Society of England.* We give a few notes of the scientific part. Water being 1000 : the specific gravity of good cow's milk is 1030 ; woman's milk, 1020 ; goat's and ewe's milk, 1035 to 1042 ; ass's milk, 1019. Under the microscope milk appears a transparent fluid, in which float innumerable small, round or egg-shaped globules, the so-called milk-globules, which consist of thin shells of curd or casein, inclosing the fatty matters. The fats of butter separated from these globules, the fluid is a perfect solution of curd or casein albumen, milk sugar, and mineral matters —100 parts of casein, according to Professor Voelcker's analysis, consists of carbon, 53·57 ; hydrogen, 7·14 ; nitrogen, 15·41 ; oxygen, 22·03 ; sulphur, 1·11 ; phosphorus, 0·74. Pure casein of milk is precisely the same as legumin, the casein of plants, and possesses the same physical and chemical properties. The sugar of milk is composed of carbon, 40 ; hydrogen, 6·66 ; oxygen, 53·34. The mineral matters of milk comprise the phosphates of lime, magnesia, and peroxide of iron ; the chlorides of potassium and sodium ; and free soda. By churning cream, the casein shells of the milk globules are broken and their contents made into butter ; of which, when pure, palmitin, with a little stearine, constitutes about 68 per cent. The peculiar flavour and colour of butter are due to the presence of about 2 per cent. of odoriferous oils—butyrin, caproin, and caprylin. The more perfectly the fragments of the casein shells are removed from the butter the better it will keep, since their presence occasions the formation of certain volatile, uncombined fatty acids, which spoil the flavour of butter and render it rancid and unwholesome. Dr. Voelcker dwells at some length on the best dairy arrangements, &c. With respect to the adulteration of milk, he expresses his disbelief in the list of ingredients stated to be thus employed (such as sheep's brains, chalk, &c.) For the measurement of the adulteration with water, so generally used for this purpose, he describes various lactoscopes, galactometers, &c.

STEREOCHROMY, OR WATER-GLASS PAINTING.

THIS process has gained a triumph in the Report of the gentlemen who have pronounced an opinion on the most desirable materials for the execution of the paintings in the Houses of Parliament. Frescoes executed in lime have been found extremely unsatisfactory, and the members of the Government Commission of Inquiry (among whom may be named Mr. Ruskin, Mr. L'Estrange, Mr. Gambier Parry, Mr. Maclise, and Professor Hofmann), have at last decided that future frescoes should be painted by the Water-glass process, which is believed to be a perfectly permanent mode of painting.

M. Johann Ness Fuchs is the chemist to whom the credit is given for the discovery of the method of dissolving flint, which dissolved flint is known as water-glass, or soluble silicate. This chemist found that by fusing silica with an alkali (soda or potash), he made a glass which was more or less soluble, according to the quantity of alkali employed. Let us here remark one important fact, the knowledge of which has of late materially aided in the success not only of stereochromy, but of all applications of water-glass. Silica or flint, we have already said, when fused with an alkali, forms a silicate of the alkali used. This silicate may, by using a large proportion of alkali in its manufacture, be made so soluble as to dissolve in water at (212° Fahrenheit) the boiling point. But the employment of so large a proportion of alkali seriously interferes with the subsequent uses of the solution. If, on the contrary, the silicate be made with a minimum amount of alkali, it nearly represents bottle-glass in its appearance and general characteristics, and is only soluble under a high pressure of steam; and thus, according to the pressure available, so may the alkalinity be decreased, and consequently the value of the solution increased. We may add further, that the more neutral or the less alkaline the silicate, the longer it takes to dissolve; a long continued digestion, even at a high temperature, being necessary to reduce that silicate which nearest approaches to neutrality.

This silicate, then, is the base of all operations in stereochromy, which process has been suggested by the firm agglutinizing power of the silicate, and the extreme hardness and durability of silica. Any substance mixed with the former, especially if it be of great thickness (*i.e.* heavy specific gravity), will be so concreted that scarcely any natural material could vie with it in toughness when perfectly dry. The latter condition is a *sine quâ non*, for if exposed to the action of water, or even damp, it will return to its original gelatinous condition. If, however, the substance concreted have any chemical action on the silicate, such, for instance, as by eliminating carbonic acid, the alkali will be changed in its character, becoming a carbonate; in which case it loses its solvent power, and the silica will be set free in an insoluble form to combine with, or influence more or less the surrounding particles with which it was concreted. Again, if only a thin film or coating of a nearly neutral silicate be exposed to the action of the atmospheric air, free from the effect of rain or damp, there will be found in the atmosphere sufficient carbonic acid to act upon the alkali as in the before-mentioned manner, and an insoluble pellicle will be formed. On the contrary, if a highly alkaline silicate be used, the alkali overcomes the power of the carbonic acid of the atmosphere, and constant efflorescence or deliquescence is the result. Fuchs, in his process of stereochromy, perseveringly tried all available means to perfect his system, but it has been left to Kaulbach, and others since his death, to reap the field his labours have sown. His first efforts were directed to the use of carbonated pigments and a siliceous menstruum; but here one of the greatest difficulties assailed him. The decomposition of the silicate by the carbonate was so rapid that, before the brush could make the desired touches, the paint had coagulated. And it should here be observed, that when once this coagulation has taken place, it is a certain sign that the chemical action has also been completed; and if the contact between the particles thus formed be once destroyed, they are perfectly inert, and will not again cohere (any more than an effervescence can be restored by the addition of any amount of acid when once the alkali is neutralized). Fuchs, however, did adopt this system, for want of a better, adding silicate to the coagulated paint to restore it to the desired thinness and fitness for working; but he of course knew that he was then dependent entirely upon the agglutinizing effect of the silicate and the carbonic acid of the atmosphere for its future insolubility.

Various substances, such as oil, grease, milk, size, &c., having been tried for retarding the quick action of the silicates, were found inadmissible on account of their introducing an element subject to oxidation, and thus disintegrating the colour after it had been laid on. Then various mediums were tried to convey the colour on the ground without the admixture of silicate in the process of painting, but to apply it afterwards with a brush as a coating. The softest fitch, however, was found to disturb the colour and more or less damage the picture; the height of some of the colours prohibiting the use of a sufficiency of the binding medium. All these difficulties, it is asserted, are removed by the system at present adopted by Messrs. Kaulbach, of Munich, and Mr. Maclise in our own country. The method adopted by these gentlemen is as follows:—The colours, which are duly prepared to withstand the decolorizing effect of the alkali, are laid on with water only; and when the artist has completed his picture, he takes a syringe, invented and constructed especially for this purpose, and throws upon the painting a mist of the silicate of potash. This mist somewhat resembles a Scotch mist, in which the atmosphere is highly charged with water without anything like a liquid drop being apparent. All, then, depends upon this mist falling so gently upon the painting as to saturate it without removing or interfering with one atom of its surface. When, however, the painting has received the first application of the silicate, its colours are so far fixed that subsequent applications may be made with less delicacy; and when completely saturated, the colours are so permanently fixed, that those which contained carbonic acid, such as carbonates, or sulphuric acid, such as the sulphates, are irremovable even by scrubbing. Other colours or pigments depend upon the rules before-mentioned for their permanency.

In ordinary painting for external purposes a modification of the same system is already in use. The patentees are Messrs. Bartlett Brothers and Co., of Camden Town, and their system we believe to be the use of a tenacious material, such as pipe-clay, to hold the carbonates on the surface to be operated upon until the fixing solution, which we believe to be a silicate of potash, can be applied with a brush in the usual manner, which renders the whole coating permanent.—*Report in the Builder.*

CHEMISTRY OF WINE.

AN interesting communication, being the first of a series of studies on this subject, one of vital importance to French commerce, has been made to the Academy of Sciences by M. Pasteur, so eminent for his researches on fermentation. It relates to the action of oxygen in the process termed "vinification." He states: —1. That the must of the grape does not contain any oxygen gas in solution, but only carbonic acid and nitrogen; and that he has operated on different species of white and red grapes. One experiment on must gave him—carbonic acid, 78·5; nitrogen, 21·5; oxygen, 0. 2. If the must be abandoned, even with a large surface, it does not oxygenate. He finds in it, in proportion as fermentation appears, only carbonic acid and nitrogen. Consequently, the oxygen of the air combines with must only in proportion with its solution in the oxydizable principles naturally contained in the juice of the grape. 3. This combination of the oxygen of the air with the must is not rapid. We obtain this result by agitating the must in the air, analysing the gases dissolved after agitation. Five litres of must were agitated in a large bottle containing ten litres of air. Fifty cubic centimetres of gas, extracted from the must a quarter of an hour after agitation, left thirteen cubic centimetres of gas not absorbable by potash, which contained 20 per cent. of oxygen. The combination of the oxygen of the air with must modifies its colour, gives it an agreeable odour, and exercises a very considerable influence on its fermentation. We have no space to pursue the subject further, but must refer those interested to the *Comptes Rendus* (vol. lvii., No. 23). M. Pasteur says, in conclusion, that the facts which he has brought forward will suggest new ideas on the methods to be pursued, both for the conservation of wines, the giving them the qualities of age, the action of currents of air in cellars, the influence of old and new casks as more or less suitable for evaporation, and the effect of bottling as diminishing in a great measure the aeration of the wine.

An experiment, interesting to wine-drinkers, has been made by M. Berthelot, the celebrated professor. It was he who first discovered that there is a particular oxidizable principle in Bordeaux and Burgundy wines to which he attributes their flavour. In pursuing his studies he was induced to examine the influence which oxygen exercises over wine. The result convinced him that this action is most unfavourable, and that it entirely destroys the bouquet, which is replaced by a most disagreeable flavour. M. Berthelot found it sufficient to pass a current of oxygen into the choice wines of St. Jean and Thorin to produce this result, and demonstrate experimentally that a very small quantity is sufficient to destroy the bouquet of a quart of Thorin, and that the absorption of oxygen by wine, accelerated by the elevation of the temperature, is rendered almost immediate by the addition of an alkali.

The observations of this distinguished chymist prove how necessary it is to preserve wine in a perfect state from the action of the oxygen contained in the air, since the prolonged contact of 10 cubic centimetres of oxygen—that is, 50 cubic centimetres of air—is sufficient to destroy the bouquet of a quart of wine. It is to the slow penetration of oxygen into bottles that M. Berthelot attributes the destruction of flavour which every wine experiences at last. The reason that the racking off of new wine from the vat to the cask does not produce a similar result is that new wine, being saturated with carbonic acid, disengages a portion of it when exposed to the air, so that it is in a great measure preserved, a very small volume of air disengaging a considerably greater volume of carbonic acid. The decomposition of wine in bottles half full, and the diminution of the flavour, well known to all connoisseurs, are caused by the action of oxygen. The complete destruction of the flavour of wine by the addition of an alkaline mineral water, such as that of Vichy, is explained by the preceding facts.—*Letter in the Times.*

The proportion of the ethers in wines has been critically examined by M. Berthelot, who has reported to the French Academy of Sciences the results, showing the proportions of water (varying from 95 to 75 deg.), of alcohol (5 to 25 deg.), and etherified alcohol (8·5 to 32 deg.). The succession of the phenomena of etherification in vinous liquors depends on the initial composition of the liquors at the moment when fermentation is terminated, and on the changes which they may undergo during the course of their conservation. With regard to the effect of the proportion of acid and alcohol, M. Berthelot states, without entering into a detailed discussion, that whenever alcohol or the acid increases, the proportion of the ether tends to increase in virtue of the slow reaction which is set up; and whenever the alcohol or acid diminishes the quantity of ether also diminishes; if the reaction be complete, a certain quantity of ether will be decomposed. Some ferments have the power of doubling the ethers already formed, as M. Berthelot has shown in the case of the reaction of pancreatine upon acetic acid.

METHYLATED SPIRIT.

METHYLENE is a highly volatile and inflammable liquid produced from the destructive distillation of wood; whence *Methylated* Spirit, or wood spirit. It is permitted to be used, duty free, in arts and manufactures. Hitherto, no effort to obtain a potable spirit from methylated alcohol has succeeded. A patent has been granted for a process which professes not only to accomplish this object, but to render wood spirit itself potable, and that, too, at a cost almost nominal; and it has afforded matter for earnest discussion among some of our leading pharmacologists, who, anxious to preserve the integrity of medicinal preparations, have not unreasonably been alarmed by the assertion that wood spirit can be so far defecated as to render it almost indistinguishable from vinous alcohol, and by the exhibition of specimens of such spirit which might be used, instead of spirits of wine, for pharmaceutical purposes. But after a series of experiments, Mr. Phillips, of the Revenue Laboratory, has not been able by the process indicated to render either methylated or wood spirit potable, although it was submitted to numerous successive distillations, which from their costliness could not be applied profitably on a commercial scale.

One of the latest Acts passed, Session 1863, was to reduce the duty on rum. It recites that by the Act 18th and 19th Victoria, cap. 38, spirit of wine was allowed to be methylated duty free; and that it is expedient to allow foreign and colonial rum to be methylated, on payment of reduced duty. Rum may now be "methylated" in the Customs' warehouse; but the wood naphtha, or methylic alcohol, or other article to be mixed with the rum, is to be provided by the Inland Revenue Commissioners; and the mixture is to be denominated "methylated spirits," and such spirits may be exported.

Meanwhile, the Inland Revenue returns in 1863 showed a decreased consumption of spirit, from the fact of methylated spirit taking the place of duty-paid or pure spirit. Of the one article of spirit of nitre, very little is sold which is not distilled from "methylated finish." This increased quantity of sweet spirit of nitre sold is not taken medicinally, but is extensively used in the adulteration of potable spirits.—*From Knowledge for the Time, a new work, by the Editor of the present volume.*

THE MOLECULE OF WATER.

Dr. Odling, F.R.S., in a paper read to the Royal Institution, referred to the great change in opinion which had taken place during the last dozen years in relation to this question (of great interest to chemists), to the effect that the Molecule of Water, which had formerly been represented with a single combining proportion of hydrogen, was now most frequently represented with two combining proportions, in conformity with the opinion of Davy, Gay-Lussac, and others. He argued that the question was entirely one of experiment. If the hydrogen of water was experimentally indivisible, then it constituted a single proportion, or an atomic proportion. If, on the other hand, it was experimentally divisible, into two equal parts, it must consist of at least two atomic proportions. He showed that in the case of marsh gas the hydrogen was replaceable in fourths, at four successive stages; and that in the case of ammonia it was replaceable in thirds at three successive stages; whence chemists were unanimous in representing the molecules of marsh gas and ammonia with four atoms and with three atoms respectively. He then contended that the hydrogen of water was replaceable in halves at two successive stages; and that, consequently, its molecule ought analogically to be represented with two atoms of hydrogen. Indeed, the binary replacement was even more decided than the ternary replacement in ammonia and the quaternary replacement in marsh gas. In muriatic (or hydrochloric) acid the replacement of hydrogen took place at one stage only, and, consequently its molecule was represented with but one atom of hydrogen. This series of formulæ is warranted by a very remarkable physical consideration—namely, that with equal volumes of marsh gas, ammonia, steam, and hydrochloric acid, the marsh gas yielded four times as much, the ammonia three times as much, and the steam twice as much hydrogen as was yielded by the hydrochloric acid. Among many other experiments, Dr. Odling exhibited on a large scale the properties of the spontaneously inflammable gas, known as silicated hydrogen, which had been prepared for the occasion by Dr. Martius, the discoverer of the process for its manufacture.

QUALITY OF WATER.

THE quality of water in relation to the arts and to medicine has been very fully considered by M. E. Chevreul in his "Chemical Researches on Dyeing," the thirteenth and fourteenth memoirs of which have been laid before the French Academy of Sciences. Although the employment of distilled water in dyeing has been found to possess many advantages over well-water and river-water, such as that of the Seine (*e.g.*, the first with salts of copper giving an azure tint, which the other will not), yet it is found that, when woollen stuff is passed through steam, the sulphur that is contained in the wool will form with the salts of copper the reddest colour that would have succeeded to the azure-tinted whiteness of the wool. In accordance with the results of many of the researches of the present day, M. Chevreul says that his experiments prove the grave inconveniences of the "absolute" in our judgments. In regard to medicinal waters, he considers that we have been indebted to empiricism for our knowledge of the diverse actions of sulphurous, ferruginous, and alkaline waters in the animal economy. He exemplifies the necessity of accurate analyses by pointing out the errors which have ensued in the preparation of artificial mineral waters. For instance, it has only lately been discovered that some mineral waters contain arsenic. How, then, can a water be prepared without fully comprehending the effect which this ingredient has upon the human system, one which almost certainly would be lost in the imitation? To determine the true action of medicinal waters, M. Chevreul requires that we should know—1, The definite matters or chemical species contained in the water; 2, The influence of the climate in which the water is taken by the sick persons; 3, The change in their habits consequent upon their removal from home; and 4, The influence of their respective idiosyncrasies (their physical and mental peculiarities).

PURIFICATION OF AIR BY THE VAPORIZATION OF WATER.

IN a communication to the French Academy of Sciences, M. Morin states that during his studies on ventilation his attention was especially drawn to the arrangements at the British Houses of Parliament made for purifying the air by steam before permitting it to enter, both in winter and summer. He was led, in consequence, to attribute a salubrious effect in the air to the presence of watery vapour dissolved in the air; possibly due, like the rain in storms, to the development of a small quantity of electricity (conformably to the experiments of Saussure and Pouillet), which modifies the air and produces active oxygen, so efficient in destroying the emanations of decaying bodies and other effluvia. M. Morin accordingly caused experiments to be made at the Conservatoire des Arts, the results of which he considers to favour his opinion, and he accordingly calls upon the medical profession and sanitary commissioners to examine the question.

RAIN-WATER.

THE Rain-water of Paris has been examined by M. Robinet, who collected 118 specimens during the period from March 1, 1862, to September, 1863. On evaporating, the water left a yellowish circle and a white centre, the latter being due to sulphate of lime, existing in the atmosphere of Paris, and the latter to magnesia, possibly conveyed from the sea by winds. This rain-water, when mixed with nitrate of silver, assumed a red colour of various tints, and formed a garnet-coloured deposit, containing silver. M. Robinet states that the nature of the substance producing this coloration is not known.

BROMINE IN THE WATER OF THE DEAD SEA.

ANALYSES of this water by Dr. Roux, of Rochefort, have been reported to the French Academy of Sciences by M. Pelouze, Gay-Lussac, Boussingault, and other chemists, who have examined the water of this great lake, determined that its composition varies within certain extensive limits—*e.g.*, its density ranges from 1·01 to 1·20—an enormous difference. The quantity of solid matters it contains (22 or 23 grammes per litre or kilogramme) is also remarkable; but what is still more deserving of attention is the considerable proportion of bromine it contains (nearly 3 grammes per litre). If bromine should ever become an industrial agent, an inexhaustible source will be found in these waters, in which it exists almost entirely combined with chloride of magnesium. We may remind our non-chemical readers that bromine (so named from *bromos*, Greek for a stench), is a poisonous volatile liquid element, discovered in salt water by Balard in 1826. It has not as yet been found in the free state, but is met with in combination in salt springs, in the ash of seaweed, in sponges, and in many marine animals. As bromide of silver, it is found native in Mexico and Chili, and at Huelgoeth, in Brittany. Very small quantities are found in Silesian zinc ore, and in English rock salt.

ON DISINFECTANTS.

Mr. H. B. Condy has read to the British Association a paper in which he remarks, that the idea of artificial Disinfection by chemical means was not opposed to the operations of nature, since the action of the air in overcoming the foulness which is inseparable from the congregating together of men in dwellings is explainable only by the laws of chemistry. In studying, consequently, the best means of seconding nature in her efforts for disposing of the waste products of organic life, we had only to copy her admirable processes, in order to arrive at the most perfect results. The researches of recent times on the composition and economy of the atmosphere pointed clearly to oxygen, and especially to active or ozonic oxygen, as the chief means by which natural disinfection is accomplished. There were two classes of circumstances in which the auxiliary aid of disinfectants is very frequently required to overcome unwholesome influences—viz. 1, against the deleterious emanations which generally proceed from those labouring under disease, and more particularly when such disease is of a contagious nature; 2, against the taint of organic decomposition. In both these cases, the chemical objects to be kept in view were substantially the same. The infective material in either case is supposed to be an organic compound, declining by successive transformations from a highly complex form towards that state of ultimate repose which belongs to complete oxidation. Its dangerous qualities are dependent on its condition while passing through those steps of transition during which it acted after the manner of a ferment. Disinfectants were of two classes: 1, those which, by fixing the organic matter in a form unfavourable to oxidation, thus reduce to the utmost its tendency to undergo chemical change, and which are more properly designated *antiseptics*; 2, those which more or less rapidly break up the organic matter by producing its oxidation and conversion into imputrifiable products, and which alone are properly designated *true disinfectants*. The advantages possessed by the preparations indicated by the author were thus summed up:—They had no smell whatever of their own, gave off no odorous gas during their operation, and when diluted for use were devoid of perceptible action, except on offensive matter: they were thoroughly efficient and permanent in their effects, disinfecting as well as deodorizing; perfectly safe to use, because not poisonous; not mistakeable for other substances on account of their characteristic colours; capable of being regulated as to quantities required by the depth of colour of their solutions; and applicable in a great number of cases for which no other disinfecting agents can be employed.—*From the Reader*.

A REMEDY FOR DIPHTHERIA.

This affection, which comprises those known under the various names of bad sore-throat, angina, croup, and the French angine couenneuse, has hitherto been considered one of the most difficult to cure.

Dr. Trideau's method consists in administering Storax under the form of a syrup; but we now find in the *Revue Thérapeutique* a paper by Dr. A. De Grand, Boulogne, late French Vice-Consul at Havannah, in which he mentions Ice as an infallible specific As this, from its extreme simplicity, would, if effective, be far superior to any yet tried, we cannot refrain from quoting the cases mentioned by the author, who published this remedy as far back as February, 1860, and consequently complains (not without reason, if its efficacy is such as he describes it) of the inexcusable negligence of practitioners in not taking notice of it, and thereby allowing many valuable lives to be lost. The following cases came under his observation after that date. In March and April, 1861, the disease in question broke out under an epidemic form, and chiefly attacked adults, with such virulence that in one week three young women died in a single house. One of De Grand's patients afflicted with blephacite was seized with it, and as he could not immediately attend, owing to the severity of the case another physician was called in, who ordered emetics and aluminous gargles, which produced no effect. At length Dr. De Grand came, and found the tonsils greatly swollen, and a false membrane covering them. He immediately administered small pieces of ice, and by the following morning the tumefaction of the tonsils had diminished by half, and the false membrane had nearly disappeared That very evening the woman was enabled to take food. A few days after her brother was seized with sore throat, presenting the same preliminary symptoms as those of his sister: but he, profiting by this example, without waiting for the doctor, at once took ice, and was rid of his sore throat in a few hours Some days later Dr. De Grand was summoned to a young lady who had been labouring under the disease for the last forty-eight hours; all remedies had failed, and the parents, relations, and friends of the family were plunged in the deepest sorrow. When Dr. De Grand ordered ice a general cry of astonishment was uttered by all present. Ice for a sore throat! Impossible! it was sheer murder! Dr. De Grand maintained his ground, and after much expostulation, during which much time was lost, he obtained his end Before twenty-four hours were over the patient was in full convalescence. Being at Vera Cruz on a mission, he was requested to see a young man who was attacked with malignant sore throat, and had been treated without effect by cauterizations with hydrochloric acid and astringent gargles Here again he had to battle with the prejudices of the family, but was at length allowed to administer ice. The young man recovered in the course of the following day. Dr. De Grand, it is confidently stated, has now been using this remedy for the last twelve years without having met with a single failure. Cold gargles have been employed with success by Dr. Blanc, of Strasburg: why not ice? —*Galignani's Messenger.*

PURE PEPSINE.

PEPSINE may be precipitated from its solutions by agitation with cholesterine, with phosphate of lime, or even with animal charcoal. Dissolved in water containing phosphoric acid, it may be precipitated when we neutralize by lime water, it is then contained in the precipitate of phosphate of lime, without always being found in a state of combination. On these facts M. Brucke has founded a new process of procuring this important substance in a state of purity hitherto unknown, which has enabled him to correct a number of assertions respecting it to be found in treatises. The details of his process for obtaining it from the mucous membrane of the stomach of a pig will be found in the *Journal de Pharmacie*, where it is said that our notions respecting pepsine

ought to be changed, and that its analysis is yet to be made.-
Illustrated London News.

QUININE.

INDIAN Quinine has at length been produced, through the able exertions of Mr. Clements Markham, now of the India Office, as detailed in his interesting travels in Peru and India. Specimens of bark grown in India of only two years' growth have been analysed, and found to contain very white crystals of sulphate of quinine and other febrifuge alkaloids in as large a proportion as the barks from South America. This fact is of immense social importance to Europe, as the scarcity of quinine is daily becoming more severely felt. It will also undoubtedly give an impulse to the planting of the cinchona trees in India, and thereby tend greatly to promote the prosperity of that part of the British empire.

BILE.

THE presence of cholesterine (the fatty matter of bile) has been determined in various vegetables by M. Beneke. He states that, after suspending the hard yolk of egg, cerebral substances, veal-jelly, and other substances of an animal origin, for thirty-six hours in alcohol, at a temperature of from 30 to 40 degrees cent., by after-treatment M. Virchow obtains a substance which he has named "myeline." M. Beneke shows that this substance always contains cholesterine, and proceeds to show that it is to be found in several vegetables, especially peas, in several species of grain, and even in olive oil. M. Beneke is continuing his researches on this interesting subject.—*Journal de Pharmacie.*

PHOTOGENIC GAS.

