THURSDAY, JANUARY 24, 1878

RAYLEIGH'S "THEORY OF SOUND"

The Theory of Sound. By J. W. Strutt, Baron Rayleigh, F.R.S. Vol. I. (London: Macmillan and Co., 1877.)

THE author, who already, by a series of interesting treatises belonging to different branches of mathematical physics, has acquired a respected name in the domain of science, undertakes to give a complete and coherent theory of the phenomena of sound in the work above mentioned, the first volume of which has recently been published; and he does this with the application of all the resources furnished by mathematics, since without the latter a really complete insight into the causal connection of the phenomena of acoustics is altogether impossible. We must confess that, even in spite of the most intense exertion of the powers of mathematical analysis, in the present state of its development several problems remain unsolved, for which, indeed, the conditional equations are known, but for which it has not yet been found possible to carry out the calculation.

The author will merit in the highest degree the thanks of all who study physics and mathematics if he continues his work in the manner in which he has begun it in the first volume. The separate treatises in which the acoustic problems that have been solved hitherto are discussed, are for the most part dispersed in the publications of academies or of scientific societies, which can be found only in larger libraries, and which frequently are not at all easily traced. But even if one has found a treatise of this kind and reads it, it happens often enough that the author refers in his quotations to other works quite as difficult of access, the knowledge of which is necessary for understanding his treatise. Thus the zeal of the student is paralysed by a number of purely external difficulties, and the ordinary result at which an intelligent student arrives after a few attempts in this direction, is that for problems in which he takes great interest he prefers starting anew to find the solution, rather than trying to hunt for it in libraries. Even if we must admit that the insight into the essence of a problem for which one has found the solution oneself is much deeper and clearer than when one has obtained the solution from some other author, yet an enormous amount of time is thus lost, and the survey of the whole extent of solvable problems remains incomplete. A survey of this kind, however, is necessary for all who wish to work at the progress of science themselves. For in order to obtain decisive results by new scientific investigations it is necessary above all things to be quite clear with regard to the question for which forms of experiment or of observation the theoretical deduction from principles can be carried through as purely as the experiment itself. I know by experience that a number of young physicists lose their time and their zeal by trying to solve problems which, taken by themselves, are very interesting, but for which at present the deductions from the theoretical principles for the given case can only be drawn in coarse approximation, and where the experiments cannot be freed from important sources of error.

While praising Lord Rayleigh's book as a means of overcoming the difficulties described, I do not at all wish to designate it as a mere compilation. On the contrary, it is a perfectly coherent deduction of the special facts from the most general principles, according to a uniform method and in a consequent manner. The mechanical principles of the doctrine of minute oscillations are contained in the present volume and are developed in greater generality than in any other book known to me. For this purpose the author in the first chapter explains the general physical principles of sound, of its propagation, of pitch and its dependence on the rapidity of vibration, of the musical scale, of the quality of sound and its dependence on the harmonic over-tones; and in the second one the doctrine of the composition of harmonic motions of either equal, or nearly equal, or consonant numbers of vibrations, and further illustrates them by the description of the physical phenomena and methods in which the principles developed are applied, and to which belong the doctrines of musical beats and of the physical methods to render the forms of vibrations visible.

Then follows the development of the most general peculiarities of oscillating motions, first, in the third chapter, for mechanical systems to the motion of which only one degree of freedom is allowed, and then, in the fourth chapter, for systems with a finite number of degrees of freedom. There is a great multitude of peculiarities common to the most heterogeneous sounding bodies, which up to the present have mostly been found in certain instances only, but which can also be deduced from the most universal form of the motion-equations of systems of one or more degrees of freedom of motion. The author in the form of the equations and in the manner of denotation, closely follows the "Natural Philosophy" of Thomson and Tait; in fact the whole manner of treatment of the mathematical problems corresponds so closely to that adopted in the work just mentioned, that Lord Rayleigh's book may be looked upon as the acoustic part of the excellent handbook of the two celebrated physicists named.