SOME decisive experiments have been made at 95, Bishopsgate-street, with Mr. Mongruel's patent cold vapour regenerator, an invention for the production of a brilliant and economic light from ordinary gas or atmospheric air. The Photogenic Light was invented by M. Mongruel in the beginning of 1862, and it is stated to be already adopted in several of the large towns of France, and in many of the largest cafés and establishments of Paris. It was, moreover, reported on by a Commission appointed for the purpose by the Société des Sciences Industrielles, Arts et Belles Lettres of Paris in October, 1863, and the results of their inquiry are thus stated :—1. That there is a guaranteed reduction of 50 per cent. at least in the consumption of gas to give an equal light. 2. Or, with an equal consumption, there is a luminous intensity double or treble that of the primitive light. 3. Whiteness, regularity, and tranquillity of the flame, which, softer to the sight, fatigues less in reading or working. 4. Purification of the gas from its pitchy or naphthaline atoms, from its ammoniacal vapours, and the sulphurous acids it carries with it from the factory.

5. Consequently, preservation of paintings, varnish, gilding, and delicate colours, which, in establishments lighted by gas are so promptly attacked by these mordant agents. 6. Complete absence of odour and smoke. 7. Lastly, real advantages for the consumer, to whom the inventor guarantees, all expenses paid, 25 per cent. of positive economy on his habitual expenses for gas-lighting. The first experiment was made upon the ordinary gas in use in that part of the city. This gas, when passed through the generator containing the liquid used by M. Mongruel, acquired a vastly increased illuminating power, while the flame of the jets was purer, softer, and steadier. But though the light was more intense the expenditure of gas was less, for, tested by a gas-meter and chronometer, the consumption given was in the proportion of 6 to 10, which is equivalent to a saving of 40 per cent. The next and the most interesting experiment was made upon atmospheric air, which, when passed through the apparatus and liquid, burned with a beautiful clear and steady light. Some idea of the brilliancy of this light may be obtained when it is stated that as measured by a photometer one jet of the ignited air gave more illuminating power than four jets of ordinary gas of equal size. As far, therefore, as the experiments were concerned, nothing could be more complete and satisfactory. What was wanted, and M. Mongruel appears to have succeeded in inventing, is an apparatus which will produce a constant vapour, always equally rich in carbon, so that the light is at all times the same. In all other apparatus used for the purpose, the generation of the vapours being effected in the mass of the liquid contained therein, the most volatile parts of the liquid naturally first escape, thus impoverishing the remainder, which daily gives less and less light, until the light disappears altogether, while a considerable quantity of the liquid is still left in the apparatus. In M. Mongruel's generator, on the contrary, the mass of the liquid is enclosed hermetically in an upper chamber, whence it descends by a small tube, to form a thin sheet on the bottom of the lower chamber, wherein its vaporization is effected, and is supplied drop by drop, only as what has preceded it is consumed.—*Abridged from the Mechanics' Magazine.*

RESEARCHES ON OZONE.

THE new facts elicited respecting Ozone, during the past year, have been numerous and important.

M. Ramon de Luna announces in the *Annales de Chimie* the following easy method of preparing Ozone. He asserts that, whenever chemical reaction takes place in atmospheric air, the oxygen is ozonized, and that, moreover, paper rendered blue by ozone is completely decolorized in an atmosphere of hydrogen. To prepare ozone it is only necessary to fill a bottle with ordinary oxygen, and to pour in some concentrated solution of caustic potash, and then a little strong sulphuric acid · the paper is turned blue in a moment, and the odour of ozone will be perceived. M. de Luna suggests that the paper is bleached when placed in hydroen by the formation of hydriodic acid, which is again decomposed by the ozone when the paper is returned to the ozonized air. The influence of ozonized air upon animals is stated by Dr. Ireland, in the *Edinburgh Medical Journal*, to be as follows :—I. Ozonized air accelerates the respiration, and, we may infer, the circulation. II. It excites the nervous system. III. It promotes the coagulability of the blood, probably by increasing its fibrine. In the blood, however, ozone loses its peculiar properties, probably entering into combination with some of its constituents. IV. Animals may be subjected to the influence of ozone for some hours without injury, but in the end it is likely to destroy life.

The action of Ozone on organic substances has been examined by M. Gorup-Besanez. From an analysis of his paper (in *Wöhler's Annalen der Chemie*), given in the *Chemical News*, we select a few points which support the conclusion of the author on the analogy which seems to exist between the reactions of ozone and the combustion in the animal organism. He found that a watery solution of pure uric acid, with the addition of a few drops of potash, absorbed ozone, with a continuous disengagement of ammonia. Urea also quickly absorbed ozone, disengaging ammonia in the presence of potash. Grape sugar was not attacked by ozone; but, in the presence of soda, potash, or carbonate of soda, it was entirely transformed into carbonic and formic acids. Cane sugar oxydized much more slowly, forming the same products. The fatty volatile acids which resisted the action of ozone were burnt slowly and continuously in the presence of alkalies; and solid fatty acids, such as stearic and palmetic acids, were attacked very slowly, even when accompanied by an excess of alkali. Carbonic acid was immediately formed, but no fatty acid, containing a less number of carbon equivalents. Ox-bile, purified chemically, absorbed large quantities of ozone; and, at whatever stage of the reaction the liquid was examined, there was only found in it carbonic and sulphuric acids besides the undecomposed acids. Gelatine, by the action of ozone, was wholly transformed into a body with altogether different properties, not being in the form of a jelly.

M. Poey, of the Havannah, has communicated to the French Academy of Sciences an account of his experiments showing the production of Ozone in the vegetable kingdom. On the 1st of April last, at three o'clock p.m., he placed under a cylinder of glass, eighty centimetres high and twenty-two centimetres broad, an aromatic shrub (*Psidium aromaticum, govavier*) and some stalks of other plants which abundantly produce essential oils. The lower extremity of the cylinder was solidly fixed in the earth and covered with wet mould. The upper end of the cylinder was closed with a sheet of white paper, securely glued After having previously placed within the cylinder several bands of ozoscopic paper, the whole was hermetically closed, so that not the smallest quantity of air could penetrate into the interior. For the first twenty-four hours, the cylinder having been exposed towards the north in a very strong light, but sheltered from the solar rays from the south, all the paper reagents remained entirely white; only on the internal surface of the cylinder watery vapour was deposited. In the next twenty-four hours M. Pocy strongly wetted the soil, so as to cause great evaporation, and exposed the cylinder to the direct solar rays; but no action appeared. On April 4 he took off the paper cover, when a strong aromatic effluvium was disengaged. Then, without in any way altering the position of the cylinder, the plants were left uncovered, and in about an hour (at one o'clock p.m.) the ozonoscopic paper had taken a slight coloration; at sunset it was already blackening, and at half-past seven it had acquired a most intense colour. Other experiments confirmed the facts. Dried leaves and branches produced much less ozone than green ones, and the quantity varied with different plants, according to their nature, in proportion as they exhaled more or less essential oil, &c. These experiments seem to prove that neither the action of light, humidity, nor of the small quantity of air contained in the cylinder sufficed to colour the paper reagent, which only became sensitive when exposed to large masses of the circumambient air.—*Illustrated London News.*

Mr. W. C. Burder gives the following hints:—1. There are certain conditions of atmosphere when the test-papers lose some of their colour before the regular hours of observing. Occasional supernumerary observations should therefore be made as a check. 2. There are some occasions when the amount of ozone much exceeds "10" (the maximum amount of colour), in the interval between the hours of observation, unless these are very frequent. The obvious remedy is to renew the test-papers and multiply the number of observations on such occasions, particular care being taken to avoid errors from this source when the mean amount is deduced. 3. In all the scales I have seen which are sold with the boxes of Schoubein's papers, the tints are very badly graduated. Tint "5" for instance, instead of being half of "10," is often not one-third of it. It is feared that this error will seriously interfere with comparisons of the amount of ozone at various stations hitherto; and it is of the utmost importance that this should be altered for the sake of the future.

Mr. Burder, writing in September last, says that "the wind which has recently come over the sea invariably or almost invariably brings with it a large amount of ozone, while a land breeze usually yields but a small amount. A strong W.S.W. wind here [at Clifton] is always charged with a large quantity of ozone, while other winds are generally but slightly charged with it, and such as have passed directly over the city of Bristol are altogether free from it. A recent visit to Sidmouth, on the south coast, has quite confirmed my previous notions in regard to sea breezes and ozone, and I may mention that a correspondent in New Zealand, to whom I sent some test papers, assures me that he has obtained similar results in that island. Facts such as these, now satisfactorily proved, may help us in our endeavours to ascertain the truth in reference to this rather mysterious agent, which, in addition to its interesting nature in a meteorological point of view, is generally considered as of importance in regard to health."

M. Soret's Researches on Ozone (second series), laid before the French Academy of Sciences, include certain new experiments endeavouring to find out the reason of the extraordinary fact remarked by Andrews and Tait, of Belfast, that electrified or ozonized oxygen increases in volume when brought to the state of ordinary oxygen, showing that the density of ozone is much greater than that of oxygen. M. Soret has fully confirmed the statements of the above-mentioned chemists. He has seen the oxygen notably increase in volume when deozonized by heat; and he affirms, moreover, that this increase is proportional to the quantity of ozonized oxygen absorbed by the iodate of potassium brought in contact with it. He is also convinced that ozone is only an allotropic condition of oxygen.

SPECTRUM OF HYDROGEN.

M. LECLANCHE has communicated to the Chemical Society of Paris a memoir on the Spectrum of Hydrogen. He remarks upon the coincidence of three bands—red, green, and blue—with the three lines, C, F, and a secondary one near G, of the solar spectrum, and he considers that these lines are due to hydrogen and not to metals. This is remarkable, as the line, if we remember rightly, is strongly persistent in many stellar spectra.—*From the Reader*.

ODOUR OF PRECIOUS STONES.

FOURNET discovered that many precious stones owed their colours to carburets of hydrogen. In 1855 J. Schneider, by analysis, confirmed this discovery. In a note recently inserted in *Poggendorff's Annalen*, Schneider calls the attention of mineralogists to the empyreumatic odour which certain forms of quartz and granite give forth when rubbed. He thereby perceives the indication of the presence of organic matter or a carburet of hydrogen.—*Cosmos*.

ATMOLYSIS, A NEW METHOD OF ANALYSIS OF GASES.

MR. T. GRAHAM (the Master of the Mint) has forwarded to the Imperial Academy of Sciences at Paris a memoir on the motion of Gases in their passage under pressure through fixed porous plates, and the partial separation of mixed Gases which may be obtained by such means. In his important researches on diffusion, published in 1834, he made use of a "diffusiometer," formed of a cylindrical tube of glass a little less than an inch in circumference, and about ten inches in length, one of the ends of it being stopped with a plate of plaster-of-Paris about one-third of an inch in thickness, whereby it was converted into a species of test for gases. Mr. Graham now employs plates or the porous graphite or plumbago, artificially prepared by the late Mr. Brockedon. When the tube is being filled with hydrogen the porosity of the graphite is checked by means of a thin plate of gutta-percha. When this is removed the gaseous diffusion immediately begins through the pores of the graphite, and in forty or sixty minutes the whole of the hydrogen has escaped through the diffusiometer, and is replaced by a volume of atmospheric air much less considerable (about one-fourth), conformably to the law of the diffusion of gases. During this time the mercury in the tube rises several inches, giving a most striking proof of the intensity of the force by which the reciprocal penetration of the gases is effected. Our space will permit us to give only some of the new results obtained by Mr. Graham. He shows that the rapidity of the passage of gases into a vacuum depends on their specific weight. A gas falls into a vacuum with the velocity acquired by a heavy body when falling from an atmosphere composed of the gas in question, supposed to be everywhere of a uniform density. The height of this uniform atmosphere will be in an inverse ratio to the density of the gas. An atmosphere of hydrogen, for example, would be sixteen times higher than one of oxygen. If the swiftness of the effusion of oxygen be represented by 1, that of hydrogen will be expressed by 4 (the root of 16). This law has been submitted to experimental verification, and is quite analogous to that which regulates molecular diffusion. But the phenomena are essentially different. The swiftness of the effusion of a gas is many thousand times greater than that of diffusion. The swiftness of the effusion of air is as rapid as that of sound. The partial separation of a mixture of gases and vapours of different degrees of diffusibility, effected by permitting them to diffuse themselves through a plate of graphite into a vacuum, is thus a new method of analysis, which Mr. Graham proposes to name "atmolysis," and which possesses a practical character susceptible of very extensive applications. The separation is much more considerable when the pressure is greater and attains its maximum, in permitting the gases to diffuse themselves in a perfect vacuum. A great many experiments have been made in relation to this, the most interesting being the concentration of oxygen in atmospheric air by means of an "atmolyzing tube." The molecular or diffusive mobility exercises a certain influence on the heating of gases by contact with heated liquid or solid surfaces. The more rapid the molecular movement of a gas is, the more frequent will be the contact of the molecules and the quicker will be the communication of the heat. To this is probably due the greater cooling power of hydrogen as compared with that of oxygen, or air, as was observed by Dalton, who also attributes this property of hydrogen to its mobility.

OXYDIZATION.

A POWERFUL Oxidizing mixture has been made known by a Dutch chemist, M. Bœttger. It is formed by a mixture of three parts of oil of vitriol and two parts of permanganate of potash. Ether, alcohol, essential oils, and other inflammable bodies are fired by mere contact; and sulphur is oxydized to sulphuric acid with a rustling noise. If a small portion be placed in a flask, the air in it is instantly ozonized.

ATMOSPHERIC OXYGEN.

THE agency of Atmospheric Oxygen in the destruction of dead animal and vegetable matters has been closely examined by M. Pasteur, who has laid before the French Academy of Sciences the results of his experiments. These essentially consisted in abandoning certain very alterable organic substances, such as urine, milk, damp wood shavings, and albuminous matters for a longer or shorter period of time to the contact of air deprived of the germs of the lowest organisms. Those substances not only did not putrify or ferment, as M. Pasteur had already shown, but they underwent a very insignificant oxidation. After several years of exposure to a temperature between 77 deg. and 84 deg. Fahr., the oxygen in the vases was not entirely consumed, and in some cases only a very small quantity had disappeared. M. Pasteur then repeated the same experiments with the same conditions, but under the influence of the development of the germs of the smallest infusorial animalcules, and in the course of several days all the oxygen had disappeared, having been replaced by carbonic acid. These little beings, he therefore concludes, are the principal agents in the slow combustion of animal and vegetable organic matters. The energy of their action is sometimes very extraordinary, as in the case of the combustion of alcohol by the mycodermes, made known by M. Pasteur about a year ago. These experiments, he considers, give the final blow to the doctrine of spontaneous generation and to the modern theory of fermentation.

M. Donné has reported to the French Academy of Sciences a series of experiments on eggs, some being exposed to the action of the atmosphere, others protected from it. In the uncovered eggs, at the end of eight days, a powerful microscope revealed the growth of numerous filaments of penicillium, accompanied, when the weather was warm, by a kind of compound fructification of yellow bodies, accompanied by other changes. The protected eggs remained perfectly unaltered for weeks, but when once the eggs were brought into free contact with the air decomposition proceeded with great rapidity, with its usual accompaniment of infusorial and microscopic beings. M. Donné gives many details which prove the absolute necessity of the intervention of the germs present in the atmosphere in order to give birth to these minute beings.—*Illustrated London News.*

CARBONIC ACID IN PLANTS.

THAT the Leaves of Plants exhale Carbonic Acid during the night is well known. M. Corenwinder has reported to the French Academy of Sciences the results of experiments made by him, showing that this exhalation varies in quantity according to the temperature, and ceases, or very nearly so, when the thermometer stands at zero. In artificial darkness during the day the leaves exhale more carbonic acid than in the night, because the temperature is more elevated. The young leaves do not possess this property, but acquire it as they grow in size. The full-grown leaves never exhale carbonic acid in the daytime in the open air where they receive the lights from all parts, but they do so abundantly when they are removed into an apartment and not exposed to the rays of the sun. One day M. Corenwinder applied his collecting apparatus to a nettle which he had planted in a flower-pot. The weather was cloudy, and the temperature varying from 15 to 18 deg. cent. From morning till midday not the slightest disengagement of carbonic acid was observed, but when the plant was removed into the laboratory (an apartment lit by side windows which were opened) the leaves began to exhale carbonic acid in a very short time, and in the evening a considerable quantity of carbonate of barytes had been formed in the baryte water employed as a test. M. Corenwinder found that the leaves coloured red, brown, purple, &c., possess the same property as the green leaves.

CARBONIC ACID IN THE AIR.

M. MENE has forwarded to the French Academy of Sciences the results of his observations on this topic in a series of tables, from which he derives the following conclusions —1. During the whole year carbonic acid does not exist in the atmosphere in the same quantity. 2. During December and January, the gas in the air is nearly in an equal quantity; the amount increases in February, March, April, and May, but diminishes from June to August, an increase takes place from September to November, and in October it attains its maximum for the year. 3. There is more carbonic acid in the air during the night than in the day. 4. There appears to be a slight oscillation in the amount during the day, a small increase being observed towards midday. 5. The amount of carbonic acid in the air is generally found to be greater after the fall of rain than previous to it.

ABSORPTION OF GASES BY CHARCOAL.

THIS is the subject of a paper by Dr. R. Angus Smith (so eminent for his method of testing the purity of the atmosphere) in the *Proceedings of the Royal Society*. His observations show that—1. Charcoal absorbs oxygen so as to separate it from common air, or from its mixtures of hydrogen and nitrogen, at common temperatures; and, 2, that charcoal continues this absorption for at least a month, although the chief amount is absorbed in a few hours, sometimes in a few seconds, according to the quality of the charcoal. 3. It does not absorb hydrogen, nitrogen, or carbonic acid for the same period. 4. Although the amount absorbed is somewhat in the relation of the condensibility of the gases by pressure, this is not the only quality regulating the absorption of oxygen at least. 5. When it is sought to remove the oxygen from charcoal by warmth, carbonic acid is formed, even at the temperature of boiling water, and slowly even at lower temperatures. 6. Charcoals differ extremely in absorbing power and in the capacity of uniting with oxygen, animal charcoal possessing the latter property in a greater degree than wood charcoal. 7. Nitrogen and hydrogen, when absorbed by charcoal, diffuse into the atmosphere of another gas with such force as to depress the mercury three quarters of an inch. 8. Water expels mercury from the pores of charcoal by an instantaneous action. 9. The action of porous bodies is not indiscriminate, but elective.

PHENOMENA OF PUTREFACTION.

M. PASTEUR, *imprimis*, says :—"Whenever animal or vegetable matters change spontaneously and develop fetid gases, it is called Putrefaction. This definition has two opposing defects : it is too general, since it brings together phenomena essentially distinct ; it is too restricted, since it separates others which have the same nature and origin" M. Pasteur has been led to investigate these phenomena in connexion with his researches on fermentation, especially in relation to the putrid diseases so painful to humanity. The most general consequence of his experience is very simple—that putrefaction is determined by organized ferments—the animalcules of the genus Vibrionia, which, as has been before shown, can exist without free oxygen gas. We have no space for the details of the interesting experiments, which have led M. Pasteur to say that "the putrescible liquid becomes the seat of two kinds of very distinct chemical action which have correlation with the physiological functions of the two kinds of beings which are nourished by them. The vibriones, on the one hand, which live without the co-operation of the oxygen of the air, determine in the interior of the liquid acts of fermentation ; that is to say, they transform nitrogenous matters into products more simple, yet still complex. The basteria, on the other hand, consume these latter products, bringing them back to the state of the most simple binary compounds—water, ammonia, and carbonic acid. When the body of an animal is abandoned after death, whether in contact with the air or sheltered from it, all the surface is covered with dust—that is to say, with the germs of inferior organisms. Its intestinal canal, where fecal matters are formed, is filled, not only with germs, but with fully developed vibriones, as was seen by Lewenbroeck. These vibriones are much more advanced than the germs on the surface of the body. They are in the state of individual adults deprived of air, immersed in liquids, and possessing the means of multiplication and function. They begin the work of putrefaction in bodies which have not been preserved by life and the nutrition of the parts. M. Pasteur does not consider gangrene to be putrefaction, but rather an organ, or part of an organ, preserved from putrefaction, in spite of death, by the liquids and solids reacting chemically and physically, independent of nutrition. He compares gangrene to the ripening of fruit after it has been taken from the tree which bore it.—*Illustrated London News.*

FERMENTATION.

A NEW example of Fermentation, due to the presence of infusorial animalcules which are able to live without free oxygen and without any contact with the air, has been laid before the French Academy of Sciences by M. Pasteur. We have not space sufficient for the details of the experiments narrated in the *Comptes Rendus*, but give merely the general conclusions. "It is permitted to us to comprehend with what facility may be produced a spontaneous fermentation of tartrate of lime, when special care is not taken to exclude the germs disseminated in the atmosphere or in the dust deposited by the air on all objects; and we can also comprehend the fermentation of tartrate of lime in liquid freely exposed to the contact of air, provided that the thickness of the liquid layer be sufficient; but it is now affirmed that at the surface are multiplied the infusorial animalcules which consume the oxygen gas, and give off carbonic acid; while in the deposit and in the midst of the liquor are developed animals which do not require the oxygen for their existence, and which are preserved by the former animals from its injurious contact. There is no necessity for artificial methods for excluding the oxygen from the liquids. Its abstraction is effected before fermentation begins." M. Pasteur promises to devote further consideration to the products of the fermentation of the tartrate and lactate of lime; the chemical composition of the infusoria; and a kind of fibrin which accompanies them; as well as colouring matters.

WHO DISCOVERED PHOTOGRAPHY?

AT the meeting of the London Photographic Society, on Nov. 3, 1863, Mr. Smith, Curator of the Museum of Patents, at South Kensington, detailed the discovery of certain sun-pictures taken at the close of the last century, the existence of which up to the present time affords sufficient evidence of their durability.

It appears that in clearing out the old house of Matthew Boulton, at Soho, near Birmingham, half a century after his death, in 1809, whilst removing a vast collection of documents, there were found a number of crumpled and folded sheets of paper, with pictures on them of a most puzzling kind. They were found to consist of copies, on large sheets of very coarse foolscap paper, of certain well-known designs by Angelica Kauffmann;

the porous water-marked paper being thickly coated with some varnish-like substance, on the surface of which the picture had been produced.

These sheets, as well as others subsequently discovered, presented the same characters—a glossy surface, with minute varnish-like cracks; the drawing of the figures most elaborately finished, the lights and shades so fully rendered, as to give much of the effect of a mezzotint; and an invariable reversal of the position of the figures. These paper-pictures were sent to London, and submitted to the best authorities on the subjects of drawing and painting, when they were pronounced to have been produced by some process entirely different from any previously seen, and certainly not to have been done by hand. This led to immediate search being made for any more of the pictures that might exist; also to inquiries among the oldest inhabitants, for any one who had lived at Soho in the time of Boulton, and could supply information respecting them.

In a broker's shop were found several more of the pictures, which had been brought from the house at Soho as waste paper. One of these represented a large figure-picture by West, and was on two sheets of paper, each about 2 ft. by 18 in., intricately cut at the joining-place, so that the line of union might fall at the edge of a shadow, and not be perceived when the two halves were put together to form the complete picture. Further research at Soho also led to the discovery of a couple of silvered metal plates, each about the size of a sheet of note-paper, precisely resembling in appearance those used by Daguerre in the early days of photography. On each of these plates was a faint image of the house at Soho, so unmistakeably taken from nature, and so evidently produced by the aid of light, that all experts of any authority at once pronounced them to be photographed pictures taken directly by means of a camera. Attached to these plates was a memorandum stating that they were sun-pictures representing the house prior to certain alterations made in 1791. Following out their search as to the means by which these pictures were produced, the investigators learnt that there had once been found a camera in Boulton's library, answering in description to the kind of instrument required for plates of this size. Unfortunately, this had been given away, and great was the hunt to find some traces of its subsequent career. But the discovery of the recipient of the treasure did not much help matters, as he had subsequently lost it during a removal. So the search is still going on. Not very long ago, there was living an old man who had for many years been employed at Soho, and who related how the wise men used to come there at each full moon,* and used to sit very late

* This was the famous body called the Lunar Society, which included among its members the chief scientific men of the day, who held their meetings on the night of every full moon. It is reasonable to conjecture that many matters, scientific and otherwise, were discussed at the meetings of such eminent men, other than are set down in the meagre records of the transactions of the Lunar Society.

at night; and that he remembered Mr. Boulton and some of them once took a picture of the house, and had to go into a dark place during the process.

So far the evidence as to the metal plates, which, if substantiated, will go far to prove that the discoveries of Niepcé and Daguerre were anticipated by Boulton. It may possibly prove more; for the resemblance between these plates and the early productions of Daguerre is really marvellous if only accidental, and if no link be found to connect the two processes. But the further evidence already obtained as to the pictures on paper discovered at Soho, presents quite a tangle of curious circumstances. From invoices and other office-papers, all bearing date about the end of last century, it is evident that these pictures, however produced, were actually sold at Soho in large quantities, and at low prices. The demand for them was great, and considerable pains appear to have been taken to prevent the method of their production becoming generally known. So there must exist a large number of them at the present time, scattered through various collections and portfolios. The glazy surface, the porous, rough, water-marked, foolscap paper, bearing Whatman's impress and the reversed figures, will distinguish them; for their appearance on cursory examination very much resembles that of the common coloured mezzotints which our grandsires so much affected.

It appears that Sir William Beechey painted Boulton's portrait about 1794, the picture being subsequently exhibited at the Royal Academy. He was horrified on being shown a number of paper pictures, similar to those recently discovered, and he got up a petition signed by a number of artists, and presented either to or through the Lunar Society, entreating that the manufacture of these pictures might be stayed, as it would inevitably ruin the picture trade. A sort of foreman of Boulton's, named Edginton, appears to have superintended the production of these pictures, if he did not actually discover the process by which the transfer to paper was done. Several of his letters are extant referring to the subsequent colouring which some of the pictures underwent; none of them, however, afford any clue to the original method of their production. But a little later, and after the alarm was taken by the artists, we find a talk of granting Edginton a Government pension. This fell through because of a curious autograph letter of Matthew Boulton's which has been fortunately found. In this letter, officially addressed to the minister, he claims for himself the discovery of the process on account of which Edginton's annuity had been contemplated; he intimates his knowledge that the grant was only intended to ensure the discontinuance of the process, suggests that he could arrange this in a much more certain way, and concludes his letter with a strong hint that he is open to be dealt with. Whatever ensued as the result of this letter, it seems very clear that the production of the pictures was thenceforward discontinued.

Here the evidence comes to an end so far as regards these curious paper pictures, and the silvered plates which the highest authorities refer to about the year 1791. In this same year, Thomas Wedgwood, son of the famous potter, was certainly at work on photography, as is shown by his bills and orders for apparatus and chemicals. At the meeting of the Photographic Society there was exhibited, side by side with the above-mentioned plates, a photograph of a neatly-laid breakfast table, taken upon paper by Wedgwood, and the information about it tended to the conclusion that it also was done in the year 1791. Thus far we have written the history of this curious discovery in accordance with the evidence laid before the Photographic Society; but still there are many links wanting before it can be taken as proved that the pictures found at Soho were produced by photography. If it shall be shown that they were so produced, then it will also be established that at that time photographic feats were done which we cannot now-a-days accomplish. For it has been proved by chemical analysis that these pictures do not contain a trace of silver, and must therefore, if of photographic origin, have been produced by some process that has been lost to us. That an art promising such great results should have been suffered to die out, is in itself curious in these days of diffusion of knowledge; but still more remarkable is the double coincidence existing between the independently produced metal and paper photographs of Boulton and Wedgwood in 1791, and of Daguerre and Fox Talbot in 1839.—*Abridged from the Saturday Review*, Nov. 7, 1863.

PHOTO-MICROSCOPIC STONES.

THE Abbé Moigno has exhibited and explained to the British Association the Photo-microscopic Stones, executed by M. Dagron. Sir David Brewster was the philosopher to suggest the possibility and mode of producing these very interesting and curious works of Art by which in the small compass of a stone capable of being set in a ring and worn on a lady's finger, when the stone is looked through at strong light the most interesting groups taken by Microscopic Photography can be distinctly seen. The Abbé exhibited several very beautiful specimens of this new art executed by M. Dagron.

PHOTOGRAPHY OF COLOURS.

M. NIEPCÉ SAINT-VICTOR has for a long time occupied himself with the very interesting subject of the reproduction of colours by Photography. Some time since he announced to the scientific world his success in obtaining red, blue, and green; but, at the same time, he confessed that to obtain a yellow tint in combination with others was a matter of extreme difficulty, if not at that time practically impossible to him. Of course, there was nothing at all surprising in this, as every one knows that yellow is most troublesome even in ordinary photography. However, M.

Niepcé has announced to the French Academy of Sciences that he has at last succeeded in reproducing yellow tints by preparing his silver plates in a bath composed of hyperchloride of soda instead of potash, and he produced specimens which are said to hold out great expectation of complete success. He had not yet, however, succeeded in absolutely fixing the colours; they remain perfect so long as the plate is kept in the dark, but soon disappear when exposed to the light. But in this respect, also, M. Niepcé has made important progress; for, by the application of gum benjamin as a varnish to the plate, he has managed to retain the colours for three or four days even when exposed to the full glare of a July sun.

The memoir read before the Academy by M Niepcé certainly contains much interesting matter. Amongst other things, he has discovered that all compound colours are decomposed by the heliochromic process. The examples given are highly interesting—for instance, if a natural green, such as that of the emerald, of arsenite of copper, of oxide of chromium, sulphate of nickel, or carbonate of copper, be presented, it is reproduced on the plate, but, if the green be a compound formed, for instance, of chrome yellow and Prussian blue, that of a textile fabric dyed with a mixture of the two latter colours, or that produced on glass in a similar manner, it produces a blue colour in whatever manner it is treated. Moreover, when transparent blue and yellow glasses are used, so as to produce a green, it matters not whether the blue be before or behind or placed between two glasses of the other colour, the effect is invariably the same; no matter how long they are exposed to the light, the product is always blue. An orange effect produced by the combination of red and yellow glasses produces invariably red. A red and blue glass together produce at first a violet, because the plate itself is red, but the result is blue. White paper coloured green by means of the recently-discovered Chinese green, made from the juice of the buckthorn, has but a sluggish action upon the heliochromic plate, but, after a long exposure to the light, a blue-grey is produced, and the same effect is obtained from foliage of a grass-green colour in the camera; but bluish-green foliage, such as that of the leaves of the dahlia, produces a tint that is almost positive blue. The eye of a peacock's feather is well rendered in the camera, the tints appearing to vary between blue and green.

Apart from photographic purposes, the experiments of M. Niepcé Saint-Victor promise to be of considerable assistance in the analysis of the solar spectrum; for it is evident that his attempts to fix the colours of nature on a heliochromic plate go far to confirm the new theory which recognises the existence, not of three, but of seven primitive colours—namely, violet, indigo, blue, green, yellow, orange, and red. The actual value of M. Niepcé's discoveries, in an artistic point of view, cannot be calculated until the results are placed before the world in a practical form; but the interest which they possess for the artist as well as the man of science is undeniably great.

THE SUN PHOTOGRAPHING WITH PRINTERS' INK.

MR. JOHN POUNCY, of Dorchester, who was awarded a silver medal and 400f. for his "carbon process" by the Photographic Society of France, has taken out a patent for an important improvement, by which he has brought ordinary printers' ink into the service of photography. This ink is mixed with certain chymicals, and spread completely over the paper intended to be submitted to the action of the rays of light through a "negative;" and the secret consists in rendering it so sensitive that an indelible photograph may be fixed on the paper, leaving the other portions so free as to be easily washed off. The time required for exposure is comparatively short, and the advantage is, besides that of permanence, the fact of the subject being fixed, developed, and, as it were, completed without the various manipulations required under the old system. The superfluous ink is removed by spirits in ten minutes or a quarter of an hour, displaying a picture for delicacy of tone, beautiful gradation of light and shade, and minuteness of detail fully equal to anything heretofore obtained in photographic printing.

By this process photographs are literally and at once imprinted directly from negatives with printer's ink on paper by the sun. Zincography was a notable enough step towards sun-printing with printers' ink; but in that more circuitous and indirect process *the sun* does *not* print upon paper with printers' ink; whereas, in this case, the ink takes the place of nitrate of silver and everything else whereby surfaces have heretofore been made sensitive; so that the process is a direct operation of the sun itself with printers' ink on paper. We have seen photographs done by Mr. Pouncy in this way· really, they are surprisingly clear and distinct, with good half tints; and, although we have seen finer photographs, the process is not only a promising, but a highly important one, for hereby we obtain permanent solar imprints.—*Builder*.

REPRODUCTION OF ENGRAVINGS, ETC., BY THE AGENCY OF LIGHT.

M. MORVAN has reported the following process to the French Academy of Sciences:—On a lithographic stone, which has been coated in a dark place with a varnish composed of albumen and bichromate of potash, he places the right side of the picture to be reproduced, whether it be on glass, cloth, or paper. The stone is then exposed to the action of light for from thirty seconds, to two or three minutes only, if it be placed in sunshine; but for from ten to twenty-five minutes more if it be in the shade. At the expiration of that time, he takes off the picture and washes the stone—at first with soapy water, and then with pure water—and immediately afterwards he inks the stone with a printer's roller. The design is already fixed, for the image begins to appear black on white ground. It is then covered with gum, and the operation is finished. The light has fixed the varnish and rendered it insoluble wherever it has struck it; but all the parts of the stone shaded by the picture have remained soluble, and consequently liable to be attacked by the soda and acid, besides retaining the substance of the soap. The action here produced on the stone is applicable alike to engraving and lithography. The advantages of the process, according to M. Morvan, are simplicity and rapidity of the operation; exactness of the reproduction; no need of negatives; the model positive is obtained positive and preserved absolutely intact and immaculate; it possesses solidity at least equal to that of engraving on stone properly so called; and, finally, extreme economy of the process, due to the moderate price of the substances employed.—*Illustrated London News.*

PHOTOGRAPHIC WASTE PAPERS.

A PROCESS for their utilization is described by M. A. Davanne, in the *Répertoire de Chimie.* The papers are first burnt in the laboratory furnace, and the ashes left without stirring for several hours in order that all the carbon may be consumed. They are then weighed, and ten parts of these cinders mixed with five parts of dried carbonate of soda, and from two to one and a half of sand, subjected to an elevated temperature, produces readily granules of silver; and the drop thus obtained dissolves readily in nitric acid diluted with water to about its own volume. The gold alloyed with the silver remains under the form of a black powder at the bottom of the capsule in which the operation is performed. In general, ashes produced from the cuttings of proofs, from the *débris* of filters, &c., renders from 40 to 50 per cent. of their weight in silver, and the drop of silver contains from 1 to 2 per cent. of gold.

PHOTOGRAPHS OF THE DISCHARGE OF THE LEYDEN JAR.

M. FEDDERSEN states, in the *Annales de Chimie*, that he has established, by a long series of researches, that there are three kinds of this discharge:—1. The intermittent, in which the electricity escapes successively by isolated sparks, as it were drop by drop, at the point of interruption of the arc, which forms otherwise a continuous circuit. It is especially observed when we interpose in the circuit bad conductors of electricity. 2. The continuous discharge, in which the electricity flows out in the conducting circuit, forming a current till it is all exhausted. It is produced when the isolating interposed body becomes conductive through the passage of partial discharges traversing it in the form of sparks. 3. The oscillating discharge, in which the discharge of the battery oscillates from one armature to the other with a gradually decreasing intensity. M. Feddersen, by the employment of mirrors, fixed and movable, has succeeded in photographing the above-mentioned phenomena, which are now represented in coloured plates appended to his interesting memoir. He concludes by stating that the results which he had thus obtained, in his opinion, have established the principles of the mechanism of the discharge, rendered visible the oscillatory discharge, and given some of the principal laws which regulate it.

PHOTO-ZINCOGRAPHY AND PHOTO-PAPYROGRAPHY.

MR. JOHN LOCKE, of Dublin, has communicated to the *Athenæum* the following note.—It is curious to observe, whenever the properties of any substance (if light can be so designated) have been discovered, and the students of the science are intent upon multiplying the variety of its applications, how by apparent accident, and sometimes coincidently, the phenomena of a new art are suggested to persons widely sundered by place and circumstance. Colonel Sir Henry James, at Southampton, and Mr. Osborne, at the Antipodes (Melbourne), hit upon the zincograph in the same month; the latter obtaining for his invention a patent, with a reward of 1000*l*. from the spirited and munificent Government of Victoria; Colonel James, and his accomplished subordinate, Captain A. de C. Scott, resting content under the conscious sense of public usefulness with the honour conferred by the noble and enlightened of all lands. In December, 1859, an ingenious young lady asks Sir Henry how she could get her etchings cheaply printed, and he takes one of them to the Ordnance Office at Southampton, submits it to the chromo-carbon process, and transfers the imprint to the zinc plate.—This was the first Zincograph. Again, shortly afterwards, one of the workmen having, by mistake, laid the ink on the wrong side of the paper, thus giving a reversed outline, Sir Henry obtains from this negative on paper a copy of the original, and ascertains that the negative can be printed on paper instead of glass.—Here was the first Papyrograph. Now, by these discoveries we possess the means of reproducing, with a fidelity, cheapness, and durability hitherto unattained, copies of any subject unaltered, enlarged, or reduced in size, and with every gradation of shade or tone; for the lithographic ink used, of which the main ingredient is pure carbon, is, like the carbonized ink of some of the ancient palimpsests, ineffaceable except by the destruction of the material on which it is inscribed. In the reduction of plans and maps the greatest deviation by the photographic process did not amount to $\frac{1}{400}$th part of an inch in the rectangle; and even this minute error is not cumulative, and can be estimated with mathematical accuracy, if required. With deeds, MSS. and all artistic and natural objects, so minute a deviation would, even if appreciable, be of no consequence. It would not be admissible to detail here the modes and manipulation of these novel appliances of photography, which afford to all the learned professions, as well as the workers in every employment, useful and ornamental, advantages as widely diffused as the very light which is their intervenient instrument; but the manipulation is not so difficult, nor the materials so expensive as to prevent the practice of photo-zincography and photo-papyrography even by lady amateurs, who would wish to furnish their drawing-rooms with facsimiles of objects of rare beauty and elegance, whether the originals be the productions of their own talent, or gathered from the kingdoms of Nature and of Art.

PROPAGATION OF LIGHT.

M. BABINET has read to the French Academy of Sciences a note entitled, "A New Mode of Propagating Light," in which he treats of the regular luminous waves which result from a network or streaked surface placed in the path of a luminous band. From this proceed many spectra of great brilliancy, anterior and posterior, the origin of which cannot be derived either from propagation in a straight line, or from reflection, refraction, or diffraction. The very regular wave from the network borrows each of its elements from the waves which successively arrive at the network, and thereby obtains characters quite exclusive. The compensation in the celebrated experiment of Arago, which, according to Fresnel, prevents the influence of the motion of the earth from becoming sensible in the phenomena of the prism, has no place in regard to the network and M. Babinet concludes that, by substituting the network for the prism, we shall be able to render sensible that influence, so long and so unsuccessfully sought for by Fresnel and himself. For further details we must refer our readers to the Academy's *Comptes Rendus*, No. 10.

NEW PHOTOMETER.

THIS new instrument, invented by Professor H. Dove, is described by him in the *Philosophical Magazine*. With regard to microscopes he proposes the diminution of the aperture of the objective tube, the removal of the source of light from the same, the increase of the acting surface of the source of light by inclining it towards the aperture which represents the rectangular projection of that surface, in which case the cylindrical aperture can be so arranged, by adding a tube blackened on the inside, that only parallel rays may fall on the photographic picture ; and the rotation of an ocular provided with an analyzing Nicol after the analyzing Nicol has been placed in the aperture of the objective tube. For details as to the mode of construction of the apparatus and its application, we must refer to the paper itself, merely adding Mr. Dove's estimation of the advantages of his method over those now in use—viz., that it is very delicate : that it can be applied to objects of any size in the same manner, whether they are brightly or feebly luminous, of the same or different colours, and whether transparent or opaque ; that moreover, it is fitted for determining the intensity of light of optical instruments ; that it allows of several different methods of measurement which mutually control each other ; and, lastly, that it is obtained by means of an instrument which is in the hands of every working man of science.

Natural History.

ZOOLOGY.

THE MAMMALS.

A NEW classification of the mammals has been proposed by Mr. James D. Dana, in the American *Journal of Science*. He remarks that the precise position of man in the system is still the subject of discussion. Cuvier, in distinguishing him as of the order Bimana, and monkeys as of the order Quadrumana, did not bring out to view any profound difference between the groups. Man, on this ground alone, would be far from certain of his separate place. Professor Owen, in his recent classification of mammals, makes the characteristics of the brain the basis of the several grand divisions; but, as he admits, the distinctions fail in many cases of corresponding to the groups laid down. No study of the brain alone would suggest the real distinction between the groups, or prove that man was not co-ordinal with the monkeys. The fitness of the parts of the body of man for intellectual uses, and his erect position, have been considered zoological characteristics of eminent importance, separating him from other mammals. But even these qualities are not to many zoologists authoritative evidence on this point. The criterion which Mr. Dana considers decisive is, that while all other mammals have both the anterior and posterior limbs organs of locomotion, in man the anterior are transferred from the locomotive to the cephalic senses they serve the purposes of the head, and are not for locomotion. The cephalization of the body (that is, the subordination of its members and structure to head-uses), so variously exemplified in the animal kingdom, here reaches its extreme limits. Man in this stands alone among the mammals. Mr. Dana suggests the following divisions and classifications—for his reasons we must refer to his paper, which is reprinted in the *Annals of Natural History* —I. Archontia (or Dipoda)—Man alone. II. Megasthena—1, Quadrumana 2, Carnivora; 3, Herbivora; 4, Mutilata. III. Microsthena—1, Cheiroptera; 2, Insectivora; 3, Rodentia; 4, Bruta (Edentata). IV. Ooticoidea—1, Marsupialia; 2, Monotremata. The orders in II. and III. have a precise parallelism. The bats (Cheiroptera) represent the monkeys (Bimana) the Insectivora; the Carnivora, the Rodents, the Herbivora, and the Bruta the Mutilata. In regard to centralization, there is in the series of orders an advance by stages to the acmé—man.

RESPIRATION DURING SLEEP.

IN a paper on the quantity of air necessary for this purpose, recently laid before the French Academy of Sciences, M. Delbruck, after referring to the habit of wild animals which retire for rest to dens and shelter themselves as much as possible from the access of fresh air, a practice imitated by man in the savage state, and by soldiers who cover their faces when sleeping in the open air, concludes by saying:—"Plants exhale by day the oxygen which they absorb during night. Should not analogy lead us to recognise that animals ought to inspire during sleep a little of the gas which they exhale when awake?"

MECHANISM OF BIPED LOCOMOTION.

PROFESSOR MARSHALL has described to the Royal Institution, by the aid of models and diagrams, in detail, the columns of support, the joints and their accompanying muscles, the position of the centre of gravity and the means of maintaining equilibrium in the acts of standing, sitting, walking, running, and leaping. Especial attention was directed to the advantage of the atmospheric pressure on the joints, amounting in the knee, where so much flexibility is required, to 60lb., and in the hip joint to 26lb. In conclusion, the Professor pointed out the differences in the anatomical structure of the spider-monkey, chimpanzee, ourang-outang, gorilla, and man. The following were given as rates of locomotion per hour:—Shark and salmon, 16 and 17 miles; flies, 4 to 6 miles; eider-duck, 90 miles; hawk, 150 miles; worms, 30 feet; racehorse, 40 to 60 miles, man—walking, 4 to 5 miles, running, 12 to 15 miles.

GIPSIES.

MR. CRAUFURD has read to the Ethnological Society a paper "On the Origin of the Gipsies." The origin, as our old English has it, of the "outlandish persons calling themselves Egyptians or Gipsies," and constituting "a strange kind of commonwealth among themselves of wandering impostors and jugglers," is at least a subject of great curiosity, not to say of ethnological import. Although their first appearance in Europe was coeval with the century which witnessed the discovery of the New World and the new passage to the Indies, no one thought of ascribing to them a Hindoo origin, and this hypothesis, the truth of which the author now proposed to examine, was of very recent date. Their Hindoo origin was not for a long time even suspected; it has, however, of late years received general credence. The arguments for it consist in the physical form of the people, in their language, and in the history of their migration. Each of these topics the author examined separately in detail. The conclusion the author came to was that the gipsies, when above four centuries ago they first appeared in Western Europe, were already composed of a mixture of many different races, and that the present gipsies are still more mongrel. In the Asiatic portions of their lineage there is probably a small amount of Hindoo blood, but this he thought was the utmost that can be predicated of their Indian pedigree. Strictly speaking they are not more Hindoos in lineage than they are Persians, Turks, Wallachians, or Europeans, for they are a mixture of all these, and that in proportions impossible to be ascertained.

MAN AND THE ANTHROPOID APES.

Mr. C. C. BLAKE has read to the British Association a paper "On the Syndactylous Condition of the Hand in Man and the Anthropoid Apes." The author said :—"I call the attention of the Section to a curious abnormity which is presented by the integument of a specimen of old male gorilla which was brought from the Gaboon by Mr. W. Winwood Reade, and presented by that gentleman to the Museum of the Anthropological Society of London. Specimens of gorilla have been the subjects of the elaborate and complete memoirs which have appeared from the pens of MM. Duvernoy and Isidore Geoffroy St. Hilaire, in the Archives of the Paris Museum (vols. viii. and x.), and by Professor Owen in various parts of the *Zoological Transactions*, who have, with other authors, all coincided in the statement of a fact, true as regards the specimens with which they were acquainted, which probably represent the majority of specimens of gorilla which have been examined in Europe The statement, reduced to a general proposition, was, that the integument of the skin of the fingers was more or less connected across the first digital phalanx in such a manner that the first joints were firmly connected together by skin, sometimes as far as the distal extremity of the first phalanx, sometimes merely to the middle of this phalanx. In no specimen of gorilla, of the description of which I am yet cognisant, are the digits of the anterior extremity free to the same extent as in man, in which the distal extremities of the metacarpals mark the termination of the amount of syndactylity of the hand. In the specimen of gorilla to which allusion is made in this short note, the digits of the fingers present a different condition of connexion from the typical specimens described by zoologists The second (index), third (medius), and fourth (annulus) digits are free beyond the distal end of the metacarpals as in the human subject; the fifth digit (minimus) is also in a less degree attached to the annulus than in the specimens of gorilla contained in various public museums We have thus a specimen of gorilla in which the digits of the hand are almost as free as in the hand of the lower races of mankind. Careful examination by a lens of the integument before the preparation of the specimen by Mr. Leadbeater. who first called my attention to this abnormity, demonstrates the fact that the epidermis covers the cutis on the inner sides of the interdigital spaces of the first phalanges of this specimen. The consistency of this epidermis merely differs in degree from that of the homologous structure in the foot and other parts of the body. It would be interesting to compare such a curious abnormity of the integument with the similar abnormities which exist in the human species. The human fingers are most frequently connected together by Syndactyli, and remain during life in that state of arrested development (as regards the integument) which is typified by the permanent stage of the development of the gorilla. On the other hand, I have never yet met, either in the chimpanzee or ourang-outang, with a similar case of freedom of digits to that here described. We must, however, recollect that the number of specimens of chimpanzee and ourang-outan, which have been accurately described anatomically, form a very small per-centage. How many individuals of gorilla may exist, in which there may be a similar 'accidental' variety, must remain for a long time unknown to us. Syndactility is often congenital. A case has recently come before my observation of a married female, in which the *medius* and *annulus* of both hands are firmly connected together by integument. A similar condition prevails in one of her children, another has deformity on the right hand, while the youngest preserves the digits in their normal condition. The speculation whether a like rule or its converse may or may not prevail in the ape—whether it might not through generations during which the congenital defect of the gorilla, or absence of the characteristic syndactility, might be transmitted, operate towards the production of a more prehensile form of hand, must, however, be postponed until a series of specimens shall be examined by anthropologists or zoologists."

THE GORILLA.

MR. WINWOOD READE has communicated to the Zoological Society some "Notes on the Derbyan Eland, the African Elephant, and the Gorilla," founded on information obtained by him during a recent visit to Senegambia, the Gaboon, and the adjacent parts of Western Africa. The conclusions Mr. Reade has formed with regard to the gorilla, as derived from the evidence received from the hunters of the Gaboon, are that M. Du Chaillu obtained his specimens of this animal second-hand, and that its reputed ferocity had been vastly exaggerated.

THE ANATOMY OF THE CHIMPANZEE.

THE memorable duel between Professor Huxley and Professor Owen at the meeting of the British Association in 1862 gave considerable interest to a paper read at last year's meeting, "On the Anatomy of a young Chimpanzee." Dr. Embleton, who had drawn it up, comes to the conclusions which have already and for some time past been made public by Professor Huxley, viz.—1st, that the chimpanzee is not, properly speaking, quadrumanous, but that it possesses four prehensile extremities—namely, two hands and two feet; and, 2nd, that the brain of the chimpanzee differs from the brain of the man only in size and weight, therefore, in the smaller size and extent of its cerebral convolutions, the same parts without exception, exist in both brains. Whether cerebral matter of the ape differs from that of man in microscopic characters, or how otherwise it may differ, are problems which the doctor thought remain yet to be worked out.

SNOUT OF THE HOG.

At a meeting of the Boston Society of Natural History, U.S., Mr. Wilder has described the muscles which move the snout of the hog. The elevator has a very long tendon, and its muscular attachment is very far back, protected by a long ridge, and safe from all ordinary accidents ; the depressor, on the contrary, is very short, and attached very near the terminal cartilage ; both muscles of the important organ being thus protected from injury. He remarked that, while we consider the long snout of the hog compared with that of common animals, as a sign of what we know to be his beastly nature, yet the same organ, still further prolonged into the trunk of the elephant, changes its function with the nature of the animal, so as to be capable of executing very various and delicate motions. So that it is not always safe to take a single organ as an index of the nature of the possessor.

THE NORTHERN WHALE.

The Northern Whale (Balæna mysticetus) is the subject of an illustrated monograph by Drs. F. Eschricht and J. Reinhardt, of Copenhagen. Of all the mammalia, the cetaceans are the least known, both in regard to their geographical extension and their anatomy, due, doubtless, to the colossal size of a large number of the species. It is generally believed that the northern whale, which is now confined to the Polar Sea, descended annually into the temperate regions of the Atlantic, as far as the Bay of Biscay, and that it is not only the persecution of the whalefishers which have compelled it to seek a retreat in the midst of the frozen seas. This opinion is now shown to be erroneous, and rested only on the confounding two distinct species of whale. Like other whales, the northern is migratory, and changes its quarters according to the seasons ; and the systematic registers of the Danish colonists of Greenland show that often the same individual reappears at the same epoch in the same fiord. The females of the southern whale visit the coast of the Cape in June to bring forth their young and return to the high seas in August or September. It has been supposed that the migration of the northern whale is for a similar purpose. This, however, is not considered to be the case. Its movements are attributed to climacteric changes alone, and especially to the transport of ice into Baffin's Bay. It lives entirely in the midst of glaciers, and therefore is found in the south during winter and in the north during summer. The whalefishery has diminished its numbers, but not altered its mode of life. It is stated now that the whale believed to have visited the North Atlantic Ocean is a totally different species—viz., the one termed by the Basques, Sarde ; by the Germans, Nordkaper ; by the Americans, Right Whale ; and by the Icelanders, Slettebackur, or Sletbag, a much more violent and dangerous animal than the northern whale, and is also smaller and less rich in oil. The fishery for the latter ceased towards the end of the last century ; but it is not probable that it is totally extinct. On Sept. 17, 1854, a whale, with its little one, appeared before St. Sebastian, in the Bay of Biscay; the mother escaped, but the young one was taken. From a drawing of the skeleton MM. Eschricht and Reinhardt are convinced that it belonged to a species distinct from the Greenland whale. It may now be assumed that the name "Balæna mysticetus" has been applied collectively to various species of whale.—*Illustrated London News.*

EGGS OF BIRDS.