With all systems of this kind if there are no exterior forces acting upon them, we find, on the whole, a number of proper tones equal to the number of degrees of freedom, and the pitch of which does not depend on the amplitude of the vibrations as long as this one remains small enough. Exceptionally, however, several of these proper tones may be of equal pitch. If there is no friction or dissipation of energy the amplitude of every kind of oscillation remains constant. To each separate proper tone a certain form of motion of the whole system belongs; so that the directions and magnitudes of the displacement of the separate points of the system are different in each case. Each arbitrary motion of the system produced in any arbitrary manner, may be regarded as a superposition of these forms of vibrations belonging to the various proper tones of the system. In order to find the amplitude and phase of these different vibrations for a given original displacement and of given velocities of its different parts, quite similar methods are adopted as those which are employed to develop a given periodical function into one of Fourier's series; only the whole method here becomes far more intelligible and has a thoroughly certain foundation, because we have to do with a finite number of unknown factors instead of with the infinite number of continuously

succeeding values of a function, with finite sums instead of with integrals or with infinite series. Of course for Fourier's series as well as for the developments of Laplace by means of spherical harmonic functions the proof for the correctness of their values can also be furnished in the case of continuous functions. For a large number of other functions which are given by differential equations of the second degree this proof results, under certain suppositions regarding the continuity of the functions and the limit conditions, from the theorems of Sturm and Liouville, which Lord Rayleigh explains when speaking of the vibrations of strings of unequal thickness. Yet in mathematical physics we are still compelled to employ a great number of series-developments of functions which do not belong to this class; and even the vibrations of rods and plates are cases in point. In this respect the treatment of the problems mentioned with a finite but arbitrarily large number of degrees of freedom of motion is interesting also with regard to analysis.

For vibrating systems of one degree of freedom, the oscillations of which are subjected to damping, the doctrine of the laws of resonance is developed in the third chapter. The author calls the vibrations which are continuously maintained by the influence of a periodical force acting externally, *forced vibrations*. In all cases their intensity is greatest when their period of vibration, which equals the period in which the force changes, is also equal to the period of the system vibrating freely and without friction. For the relations between the intensity and the phase of the co-vibration, between the breadth of the co-vibration in case of small alterations in the pitch and the degree of damping, which I had myself proved for certain instances and used for certain observations, the general proof is given here. The author has further employed these chapters to set up certain general maxims respecting the direction and magnitude of the corrections which must be made in cases where one cannot completely solve an acoustic problem, but can only find the solution for a somewhat altered vibrating system. These are like the outlines of a "theory of perturbations" applied to acoustic problems. The author illustrates these maxims by many various examples. Thus, for instance, he replaces a string by an imponderable stretched thread which carries weights either in the middle only or at certain distances from each other; or a tuning-fork by two imponderable springs with weights at the ends.

For vibrations of very small amplitude, the forces which tend to lead the moving points back to their position of equilibrium may always be considered proportional to the magnitude of their distance from the position of equilibrium. As long as this law holds good, the motions belonging to different tones are superposed, without disturbing one another. But when the vibrations become more extensive, so that the law of proportionality just named no longer applies, then perturbations occur which become manifest by the appearance of new tones, the combination tones. In my book on acoustic sensations ("Die Lehre von den Tonempfindungen") I have myself explained this manner of origin of the combination tones, only for the motion of but a single material point. In Lord Rayleigh's book this explanation is given with reference to any compound vibrating system of one degree of freedom, and it is further amplified with regard to the manner in which the forces deviate with the displacements from the law of proportionality.

Certain laws of reciprocity, of which I had given single instances in my investigations on the vibration of the air in organ pipes, may be proved in a general way for all kinds of vibrating elastic systems. If on the one hand at point A an impulse is given, and the motion at point B is determined after the time t has elapsed, and if on the other hand an impulse is given at point B in the direction of the motion which occurred there, and, after the time t, the motion-component falling into the direction of the first impulse is examined at point A, then the two motions in question are equal if the impulses were equal.