D. DAVY, in a paper read to the British Association, after pointing out certain qualities of resemblance common to the Eggs of different kinds of Birds—such as, especially, the alkaline nature of the albumen, and the acid of the yolk, and the two are in opposite electrical conditions—described the course of the experiments he had made to endeavour to ascertain in what respects the eggs of different species differ. His results seem to warrant the following conclusions —1. The colouring matter of the shell is organic, and similar to that of leaves and flowers, and in part depends on molecular arrangements. 2 The albumen in quantity greatly exceeds the yolk, but in eggs of different species in no regular manner, whilst, in all, the quantity of solid matter in the yolk is proportionately much larger than in the white. 3. The temperature at which the coagulation of the albumen takes place varies in almost every instance, and the firmness of the coagulum does not appear to be regulated by the proportion of solid matter which the albumen yields in evaporation. 4. The coagulum of each has an aspect of its own, varying in different instances as to tint and degree of translucency, and in some varying in colour.

THE DEMOISELLE CRANE.

IN the *John O'Groat's Journal* (July, 1863) is recorded the occurrence for the first time in Britain of the above-named bird; that the second of two, which had flown over from Deerness on the mainland to the neighbouring island of Copinshay, returned to Deerness a day or two afterwards, "and was again seen in the fields, most probably in search of its mate. Several parties endeavoured to stalk it, but without success. It is described by some of the country folk as 'looking nearly as big as a sheep,' which, of course, must be taken with considerable limitation, as the birds are both most likely about the same size."

NEW AUSTRALIAN BIRD, THE KAGU.

THE Kagu (*Rhinochetus Jubatus*), has been added to the collection in the Zoological Gardens, and is thus described by Mr. A. D. Bartlett, in the *Proceedings of the Zoological Society.*

At the first sight of this bird one is struck with its resemblance to several different genera, one and all of which appear more or less represented in its singular combination of characters. The action and movements of the Kagu are generally quick and lively, so opposite to the slow and chameleon-like movements of the true herons that one can hardly suspect it to be an Ardeine bird. This, however, it doubtless will prove to be, but so modified and adapted to a different kind of diet and mode of life, that its real affinities are difficult to recognise.

The skeleton and internal anatomy of the Kagu being entirely unknown to Mr. Bartlett, he can only form an opinion of the affinities of this bird by its external characters, habits, &c.; and he finds that the remarkable powder-down tufts, which are well developed in all the Ardeines, are carried to a greater extent in this bird; for above and around the wings, on the breast beneath the wings, and on the back and belly, this structure exists, and the enormous quantity of the white powder given off is surprising. The strong resemblance between this bird and *Eurypyga*, even in the markings upon the wing and tail feathers, the mode of spreading out the wings, and other resemblances convince Mr. Bartlett that he is right in considering the Kagu to be more closely allied to *Eurypyga* than to any other bird that has come within his notice. It is engraved in the *Illustrated London News*.

PALLAS'S SAND GROUSE.

On May 23, 1863, a covey (about 14) of that very rare bird, described by Sir William Jardine as Pallas's Sand Grouse, was seen in the Isle of Walney. "A person who had just shot a beautiful brace—a cock and a hen—described them as very tame, and allowed him to approach quite near to them while feeding in a field of corn, when they rose with a peculiar cry, but did not fly far.

"The bird is about the size of the golden plover, the cock much smaller than the hen; plumage of a brownish yellow colour, spotted and pencilled with black and dark brown. The tips of the wings are adorned with a dark-coloured long pointed feather, and the tail has two similar ones, giving the bird the appearance, when standing at a little distance, of having two long forked tails. The legs and feet are covered with thick down; both are short, and the latter very curious, having soles of thick scaly armour. The toes are exceedingly short, making the footprint almost resemble that of a rat. The cock has a blaze of bright orange on each side of the head, a band of pencilled feathers across the crop, and a dark patch on the belly.

"This bird is said to be an inhabitant of Chinese Tartary. How came it to the Isle of Walney? If for the purpose of breeding, surely it ought not to be disturbed.

"It is, of course, illegal to kill it at this season, and it is trusted the people of Walney will protect and encourage this singular bird. They found a great loss in the expulsion of the seagull from its breeding ground there. It is now returning, and probably will be protected. Let us hope that Pallas's sand grouse may also find in the island a safe breeding ground."—*Communicated to the Times* by Mr. E. J. Schollick, Aldingham Hall, Wolverston.

Another specimen of sand grouse, shot almost simultaneously with the above, is thus described :—"On dissection of the bird I found something queer about the breast-bone. It is quite unlike that of partridge, quail, or true grouse. The keel also is very deep ; there is no other British bird so deep except the swift's. I never saw a bird fly so fast. The extent of wing is 2 ft. 2½ in. The length of body (including the long tail feathers) about a foot less."

At the late Meeting of the British Association, Mr. N. Newton stated—These birds, which are commonly known as Pallas's Sand Grouse, and which are of Chinese origin, have made recent visits to this country, but have been rapidly exterminated or driven away. It appeared from the statement of the paper, that about 109 of these rare birds had been killed in the British Isles, of which 63 were shot in Norfolk and Suffolk. Mr. Newton expressed an opinion that a good deal of what they heard about bird love was nonsense ; but strongly condemned the unnecessary slaughter which had taken place, and was still taking place, among this species, which would have established itself here if it had received the commonest hospitality.

THE GREEN SANDPIPER.

Mr. A. NEWTON has read to the Zoological Society some notes "On the Mode of Nesting of the Green Sandpiper (*Totanus ochropus*)," relating to its now well-ascertained habit of breeding upon trees, sometimes at an elevation of thirty feet above the ground, and generally selecting for this purpose the deserted nests of other birds.

THE NEW ZEALAND MOAS.

A STATEMENT has appeared that one of the most gigantic of birds, a Moa or Dinornis, believed to be extinct, has been seen alive in New Zealand, and that an enterprising colonist had offered a reward of 500*l.* for its capture, dead or alive. Upon this Mr. Berthold Seeman observes in the *Athenæum*.—"The public seem to be divided respecting the amount of credence to be attached to the story ; but the fact that a gentleman residing on the spot thought it worth while to offer a handsome reward would seem to show that there was, in his judgment, some probability on the very face of it. That some of the smaller species of Dinornis may still be alive is an opinion which even Prof. Owen, if I understand him rightly, entertains. If extinct, the Moas have become so probably in quite recent times—that is to say, *since* the occupation of New Zealand by the Maoris. This opinion, I think, may be supported by philological arguments, briefly stated in my Official Reports on the Fiji Islands, presented to Parliament, May, 1862, and also in my *Viti*, p. 383, where I said :—"'Toa' is the Fijian form of the word 'Moa,' applied throughout Polynesia to domestic fowls, and by the Maoris to the most gigantic extinct birds (*Dinornis*, sp. plur.) disentombed in New Zealand. The Polynesian term for birds that fly about freely in the air is Manu or Manumanu; and the fact that the New Zealanders did not choose one of these, but the one implying domesticity and want of free locomotion in the air, would seem a proof that the New Zealand Moas were actually seen alive by the Maoris about their premises, as stated in their traditions, and have only become extinct in comparatively recent times."

CULTURE OF FISH.

MR. FRANK BUCKLAND has given at the Royal Institution a discourse "On the Culture of Fish," of which we can only give here the principal facts. Fish are exceedingly prolific. A common hen will lay in the year 120 eggs; but some fish deposit millions. The hard roe of the salmon contains from 15,000 to 30,000 eggs; and it has been computed that, in proportion to their weight, a trout for every pound produces 10,008 eggs; a herring for every half pound, 19,840 eggs; and a cod, for 15lb., has 4,872,000. Mr. Buckland especially considered the culture of salmon and trout. These fish form nests in the gravel in shallow water, and ascend rivers for that purpose The eggs are exposed to many dangers, being eaten frequently by the parents themselves and other fish—by the water-shrimp, by larvæ of the dragonfly and other insects, by rats, and by birds, especially the swan. Mr. Buckland represented the little waterousel to be their friend rather than an enemy, since it preys on insects. When the fish are hatched and somewhat grown they fall a prey to the lophious, or angler-fish, &c. But the poacher is the greatest enemy of fish culture, since, by his instrumentality, tons of fish in an unfit state for food are annually exported to the Continent. In consequence of all these obstacles, only one young fish in a thousand survives to become human food. Mr. Buckland asserts that this destruction may be obviated by artificial cultivation. He exhibited a series of shallow troughs, floored with sifted gravel which had been boiled, filled with running water, containing numerous young trout and salmon, several days old, in full health and vigour. All that is required is that the eggs should be placed in these troughs in water, kept in an equable temperature, from 40 deg. to 45 deg. Fahr., and "let alone." In about thirty-five days the fish can move, the eye is developed, but not the mouth, the animal deriving its nourishment from the umbilical vesicle. In forty-nine days the trout is fully hatched By means of a microscope and the electric lamp magnified images of the living fish in the egg and of some fish a few hours old were shown on a screen. The young fish are very voracious, and require feeding, for which ground dried liver has been employed. After referring to the energetic and liberal patronage of pisciculture by the French Government, he referred to the great exertions of persons in this country — viz., Lady Neville, Lord Mountcharles, Messrs. Gurney, Smee, and Hall, and especially Mr. Ackworth. Mr. Ponders, during one month, has placed in the Thames 76,000 young fish (10,000 salmon, 50,000 trout, 3000 char, and 13,000 grayling). The culture of fish is also successfully practised at the Zoological Gardens. Another important element of progress is the invention of methods for conveying fish eggs to Australia and other places, where they are readily hatched; and it is hoped that by this means our stock of edible fish may be largely augmented. Mr Buckland concluded by dilating on the great importance of energetically pursuing the culture of fish as a prolific source of national wealth and as an easy method of largely increasing the food of the people.

Mr. Alfred Smee thus describes the French Pisciculture, devised by Professor Coste, of the College of France, in Paris, and practised on a large scale at Huninguen. "I learnt the system at Paris in 1859, and brought it at once to England, but even now it is not as sufficiently known or appreciated as it deserves. The plan consists in placing the ova on a gridiron of glass, where they remain with a jet of water passing over them till the young fish are hatched.

"Coste's system is absolutely perfect and leaves nothing to be desired, provided excess of light is excluded. Any number of fish may be hatched at a cost and trouble almost nominal, for I do not think that I lost 5 per cent. this year of good eggs subjected to the process. Much, however, has still to be learned with respect to the treatment of the young fry, for it is still a debateable question whether we should place them in small streams full of weeds and animalculæ, their natural food, or cram them, as the French recommend, with the flesh of frogs or powdered bullock's liver. I adopt the former plan, but am not so confident as to its superiority as to consider it the sole good treatment of these delicate juveniles."

While we admire the enthusiasm of naturalists and others who have so warmly taken up the subject of artificial Fish Culture of late years, we cannot withhold our own doubt as to *the value of fish as an article of food.* It is in the scale of nutriment the last but one of our edibles; the succession being meat, milk and eggs, farinaceous food, fish, and vegetables. In some parts of India, *fish-eater* is another name for a weak or silly person. Hence to recommend it as food for strong working-men is useless—our industrial population know better. Again, fish require to be in good condition, and to be well cooked, an art in which comparatively few persons excel; fish require time and expense to be well dressed. After all, in England we make the most sensible use of fish, which may be very well in a large dinner, but as a substantial meal is little worth.

The salmon and trout appear to be the only British fishes worthy of culture; an admission recently made by an able writer, who had swelled the chorus in praise of fish as an article of food.

The owners of Salmon fisheries in England have vastly improved them by putting a stop to the wasteful system which, in many rivers, has almost destroyed this fish. In the Severn, notwithstanding its extremely depreciated condition, there has been a very considerable increase in the quantity of new fish captured, and the number of spawning fish that passed up was beyond what was ever before witnessed The salmon produce of the Tay is about 15 times that of the Severn, though the Tay is only half the size of the Severn, is of no better quality, and does not produce half the number of fish it might.

A great change has been made in the law by the Act of 1861: objectionable engines have been abolished, or restrictions imposed upon them, artificial obstructions will gradually disappear as the Act is put in force, and free gaps and fishpasses restore to the fish the highway provided by nature for their breeding operations.

Some schemes for the extension of pisciculture in England are now being matured Mr. Buckland has described his experiments of fish hatching in the Thames, how they will succeed must be left to time to develope If a great series of breeding-ponds were constructed to feed the Severn, it would tend to the multiplication of our finest salmon, and assuredly raise the fish rental of that fine river to a very high point.

FOOD OF THE SALMON.

On the Food of the Salmon and its Parasites, some notes appear in the *Journal of the Linnean Society,* contributed by Dr. W. Carmichael M'Intosh. Some time ago Dr. Knox, in a paper read before the Society, controverted the views of Valenciennes, who describes the salmon as voracious and a devourer of fishes, adding that "from the time it enters the fresh water it ceases to feed, properly speaking, although it may occasionally rise to a fly, or be tempted to attack a worm or minnow, in accordance, seemingly, with its original habit as a smelt; and that, after first descending to the ocean and tasting its marine food, it never again resorts to its infantile food as a constant source of nourishment" He also stated that "nothing whatever is found in the stomach or intestines of the fresh sea salmon but a little reddish substance, which he found to be the ova of some species of Echinodermata,' and affirms that such is the sole food of the salmon in the sea. Yarrell asserts that the salmon feeds on small fishes and marine animals, while Dr. Fleming says that their favourite food in the sea is the sand eel. To test the accuracy of these statements, Dr. M'Intosh, with regard to the Tay, examined the stomachs and intestines of upwards of a hundred salmon and grilse caught in the river this year from February to June." In summing up the evidence Dr. M'Intosh expresses his opinion that it is a mistake to suppose that salmon do not feed in fresh water at all, as well as to suppose that they feed voraciously. The true state of matters would seem to be that in fresh water they feed rarely, and at intervals, but not from want of voracity, as the contents of the above-mentioned stomachs show, and, further, that such food is occasionally found in the stomach from February to August.

THE HERRING.

SOME extracts from the Report of the Royal Commission (consisting of Professors Lyon Playfair and Huxley, and Lieutenant-Colonel Maxwell) appear in the *Edinburgh Philosophical Journal*, and contain some interesting particulars respecting the natural history of this valuable fish. It is found in four conditions.—1. Fry or sill, 2. Maties or fat herring; 3. Full herring; 4. Shotten, or spent herring. Adult full herrings generally vary in length from ten to fifteen inches; they may vary, it is said, from seven to seventeen inches. Their food consists of small crustacea and fish, and particularly sand eels; while in the matie condition they feed voraciously. Their enemies are fish (cod, ling, &c.); birds (gulls and gannets); marine mammals (porpoise, and other cetacea), and man. In 1861 there were in Scotland, and that part of England over which the Fishery Board have jurisdiction, 42,751 fishermen and boys engaged in the herring fishery. The total take of the year would give about 20,000 herrings for each of these persons, or nearly 900,000,000 for the whole! This vast number sinks into insignificance if compared with the total destruction effected by agencies over which man has no control. Consider the destruction of large herring by cod and ling alone. It is a very common thing to find a codfish with six or seven large herrings in his stomach, of which not one has remained long enough to be digested. If, in order to be safe, we allow a codfish only two herrings per diem, and let him feed on herrings for only seven months of the year, then—2 herrings × 210 days = 420 herrings—his allowance during that time; and fifty codfish will equal one fisherman in destructive power. But the quantity of cod and ling taken in 1861, and registered by the Fishery Board, was over 80,000 cwt. On an average thirty codfish go to 1 cwt. of the dried fish. Hence, at least 2,400,000 codfish were caught in 1861 But, if fifty codfish equal one fisherman, 2,400,000 will equal 48,000 fishermen. In other words, the cod and ling caught on the Scotch coast in 1861, if they had been left in the water, would have caught as many herrings as a number of fishermen equal to all those in Scotland, and six thousand more, in the same year.

STURGEON.

MR. FRANK BUCKLAND, in a letter to the *Times*, July 29, 1863, writes:—"A few days since, one of these fish, about three feet long, was caught in a whitebait net near the mouth of the Thames, and brought alive to Billingsgate. It was bought by Mr. Charles, fishmonger of Pimlico, who kept it some three days in a tank, and then sent it to the Zoological Gardens, where it now is. The fish seems in good health, all but a wound which has been made by a rope just above his tail. Mr. Bartlett and myself have had a consultation as to what to give him to eat, for he will not touch earthworms or small fish, and we have agreed to try him with water shells of various kinds, for having lately dissected the stomachs of several sturgeons, especially one, the property of Mr. Heck, of Portman-street, which was 9 feet 2 inches long, weighed nearly 4 cwt., and contained no less than three large buckets full of caviare or roe, I have found the contents of the stomachs of sturgeons to be principally comminuted portions of shells, and occasionally sand worms."

On July 6, 1863, a fisherman of Rochester, in Limehouse-reach, a short distance below Rochester-bridge, succeeded in catching an unusually large Sturgeon, which, after some difficulty, he landed. The fish, one of the largest ever caught in an English river, measured exactly 7 ft., and weighed 170 lb. The sturgeon being what is termed a "Royal" fish, belongs by ancient charter to the Mayor of Rochester: on receiving it his worship at once forwarded it as a present to the Prince of Wales, in the custody of the water-bailiff, the fish being delivered alive at Marlborough House on July 7. This is the second large sturgeon captured in the Medway within a very short time, the last Royal fish being caught by the same fisherman who effected this capture.

THE LOBSTER.

THE nervous system in the Lobster has been minutely considered by Dr. M. S Clouston, who has published an elaborate paper, with two engravings, in the *Edinburgh Philosophical Journal* He says, in conclusion, that a careful consideration of the minute structure of the nervous system of any invertebrate animal, such as the lobster, shows us that histologically and physiologically the vertebrate and invertebrate animals are nearly allied. In every essential point the ganglia and interganglionic cord of the lobster correspond to the spinal cord of the vertebrata, while the cephalic ganglion is analogous both in structure and function to the brain. The tendency to segmentation seen in both kingdoms is most marked in the nervous system of the invertebrata, because in this division the nervous system does not form the centre round which all the other parts are developed, as is the case with the spinal axis of the vertebrata. Such an examination makes us esteem lightly such generalizations of the mere external form of the nervous system as that made by Audouin and Milne-Edwards in the crustacea, as being only a prelude to a more natural and scientific classification.—*Illustrated London News.*

THE KING CRAB (POLYPHEMUS).

IN the *Annals of Natural History*, Dr. E. J. Gray communicates some remarks on the uses of the elongated spinelike tail of this genus of crustacea. In the shallow tank at the Liverpool Museum are some living specimens, where Dr. Gray was shown one use these crabs make of the appendages. When turned over on their backs, he saw them bend down the tail until they could reach some point of resistance, and then employ it to elevate the body and regain their normal position. He states that they never have been seen to use this tail for the purpose which has often been assigned to it—that is, for leaping from place to place by bending it under the body like the toy called a "spring-jack" or "leaping-frog."

FRENCH OYSTER-FISHERY.

THE number of Oysters taken by the boats of Granville in the season of 1862-3 was about 4,500,000. The open sea fishing only produced 200,000; but the number of boats which took part in it was small, in consequence of the little profit which the fishermen expected. The oysters having been sold at 28f the thousand, the total profit of the season has been 126,000f. The number of fish just mentioned, and the amount obtained, are the smallest yet known in a season at Granville. The fishermen of Cancale have not been more fortunate, in consequence of the impoverished state of the beds, formerly so productive, but which for some years past have been worked by too large a number of boats. In the season 1861-2 the Granville boats took 13,396,677 oysters, which, being sold at 18f. the thousand, produced 241,140f. The Granville season of 1852-3 produced 91,000,000 oysters, which sold for 720,138f. The Cancale fishermen then obtained almost similar results, although oysters were only worth 7f. or 8f. the thousand instead of 26f. or 28f., which must be paid in consequence of their scarcity.

VIPERS IN FRANCE.

THE large increase of these reptiles in France, observed of late years, having become serious enough to induce the Government to suggest to the Councils-General of Departments the propriety of voting a sum of money for their destruction, the following Report presented to the Society of Acclimatization on the subject by M. Léon Soubeiran acquires peculiar interest. The vipers known in France are of three kinds. the Vipera pelias, the head of which is covered with smooth laminæ instead of scales; the Vipera aspis, with scales all over, and a truncated head; and the Vipera ammodytes, also with a scaly head, but ending in a soft point. Vipers are extremely irascible, and although they usually take to flight at the approach of man, they will sometimes attack and pursue him. In Haute-Marne the council of the arrondissement of Chaumont in 1856 voted 1500f. for the purpose, every head of a viper being paid 50c.; the sum, however, proved quite insufficient, the number of vipers killed being 17,415. In 1858 the number was 11,582, and the total amount in six years was 57,045 vipers in that single department. The destruction of this reptile, however, is best effected by favouring the multiplication of crows and pigs. —*Galignani's Messenger.*

"THE GREAT SEA-SERPENT."

THE existence of this extraordinary object of curiosity, if not also of terror, has acquired additional corroboration in the subjoined letter, which has been received in Liverpool from one of the officers of the African mail-steamer *Athenian*:—"Cape Palmas, May 16, 1863.—All doubts may now be set at rest about the Great Sea Serpent. On the 6th of May the African Royal mail-steamer *Athenian*, on her passage from Teneriffe to Bathurst, fell in with one. About 7 a.m. John Chapple, quartermaster, at the wheel, saw something floating towards the ship. He called the attention of the Rev. Mr. Smith and another passenger, who were on deck at the time, to it. On nearing the steamer the object was discovered to be a huge snake, about 100 feet long, of a dark brown colour, head and tail out of water, the body slightly under. On its head was something like a mane, and the body was about the size of our mainmast."

LIFE IN THE DEEP OCEAN.

WE read in the *Proceedings of the Natural History Society of Boston, U.S.*, an observation of Mr. Marcou, in regard to deep-sea soundings, that a Norwegian naturalist had recently obtained, by means of the same instruments used by Captain M'Clintock and Dr. Wallich, between Cape North and Spitzbergen, living animals from a depth of 8400 ft. (more than a mile and a half). At this depth, where the temperature was only three-tenths of a degree centigrade (nearly the freezing point), were found living polyps, mussels, tunicata, annelides, and bright-coloured crustaceans. The same naturalist had found ammonites (probably Jurassic) and leaves resembling those of the palmetto (probably Miocene) at Spitzbergen.

THE SILKWORM IN FRANCE.

M. GUÉRIN-MÉNEVILLE has given the Société d'Acclimatation an account of the results obtained in various parts of France from the endeavours to overcome the baneful effects of the disease of the Silkworm. It appears from this account that all the attempts to find a specific against this disease have signally failed; but that most practical men are now of opinion that the disorder is owing to the blight which has attacked the mulberry tree in various districts. It is now certain that breeds brought from places where the disease of the silkworm does not exist yield a good crop the first year in the infected districts, but cannot be propagated, their eggs being tainted like those of the diseased worms. Hence breeders are obliged every year to import eggs from foreign countries, when they can find healthy ones, which becomes daily more difficult. Nevertheless, from the experiment made with great care, it would seem that eggs obtained from diseased silkworms will produce a breed exempt from the disease in a country where the latter has not yet broken out. In order the better to compare the results obtained in different departments, M. Guérin-Méneville has established a "central laboratory of comparative sericiculture" at the school of Ailanthiculture, which he has founded at the Emperor's farm near Vincennes, where all the experiments made by the various agricultural societies of France are repeated, compared, and centralized. The acclimatization of the silkworm which feeds on the Ailanthus, or Japan varnish-tree, is progressing favourably both in France and in other parts of Europe. The Palma Christi silkworm has succeeded admirably at La Plate. That which feeds on the oak has failed in France for the present, but it is likely to succeed this year in Holland, eggs having been brought over from Japan by M. Pompe Van Meert der Woort. This silkworm is called "Yama-mi" by the Japanese; it lives in a wild state in an island called Fatsy-sio, which is a place of exile. The silk it yields is made into very strong stuff, which never changes its colour, but which, on the other hand, takes no dye. This silk is a monopoly of the Japanese Government, and is not allowed to be an article of trade.

TRIGONA CARBONARIA.

THE President of the Entomological Society has exhibited the nest of *Trigona Carbonaria*, from Queensland · this led to an interesting discussion, participated in by the President, Prof. Westwood, Mr Waterhouse, and Mr. Bates, as to the true position and affinities of this so-called Trigona, and as to the form and the origin of the form of the cells of bees in general.

THE HONEY-BEE.

IN the *Annals of Natural History* for April we have the translation of part of a paper on "The Geographical Distribution and Varieties of the Honey-Bee," by Dr. A. Gerstacker, of which we give a few points;—Latreille, Brun, and other writers considered that our common bee, as distinguished from the Italian bee, is indigenous to the north of Europe. An opposite opinion is also very generally held. The latest writer on the subject (Von Berlepsch) says that our bee is demonstrably indigenous in the hot countries of the Old World, where an almost perpetually serene sky enables it to work throughout nearly the whole year; and that, at a very early period, human civilization carried it into northern localities, where it is compelled to remain in its dwelling, contrary to its nature, for several cold months. It has no winter sleep like other allied insects indigenous to the country. Dr. Gerstacker, however, after examining the arguments adduced, considers that we must still regard the question of the origin of the honey-bee as in a state of complete uncertainty.

Mr. Waring has exhibited to the Entomological Society some dead pupæ of drones which he had found near the entrance of one of his beehives: they were not quite fully matured, and it would seem that the bees must have cut off the caps of the cells, and cast out the dead pupæ; but he was unable to throw any light upon the cause of their death.

The President of the Entomological Society has exhibited specimens of *Branla cacæ*, which on the Continent had been found to be very destructive of the honey in beehives; it had only recently been found in this country, and had been imported with the *Apis ligustica*, in a hive of which species the exhibited specimens had been discovered.

HERMAPHRODITE INSECTS.

MR. BOND has exhibited to the Entomological Society Hermaphrodites of *Anthocharis Cardamines* and *Papilio Machaon*, the former captured near London. the latter from Whittlesea Mere · in both specimens the right side of the insect was of the female form, and the left side of the male form.

The President of the Society has also shown drawings of two hermaphrodites of the honey-bee . in the first specimen the right side partook of the male characters, the antenna, eye, anterior and intermediate leg being male, whilst the wing and posterior leg were female or worker, and the left side was entirely worker : the second specimen was partly male and partly worker, the left side partaking of the male characters , the left eye, antenna, wing, anterior, intermediate and posterior leg being of the true male form ; the abdomen was considerably enlarged on the left side.

RARE INSECTS

WE find the following in the *Proceedings* of the Entomological Society, July 6 —Professor Westwood exhibited *Gracilaria rufipennella*, bred from larvæ recently found in the Italian portion of the Tyrol, which had rolled up the leaves of walnut-trees, the ordinary food of the species being the plane-tree ; also sketches of the larva and pupa of the genus Coronis, from the collection of Dr. Kaden at Dresden, and of the genus Castnia ; the larvæ of the latter burrowed in the stems of trees, and was a large fleshy grub, like that of a Longicorn beetle, whilst the pupa had its abdomen furnished with two rows of reflexed spines, which enabled it to work its way along the burrowed stems after the manner of Cossus, also specimens of *Papilio Castor* and *P. Pollux*, described in the *Arcana Entomologica* as two species, but which Mr G. Gray considered to be the sexes of one species; the professor, however, possessed the males of both forms, and the female of Pollux ; and one of the exhibited specimens of *P. Castor*, from the collection of Mr. Semper, of Altona, was a hermaphrodite, or rather had a gynandromorphous wing, part of that wing both on the upper and under sides (but not equal or corresponding parts on both sides), having the marking and coloration of the male, and part having markings and coloration which were properly those of the female. From a consideration of these circumstances, he was still disposed to maintain the specific distinctness of *Papilio Castor* and *P. Pollux.* Professor Westwood also exhibited the imago of *Eucheira socialis*, from Mexico, a species whose larvæ were gregarious, and which formed the singular family-cocoon described by him in the first volume of the Society's *Transactions.*

MINING OF LEPIDOPTERA.

PROF. WESTWOOD has exhibited to the Entomological Society a large tough pouch from Africa, which had been cut off from the branch of a tree to which it had been suspended it was doubtless the nest of some gregarious Lepidopterous larva. He also exhibited leaves of various plants mined by Lepidopterous larvæ, and mounted on glass, so as to show the larvæ inside : this mode of exhibiting the miners, and the shape and peculiarities of their workings, was due to Mr. Stone, of Brighthampton.

UTILITY OF COLOURING.

MR. T. W. WOOD has made some remarks to the Entomological Society on the Coloration and mimicry of nature visible on the under side of the wings of *Anthocharis Cardamines* when at rest, and on the utility of this colouring in the preservation of the insect. The butterfly might, during May, be found towards evening or in cloudy weather at rest in very exposed situations, on the tops of grasses and flowers, and more particularly on those of *Anthriscus sylvestris* · the chequered white and green of the wings exactly resembled the small white flowers of the Anthriscus, as seen against the green background of the hedgerow behind, and thus preserved the insect from observation . it was to be remarked, too, that, except as a secure resting-place, the butterfly did not appear to be partial to the Anthriscus, but preferred to hover over and suck the juices of the wild geranium and other plants.

ACCLIMATIZATION OF ANIMAL AND VEGETABLE PRODUCTS.

IN the *Annals of Natural History* Dr. J. E. Gray has inserted a copy of the circular on this subject prepared by Mr. Wallace, approved of by a committee formed at the British Association meeting at Cambridge (consisting of Dr. Sclater, Mr. Alfred Newton, Mr. Wallace, and Dr. Gray), and now in course of distribution. The following are some of the points of inquiry to which the attention of persons resident in extra-European countries is especially requested —1. As to the domesticated animals indigenous to the country, their differences from the wild races, the possibility of domesticating the latter, &c. 2. As to the domesticated animals which have been introduced from other countries, the date of their introduction, food, habits, longevity, fecundity, diseases, &c. 3. Special inquiries relating to the more common domestic animals—viz., sheep, horses, cattle, dogs, ducks, and geese ; the capability of forming hybrids, &c.

ACCLIMATIZATION AT THE ANTIPODES.

THE Acclimatization Society of Victoria has obtained a valuable site in a reserve of 500 acres appropriated as the Royal Park. To this spot the Society and its friends are enabled to take the animals and birds which they may import into the colony. In order to fit it for the reception of animals, a sum of about 4000*l.* has been expended There are paddocks with sheds erected, into which the goats and llamas that feed about the park in the daytime are driven for shelter. Arrangements have been made for dividing and classifying the live stock. Substantially-constructed cages contain pheasants and doves, and such class of birds, with shelter cots in the centre. The water fowl have their ponds in which to disport themselves, and an island on which to breed. The zebras, the elks, and the ostriches have their separate compartments; a system, in short, is provided even more complete than that which exists at our own Zoological Gardens in the Regent's Park. Here a host of small birds, after resting from the fatigues of their voyage across the sea, are set at liberty to breed in the country, and establish for their races a home among the wilds of Australia. The birds which have been set free at the Botanical Gardens of Victoria have been 18 canaries, 18 blackbirds, 24 thrushes, 6 Californian quail, 60 English wild ducks, 35 Java sparrows, 4 English robins, 8 turtle-doves, and 50 mino birds. At Philip Island there have been located 5 pheasants, 6 skylarks, 6 Californian quail, 4 thrushes, 4 blackbirds, 1 pair white swans; at Sandhurst, 4 pheasants, 4 skylarks, and 4 thrushes; at Yarra, 6 thrushes and 4 skylarks; and near Sydney, 7 thrushes, 4 skylarks, and 10 blackbirds.

BOTANY.

THE ELEMENTARY TISSUES OF PLANTS.

M. LESTIBOUDOIS has submitted a memoir on this subject to the French Academy of Sciences. After mature consideration of the internal structure of plants, he arrives at the conclusion that we cannot consider as a general and, so to speak, exclusive apparatus those reservoirs which show very dissimilar dispositions, which contain very heterogeneous liquids, and which are wanting in the greater number of vegetables. As to the vessels stated to contain transparent and granuliferous liquids, and to branch out and become anastomosed, like certain lacteal vessels, M Lestiboudois is not able to affirm their presence. He frequently met with transparent tubes, filled in various degrees with granuliferous liquids; but these tubes were straight, and not anastomosed. "We cannot, then," he says, "admit that there is in plants a special circulatory apparatus. All the parts of diverse forms may concur in the transport of nourishing liquids and, whatever be the diversity of the conformations belonging to the organic elements and the proper functions which may be assigned to them, we cannot rationally consider the unity of tissues in vegetables to be established."

THE CONTRACTILE TISSUES OF PLANTS.

An abstract of M. Cohn's memoir on this interesting subject, so intimately related to the boundary-line between the animal and vegetable kingdoms, appears in the March number of the *Annals of Natural History*. There are differential characters between the higher forms of each sub-kingdom, yet the phenomena of irritability and of movement on parts of many of the higher plants bear a general resemblance to those presented by the tissues of the higher classes of animals, though their active cause has been attributed to mechanical forces in connexion with structural peculiarities. After a great number of experiments and due consideration on the phenomena, M. Cohn concludes that these and other researches go to demonstrate that the cell tissue of the filaments of centaurea possesses irritability (in the sense used by Haller), and likewise an innate motive power, both these properties resembling in all essential points their like as found in the contractile and irritable parts of animals. This analogy, however, does not imply the existence of muscles and associated nerves as found in the higher animals, where a physiological differentiation of tissues prevails, in order to qualify for the performance of functions of the highest order, but points more precisely to the irritable and contractile tissue of the lowest animals which possess neither muscles nor nerves. The translation in abstract of M. Cohn's memoir is by Dr. J. T. Arlidge.—*Illustrated London*

NEW GARDEN AT PARIS.

It is not generally known that the Municipal Council of Paris have founded a large establishment in the Bois de Boulogne, near La Muette, in which legions of plants of every description are reared, and which are afterwards transplanted to ornament the numerous public gardens throughout Paris. This plantation, said to be unique in Europe, has lately been increased by an addition which forms altogether a superficies of 4400 yards. Within this space there are no less than 25 hothouses of various descriptions, and greenhouses, representing a glazed surface of 10,000 yards. One hothouse, which covers 433 yards of ground, is appropriated to the cultivation of palm trees and other tall plants, of which there are at least 2000 at present growing there. Another hothouse 500 yards long covers 250 camelias. Several plants are to be seen which were originally raised at Malmaison by the Empress Josephine. 2500 fuchsias, of at least 100 varieties, are to be seen in another hothouse of 110 yards long specially reserved for them. There are likewise in another part of the garden a great number of valuable Chinese plants. The hothouses are warmed by twenty-two machines for heating water, and by two powerful caloriferes for producing hot air.

TRANSPLANTING OF LARGE TREES.

SIR JOSEPH PAXTON and other English horticulturists were, we believe, the first who attempted, or at any rate perfected, the system of removing large trees from one place to another; but during the last few years it has been practised in Paris to an extent unknown elsewhere. At spring and fall the transplanting trucks, or wheeled frames, are to be seen in all directions, and the Champs Elysées, the Boulevards, and the various squares recently laid out in many parts of the town, have been adorned with thousands of noble trees by these means. A Report was made on the subject the other day to the Central Society of Horticulture, by which we are told that horse-chestnut trees more than 39 inches in diameter, and a catalpa tree 150 years old and 23 inches in diameter, have been transplanted with success. Another and very remarkable case is mentioned, namely, that of three good-sized trees growing in such a manner that they could not be separated, having been removed together from a private garden about to be destroyed, the mass of roots and earth measuring five metres, or about sixteen feet English in length. It has been discovered, that the bleeding of trees, and the attacks of insects, after the cutting off of branches, may be effectually stopped by the simple method of well brushing the part exposed with a paste made of wood-ashes and water: the ash enters between the fibres of the wood and prevents exudation, while the alkaline property of the mixture keeps off insects.—*Popular Science Review.*

THE WHEAT CROP OF 1863.

MR. LAWES, of Rothamsted, has communicated to the *Times* the following account of the wheat crop of last year's harvest, with some of the results of his own experience on the subject.

"On a field of 14 acres, I have grown wheat every year, for the last twenty years. During the whole of this period, one portion of the land has been left entirely unmanured, another has received 14 tons of farmyard manure annually, and the remainder has been divided into numerous plots, which have respectively been manured with different artificial combinations, some calculated to yield moderate crops, and others the heaviest produce which the characters of the soil and seasons will admit of. With some exceptions, the same description of manure is applied year after year on the same plot, so that the variation in the produce from one year to another is mainly due to the characters of the seasons; and experience has shown that the produce of this field affords a tolerably correct indication of the general character of the wheat crop over a pretty wide area.

"The following is a statement of the amounts of produce obtained without manure, and by farmyard manure in 1863, compared with the average of the preceding ten years under the same conditions :—

	Bushels of Corn per Acre.		
	Harvest, 1863.		Average of 10 Years. 1853-1862.
Unmanured every year ..	17¼	...	15½
Farmyard manure every year .	44		35¼

"Thus, even the unmanured land has given rather more produce in the favourable season of the twentieth year than the average of the preceding ten years; but the increase due to season was far greater where the farmyard manure was employed. It was even greater still in many of the cases where artificial manures were applied, as the following results (which include those of all the plots where the yield of the present season exceeded 50 bushels per acre) will show :—

Bushels of Corn per Acre.			Bushels of Corn per Acre.		
Harvest, 1863.		Average of 10 Years, 1853-1862.	Harvest, 1863.		Average of 10 Years, 1853-1862.
53½		35½	53¼	..	33½
54	..	35¼	53¼	..	34
56½	..	37	54	.	33¾
55		37½	53½		34¼
55½	.	33¼	56½	...	37½
54¼		34¼	55	.	38
53¼	..	34½			

"It is seen that in almost every one of these cases the produce of 1863 was one-half more than the average of the preceding ten years, with the same description of manure. The quality, as indicated by the weight per bushel, was also considerably above the average. It should be observed, too, that on only one of these plots has there ever before, during the whole course of the experiments, been obtained as much as 50 bushels per acre, and on it only twice—namely, in 1854 and 1857.

"I may add, that in an adjoining field, not treated experimentally, but under the ordinary management of the farm, the yield of wheat this year (after clover) is more than 63 bushels per acre.

"These results may, I think, be taken as fully confirmatory of the generally expressed opinion that the wheat crop of 1863 is one of the largest that has been grown for many years, and also of superior quality. Those who fear that our soils are becoming rapidly exhausted may, perhaps, derive some comfort from the fact that a field of ordinary wheat-land has grown 20 crops in succession, the twentieth crop, even without manure, being heavier than the average of the ten preceding years, and that obtained by various artificial manures being considerably heavier than in any preceding season of the series."

SULPHURING VINES.

A PAPER has been read to the French Academy of Sciences, received from M. Bouisson, on ophthalmia produced by the Sulphuring of Vines. From the moment this practice was had recourse to for the purpose of destroying the oidium, it was perceived that sore eyes became very prevalent among the labourers engaged in that work. Sulphur is employed under the form of a sublimate called flowers of sulphur, or else in a triturated state. In the former case it contains a small but perceptible quantity of free sulphuric acid; in the latter case there is hardly a trace of it; and accordingly, the sublimate is infinitely more efficacious than the mere powder. Under the microscope, the powder presents irregular forms ending in angles and points, while the flowers appear under the form of very small round globules; hence the mechanical action of the former is much more irritating than that of the flowers of sulphur. But mechanical irritation being less active than the chemical one of sulphuric acid on the conjunctiva or external coat of the eye, triturated sulphur is less injurious to that organ than flower of sulphur. Regarding the instruments used for the diffusion of sulphur, the bellows are less hurtful to the eyes than the sieve, which scatters about a great deal of the powder in the air. A man works seven hours per day, during which time he expends ten kilogrammes of sulphur. The operation lasts five days per hectare, and is repeated three or four times during the season. Sore eyes are chiefly prevalent during the last sulphuring process, showing that heat and drought increase the irritating effects of sulphur. Women and children being chiefly employed in the operation, they are most subject to this kind of ophthalmia, which, however, is not malignant, and generally consists in a mere inflammation of the conjunctiva. The mixture of sulphur with lime, recently proposed, is more hurtful to the eyes than sulphur alone; but mixture of sulphur and plaster is better for the eyes, though detrimental to the respiratory organs.

CULTIVATION OF FRUIT TREES.

WE find in *Galignani's Messenger* an account of M. Jacquesson's extensive grounds near Châlons, where a new system of Arboriculture has been introduced, under the management of M. Daniel Hoolbrenck. The following description will give an idea of that horticulturist's method. In the case of vines, M. Hoolbrenck, at the end of winter, bends down one or two vine-shoots of the preceding year upon each stock, so as to lie below the horizontal, at an angle of 112 deg. counted from the vertical. All the other shoots are pruned away. In consequence of this inclination, the sap lingers under the bark, and favours the development of a great number of buds, which in due time become branches laden with grapes. On the other hand, the sap produces at the base of the inclined branch a vigorous shoot, which springs up vertically, and which, in the following year, will replace the fruit-branch. When several buds appear on the stem which, in the preceding year, produced the shoot laden with grapes, the weaker ones are removed, and only that which appears most vigorous is preserved. By this means the exhaustion of the stock is prevented, and in the following autumn a long and vigorous shoot is obtained, which replaces the other. M. Hoolbrenck proposes to apply this method to all fruit-trees. Nevertheless, as the pear, apple, and plum-trees produce fruit on the old branches, those which bore fruit in the preceding year cannot be suppressed. The bending of fruit-branches on the pear and apple-tree has produced extraordinary results in M. Jacquesson's orchards young pear-trees in the nursery, their branches two years old, were laden with abundance of very fine fruit. The bending-down of the fruit-branches is peculiarly well adapted to trees that are slow in producing fruit. It gives the shoots which would only yield wood time to be transformed into fruit branches in the course of a year, and it favours the production of fruitful shoots, even on the old branches and bark. Experience will show whether the trees subjected to M. Hoolbrenck's mode of treatment will live long, and continue to yield the abundant crops they have been producing for these last two years. Certain it is that his system is also applicable to herbaceous plants, such as asparagus for instance, the stems of which, being bent down, produce new alimentary shoots from the middle of August to the middle of September. But M. Hoolbrenck does more it is well known that the white part of asparagus is bitter and hard, and, therefore, unfit to eat. M. Hoolbrenck takes a bottle with the bottom broken off, and gives it a strong coating of whiting With this fragment of a bottle thus prepared he covers each shoot of asparagus, as it makes its appearance, thus preventing the admission of air and light. By this means all that part of the asparagus so protected becomes as edible as the upper part. M Hoolbrenck treats the ailanthus, or Japan varnish tree, in the same way, in order to provide a larger quantity of food for the new species of silkworm that feeds upon it, and which he protects from birds by nets.

THE OIDIUM, OR VINE DISEASE.

An article on this scourge of the wine-producing countries has appeared in the *Transactions of the Royal Scottish Society of Arts*, by its Vice-President, Mr. Mackay, from which we select a few facts Of the remedies proposed, none has been so effectual as the free application of sublimed sulphur. This has saved the old vine at Hampton Court and many others. But it is manifest that it cannot be used in extensive vineyards. Mr. Forester calculated that the cost of applying sulphur to the vines of Portugal would equal a year's revenue of that kingdom. (?) M. Lazaris, of Athens, is said to have preserved vines by powdering them with a kind of argillaceous clay. It is very gratifying to learn that the disease has very greatly abated on the Continent, and, we hope, will shortly disappear. One good effect has resulted from this calamity—the increased attention given to the health of the plants and to improved methods of its cultivation.

M. Druelle, of Niort, in the department of Deux-Sèvres, has reported to the French Academy of Sciences on the successful employment of salt as the means of preserving vines from the attacks of the oidium. His process consists in depositing about a pound of unrefined sea-salt in a small hole at the foot of each vine in November or December. Last year the vines thus treated completely escaped the disease, which made great ravages on the other vines. M. Druelle's note has been referred to the consideration of the eminent physiological botanists, MM. Payen and Decaisne.—*Illustrated London News (abd.)*

THE BANANA.

In December last was to be seen in the garden of the Horticultural Society at South Kensington a bunch of fruit of the West Indian banana (*Musa Cavendishii*) of unusual size. It was 5 ft. in circumference at the broad end of the bunch, and weighed 86 lb. (50 lb., we believe, is reckoned a very fine bunch). Most people are under the impression that it takes a long course of years to get fruit from the banana in England. The fruit in the Horticultural garden may dispel this notion. Mr. P. L. Hind, F.R.H.S., of Byfleet, Surrey, who sent the fruit for exhibition, received some small plants from the West Indies on the 6th of September, 1862; and under the skilful culture of Mr. Carr, his gardener, one of these produced this enormous fruit; in fact, the bunch was little short in size of the plant which produced it. The plant was 4 ft. 6 in. in height, and the bunch about 3 ft. It is unnecessary to say that the bunch had to be tied up and carefully supported.

ORCHIDS.

The cultivation of orchids is gradually undergoing a great change in this country. We now learn from the *Journal of the Royal Horticultural Society* that the proper place in which to grow them is a moderately cool, moist house. They are no longer thrust in stoves whose stifling breath was scarcely less baleful to them than are to us the fevered blasts of "the white man's grave." So long ago as 1846, Mr. Linden drew attention to the fact that the Columbian species have no affection for a high temperature, and that many prefer a low one. In Columbia, in South America, it is said that no fewer than thirteen species occur between 10,000 and 11,000 ft., where Humboldt tells us it is as cold as the mean of the month of March near Paris. One species of Epiendrum Mr. Linden found in Columbia at a place where the mean temperature was about 40 deg., where trees were wanting, only pastures found, and where it occasionally snows. In the hot lands, on a level with the sea, orchids do not seem able to exist;

and yet we have gone on, nearly twenty years since, treating orchids as if everything had been quite the reverse. Mr. Weir, the society's collector, has been sent on a mission to obtain new species; his field of action being especially the Andes of New Granada, Quito and Peru. It is to be hoped that many cultivators will avail themselves of the opportunity of obtaining the plants which he may send home to give orchid-growing in this country a fair trial on the rational system. Instructions are given in a paper by Mr. Bateman, inserted in the number of the journal from which the foregoing remarks are selected.

THE COTTON-PLANT IN ITALY.

A REPORT from the Royal Commissioners has been presented to the Italian Government on the cultivation of the Cotton-plant in Southern Italy. About 80,000 bales of cotton have been grown during the past season in the latter district, including Sicily. This quantity would, it is said, have been trebled, had it not been for the excessive drought that prevailed. The attempts hitherto made to grow the celebrated Sea Island cotton have failed; the quality produced is, however, very good, returning a profit to the cultivator, at the present price of cotton, of 20*l.* an acre. A very satisfactory feature of the Report is the favourable nature of a vast area of Central and Southern Italy for the growth of cotton. There is very little doubt that Southern Italy alone could easily furnish 550,000 bales of excellent cotton annually, which exceeds by 50,000 bales the quantity produced by South Carolina. The insignificant quantity of cotton now grown in Italy is the more remarkable, when it is remembered that during the last century it was cultivated as far north as Tuscany, and was so abundant, that during the wars of Napoleon the First, and the Continental blockade, Italy supplied almost the whole of Europe with cotton. The plant was especially grown around Naples, and was known in commerce as Castellamare cotton.

COTTON GROWING IN FRANCE.

THE Marquis de Fournès has been successful, at Marseilles, in his experiments on cotton growing, and has been enabled to send the Society three samples of cotton, viz.:—1. Louisiana, or short staple, remarkable for the luxuriant appearance of its capsules or pods, and the abundance and whiteness of its filaments; 2. Sea-island cotton, or long staple, which is not so white or thick, apparently, but infinitely more valuable on account of its long fibres, its fineness and strength; 3. the *Kian-nam* quality, which, however, has been rather backward. M. de Fournès is of opinion that the crop of 1862 is quite equal in quality to that he exhibited in London last summer, and which was considered the third, as to quality, of all the samples from other parts.

CULTIVATION OF CINCHONA.

MR. C. R. MARKHAM has read to the British Association a paper "On the Cultivation of Cinchona in India." Dr. Thompson said it was those only who knew how rapidly the supply of quinine from Chili and South America was being exhausted that could know how inestimable was the work which the paper described. The experiments which had been made had shown, not only that the plant might be grown in other countries, but that the bark of the young tree yielded a much larger proportion of quinine than that of the old. The good which would result from carrying the cultivation of the plant into new fields was immense; for while the application of quinine was extending, many of the hospitals had to restrict its use on account of the expense, and the result of the recent discoveries would be that physicians, when prescribing bark alone, would give the preference to young bark.

Mr. J. E. Howard has exhibited to the Linnæan Society specimens of the first Cinchona bark sent over to this country from India, and described the chemical and microscopical characteristics; stating that he had found the per-centage of alkaloids quite equal to that which he had obtained from the bark of the same species grown in South America He also stated that he had obtained quinine in minute quantities from the leaves, and showed some of this alkaloid in etherial solution obtained from the leaves, together with two small phials of sulphate of quinine, obtained from the bark. (*See also p. 210 of the present volume.*)

THE CALABAR BEAN.

MR. J. NUNNELEY has described to the British Association the properties of this extraordinary plant. The Calabar Bean was brought to this country and first introduced to notice by Dr. Christison, who, in investigating its properties, though he found no ill effects at first, in a few days became utterly prostrate. He made no further experiments upon himself; but he has since been actively engaged with Dr. Fraser in experiments to determine what is the active principle in the bean. During the experiments of Dr. Fraser it was accidentally discovered that, when a portion of the extract was placed upon the eye, it had the effect of nearly closing the pupil. They knew that some poisons—Belladonna, for instance—dilated the pupil; but they had not before heard of anything that contracted it. The experiments at present were necessarily in very few hands. Mr. Nunneley described several experiments he had made with dogs, cats, and other small animals, and remarked that these animals seemed—although the poison given to them had no smell, and was mixed with food they liked—to have an instinctive knowledge that it was bad for them, and refused to take it until they were absolutely forced. It produced excessive salivation, and it made the animals very irritable. Mr. Nunneley also detailed the results of several fruitless experiments made to discover what was the active principle of the poison.

THE ORDEAL POISON-TREE OF MADAGASCAR.

Dr. Meller (in the suite of the late Mission to King Radama) describes the Tanghinia venefica, Voan tangan of the Malagasy (the ordeal poison-tree), growing along the coast. It was in full flower and fruit as the travellers passed. It was one of the most beautiful trees seen by them, and very abundant. From one of the Christians at Antananarivo, who went through the ordeal during the days of persecution in the late Queen's reign, Dr. Meller learnt the mode of its administration. The fruit was taken, bruised, and boiled whole, a fowl was boiled and the broth set aside; three pieces of the skin of the fowl were cut and put into the broth. A cupful of the poison was first administered, followed by another of the broth containing the three pieces of skin. If vomiting did not speedily set in, the poison soon killed; but if it did, it was kept up by constant exhibition of the broth and warm water, until the three pieces of skin were ejected. Should these obstinately remain, it was held as evidence of guilt, and another dose of the poison was administered.

THE POISON-TREE OF JAVA.

The Upas-tree, a native of Java, is so well known in that island for its deleterious qualities, that it is generally called the Poison-tree. There are, we believe, only two species, the *Upas antiar* and the *Upas tieute*, both of which yield a milky juice with which weapons are poisoned.