Chapters VI. to X. of Lord Rayleigh's book treat of the vibrations of strings, rods, membranes, and plates. The vibrations of strings have played an important part in acoustics; their laws are simple, and the physical conditions which the theory demands are fulfilled with comparative facility, different modes of producing the tones may be employed, and a number of various motions may thus be produced. It is just because the physical phenomena in connection with strings were well known, that the observation of the way in which the ear is affected by their various modes of vibration has materially facilitated the solution of the problems of physiological acoustics. The musical importance of strings rests on the circumstance that the series of their proper tones corresponds to that of the harmonics, the vibration-numbers of which are entire multiples of those of the fundamental tone. For this reason, if the motions of many proper tones are superposed on one string, a periodical motion again results, and this is the cause why on strings we can produce notes of the most varied quality. We need only remember how differently the same string sounds according to whether it is plucked with the finger or with a metallic point, whether a violin bow is drawn across it or whether it is caused to vibrate by means of a tuning-fork

In this chapter less new work remained to the author; however, this example shows how much easier it is to understand all these separate problems if they are not treated separately but developed in coherent representation, after the most general principles, the validity of which is independent of the special peculiarity of the case, have been first explained.

The short chapter VII. gives the laws for the longitudinal and torsional vibrations of rods; the laws are simple and resemble those of the open and stopped organ pipes. The lateral vibrations of rods, during which these bend, give more complicated analytical expressions; their proper tones do not form a harmonic series, but are given by the roots of a transcendental equation. The tones are different according to whether one or both ends of the rod are free to rotate and to move, or free to rotate, but hindered from moving (supported), or hindered from rotating and moving (damped). With this more complicated problem the advantage of first treating of the general principles becomes clearly apparent. The forms of the simplest vibrations are calculated and represented graphically. The mode of vibration of a stretched rod, for which Seebeck and Donkin have already given the solution, is also treated here in order to determine the influence of rigidity upon the vibrations of strings.

Then the vibrations of a uniformly-stretched membrane are investigated. This investigation is of more theoretical than physical importance, since it shows in a case which may be treated in an easier way, the peculiarities of vibrations which are capable of spreading in two dimensions. Unfortunately we have not yet succeeded up to the present in obtaining good membranes which would be fit for experiments of measuring in order to investigate, with some degree of exactness, how far theory corresponds with the experiment.

On the contrary, in the case of elastic plates, the vibrations of which the author treats in the last chapter of the present volume, the experiments can be made with more accuracy, while the analytical difficulties are so great that, on the whole, only few cases permit of a solution of the problem. Indeed, even the formulæ expressing the conditions which must be fulfilled at the edge of the plate have given rise to discussions. Poisson had thought that three conditional equations were necessary for the edge; Kirchhoff has shown that in reality only two are required. Lately M. Mathieu opposed this view. Lord Rayleigh has adopted Kirchhoff's views, and no doubt with perfect right. He gives the analysis of the latter of the vibrations of a circular plate, and has made an important addition of his own to the solvable cases, by teaching us how to deduce theoretically a series of vibration forms of square plates, at least for that case where they consist of an elastic substance the resistance of which to change of volume may be neglected; and these theoretical deductions sufficiently correspond with the forms observed. Also for elastic rings and for cylinders vibrating in the manner of bells, he has improved the theory in an essential point, by proving theoretically and experimentally, that the node lines of such plates execute vibrations in a tangential direction. These tangential vibrations are the ones which are first produced if the edge of a drinking-glass is rubbed with the wet finger.

The above survey will give an idea of the numerous contents of the book. As in the treatment of the separate problems it touches everywhere the limits of our present knowledge, it cannot but demand sound mathematical knowledge on the part of the reader. Yet the author has rendered it possible, by the very convenient systematic arrangement of the whole, for the most difficult problems of acoustics to be now studied with far greater ease than hitherto. He thus proves himself to be a philosopher who does not lose the liberty of intellectual supervision, even when he is occupied with the most abstruse calculations. H. HELMHOLTZ

HINDUISM, BUDDHISM, AND ISLÁM

1. *Hinduism.* By Monier Williams, D.C.L. 2. *Buddhism.* By T. W. Rhys Davids. 3. *Islám and its Founder.* By J. W. H. Stobart, B.A. (London: Society for Promoting Christian Knowledge, 1877.)