The *Abeille Médicale* states that a short time ago a scientific gentleman at Berlin received a small quantity of the condensed juice of the Upas, and resolved to try the effects of it upon himself. One afternoon he accordingly took three grains of this drug, which he found very bitter and rather saltish. Immediately afterwards he felt extremely gay, and a bad headache which he had at the time disappeared, but after a while he experienced a sensation of oppression in the stomach. Nevertheless, he had the imprudence to go out; on turning a corner he became aware of a considerable stiffness along the spine, this was about half an hour after having taken the poison. An hour later, while taking a cup of coffee, he felt a violent shock throughout his body and stiffness at the extremities; at the same time his head was thrown backwards, he lost all power of speech, but his mental faculties remained unimpaired. There was a slight remission of these symptoms for a few minutes, and then a fresh attack came on, and this continued until the patient at length succeeded in expressing a wish to be taken to the hospital of La Charité. As he was being helped downstairs to get into a carriage a new attack impeded his progress, but during the drive he had none, although the slightest shake seemed sufficient to bring it on. These attacks were attended with but little pain, deglutition was very difficult, and the patient felt very weak. After every attack the muscular system relapsed into inertness. At the hospital emetics were immediately administered to expel the poison if any remained, the vomiting was attended with sudden starts, spasms in the glottis, and difficulty of breathing, the latter symptom, however, soon subsided. The pulse was at 72. Thirty drops of laudanum were administered at the rate of ten for every quarter of an hour, and then thirty more, in three parts, at intervals of half an hour. The patient fell asleep, but was often awakened by the contraction of the muscles of the back and neck. Laudanum was again administered, and sleep returned. On the following morning the patient felt very weak, but only complained of stiffness in the left muscles of the neck; the pulse was at 66. Wine and light food were now given instead of medicine, and on the sixth day the patient left the hospital perfectly recovered.—*Galignani's Messenger.*

Geology and Mineralogy.

GEOLOGICAL SURVEY.

THE Geological Survey made considerable progress during the last year· 2430 square miles were surveyed in Great Britain; the publication of the maps proceeded, and memoirs were issued illustrating the geology of the Isle of Wight, and the country round Bolton-le-Moors In Ireland, the new ground examined amounted to about 1028 square miles; four new numbers, explanatory of the maps, were issued. The surveyors were also engaged on the re-examination of the districts of igneous rocks running from Wicklow into Waterford. Of the Royal School of Mines, formerly called the Government School of Mines, Sir Roderick Murchison reports satisfactorily. Statistical records of all our lead mines, carefully prepared, now extend back to 1766. Since 1815 every sale has been recorded. The production of copper and tin mines is regularly registered, and the statistics of copper mining are now complete from 1815, and those of tin since 1852. The estimated value (at the place of production) of the coal and metals produced in the United Kingdom in 1861 was 34,602,853*l*. The results elicited by the Exhibition were very encouraging to all who take an interest in the Royal School of Mines The pupils were foremost among the champions of the great industrial contest. The new industry of coal-tar colours is generally admitted to have been the most striking feature in the department of chemistry, and this industry emanated directly from the laboratory of the Royal School of Mines; Mr. Perkin, Dr Medlock, Messrs. Nicholson, Maule, and Simpson, to whose exertions the colossal development of these branches of chemical manufacture is chiefly due, received their chemical education from Dr. Hofmann in this institution. The foreign jurors bore testimony to the accuracy of delineation in the maps and sections of the department, and the order and arrangement of the museum; and it was from this that so many valuable donations were offered to the museum. Signor Sella, recently Minister of Finance of the Kingdom of Italy, himself a distinguished mathematician and crystallographer, and employed by his Government to visit the mining and geological schools and establishments of Europe, with a view to the formation of a geological survey of Italy, writes, in an official report, "England is, without doubt, the country where geological maps are prepared with much greater accuracy than in any other land. The singular importance of her mining industries, the spread of the elementary principles of geology, the zeal applied by the geologists charged with these labours, and the precision of their works have been so accomplished that few undertakings of the British Government have so much contributed to the benefit of the public as the Geological Survey of the United Kingdom."

GEOLOGICAL HISTORY OF THE BRITISH ISLES.

SIR RODERICK MURCHISON believes, first, that the eastern shores of Great Britain, where Cæsar landed, have not changed their relation to the sea-level since that period; secondly, from finding remains and bones of the same species of extinct mammalia in the gravel of Britain and the Continent, that it is proved, that at a comparatively recent period our islands were united with France; and, thirdly, from the skeletons of the great Irish elk, which are found in the bottom of the bogs in Ireland, and also in the Isle of Man and in Cheshire, that when that creature lived, these three islands must have been united.—*Anniversary Address to the Geological Society*, 1863.

RIVER OF THE GLACIAL PERIOD.

IN the Geological Section of the British Association, Mr. N. Wood and Mr. E. F. Boyd have described a Wash or Drift in the Coal-field of Durham. A channel which defines the course of an ancient river has existed up to a comparatively recent geological period between the city of Durham and Newcastle. The bed of this river-course is 93 feet below the present level of the Wear, and 140 feet below the foundations of the High Level Bridge, which is 30 feet below the bottom of the river. The condition of the *débris* met with, indicates a swift current and powerful stream. The phenomenon is evidence that at no distant era in geological time the district has been considerably depressed. Professor Phillips remarks that this ancient river was probably one of a system belonging to the glacial period.

GLACIERS OF GREENLAND.

IN the *Proceedings of the Royal Geographical Society* is a note by Dr. Rink, of Greenland, on the discharge of water from the interior of that country through springs underneath the ice.

He calculates the yearly amount of precipitation on Greenland, in the form of snow and rain, at twelve inches, and that of the outpour of ice by its glaciers at two inches. He considers that only a small part of the remaining ten inches is disposed of by evaporation, and argues that the remainder must be carried to the sea in the form of sub-glacial rivers. Copious springs of fresh water boil up through the sea in front of the glaciers that advance into it, and their positions are conspicuously pointed out by flocks of sea birds which invariably hover over them in evident search of food. A lake adjacent to the outfall of a glacier into the sea has an irregularly intermittent rise and fall. Whenever it rises the sea springs disappear, when it sinks they burst out afresh, showing a direct connexion between the springs and a sub-glacial river. Arguing from what has been observed in the Alps, Dr Rink concludes that an amount of glacier water equivalent to ten inches of precipitation on the whole surface of Greenland is no extravagant hypothesis, and he accounts for its presence partly by the transmission of terrestrial heat to the lowest layer of the ice, and partly from the fact that the summer heats are conveyed into the body of the glacier, while the winter cold never reaches it. The heat melts the surface snow into water, which percolates the ice, while the cold penetrates a very inconsiderable portion of the glacier, whose thickness exceeds 2000 feet.

At the time Dr. Rink's communication was read, Sir R. I. Murchison remarked on its importance in relation to the geology of Scotland, the northern part of which had been in precisely the same condition as Greenland is now—covered in its centre by great snowy frozen masses, which advanced towards the east, and emptied themselves by glaciers ; and Professor Ramsay added that, until people went and saw what was going on in Greenland, there would inevitably be a great many phenomena not clearly understood in our own island.

SNOWDONIA.

SIR CHARLES LYELL, in a discussion of the Geological section of the British Association, referring to certain shells which had been found in Wales, said it was proved to demonstration that the whole of Snowdonia, the highest mountains in Wales, were islands at the time the shells existed. The changes that must have taken place in the earth's crust to produce this permanent upheaval were really most astonishing ; and it was proved how the study of the living species of shells, which Mr. Jeffreys had so successfully cultivated, opened up wonderful geological inferences in regard to the changes that had taken place in the earth in modern times.

GEOLOGY OF FLORIDA.

GEOLOGISTS who are familiar with the idea of geological phenomena worked out through periods of inconceivable duration will, perhaps, be able to appreciate Mr. E B. Hunt's argument on the growth and chronology of the great Florida reef. After stating the dimensions of the reef, Mr. Hunt proceeds :—"Taking the rate at twenty-four years to the foot, we shall have for the total time $24 \times 250 \times 900$, on the data as stated ; or, we find the total period of 5,400,000 years as that required for the growth of the entire coral limestone formation of Florida."

PROGRESSIVE DEVELOPMENT OF ORGANIC LIFE.

SIR CHARLES LYELL, in addressing the Geological section of the British Association, regretted the short time left for discussion of a question relating to the theory of Progressive Development of Organic Life ; for, if the facts put forward were true, one of the greatest blows had been struck at the theory of development, as generally understood, that could possibly have been dealt. There had been too great an inclination on the part of geological discoverers to assume that any given form of animal entered into this planet at the period of the rock in which it happened to be found : and the warning he had constantly given against this tendency had been interpreted as a much stronger protest against the doctrine of progression than it ought to have been. When the first of these reptiles, a new form, was announced to be found in a rock, reported on good authority to be Devonian, or, at any rate, palæozoic, he did feel a pleasure in the rebuke such a fact gave to the doctrine that no reptiles existed at that period. It always appeared to him unphilosophical, merely because we knew nothing of the vertebrate life of that period to assume therefore that no reptiles existed older than the trias. But, afterwards, when it was discovered that the Stagonolepis, a supposed fish, was a crocodilian reptile, and that some of the other forms were the same as those of the crocodiles now living in the Ganges, he began seriously to doubt whether his friends had assigned a true position in the geological series to these beds. Now, he quite saw from the investigations that these must be admitted to be a consecutive regular series from unquestionably old red beds containing the well-known fishes up to the beds containing those reptiles. He was inclined strongly to conclude that we had here a conformable series, containing in the lower part Devonian rocks, and in the upper part something newer than the coal.

DISCOVERY OF THE SOURCE OF THE NILE.

On April 28, 1863, intelligence was received that Captains Speke and Grant had completed their arduous journey across Eastern and Central Africa, from Zanzibar to Khartum, on the White Nile, where they had arrived in safety.

Sir Roderick Murchison, at the meeting of the British Association, referring to this great labour to set at rest the unsolved question of ages as to the true source of the Nile, remarked upon the fact that "traveller after traveller, from the days of the Egyptian priests and of the Roman emperors down to modern periods, had endeavoured to ascend the Nile to its source, and all had failed;" and that it was by reversing the process, and by proceeding from the east coast of Africa, near Zanzibar, to the central plateau land between North and South Africa, that Captains Speke and Grant had solved the problem.

We are compelled almost to limit our notice to merely chronicling this great discovery, the details of which would occupy more space than is at our command. We must, therefore, refer the reader to the published reports, and Captain Speke's Journal of the discovery. The author, summing up the gains of his travels, says:—

"The Expedition had now performed its functions. I saw that old Father Nile, without any doubt, rises in the Victoria N'yanza, and as I had foretold that lake is the great source of the holy river which cradled the first expounders of our religious belief. . . . . Let us now sum up. Comparative information assured me that there was as much water on the eastern side of the lake as there is on the western—if anything rather more. The most remote waters, *or top head of the Nile*, is the southern end of the lake, situated close on the third degree of south latitude, which gives to the Nile the surprising length, in direct measurement, rolling over thirty-four degrees of latitude, of above 2300 miles, or more than one-eleventh of the circumference of our globe. Now, from this southern point, round by the west, to where the *great* Nile stream issues, there is only one feeder of any importance, and that is the Kitangulé river; whilst from the southernmost point, round by the east, to the strait, there are no rivers at all of any importance; for the travelled Arabs one and all aver, that from the west of the snow-clad Kilimandjaro to the lake where it is cut by the second degree, and also the first degree of south latitude, there are salt lakes and salt plains, and the country is hilly, not unlike Unyamüézi, but they said there were no great rivers, and the country was so scantily watered, having only occasional runnels and rivulets, that they always had to make long marches in order to find water when they went on their trading journeys and further, those Arabs who crossed the strait when they reached Usoga, as mentioned before, during the late interregnum, crossed no river either. There remains to be disposed of the 'salt-lake,' which I believe is not a salt, but a fresh-water lake, and my reasons are as before stated, that the natives call all lakes salt, if they find salt beds or salt islands in such places Dr. Krapf, when he obtained a sight of the Kenia mountain, heard from the natives there, that there was a salt lake to its northward, and he also heard that a river ran from Kenia towards the Nile. If his information was true on this latter point, then, without doubt, there must exist some connexion between his river and the salt lake I have heard of, and this in all probability would also establish a connexion between my salt lake and his salt lake which he heard was called Baringo. In no view that can be taken of it, however, does this unsettled matter touch the established fact that the head of the Nile is in 3° south latitude, where in the year 1858 I discovered the head of the Victoria N'yanza to be I now christened the 'stones' Ripon Falls, after the nobleman who presided over the Royal Geographical Society, when my expedition was got up, and the arm of water from which the Nile issued, Napoleon Channel, in token of respect to the French Geographical Society, for the honour they had done me, just before leaving England, in presenting me with their gold medal for the discovery of the Victoria N'yanza One thing seemed at first perplexing—the volume of water in the Kitangüle looked as large as that of the Nile, but then the one was a slow river and the other swift, and on this account I could form no adequate judgment of their relative values."

MINERALOGY OF TASMANIA.

THE Government of this country have voted 3000*l.* for the purpose of investigating the mineral and metalliferous resources of the Macquarie Harbour country. The investigation has been entrusted to Mr. Charles Gould, the Government geologist, son of the eminent ornithologist. It is the universal feeling in the colony that no gentleman is better qualified for this task, Mr. C. Gould having already, by his geological explorations, rendered great service to the colony Mr. Gould, we may add, is convinced that the country he is about exploring is extremely rich in minerals.

GRAPHITE AND NEPHRITE.

M. ALIBERT, a Frenchman, while traversing a gorge in the Saian mountains which separate the Russian Empire from China, observed some unusual substance lying in the crevices of a gigantic rock: he examined it more closely, and after some days of continued labour, acquired the conviction that he was on the traces of an incomparable mine of Graphite, the precious substance with which blacklead pencils are made. The discovery of graphite only dates from the middle of the 16th century. Of good quality it is rare—more so than gold, silver, or any other production of the mineral kingdom. The discovery of graphite in the mountains mentioned above has been followed by that of nephrite or jade. Until now this mineral had only been found at a few places in the

Chinese empire, and from its high price and great rarity the official sceptre of the Sovereigns of the Celestial Empire was made of it. It will be remembered that one of the most remarkable curiosities derived from the plunder in the Summer Palace at Pekin was a jade sceptre. A block of this rare mineral, weighing 1200 lb., and of exceptional purity, has just been obtained. The Kensington Museum at London also possesses a valuable block of this mineral.

SILVER MINING.

NEW indications are constantly being furnished that the progress of modern mining adventure is likely to be as rapid with regard to Silver as Gold. During the American war the accounts from California have attracted less attention than usual; but it is known that the yield of silver in that State is steadily increasing, and that the production there, as well as in all other places, is likely to be stimulated by a settlement, recently effected, of the litigation that has for a long time interrupted the development of the new Almaden quicksilver mines. At the same time it has been ascertained that an extensive silver-bearing region exists in the Argentine Republic, in the province of San Juan, at the foot of the Andes, about 700 miles from Buenos Ayres, the yield of which, so far as experiments have yet been made, is likely to prove as rich, if not more rich than that of any field heretofore worked. Its limits have not been ascertained, but according to official reports the deposits have already been found to extend over an area of 100 miles by 40. Meanwhile, we have the announcement that at a place called St. Arnaud, in the colony of Victoria, a company are actually at work on some silver lodes, and that the entire locality is declared to be "a silver Cornwall, which until recently has been overlooked by ignorant miners, having no eyes for anything but gold." Add to this the increased development certain to be witnessed in Mexico, and especially in the province of Sonora, immediately upon the pacification of that country.—*Times (abridged), Dec.* 1863.

GOLD DISCOVERIES.

THE year 1863 has been very productive of new *finds* of gold, of which the following are the principal:—

California.—The *New York Tribune* says:—"California was never opening new mines so fast as now. The sands of her rivers may be nearly exhausted; the drift of her plains and valleys is probably far less productive than it was ten or twelve years ago, but her mountains and rocks are just beginning to yield their precious ore. We hear by every mail of new discoveries in the south and in the north, gold is found in quarters hitherto unsuspected of containing it, new lodes of silver, copper, and other valued minerals are announced in rapid succession, the famous Monte Diablo has been discovered to be veined with copper, and perhaps with other ores as well, though hitherto unsuspected thereof, while Nevada is proving rich in silver and gold, over nearly her whole extent, and Arizona bids fair to rival the California of 1849." The *Tribune* adds, that it is estimated that the Rocky Mountains will this year produce 20,000,000*l.* of gold.

Vancouver Island.—A party of experienced miners have found rich gold diggings within a dozen miles of the city of Victoria, at a point called Placers on the gold stream. The party obtained on "bench diggings," as well as on the bars of the creek, coarse gold in sufficient quantities to pay at least $5 to $7 a day to the hand. The gold is said to be so much purer than the Cariboo, that it will fetch ten per cent. more than the best yet taken from the Fraser River diggings, and the appearances of the country generally seem to justify the belief that the supply is inexhaustible. The excitement in Victoria was so great, that between 400 and 500 persons started off at once for the newly-discovered El Dorado, and in the course of a few hours after the fact became known, a regular line of waggons to the mines was established —From the *Canadian News*

Canada.—A great rush has been made for the county of Beauce, about thirty-five miles from Quebec, to the gold district, extending over forty miles. The mines of Chaudere have yielded some fine nuggets of nearly 1 oz. of pure gold, and large lumps have been washed from the banks. We learn from the Lower Provinces, Sherbrooke, St Mary's, under date of August 16th, "Five tons of quartz from the Cumminger lead, were taken off and crushed last week, and yielded 53 oz. of the precious metal. This is the product of five men's labour for six days, at a depth of 15 feet from the surface."—*Quebec News.*

Queensland.—At the beginning of winter two men pushed out from the head of the Ovens, and found gold in considerable quantity in the bed of a stream, the head of the Dargo, on the Gipps Land side of the Dividing Range, and about thirty miles from the centre of the Omeo diggings.

Wales.—Gold has been found in the town of Ruthin, in the Vale of Clwyd. Within five or six feet or less from the surface, fragments of quartz containing gold, as well as pure gold dust, were found mixed up in white sand. This discovery is of considerable interest, and indicates that the mountains to the east and south of this part of the Vale of Clwyd originally contained the metal, which has been brought down by the action of water, and deposited in the sand with or without its matrix of quartz. It is not unlikely, therefore, that these mountains may be soon added to the gold-producing districts of North Wales, which have lately attracted so much attention. Of the latter, we find it stated, that at the Castell Carn Dochan mine, many tons weight of lode-stuff have been collected, some of which has yielded gold at the rate of 18 oz. to the ton In its specular dissemination, it resembles that of Clunes, in Australia. The *débris*, of which there is a considerable quantity, yields gold of equal value with the lode-stuff Specimens of quartz have been found showing gold as rich as any that has been found at Clogau, where 32,000*l*. has been realized from the gold produce of less than 1300 tons; a result to be believed unparalleled in the world's history of gold quartz mining The gold is not associated with sulphuret in excess, so that its extraction is exempted from the difficulties generally attending the various processes of amalgamation. This is an important fact, and greatly enhances the commercial value of the discovery.

ANTIQUITY OF MAN.—HUMAN JAW AT ABBEVILLE.

IN the latter part of March, while digging in a gravel-pit at Moulin-Quignon, near Abbeville, a labourer found a flint implement and a small fragment of bone, which he immediately conveyed to M. Boucher de Perthes, who on clearing away the sand, found a molar tooth implanted in the bone. A search was immediately made, and on March 28 the lateral half of a lower jaw, unquestionably human, was found.

Messrs. Prestwich, Evans, and Taylor, paid a visit to M. Boucher de Perthes, for the purpose of comparing the new facts with previous discoveries. Mr. Evans is said to have been struck with the suspicious appearance of one of the flint heaps. The axes seemed to have been artificially stained; and on being placed in water, they looked as if all the colour would brush away. The general circumstances are said to have impressed the English geologists with a strong feeling of uncertainty.

Mr. Evans then, in two letters addressed to the *Athenæum*, adduced proofs sufficient to show that a regular system of imposition has been carried on by the gravel-diggers of Abbeville, that the majority of implements lately obtained at Moulin-Quignon are false, and, inferentially, that the human jaw which was associated with them is probably unauthentic. Mr. Evans then deputed a trustworthy person to visit Moulin-Quignon, who returned, bringing with him seven hatchets, all of which he believes to have been placed there on purpose for him to find !—in short, that they are modern forgeries ; though he doubts not, genuine specimens are to be obtained. Mr. Evans adds :—"With regard to the human jaw, the occurrence of others of similar character and in the same mineral condition at Mesnières (as mentioned by Mr. Prestwich), and their discovery there by a workman of Mautort, who not only sells forged flint implements, but also occasionally works at Moulin-Quignon, is, to say the least of it, highly suggestive " The premium offered for the discovery of human bones in the gravel has led to the attempted fraud. Still, "whatever forgeries and deceptions have been or may be perpetrated, the main facts of the case remain unaltered and unassailable. Flint implements, indisputably the work of man, have been discovered at Abbeville, Amiens, Hoxne, Bedford, and other places, in conjunction with the remains of the mammoth, rhinoceros, and other extinct mammals of the post-pliocene period, in beds of undisturbed fluviatile gravel, and under circumstances which prove that those beds were deposited at an epoch to the minds of most people inconceivably remote, and long before the surface of the country had received its present configuration."

Dr. Falconer has since published a letter, in which he states, after due investigation :—1, that the flint hatchets have been pronounced by highly-competent experts (Evans and Prestwich) to be spurious ; 2, that the reputed fossil molar tooth is quite recent ; and 3, that the reputed fossil human jaw shows no character different from those met with in the contents of a London churchyard. The inference he draws from the facts is, that a very clever trick has been performed by the terrassiers of the Abbeville gravel-pits.

FROGS AND TOADS IN ROCKS.

THE much-vexed question of living toads being found in rocks has received the following confirmation from Sir Alexander Gordon Cumming, of Altyre :—

The ground under which these living toads are found consists of two feet of black soil, from six to twelve feet of water-worn gravel, and four to eight feet of hard sandstone, all resting upon a bed of red conglomerate.

While inspecting the railway works I have myself seen numbers of living toads taken out of the conglomerate at depths of from 15 ft. to 24 ft. from the surface. An extensive, and seemingly unbroken, bed of rock covers the stratum in which these living toads are found.

The *Forres Gazette* states :—

"This fact was farther confirmed by an examination of the men present at the blasting, who produced portions of the rock, showing the precise spots where some of the toads were embedded. These were indentations on the stone of a size, but not so deep, of a hen's egg cut lengthwise in half. When the shot went off, the workmen ran to the spot and found the toads scampering away. The nests, which became exposed in the solid rock by the blast, appeared to have a coating of soft black viscid stuff, in which the toads had lain. The rock is not sandstone, but a kind of conglomerate, very compact, but with open spaces, around which crystals of silica appear."

We find, also, in Gosse's *Natural History*, second series:

"A gentleman who has just returned from Khandeish, in the south of India, informs us that in digging or rather blasting a well in Khandeish the well-diggers encouraged him to persevere, as they had found moist rock, and because within the blocks were frogs; that he saw two small frogs released out of a block of hard rock, and found water there at about 35 feet from the surface. Wherever water percolates tadpoles may be conveyed, as also air and infusoria, for their support in their advanced stage of existence, and no doubt nature enables the frog to secrete solvents, enabling it to increase its mansion, for, otherwise, how could the 'Blois toad' have prevented the process of silicification within the flint in which it was enclosed?"*

REMAINS OF THE MAMMOTH AT LEICESTER.

IN the old or Roman part of the town of Leicester has been found a large fragment of the tusk of the Mammoth, lying upon the hard, denuded beds of the "Upper Keuper Marls," at a depth of eleven feet from the surface. This eleven feet consisted of a soft, sandy, very clean drift gravel, not unlike,—except in being softer—the other drift gravels in the valley of the Soar. The tusk measured *in situ*, nine feet in length, two feet in circumference ; and, judging from its nearly uniform thickness and the curvature of this portion, it must have been originally fifteen or sixteen feet long. Owing to its great weight, brittleness, and the narrowness of the excavation, only six feet of the tusk could be brought up ; this portion is now in the Leicester Museum.

Although the tusk was found upon the Keuper beds, it seems very probable that it was not originally deposited there : the animal may have died in some of the adjacent valleys, and its remains, teeth, tusks, and bones, have been washed out into the river, then—there is much evidence for assuming—two or three miles wide. The tusk, from its great weight and the peculiarly soft nature of the gravel, worked its way down to the hard beds of the marl. Judging from the quantity of the remains discovered —teeth, tusks, and bones—this valley of the Soar would seem to have been a favourite haunt of these great Pachyderms. An entire skeleton was exhumed some few years ago near Barrow-upon-Soar ; it was lying six feet from the surface upon the lias marls. On being first uncovered it crumbled into dust, only a few teeth, fragments of bone, and a portion of a tusk being preserved. We may very easily suppose that the tract of country stretching from the marlstone hills upon which stands Belvoir

* Upon this question a long chapter of evidence appeared, many years since, in *Blackwood's Magazine*. (See the *General Index*.)

Castle, away to that elevated plateau around Naseby Field and all the western side of the valley, including the Charnwood Hills, was then covered with dense forests, the home and feeding-ground of these extinct elephants.—*Communicated by Mr. James Plant to the Athenæum.*

MAMMALIAN REMAINS IN OXON.

A CONSIDERABLE number of Elephant and other Mammalian bones has recently been met with in a cutting upon a new line of railway passing through Thame, in Oxfordshire, and forwarded to the Geological Society. They were taken from a coarse rubbly gravel, mixed with stiff clay, about 13 feet from the surface. The section, forwarded by Mr. Wilkinson, gives a surface-clay, lightish yellow in colour, and with a sandy bottom 11 feet in thickness, lying upon the gravel, the average thickness of which is 2 feet 6 inches, and which passes downwards into a light-coloured sand. About ten feet down in the clay a vase was found of coarse earthenware full of small bones; and just above the gravel another vase of coarse brown ware. The gravel extended linearly for 60 yards, and was slightly dome-shaped. Part of the bones have been submitted to Dr. Falconer, who has recognised *Elephas primigenius* of the Siberian type—teeth and other remains rather abundant; *Elephas antiquus*, a large species of *Bos* (*primigenius*? or *priscus*?)—top of radius, tibia, and horn core; many bones and teeth of *Equus Caballus fossilis*, including a finely-preserved tibia of great size, and a portion of another still larger; and some good fragmentary specimens of the horns of *Cervus elephas*. Still more important mammalian remains have been obtained by Mr. Codrington, F.G.S.

SAND-RAIN.

SPECIMENS of Sand-rain, which fell for several hours on the 7th of February last in the western part of the Canary Isles, have been sent to the Academy of Sciences by M. Berthelot, the French Consul at Sainte Croix, at Teneriffe. The buildings in several of the isles were thoroughly powdered with the sand, and the Peak of Teneriffe, then covered with snow, was coloured yellow with it for several hours, even to the summit. The weather was very stormy, and thunder frequently heard. The sand is of a bright colour, and the grains nearly impalpable. It produced a strong effervescence when mixed with acid, and lost half its weight of carbonate of lime. The insoluble residuum was composed of very fine grains of quartz, some transparent and colourless, others yellow and opaque. Mineralogically considered, this sand presented a complete identity with the sand of the Desert of Sahara, especially with a specimen from the neighbourhood of Biskra in the geological gallery of the museum at Paris. In both are found minute remains of shells, which appear to be contemporaneous with the deposition of the sand. Microscopic examination did not disclose the presence of any other bodies of an organic nature. It is not doubtful that this sand was conveyed from the Desert of Sahara, which is distant from the Canary Isles above one hundred and ninety-two miles. It appears to have been raised by a species of waterspout to a height of about three miles above the level of the sea, so as to attain to the atmospheric counter-current.

NEW TORTOISE.

THE remains of a fossil Tortoise of a new species, discovered by M. Lennier, of Havre, have been described by M. Valenciennes to the French Academy of Sciences. A remarkable distinction in this tortoise is its possessing nine ribs, all those hitherto known having but eight. M. Valenciennes therefore names it Palæochelys Novemcostatus.

COAL DISCOVERED IN BRAZIL.

WORKS treating of South America generally remarks on the absence of Coal deposits, especially in Brazil. A rumour was circulated in 1859 that a gentleman visiting the southern part of the province of Rio Grande do Sul had observed coal on the surface; and the report was quoted in an article in the *Quarterly Review* in 1860, and in Mr. E. Hull's well-known work on *British Coalfields*. In 1862 Mr. N. Plant proceeded to the district indicated, which lies partly in Brazil and partly in the republic adjoining. It embraces the rivers Jaguarao, Candiota, and Tigre, the two latter being tributaries to the former. In some places the coal beds, shown in the outcrop over miles of *pampas*, were 65 ft. thick. To the north of this large coalfield there existed two smaller beds. This is the first instance of coal having been found in Brazil, with its 3,000,000 square miles. It is a most valuable discovery for the Brazilian Government, which annually imports 250,000 tons of coal, at 49*s*. per ton. The coal is generally as good as the British, though not for ordinary burning, but for steam purposes and gas it answers well.—*Proceedings of the Manchester Geological Society.*

OUR COAL RESOURCES.

THE distribution of Coal in England is much greater than in any country in Europe; though in the United States of America, near Pittsburg, the beds of coal extend over a vast area, and one is of great thickness. The quantity of coal that is raised from the pits in this country, however, exceeds that from all the other coal fields in the world. The probable duration of coal in England has formed an interesting subject of speculation with some geologists who have estimated the period variously at from 300 to 1000 years. Sir William Armstrong, at the meeting of the British Association in 1863, estimated the minimum period of the Northern Coal-field at 200 years; but Mr. N. Wood is of opinion that of this field no conjectures of practical utility can yet be formed, as more than one-half of the basin, lying under the sea, has not yet been explored.

Sir William Armstrong's remark, however, was misunderstood, and his statement was thought to refer to the coal supply of the whole kingdom, whereas, he limited the remark to the coal-field of Durham and Northumberland. This misapprehension re-opened the question of the exhaustion of our coal resources, and led to the communication of some valuable evidence in the *Times* journal. Thus Mr. E. Hull, of the Geological Survey, states as the result of a series of investigations of the British coal-fields, that adopting the limit of depth at 4000 feet, he found there to be enough workable coal, at the rate of consumption for that year, (about 71,000,000 tons), for nearly 1000 years; and even if the consumption should ultimately reach 100,000,000 of tons, that supply could be maintained for 700 or 800 years; assumed depth, 4000 feet.

Dr. Buckland, in 1841, dwelt upon the wanton waste of coal at the pits, which, in 1836, he had maintained would finally "exhaust the Newcastle coal-field at a period earlier by at least one-third than that to which it would last if wisely economized." The waste has, however, been much abated.

Mr. Robert Hunt, however, maintains the *consumption* to be greatly under-stated. He says:—

"All calculations on the probable duration of our coal-fields have been founded on the very erroneous data which supposes that not more than 36,000,000 of coals are raised annually. We know that more than *sixty-six* millions of coals are now annually produced, and the demands upon our resources are rapidly increasing."

Sir William Armstrong himself quotes Mr. Hunt as showing that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of *eighty*-millions of tons, and that the average increase of the eight preceding years amounted to $2\frac{3}{4}$ millions of tons. A subsequent return shows the increase to be still greater.

GUANO DEPOSITS ON THE COAST OF PERU.

An important survey has been concluded of Guano deposits on the coast of Peru, and is thus described in the *Comercio*, of Lima, of the 13th of June:—The engineers, after their departure from Callao, commenced naturally at the Lobos Islands, where in their opinion were the more valuable deposits. The guano on these islands extends on a large part of the surface to a depth of 10 to 12 feet, but on some parts there are deposits of as much as 40 feet deep. The guano of the thinner strata is naturally inferior, because the mists that take place there sometimes have some influence, but in the places where the deposits are of a greater depth, the quality of the manure is superior. On both islands the first-class guano may be calculated about three millions of tons, and the one of the second class about one million of tons. For the first class guano Peru can easily obtain a net produce of 6*l*. a ton. Of the second class the net produce will not be less than 4*l*. a ton. On the Macabi group, near Malabrigo, they found a respectable stock, the whole guano of the first class, and not inferior at all to that of the Chincha islands. The labours of the engineers were interrupted, because the borer they used for their examinations broke after having penetrated with great effort to the depth of 130 feet without touching the foundation rock. In these excavations crystallized ammonia was found at 30 feet of depth. On these islands all the guano is of first quality, as we said already, and the said stock is not less than 1,500,000 tons. The work having been suspended after this accident, they sailed for the Guañape group, opposite the point of St. Helena. All the guano was found to be of the first class, and the stock, judging by the height and the extension of the deposits, which commence at the very sea, will not be less than 2,500,000 tons. On the Lobos islands the guano cannot be embarked economically but by means of long wharfs, but at both the Macabi and Guañape group, the depth of water is considerable. The total quantity of deposits upon the Lobos, Macabi, and Guañape islands is 8,000,000 tons—value 46,000,000*l.*—besides the deposits on the Chincha islands.

GRAHAM'S SHOAL.

GRAHAM'S SHOAL, or island, off the coast of Italy, which rose and sank in 1831,* was stated to have been "re-discovered" during the past year. Now, the shoal lying nearly in the track of the mail steamer running between Marseilles, Malta, and Alexandria, this information was speedily communicated to the *Times*, and produced a rejoinder showing, that so far from this being a re-discovery, or the shoal being unknown, that in 1851, so unsatisfactory were the examinations, which represented the shoal to have sunk to a depth of 36 fathoms, that it was re-examined by the *Scourge* steam-sloop, and only 10 feet of water were found on the shallowest part; and this information, with the form of the shoal, was sketched in a chart, issued from the Admiralty Hydrographer's office, and locally made known at Malta. Another examination was made in 1852, when the shoal was apparently unchanged. The 36-fathom bank, which had been mistaken for Graham's Shoal in previous surveys between 1841 and 1851, will be seen marked on the same chart, and is now called "Ramsay Patch."

PERMIAN ROCKS.

SIR RODERICK MURCHISON has read to the British Association a paper on "The Permian Rocks of the North-West of England," in which he described the Permian rocks as the newest palæozoic deposits forming a natural group characterized by community of animal and vegetable life existing in various parts of Europe.

* Fully described in the *Arcana of Science and Art*, 1832, by the Editor of the present volume, 1864.

The following abstract of this paper is from a letter by Sir Roderick Murchison, in correction of a previous Report:—"Geologists well know that there is an important development of these rocks (of which the magnesian limestone forms the principal part) in the county of Durham, whence they range southwards to Nottingham. In the east of England there exists no such grand exhibition of the lower member of the permian group (the *rothliegende* of the Germans) as that which is displayed in the north-western counties of Westmoreland, Cumberland, and Lancashire, in which this lower permian is an enormous accumulation of red sandstone and breccia. In these counties the permian group assumes a tripartite character, and consists of the before-mentioned inferior sandstones, a central magnesian limestone, and an upper sandstone, which is largely exhibited at St. Bees'-head and other places; the same tripartite arrangement being there maintained as that which Sir Roderick pointed out many years ago as prevailing in Germany and Russia.

"The name of permian, suggested for the group which lies between the carboniferous rocks and the new red sandstone or trias, was proposed by Sir Roderick in 1844, because these rocks, which previously had no collective name, were found by himself and associates to extend over a vast region of Russia (much larger than France), of which the ancient kingdom of Permia formed a part. The name has now been generally adopted by English, French, and American geologists to designate the uppermost division of the primary or palæozoic series.

"Many years ago the chief member of these rocks (the magnesian limestone and its relatives) was admirably described by Professor Sedgwick, and recently the order and succession have been extensively traced by Mr Binney and Professor Harkness in the north-west of England." In a recent examination of these deposits in Cumberland and Lancashire, in company with the last-named geologist, Sir Roderick made the communication in question, one of the principal features of which was the determination of the real age of the great and valuable deposits of the hæmatite iron ore of Cumberland and Lancashire, by showing that some of these are actually worked through a cover of permian brecchia, thus proving that this one was formed in the palæozoic era, as had been suggested by Professor Phillips.

This discovery enriched his Permian group, and it showed that that period of the earth, so remarkable in Germany for the up-pouring of porphyry, and the great change which took place in the earth after the formation of coal, enriched the Permian system by the formation of a deposit of the richest and most valuable mineral in the British isles.

Astronomical and Meteorological Phenomena.

NEW REGISTERING BAROMETER.

MR. JOSEPH CASARTELLI has exhibited to the Literary and Philosophical Society of Manchester a new Registering Barometer. The tube in this instrument is Gay-Lussac's, or the syphon form, and is enclosed in a mahogany case, in which is an eight-day clock. The arrangement is such that at the completion of every hour the hammer of the clock strikes upon a portion of the apparatus, which impels the index point on to the drum and pierces a hole in the diagram; thus forming an hourly record of the height of the barometer from week to week.

RAIN-FALL IN LONDON.

A PAPER has been read to the Literary and Philosophical Society of Manchester "On the number of Days on which Rain falls annually in London, from observations made during the 56 years, 1807—1862." by G. V. Vernon, F.R.A S.

This paper has been compiled to meet, to some extent, inquiries which have from time to time been made by medical men and others as to the number of days on which rain falls annually at any station. Of course, the remarks only apply to London and its immediate neighbourhood.

Howard's Climate of London has been used for the years 1807 to 1831, *Philosophical Transactions* for the years 1832 to 1840, and the *Greenwich Observations* for the years 1841 to 1862. During the entire period of 56 years no month occurred in which rain did not fall.

The minimum number of days occurred in 1832, the cholera year, and 1834; the number of days being 86 and 82 respectively. The maximum number occurred in 1848, the number being 223 days.

The mean monthly values are as follow:—

Month.	Mean number of days on which rain fell.	Month.	Mean number of days on which rain fell.
January	13·4	July	13·0
February	12·4	August	12·9
March	11·9	September	12·7
April	12·7	October	14·4
May	12 7	November	13·6
June	12·0	December	13·6
		Year	155·3

Taking the quarterly values, we find that rain falls on the greatest number of days in autumn, and the least in spring.

Taking the means of five yearly periods, there appears to be a kind of periodicity in the number of days on which rain falls, having a maximum in 1813 to 1817, and a minimum in 1843 to 1847.

FORMATION OF HAIL.

FATHER SANNA-SOLARO has laid before the French Academy of Sciences a new theory respecting this meteor, the formation of which he has imitated. At present meteorologists consider that hail is formed in the atmosphere by successive incrustations upon a nucleus. He believes that hailstones are produced at once nearly in the state in which they fall; that congelation begins with the exterior; that the liquid in contact with the crust cools, and the bubble of air is converged towards the centre —this latter finally bursts the shell, and the congelation of a new layer takes place. This latter is formed of two parts—one deprived of air and transparent, the other containing bubbles of air and opaque. If the hailstones reach the ground before perfect congelation, their centre will contain bubbles of air, water, and icicles; but if the congelation be suddenly completed, the nucleus will resemble snow. The Father has frozen different quantities of water in caoutchouc envelopes quite transparent, and states that he has obtained artificially all the above-mentioned phenomena, and that between the natural and artificial hailstones the only difference is, that the number of the layers, for equal volumes, is greater in the latter. The details are given in the memoir, which is printed in the *Comptes Rendus.—Illustrated London News.*

NEW BAROMETRICAL OBSERVATIONS.

WE read the following passage in the *Comercio de Lima* of January, 8, 1863:—"Lately a large barometer has been erected in the National Astronomical Observatory of Santiago de Chile. By this instrument has been observed a singular phenomenon new to science. We know, particularly through the observations of Humboldt, that the barometer rises and falls during the day in a peculiar manner, being at its maximum height at 10 a.m. and at 10 p.m., whilst the lowest readings are between 4 p.m. and 4 a.m. The regularity of this periodical movement within the tropics is such during the year, that Humboldt could tell the time within fifteen minutes. This movement has been observed with much regularity in Santiago de Chile during the winter and summer months; but in the month of February the movement entirely ceases, showing then only the ordinary maximum and minimum heights in the twenty-four hours. Señor Moesta has tried to explain this occurrence, and has demonstrated mathematically that the oscillatory movement of the barometer is produced by the sun's power, analogous to that of gravitation, and that the said movement ought to disappear in the month of February in consequence of the great variation of temperature during the course of the day. Thus the interesting result has been arrived at, that by virtue of the sun's power a movement is manifested in the atmosphere analogous to the action of the tides; and it is this that causes the rise and fall of the barometrical column in Santiago, about '1·3 of a millimètre.' This force exercised by the sun cannot be what is generally known as that of attraction; but it is the same electric force which causes the diurnal variations of the magnetic compass, and the same that produces such visible changes in the forms of comets whenever they approach the vicinity of the sun."

WEATHER PREDICTION.

M. BABINET, who is not of M. Mathieu de la Drôme's opinion as to the possibility of Predicting the Weather many weeks beforehand, nevertheless believes in the possibility of doing so within a couple of days. In his Meteorological Bulletin he observes that when the Seine rises at Fontainebleau everyone predicts with certainty that it will rise at Paris. Now, for exactly the same reason, when the barometer shows us a diminution of pressure in the air in various places and an increase in another, it may be safely argued that a mass of air has accumulated in the latter place to the detriment of the others, so that there are, so to say, vacant spaces into which new air will rush, causing storms and gales, &c. This is, in point of fact, the whole theory by which storms may be predicted a few days beforehand.

THE WEATHER.

ADMIRAL FITZROY has made his Annual Report to Mr. Milner Gibson, President of the Board of Trade, in which he gives the general summary of results obtained from the practical application of meteorology to every-day use. The results of such utilization of facts are shown by two papers appended to this report, which give statements of wind and weather following every instance of making our cautionary signals. These results are certainly remarkable; indicating a vast amount of saving through the warnings sent from London.

Applications have been made for the cautionary signals from no less than fifty-four of the places on our coasts, and as some of these have been preferred but *recently*, they are evidence of deliberate consideration, and of the value attached to the fact that by means of our regular reporting stations and the Coast Guard, aided by the organization effected locally in some districts, all the coasts of Great Britain and Ireland to which the telegraph extends (including the Isles of Man, Jersey, and Heligoland) can now be warned of coming dangers in less than one hour.

More than this, however, has *already* been effected, and more is in prospect. From France we receive telegrams twice a day: in the early morning from Rochefort, L'Orient, and Brest, which telegrams reach London as soon as our own from Ireland or Scotland; and in the afternoon, through Paris, from Lisbon, Bayonne

Brest, Helder, and Copenhagen. In exchange for which reports we send daily reports to Paris Observatory from seven places; and to Calais—for the French coast specially—at eleven, besides such occasional warnings as may be useful to the French north-west coasts, including our Channel Islands.

During 1862, many foreigners examined the arrangements at the office in London, and four of those gentlemen (who were accredited to high positions at the Exhibition) expressed intentions of establishing similar arrangements (on a smaller scale) in their respective countries—namely, France, Italy, Hanover, and Russia.

In the last autumn France commenced arrangements for a system of coast telegraphy for ordinary weather as well as for storms, and within the last few weeks Admiral Fitzroy has heard from the officer at Paris, appointed to conduct this service, that he has organized eighteen stations on the French coast.

"Especially referring to persons who would have the warning signals, but not the 'forecasts' (results of considerations on which the *signals depend*), Admiral Fitzroy quotes from his 'Weather Book' the following words:—'Frequently, remarks in favour of the cautionary signals, but in depreciation of the forecasts, have been made. Their author now begs to say that it is *only* by closely forecasting the coming weather, and by keeping atmospheric conditions continuously present to mind, that *judicious storm warnings can be given.* Forecasts grow out of statical facts, and signals are their fruit.'

"To show some of the concordant opinions of such forecasts entertained in France and Scotland, in Ireland and England, I might quote numerous printed or written passages. In this Report, however, I will only observe that the views and expressions of seafaring men, of the maritime population in general, of the Coast-Guard, and of her Majesty's officers in command, are remarkably favourable.

"Perhaps it may be asked, 'On what meteorologic conditions or changes are the forecasts based?' They depend (may be briefly replied) on considering the atmosphere as a lighter ocean, having currents, elastic expansibility, equilibrium, momentum or inertia, chemical alterations, and extreme sensibility to heat or cold, its *chief motors;* and on knowing the statical conditions of air in this oceanic envelope at many places simultaneously, likewise again similarly after certain intervals of time, by which means intercomparisons are made, showing the relative conditions and causations whence dynamic effects originate. These dynamic motions are proportional to disturbances of level, like those caused by a head of water, to inequalities of temperature and consequent *chemical* changes, with more or less electric action. They are our winds, and may be softly gentle, or as heavily boisterous as in a *tempest,* of which differences, through all degrees, instrumental means and telegraphy now give available information. To utilize their indications adequately, a central office should know the natural and general atmospheric movements, with their disturbing causes, even as a pilot knows the varieties of streams and eddies in a wide estuary.

"The whole map of a region (say the British Islands) should be outlined in the mind, as the estuary with its shoals is mentally visible to the pilot. The normal tendency of the *whole* atmosphere (in our latitudes) to *move eastward* while crossed or variously interfered with by polar or tropical currents, that in course of seasons cause every variety of wind and weather, should be *always* considered, and then, with due allowances made for gradual advances from westward, for effects of land and differences of temperature—good forecasts may be generally drawn.

"The daily forecasts so extensively, yet without public cost, sent everywhere by the newspapers (whether the full tables are published by them or not), together with the regular tabulation of facts observed in numerous and widely-separated places, afford general information now highly appreciated by a very large and increasing majority, although they are at present only tentative, and liable to errors of judgment in drawing conclusions, however reliable the facts."

WATERSPOUTS.

On Oct. 29, at Kirkham, Preston, the wind had been blowing strong for several hours until about 10 a.m., when the clouds became unusually dark and heavy, so that the town of Kirkham was much darker than has ever been previously observed at that time of day during the heaviest storms in winter. The gale increased to a hurricane, and a peculiar whirling motion was perceived in the air for several minutes, during which heavy drops of rain were falling. This was succeeded by a deluge of rain, which can only be compared to a waterspout The Willow Catholic Chapel and the Union workhouse were wrapped in a complete sheet of water, and most of the houses were partially unroofed by the violence of the wind. The peculiar whirling or circular motion in the air increased with tenfold force, and seemed to carry all before it. The water streamed in a torrent, in some places six feet deep; the whole lasted about 25 minutes.

September 4, Mr. Lowe writes from Durham:—A very fine waterspout was seen to-day by myself, Captain A. S. H. Lowe, and a guide. We were crossing Widdibank Fell, from High Force to the Cauldron Snout, and the waterspout was over Cronkley-moor (about 1½ mile off). The morning had been exceedingly fine and hot, with a brisk N.N.W. wind. From half-past 10 o'clock there were many thunder-clouds round the horizon, which increased much in size after the waterspout had disappeared. The waterspout was formed in a small cumulus, which afterwards became a thunderstorm, from which thunder was heard at 12h. 5m. east of us. This storm passed down the valley of the Tees, being violent at Middleton, Langley Beck, Barnard Castle, and Darlington.

The waterspout was first seen at 11h. 13m. a.m., lasting to 11h. 19m. 15s., when it became hid by clouds. The motion was easterly, passing from Cronkley-moor (and Carr Craggs in the far distance) across the Tees at Langdon Fell. Its diameter varied from 10 min. to a $\frac{1}{4}$ deg., and the length from 35 deg. to 10 deg. It was somewhat white and very opaque, having exceedingly well-defined sharp edges, around which was a fog-like vapour, having a direct motion. Its great singularity was the rapid changes in form which it underwent—at first nearly straight, then curved, and afterwards wavy and snake-like, at one time not unlike a flash of forked lightning. For the first $1\frac{1}{2}$ minute the waterspout almost touched the ground, after which it became higher. So perfect an example seen under favourable circumstances is of rare occurrence.

GREAT METEOR.

A LUMINOUS Meteor of the first order has been observed (it is said for the first time) telescopically by M. Julius Schmidt, of Athens. We select some particulars from *Les Mondes*. On Oct. 19 last, at five minutes past two o'clock, he observed a shooting star of the fourth magnitude slowly proceeding between the Hare and the Dove. In three or four seconds it equalled Sirius in brightness. It traversed Eridanus slowly towards the west, diffusing so much light that all the stars disappeared; and it gave a greenish hue to the Acropolis, the city, and the surrounding country. For one second it was a dazzling bolide, with a diameter estimated at about ten or fifteen minutes. M. Schmidt then placed his eye to the telescope and followed the meteor fourteen seconds. He saw no more a single luminous body, but two greenish-yellow brilliant bodies, like elongated drops, one following the other, each accompanied by a reddish trail distributed like sparks in the tail of the meteor. This extraordinary observation was reported to the Academy of Vienna, and has been transmitted to M. Quetelet and Mr. Greg, of Manchester.

SHOOTING STARS OF AUGUST, 1863.

M. COULVIER-GRAVIER has laid before the French Academy of Sciences his Annual Report on these meteoric phenomena.

The results of the examination of his table show that, setting out with two observations on the 17th and 19th of July last, there were, for the mean hourly number at midnight, with a clear sky, only 7 3 stars. Afterwards, taking the mean of three observations, we have, for July 22, 26, 27, 10 3 stars; for Aug. 3, 4, 5, 20·4 stars; for Aug. 6, 7, 8, 24 1 stars. The numbers for Aug 9 were 30 5; for Aug 10, 121 2, for Aug. 11, 48·6; for Aug. 12, 46 1; for Aug. 13, 38·2, and for Aug. 14 only 20 8. In August, 1861, M. Coulvier-Gravier drew the attention of the Academy to the fact that the year 1858 marked the term of the descending march of the phenomenon since the epoch of its greatest height,—the year 1848 when the mean hourly number for Aug. 9, 10, 11, was 110 shooting stars. In 1858 the number had descended to 39 3; in 1863 it has risen to 66 7, an increase of 27 4 stars. "We may now," says M Coulvier-Gravier, "hope for the re-appearance of these phenomena of August in all their magnificence."

Dr. Heis states that on Aug. 10 the number of shooting stars seen was so great that the smaller ones could hardly be reckoned. The observers were so placed that they could freely survey the whole of the horizon, a compartment of which was allotted to each observer, means being taken that no star should be twice noted. The brilliancy and length of the train of these stars were very remarkable. The most of them had their point of divergence with constellation Perseus.

Mr. Crumplen, at Mr. Slater's Observatory, Euston-road, considers the above one of the finest displays for many years.

There were a large number on August 9, which do not seem to have attracted much attention. On the 10th, says Mr. Crumplen, we observed upwards of twenty, which equalled or surpassed stars of the first magnitude.

Most of these were accompanied with brilliant trains, some of them enduring several minutes, and undergoing remarkable changes, especially when viewed with proper optical power. Thus a meteor seen at 10h 48m p m. (Greenwich mean time) left a train visible 4½ minutes, which curled up, assumed a semicircular shape, and then gradually faded from the extremities to the centre.

A question commonly asked is their height above the surface of the earth. This in most cases is very considerable, and will not admit of the theory of their atmospheric origin. In August, 1861, the parallax of one gave an altitude of 126 miles, the meteor traversing a course of 176 miles in five or six seconds.

On Aug. 10 M. Julius Schmidt, while passing from the Isle of Corfu to Ithaca, counted the greatest number of these meteors which he had yet observed—113 in an hour, between one and two a.m.

THE SUN'S DISTANCE FROM THE EARTH.

Mr. Stone, principal assistant at the Royal Observatory, Greenwich, has completed the calculations of the mean horizontal parallax of the sun, as deduced from observations made at Greenwich on the planet Mars at his recent opposition, compared with other similar observations made in Australia. The result is that the heretofore received mean distance of the earth from the sun must be diminished by about three millions of miles! The necessity of this reduction of distance had been previously suspected by M. Leverrier indirectly from certain planetary disturbances, which appeared to require an increase of the earth's mass compared with that of the sun. The Greenwich observations give 8″·97 for the sun's mean horizontal parallax. Dr. Winnecke, from observations on Mars made in Germany compared with others made at the Cape of Good Hope, obtains 8″·96 for this element. M. Leverrier, from planetary disturbances, suspected 8″·95! The close coincidence of these results, thus independently obtained, is not only remarkable as indicating extreme accuracy of observation, but as an additional confirmation of the firmness of grasp with which gravitation binds together the planetary Cosmos. (See also p. 129 of the present volume.)