IT is a sign of the times that a "Society for Promoting Christian Knowledge" should undertake a series of works on "non-Christian religious systems." Nor is it a less striking characteristic of our day that it should entrust the work to scholars of so liberal a faith as Prof. Monier Williams and Mr. Rhys Davids. Dr. Monier Williams's volume on Hinduism forms a model of a popular exposition of a religious system. He explains with great clearness the historical *catena* of the sacred writings on which the Sanskrit religion was based. He delineates the various movements, from the Buddhistic reformation 2,500 years ago, down to the modern revivals among the Sivaite and Vishnuvite sects, which have developed the Vedic worship into that complex structure of ritual, dogma, and social institutions, which we call Hinduism. To the ordinary English reader, this little volume will reveal a different aspect of Hindu faith and morals from that which he has been accustomed to hear from the pulpit or missionary platform. He will find that the great questions of how a man should rule his life, and what prospect lies before him after he has done with this world, have formed the subjects of religious thought and practical experience, not less anxious nor less deep among the people of India than among the western races. The ethical replies which they have given to those questions differ more in form than in spirit from the higher beliefs of Christendom. The hard and narrow judgments of the elder Mill and the zealous statements of missionaries, have too long possessed the popular mind. Prof. Williams does not appear as the advocate or admirer of Hinduism. In fact he tacks on to the end of his book a proselytising page or two, which, however in accord with the object of the Society for which he writes, form a strange contrast to the scholarly tone of his volume.

Dr. Monier Williams's tours in India have enabled him to deal with the modern phases of Hinduism from a practical, as well as from the professorial point of view. Three features of Hinduism must be distinctly realised in order to understand its vitality and influence on the people. Hinduism represents, in the first place, a very ancient growth of worship and belief; and is invested with all the authority of age and unquestioned prescription. In the second place, it is a very modern religion, whose later developments have neither been reduced to, nor are restrained by, any systematic theology; which is, therefore, plastic, sensitive to every change in the popular beliefs or modes of thought; and which, in each province of India, takes on a local colouring adapted to the necessities or customs of the local population. In the third place, Hinduism is not only a religious system, but an all-powerful social institution. It forms the outcome of religious and philosophical thought in India during several thousands of years; it also represents the organised modes of life at which a great variety of tribes and races have slowly arrived. This threefold source of strength makes itself felt in every detail. To take one instance: Caste is enforced alike by the sanctions of ancient prescription, modern religion, and social utility. It articulates the population into communities, each bound together by ties of a useful, not less than of a doctrinal sort. Caste, with the feelings of kindred and family on which it rests, forms the substitute for a Poor-Law in India; it supplies a bond something like that which in America is felt by people who attend the same meeting-house or chapel; and it discharges many of the functions of the mediæval guilds of Europe, together with others which are effected less smoothly by modern Trades' unions. It has its disadvantages—some of them very serious ones; but it curiously resembles, in several of its judicial, social, and charitable aspects, the ekklesia of the early Christians.

Prof. Monier Williams might not accept this view, but we recommend his book as at once a scholarly and a practical exposition of Hinduism, in a cheap and popular form.

Mr. Rhys Davids has done his work well, but with a difference, in his little volume on Buddhism. He has rightly separated the facts (so far as we can ascertain them) of the history of the founder from the modern legends regarding him. He gives a careful and interesting narrative of the life, explains the doctrines which Gautama Buddha taught, and the system of morals which was subsequently based upon his precepts and example. Nothing could be better than some of the passages which bear upon the aspects of Buddhism in Ceylon, China, and Tibet. But it is to be regretted that the plan of the work permitted of so little space for its influence upon the mediæval forms of Indian ritual and belief. One of the most interesting pictures which we possess of a struggle between two great faiths is to be found in Hiouen Thsang's itinerary through India in the seventh century. The narratives of the Chinese travellers form, indeed, the first historical evidence of eye-witnesses with regard to Indian manners and beliefs. They supply a key to the subsequent religious developments among the Hindus, and well merit a fuller notice. Another point of deep interest on which Mr. Rhys Davids' volume is, perhaps necessarily, silent, refers to the industrial aspects of Buddhism. It is well known that architecture in India began with the requirements of Buddhism, and that those requirements profoundly affected its whole subsequent history. Moreover, the Buddhist monks were not only missionaries; they were artists, or at any rate artisans, who carried a new civilisation as well as a new faith to the Asiatic races. Thus it was a Buddhist monk of Corean ancestry who, between 662 and 672 A.D., published the secret of making translucent pottery in Japan. The ritual of Buddhism stamped its influence on the characteristic national industry both of Japan and China; and as late as 1212 we hear of a celebrated Japanese potter, accompanied by a Buddhist monk, going on a mission to the mainland to acquire the deeper mysteries of ceramic art. The vast number of Buddhist records did much to develop the art of writing, while the circumstance that its theology centres around a single human life, gave a biographical and historical impulse to the nations who adopted it, which is unknown among the followers of the older Bráhmanical faith. Mr. Rhys Davids' book is silent on these points. But it is only just to him to add that he has managed to compress a vast amount of thought and information, of a kind perhaps more important from the Society's point of view, into his 250 pages.