ASTRONOMY AND GEOLOGY.

M. O. Struve, of Pulkowa, observes: From certain careful comparisons of the latitudes of many places in the neighbourhood of Moscow, obtained by astronomical processes, compared with those obtained by geodetic triangulation, it became manifest that Moscow stands near to the edge of a huge elliptical bowl consisting of materials lighter than those of the average density of the earth's crust. This bowl or trough is about 28 miles wide from north to south, and exceeds 40 miles in an easterly direction. The interest of the observation does not terminate with the particular case of Moscow, but seems to indicate that henceforth in all instrumental determinations depending on the level or the plumb-line, attention must be given to the lithological character for the place of observation. Here, again, is a point of contact between the two antithetical sciences of astronomy and geology.

RESEARCHES ON THE MOON.

PROF. PHILLIPS has read to the British Association the following new results :—The author having on previous occasions presented his views as to the methods and objects of research in the moon, was desirous now to state a few results, and exhibit a few drawings, the fruit of recent examinations of the moon by means of a new equatorial by Cooke, with an object-glass of 6 inches.* In sketching ring mountains, such as Theophilus and Posidonius, the author has been greatly interested by the changes of aspect which even a small alteration in the angles of elevation and azimuth respectively produce in the shadows and lights. Taking an example from Cyrillus, with its rocky interior, and fixing attention on the nearly central mountain, it always appears in the morning light to have two principal unperforated masses. By a slight change in the direction of the light, the division of these masses is deeply shaded on the north or deeply shaded on the south, and the figure of the masses—*i.e.*, the limit of light and shade seems altered. A slight change in the angle of elevation of the incident light makes more remarkable differences. On Posidonius, which is a low, nearly level plateau, within moderately raised borders, the mid-morning light shows with beautiful distinctness the shield-like disc of the mountain, with narrow broken walls, and in the interior, broad, easy undulations, one large and several smaller craters. In earlier morning more craters appear and the interior ridges gather to form a broken terrace subordinate to the principal ridge. This circumstance of an interior broken terrace, under the high main ring of mountain, is very frequent, but it is often concealed by the shadow of the great ridge in early morning shadows. To see it emerge into half-lights, and finally to distinct digitations and variously directed ridges, as the light falls at increasing angles, is a very beautiful sight. But it is chiefly to the variations in the central masses of lunar mountains and their physical bearings that the author wishes to direct attention.

Many smaller mountains are simply like cups set in saucers, while others contain only one central or several dispersed cups. In Plato is a nearly central very small cup, bright, and giving a distinct shadow on the grey ground, as seen by Mr. Lockyer, Mr.

* He has also observed the aspect of the Sun, but on this subject he reserves his remarks.

Birt, and Prof. Phillips himself. But in the centre of many of the larger mountains, as Copernicus, Gassendi and Theophilus, is a large mass of broken rocky country, 5000 or 6000 feet high, with buttresses passing off into collateral ridges, or an undulated surface of low ridges and hollows. The most remarkable object of this kind which the author has yet observed with attention is in Theophilus, of which mountain two drawings are given, in which the author places equal confidence, except that the later drawing may have the advantage of more experience. The central mass is seen under powers of 200—400 (the best performance is from 200 to 300), and appears as a large conical mass of rocks about 15 miles in diameter, and divided by deep chasms radiating from the centre. The rock-masses between these deep clefts are bright and shining, the clefts widen towards the centre, the eastern side is more diversified than the western, and like the southern side has long excurrent buttresses. As the light grows on the mountains, point after point of the mass on the eastern side comes out of the shade, and the whole figure resembles an uplifted mass which broke with radiating cracks in the act of elevation. Excepting in steepness, this resembles the theoretical Mont d'Or of De Beaumont; and as there is no mark of cups or craters in this mass of broken ground the author is disposed to regard its origin as really due to the displacement of a solidified part of the moon's crust. He might be justified by Prof. Secchi's drawing of Copernicus, in inquiring if the low excurrent buttresses may indicate issues of lava on the southern and western sides? On the whole, the author is confirmed in the opinion he has elsewhere expressed, that on the moon's face are features more strongly marked than on our own globe, which, rightly studied, may lead to a knowledge of volcanic action under grander and simpler conditions than have prevailed on the earth during the period of sub-aërial volcanoes. The author also exhibited a drawing of Aristarchus, showing some undescribed features in the aspect of that, the highest part of the moon's surface.

Any member of the Section who went to see the process of extracting the silver from lead ore would have an opportunity of witnessing, on a small scale, causes in operation producing exactly similar effects to those observed on the surface of the moon. After the process was completed, and the litharge all blown off from the pure silver, the observer would be very apt to go away, nothing apparently remaining to be seen; but, if he waited for a short time, as the mass of silver cooled, he would soon see its surface torn up by explosions from within, caused, as he (Professor Phillips) believed, by the extrication of oxygen gas, and elevations and fissures produced exactly resembling those on the surface of the moon as observed in the best instruments.

METEOROLOGY OF 1863.

Results deduced from the Meteorological Register kept at the Royal Observatory, Greenwich, during the year 1863.

1863 Months.	Mean Reading of Barometer.	Temperature of Air. Highest by Day.	Lowest by Night	Range in Month	Mean of all Highest	Mean of all Lowest.	Mean Daily Range.	Mean for Month.	Departure from average of 22 yrs	Mean Temp of the Dew Point	Mean Tension of Vapour.	Weight of Vapour in a cubic ft. of Air	Mean additional Weight required for saturation.	Mean Degree of Humidity. Saturation =100.	Mean Weight of a cubic foot of Air.	Relative proportion of Wind. N	E	S	W	Mean Amount of Cloud. 0 to 10.	Rain No. of Days it fell	Amount collected.
	In.	°	°	°	°	°	°	°	°	°	In.	Grs	Gr.		Grs.							In.
Jan.......	29·619	55·2	27·7	27·5	46·9	36·6	10·3	41·8	+3·7	37·6	·225	2·6	0·5	85	547	5	4	11	11	7·3	16	2·6
Feb.	30·141	55·7	27·2	28·5	49·5	35·7	13·8	42·1	+3·4	37·9	·228	2·6	0·5	86	557	3	5	9	11	6·5	8	0·6
March .	29·715	61·0	28·1	35·9	53·7	35·7	18·0	43·9	+2·0	37·6	·225	2·6	0·7	78	547	8	5	7	11	6·4	10	0·7
April. .	29·813	69·3	28·3	41·0	61·2	40·1	21·1	49·1	+2·8	42·7	·274	3·1	0·9	78	543	8	5	6	11	6·6	9	0·4
May	29·857	79·7	31·4	48·3	64·4	42·7	21·7	52·0	−0·9	45·2	·302	3·4	1·0	78	540	9	9	4	9	6·2	10	1·3
June....	29·727	84·0	42·1	41·9	70·1	50·1	20·0	58·1	−1·0	50·2	·364	4·1	1·4	75	531	4	4	8	14	7·2	14	3·9
July	29·961	86·0	38·7	47·3	74·3	49·4	24·9	60·8	−0·9	51·7	·384	4·3	1·7	72	532	10	6	7	8	5·0	3	0·9
Aug	29·744	84·9	46·0	38·9	73·8	53·7	20·1	61·9	+0·6	53·6	·412	4·5	1·6	74	527	3	4	11	13	7·0	13	1·8
Sept......	29·693	71·8	35·0	36·8	63·5	45·8	17·7	53·7	−3·3	46·8	·321	3·6	1·1	77	535	2	0	11	17	6·9	14	3·2
Oct......	29·638	66·5	34·0	32·5	58·8	46·1	12·7	51·6	+1·1	47·8	·333	3·7	0·6	87	537	3	7	13	8	7·2	16	1·7
Nov......	29·870	60·8	28·1	32·7	51·1	40·3	10·8	45·7	+1·7	42·4	·271	3·1	0·5	88	547	3	4	13	10	7·0	11	1·8
Dec....	29·942	54·2	26·5	27·7	48·6	36·8	11·8	43·2	+2·9	38·5	·233	2·7	0·5	83	552	3	2	8	18	6·8	7	1·1
Means...	29·810	69·3	32·7	36·6	59·7	42·8	16·9	50·3	+1·0	41·3	·298	3·4	0·9	80	541	61 Sum	55	108	141	6·7	131 Sum	20·0 Sum

NOTE.—In column 10 the sign + implies above, and the sign — below the average.

EXPLANATION.

The cistern of the barometer is about 159 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of Mr. Glaisher's corrections, in the *Philosophical Transactions*, Part I., 1848; and from the readings of the dry and wet bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Mr. Glaisher's Hygrometrical Tables *Third Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in col. 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air. [*Concluded on next page.*

The mean temperature of the air for the year was 50°·3, being 1° above the average; the temperature of the dew-point was 44°·3. The average weight of water in a cubic foot of air was 3·4 grains. The mean degree of humidity was 80, complete saturation being represented by 100. Rain fell on 131 days, being 48 less in number than in 1862, and the amount fallen was 20 inches, being 6½ nearly less in amount than in the preceding year.

The warm weather which set in on December 3, 1862 (see the *Year Book* of last year), continued with slight exception to May 17. A period of 9 days followed, comprised between May 18th and May 26th, during which the average daily deficiency was no less than 6°, this was succeeded by one of like duration, but of opposite character; the average daily excess being 3¼°; and from the 5th June to the end of the month, there was a deficiency averaging 2½° daily. From July 1st to 15th, excepting two days, the temperature of the air was in excess of the average to the amount of 2¼° daily. A cold period followed, which continued till the 1st of August, during which the average daily deficiency amounted to 3½°, and was then followed by a warm period extending till the 16th August, the excess of temperature amounting to 3½° daily. On July 19th the temperature fell to 32° in the air, and to a much lower point on the ground, at most places north of London Here it was generally cold. A generally cold period set in on the 17th August, and continued to October 9th, a period of 54 days, during which the daily deficiency exceeded 2°. From October 10th, with the exception of the period between Oct 23rd to November 9th, when there was an average deficiency of 1° daily, to the end of the year, the weather was warm, averaging an excess of 4° daily The temperature of December 1862 was in excess, as well as those of January and February, 1863, and the mean temperature of these 3 months, viz., 42°·5, is distinguished by being one of the warmest on record. In the preceding 92 years the warmest winter of all was that of 1795, its mean temperature 43°·2, this was closely approached in the years 1834 and 1846, in each of which the value was 43°·1; and these are the only instances of a higher temperature since the year 1771. In the year 1848 the temperature of the same period was 42°·4, closely approximating to the present The month of March this year was also warm, which was not the case in 1795

The mean temperature of the months January, February, and March, 1863 was 42°·6; in the year 1834 it was for the same period 42°·9, in 1846 it was 43°·6, and these are the only instances, so far as trustworthy observations extend, of an excess over the temperature of the first 3 months of the present year The mean temperature of the 4 months ending March, was 42°·9, in the year 1846, it was 43°·1; and in 1834, it was 43°·3, so that the temperature at the beginning of this year may be considered as high as ever was experienced. The average monthly temperature of the air from December 1862 to April 1863, was 44°·1, in the years 1821 and 1822, the temperature for the same period was 44°·2, being practically the same as in 1863, in no other similar period, from 1771, has the temperature been so high, so that we may fairly conclude that the temperature of the 5 months ending April 1863, is distinguished as having been the highest on record The nearest approach to this high temperature was in the period ending April 1796, when it was 43°·1, in 1834 it was 43°·6, in 1846 it was 43°·9, and in 1859 it was 43°·5

The mean temperature of January was 41°¾, being higher than any January since 1853.

The mean temperature of February was 42°·1, being the same as in 1861; one degree lower than in 1859, but, with these exceptions, the highest since the year 1850.

The mean temperature of March was 43°·9, with the exception of 1859, when it was 46°·4, the warmest since the year 1842

The mean temperature of April was 49°·1, being higher than in any Apri since 1844.

The highest temperature in the year was 86° in July, and the lowest was 26½ in December.

The mean weight of a cubic foot of air was greatest in February, when it was 557 grains, and least in August, when it was 527 grains, and the monthly average for the year was nearly the mean of these values, or 541 grains, being the same as in the year 1862.

Obituary

LIST OF PERSONS EMINENT IN SCIENCE OR ART, 1863.

HORACE VERNET, the celebrated French painter.

JOHN BURGESS, painter in water colours.

LIEUTENANT-GENERAL SIR JAMES OUTRAM, military engineer, son of the well-known Derbyshire engineer.

EDWARD TAYLOR, professor of music in Gresham College.

AUGUSTUS LEOPOLD EGG, R.A.

RICHARD TAYLOR, philology and science.

SIR GEORGE CORNEWALL LEWIS, Bart., philosophical writer.

DR. RICHARD FOWLER, natural philosophy.

BATISTA AMICI, Italian astronomer.

WILLIAM MULREADY, R A.

ALFRED FOWLER, civil engineer.

JOHN CLARK, the inventor of *The Myriorama, Urania's Mirror, &c.*

JOSEPH GWILT, F.S A , architect and antiquary; his scientific treatises, and his "Encyclopædia of Architecture," are able works.

DR. JOHN ROBERT KINAHAN, Professor of Zoology in the Government School of Mines, and one of the Honorary Secretaries of the Natural History Society of Dublin. He was a zealous and able naturalist, devoting his attention specially to the recent Crustacea, and contributed many new species to the Fauna and Flora of Ireland

RICHARD QUILLER COUCH, the son of Mr. Jonathan Couch, of Polperro, the ichthyologist and naturalist R. Q. Couch's researches into the metamorphoses of the Crustacea were appreciated by all naturalists, most of all by Mr Bell, who quoted him for many facts then new to science. He was one of the secretaries and curators of the Natural History and Antiquarian Society, for which he wrote a variety of papers on British Fishes, Crustacea, and kindred subjects He became a member of the Royal Geological Society of Cornwall, then curator and subsequently secretary and curator, contributing to its *Transactions* many papers, and annually writing a Report of the progress made in examining the geology of Cornwall.—*Athenæum.*

JOHN SHEEPSHANKS, brother of the astronomer, but better known as the munificent donor of the Sheepshanks Gallery, worth 60,000*l.*; yet, for this princely gift, Mr Sheepshanks did not receive any honorary recompence besides mere thanks. We agree with the Editor of *The Builder*, that "An Order of Merit is much wanted in this country as a legitimate recognizance of public benefactors, but, in the case of Mr Sheepshanks, and Mr. Vernon, the grant of such an order might have been otherwise supplied."

JAMES B. BUNNING, twenty years architect to the City of London. During this period he designed and superintended the execution of more great public works than any of his predecessors. The cost of these amounted to upwards of three-quarters of a million sterling Mr. Bunning was the architect of the Freemen's Orphan School, Billingsgate Market, the Coal Exchange, the New Cattle Market, the City Prison at Holloway, and the new Lunatic Asylum. His last important duty was that of designing the architectural works prepared on the occasion of the entrance of the Prince and Princess of Wales into the City, allowed to be successful and appropriate, yet as unrecognised as Mr. Sheepshanks's gift, save by public admiration. In some countries of the Continent, Mr. Bunning would have been decorated with an Order of Merit for such a labour

JAMES FENTON, consulting engineer to the Low Moor Iron Company. In early life, Mr. Fenton was for some time employed, under Brunel, on the Great Western Railway, next on the Leeds and Thirsk line; manager of the Railway Foundry, Leeds. Among the various works he executed while in that position may be mentioned the Jenny Lind class of engine—a class possessing great simplicity, and combining steadiness with speed so highly were these engines thought of on some lines, that they became adopted as the type for all their passenger engines.

PROFESSOR EILHARD MITSCHERLICH, of Berlin. "He had long been known as one of the ablest philosophical chemists of the day, and the estimation in which he was held was exemplified by the numbers who attended his classes in the University of Berlin, and the Friedrich-Wilhelms-Institut, in that city. His writings embrace a wide range in chemical science, and may be found in the publications of the Academy of Sciences of Berlin, of which he was a member, and in German periodicals. Besides these he was the author of a *Lehrbuch der Chemie*, in two volumes, which has passed through two editions, and has been translated into French. Dr. Mitscherlich was elected a Foreign Member of the Royal Society in 1828; and in 1829 one of the Royal Medals was awarded to him for his 'Discoveries relating to the Laws of Crystallization and the properties of Crystals.' It is, perhaps, by his researches into the phenomena of crystallography that he will be best remembered."—*Athenæum*.

HENRY ARCHER, the inventor of the machine for perforating postage label stamps, for this invention Mr. Archer is understood to have received from the government, 4000*l*. The circumstances of the arrangement are detailed in a pamphlet published by Mr. Archer, some years since, in which he considered himself an illused man.

WILLIAM BUCKLE, assistant coiner of the Royal Mint. He was for more than thirty years, manager of the Soho Works, for Messrs. Boulton and Watt: but for twelve years he had occupied the post above-named.

F. I. BRIDELL, a painter of high promise.

JOSHUA FIELD, F.R.S., of the firm of Maudslay and Field, engineers. He was one of the founders of the Institution of Civil Engineers, in 1817; and he was one of the earliest Vice-Presidents, holding that office until the 18th of January, 1848, when he was elected President, being the first mechanical engineer who filled the chair. "To Mr. Field, in connection with Mr. Maudslay, may be traced, in a great degree, the origin of Ocean Steam Navigation. The engines put by these gentlemen on board the *Great Western* in March, 1838, were so completely successful that they long served as a model for other builders. On Sunday, the 8th of April, 1838, she started on her first voyage from Bristol with seven passengers, and 50 tons of goods, and reached New York on Monday, the 23rd of April, thus accomplishing the 3000 miles in 13 days 10 hours. Mr. Field was not more respected for his talent as an engineer, than loved and esteemed for his amiable qualities and fine disposition" (*Mechanics' Magazine*). At his funeral, at the cemetery-gates were assembled a considerable number of workmen, principally elderly men, who have been engaged at the works for a long period. This was a touching tribute to Mr. Field's eminent worth as a master.

SAMUEL BALDWYN ROGERS, formerly of Nant-y-Glo. "His age exceeded 90 years, and although, by an improvement relating to the manufacture of iron, he largely contributed to the wealth of others, yet he died in the deepest poverty himself. He expressed an earnest wish that he might not be buried in a pauper's grave, and his brother Freemasons have responded to that wish. He was formerly employed at large ironworks in South Wales, and committed the indiscretion of publishing *An Elementary Treatise on Iron Metallurgy*. He was dismissed from his situation. The improvement which he introduced was that of iron bottoms for puddling furnaces, and it is one of great practical importance. It was never patented, nor did he, I believe, ever receive for it any substantial reward. It is true that iron bottoms for certain furnaces had been previously suggested; but to Rogers is unquestionably due the merit of having first rendered their application practicable for puddling furnaces. When he proposed them he was laughed at by some ironmasters of experience, yet they are now universally adopted. When the distressed condition of the poor old man became known—a condition not resulting from misconduct on his part—several persons connected with the iron trade assisted him with money; but assistance came too late." This sad story—another instance of the unhappy fate of inventors who, in enriching others, have impoverished themselves—appeared in the *Times* a few days after Mr. Rogers's death.

GENERAL SIR JOSHUA JEBB, a distinguished officer in Canada, America, and the West Indies; but latterly has been more prominently known as the founder and promoter of the Ticket-of-leave system. In his capacity as chairman of the directors of Convict Prisons, he had contributed several important works upon the subject of prison discipline, and the treatment of convicts. He planned the Pentonville prison, completed in 1842, at a cost of nearly 100,000*l.*; it was first named "The Model Prison," but from the partial success of the plan, its name was changed; each cell cost 180*l.*, the cost of a four-roomed house!

Dr. David Boswell Reid, chemist. He had lately been appointed by the Federal Government, Medical Inspector to their Sanitary Commission; and he was about to be employed at Washington in ventilating the new military hospitals which have been erected in different parts of the country. "Dr. Reid," says the *Scotsman*, "was a native of Edinburgh, grandson of the celebrated Hugo Arnot, the historian of Edinburgh; and was himself, at one time, an extensively-employed and successful teacher of chemistry here. His connexion with the ventilation of the Houses of Parliament is but too well known. He ventilated St. George's Hall, Liverpool—the only building in the world, he said, in which his principles of ventilation have been completely carried out. The ventilation of this building is considered very successful. Dr. Reid began his public career in Edinburgh as assistant to the late Dr. Hope, Professor of Chemistry in the University. He was also a candidate for the chair when Dr. Hope resigned." Dr Reid was unquestionably an able man, and although we have quoted the opinion of the *Scotsman*, as to the ventilation of the Houses of Parliament, we are satisfied that the merits of the system were depreciated by cabal and party spirit, and unsparing ridicule. Yet, as Dr. Reid foretold, his claims were not altogether ignored, but advocated by a public committee of noblemen and gentlemen, who took a more even-minded view of Dr Reid's talent, than it served the purpose of his *collaborateurs* to acknowledge.

Charles Robert Cockerell, Professor of Architecture in the Royal Academy. "He built the Sun Fire Office, Hanover Chapel, Regent-street, and several other edifices in London; the Taylor and Randolph Buildings and the new Public Library at Oxford; the Gothic Chapel and Speech-Room at Harrow; the Gothic College at Lampeter; and the Philosophical Institution at Bristol. Mr Cockerell was as greatly esteemed abroad as at home. Oxford made him a D.C L., Paris, in 1841, one of the *eight* 'associés étrangers' of the Academy, Rome, two years later, one of the *ten* 'members of merit' of St. Luke's; whilst Munich, Berlin, and Berne accorded to him the honorary membership of their academies In 1848 the Institute of British Architecture awarded to him its first gold medal. In conjunction with Mr J. S. Harford, of Blaise Castle, Mr Cockerell published in 1857, *Descriptions to Michael Angelo*."—(*Athenæum*.) Of Mr Cockerell, one of the soundest Architects of his day, an ably-written appreciative memoir has appeared in the *Builder*. Among his latest works is the sculpture of St. George's Hall, Liverpool.

Henry Raeburn, of Midlothian, one of the first to introduce subsoil ploughing, tile draining, and other processes of scientific agriculture, which have since been generally adopted.

Eugene Delacroix, the celebrated French painter. "He produced an immense number of pictures, and gained almost all the honours of his profession—medals, second (1824), first (1848), grand (1855),—was made Knight of the Legion of Honour (1831), Commander (1855), and Member of the Institut (1857), in place of Delaroche."—*Athenæum*

Richard Whately, Archbishop of Dublin, one of the first Commissioners of National Education in Ireland, an astute logician and political economist.

J. D. Harding, Artist.

Rear-Admiral John Washington, Hydrographer.

Camille Bertrand, the professor of medical jurisprudence at the University of Montpellier, and the author of the celebrated treatise—*Sur la Conformation osseuse de la Tête chez l'Homme et chez les Animaux vertébrés.* This work united to the most generalized and exalted conception of the subject, a thorough knowledge of the literature of comparative anatomy, rarely equalled, and never surpassed. M Bertrand died young; had he lived longer, he would have maintained his place in the scientific ranks side by side with Oken, Goethe, Spix, Owen, Huxley, and Goodsir. He, however, died full of honours, and already in the possession of a glorious and untarnished fame.

William Tooke, F.R.S., President of the Society of Arts, and esteemed in the literary and scientific circles for his amenity and kindly encouragement of humble merit. He drew the charter of the Society for the Diffusion of Useful Knowledge.

Dr. Alexander Henderson, author of the *History of Ancient and Modern Wines*, and other works, including the Journal of his Travels in Iceland.

Joseph Henry Green, F R.S, late President of the General Council of Medical Education. Mr. Green commenced his medical studies at the flourishing school of the then united hospitals of St Thomas and Guy, under the auspices of his uncle, Mr Cline, and of Mr, afterwards Sir Astley Cooper. He was subsequently appointed Professor of Anatomy to the Royal Academy, and delivered lectures annually at the institution on that subject. He was appointed President of the General Council of Medical Education and Registration by an unanimous vote of the members, and discharged the duties of the office to the entire satisfaction of his colleagues and of the profession In 1820, he succeeded the younger Cline as Surgeon to St Thomas's Hospital, and with Sir Astley Cooper then delivered lectures on surgery and pathology. As an operative surgeon he was unequalled in the skill with which he performed that for lithotomy, having in 1827 operated in 40 cases, and lost only one patient; this success is unequalled in any country, and in any other person's hands. In 1830 he was appointed to the professorship of surgery in King's College, of which institution he was at the time of his death a member of council In 1831 he wrote a pamphlet, called *Distinction without Separation*, addressed to the President of the Royal College of Surgeons, to prove that the distinction between physician and surgeon did not really exist, and that such division was highly injurious where it did. About this time he was unfortunate in entering into a wordy warfare with the *Lancet*, about the publication of his lectures, and in which he was severely handled and totally discomfited. Lecturers now see the advantage of their lectures being correctly reported in the medical papers, from which the public and themselves so largely profit. He was elected President of the Royal College of Surgeons in 1858 —*William Laurence*, F.R S.

Samuel Read, formerly member of the Admiralty School of Naval Architecture, and more recently master shipwright of Her Majesty's dockyard at Sheerness. As a member of the School of Naval Architecture, Mr. Read in early life distinguished himself by his scientific attainments and although he had to share with his colleagues of that school many injuries and indignities before he attained to the higher posts of the shipbuilding department of the Admiralty, he nevertheless was honoured by being made a member of the Committee of Reference, the Council of Science, and other like committees instituted by successive Governments for the improvement of naval architecture. His published writings upon the higher branches of his profession were numerous and of a very high order, and in particular the *Reports on Naval Construction*, which bear the names of Read, Chatfield, and Creuze, have taken their place among the standard works of the shipbuilding profession.

William Templeton, whose contributions to engineering literature have been generally esteemed. There is scarcely an establishment in England where his *Workshop Companion* is not in daily use; and his other works, though few, have proved extremely useful to the young engineer.

The executors of the late James Walker, Esq., have bequeathed to the Royal Institution a marble bust of Prof. Faraday, by Mr. Matthew Noble.

GENERAL INDEX.

THE END.

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