Mr. Stobart's Islám is conceived in a less philosophical spirit. "Light and darkness," he says, "are not more opposed than the loving doctrines of the Gospel and the vengeful spirit of the Koran." "Darkness and retrogression are engraved on every page of the Preserved Book." This is his conclusion of the whole matter, but it fails to explain the secret of one of the great historical movements which has deeply influenced mankind. Scraps of piety are scattered throughout the book, sometimes with a curious effect. Here is Mr. Stobart's conception as to how a chapter on the Ancestry of Mahomet should begin:—"We have the assurance that Noah was 'a perfect man and walked with God' (Gen. vii. 9); and as a 'preacher of righteousness' (2nd Peter, ii., 5), having with his sons been witness of the flood, handed down to his posterity the worship of the True God." Further quotation is unsuitable. Mr. Stobart's book will supply a convenient but misleading compendium for those who wish to know a little about the subject. It reproduces the bigotry which disfigured Sir William Muir's "Life of Mahomet," on which it is chiefly based, without the scholarship which rendered that Indian civilian's four volumes the standard English work on Islám.

OUR BOOK SHELF

Physical Chemistry. By N. N. Lubavin. Part II. 8vo. 460 pp. (Russian). (St. Petersburg, 1877.)

WE are glad to notice the appearance of the second and last part of M. Lubavin's most valuable work, which is devoted to the most important departments of physical chemistry. In this part the author deals with chemical reactions in general and discusses under this head some of the various theories advanced as to the distinctive characters of chemical processes; the stechiometrical laws of Dalton, Gay-Lussac, Faraday, Dulong and Petit, &c., all figures relative to these laws being given in a tabular form; chemical combinations, *i.e.*, the formation of compounds by heat, light, and electricity, and under the influence of other bodies; the development of energy during chemical processes, this chapter containing nineteen very useful tables; changes of properties of bodies when entering into chemical combinations; the decomposition of bodies by heat, electricity, and light; mutual decomposition; and chemical isomerism. Under each of these heads we find a considerable amount of most valuable information, skilfully selected from the already immense literature of that subject, and always giving the last results of recent investigations. The work will be thus of a great value for the student, giving in one volume of 800 pages of compact print a reliable and often very complete *exposé* of the results reached by science in this most important department.

Elementary Theorems Relating to the Geometry of a Space of Three Dimensions, and of Uniform Positive Curvature in the Fourth Dimension. By Simon Newcomb. (From the *Journal für Mathematik*, Band lxxxiii., Heft 4, 1877.)

THIS is an interesting contribution to the subject treated of by Riemann, Helmholtz, and others, and in this country by Prof. Clifford. The question is considered from the standpoint of elementary geometry instead of by the analytic method which has been commonly employed by writers on non-Euclidian Geometry.

Quatre Modèles, représentant des Surfaces développables, avec des Renseignements sur la Construction des Modèles, et sur les Singularités qu'ils représentent. Par V. Malthe-Bruun et C. Crone; *avec Quelques Remarques sur les Surfaces développables et sur l'Utilité des Modèles.* Par M. le Dr. H. G. Zeuthen. (Copenhague, 1877.)

IN the third edition of Salmon's "Geometry of Three Dimensions" there is (p. 289) a description of a simple way of making a model of a developable surface, attributed by Prof. Cayley to Mr. Blackburn. This suggested to Dr. Zeuthen the idea of drawing on the same model curves having contact of different orders with the edge of regression (*l'arête de rebroussement*) and of constructing new models of a very elementary nature, showing the principal singularities of developable surfaces.

Full accounts are given in a pamphlet (15 pp.) and direc-

tions for putting the models together, which consist of flat cardboard marked in accordance with the printed descriptions. The whole is contained in a neat quasi-envelope (nine inches by seven).

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Glass for Reflectors

YOUR last number (vol. xvii. p. 226) contains a very interesting paper by Mr. Norman Lockyer, in which that gentleman quotes the following passages from Mr. Grubb's paper :—

"For the 4-foot disc of glass for the Paris reflector, in place of that which has so recently resulted in failure, the St. Gobain Glass Company require twelve months' time to perfect (although, be it remembered, the quality of the glass is here of no consequence whatever); and I have been myself in correspondence with the principal glass manufacturers here and on the Continent, and not one of them is willing to undertake even a 6-foot glass disc; so that it would appear that, above that size, the silver-on-glass mirrors are out of the question." . . . . "The other great difficulty in the manufacture of reflectors is the annealing of the disc, and I believe it is this difficulty which limits to so narrow an extent the production of glass discs for silver-on-glass mirrors."

It may be interesting to your readers to know that an attempt is now being made to entirely overcome the apparently insurmountable difficulties so clearly pointed out by Mr. Grubb, and to obtain at any time without delay, and at a very small cost, discs of glass suitable for making silvered reflectors from 6 to 8, or even 10 feet in diameter.

It is almost impossible to over-rate the difficulty of producing massive discs of glass such as the one employed for the 47¼-inch reflector of the Paris Observatory, weighing, as it did, no less less than 1,546 lbs. in the rough, for, however carefully annealed such a mass of brittle, slow-conducting material may be, it will always be liable to unequal expansion, deflection, and fracture.

Fortunately, however, we have commercial plate glass to fall back upon; plates of 1 to 1½ inch in thickness can be readily made and perfectly annealed, and it is to the substitution of these large and comparatively thin sheets of glass, in lieu of thick cast masses, that my attention has been chiefly directed.

It is perfectly well known that plates of 1 to 1½ inches in thickness, if of large area, are subject to a great amount of deflection and consequent distortion of the image, which no ordinary support or backing can prevent. Several modes of converting such thin discs of commercial plate glass into efficient reflectors are about to be put to the test of practical experiment for the 50¼-inch silver-on-glass reflecting telescope which I am making and erecting at my residence on Denmark Hill.

Any attempt to support a disc of this diameter of 1½ inch in thickness against a cucheon of any kind, or loosely against a plane, must end in failure; nor can we hope to escape the difficulty by cementing the glass to any foreign substance whose power of conducting heat and rate of expansion differs from that of glass, as a giving way of the cement would be only a question of time, while distortion would result from unequal expansion of the two different materials. An intermediate course has therefore been adopted.

A strongly ribbed hollow cellular casting is made of iron 52½ inches in diameter, and 13 inches in thickness, weighing 1,400 lbs.; after slowly cooling in its mould, it will be again heated to about 900° F., and then be again slowly cooled; the whole of the external skin of the casting will be turned off in the lathe, and its face made into a true plane, less the final process of scraping; it will then be thrice annealed in oil, each time slowly raising the temperature from 60° up to 600° F., and each time slowly cooling it again. When all undue tension has thus been got rid of, its face will be finally scraped to a true plane, and a small spiral channel $\frac{1}{8}$ of an inch deep, and the same in width, will be formed on the flat face, the channels being about ½ an inch apart from each other, and extending from the centre nearly to the outer edge of the metal surface. One side of the glass disc having been previously ground flat by the plate-glass manufacturer, will have a second grinding on the grooved plane, so as to insure perfect contact all over its surface; the emery having been all carefully removed, the surface of the iron plane is to be slightly moistened with olive oil, and the disc of glass replaced upon it. A flanged iron ring will then be placed around the glass disc, and screwed firmly to the iron surface, leaving a clear annular space of about ⅜ of an inch wide between the periphery of the glass disc and the ring; a permanently tenacious viscous matter (of the character of soft marine glue) will then be poured into this annular space, forming an air-tight junction between the iron plate and the glass surface, and at the same time admitting the glass to expand or contract freely. A partial vacuum will then be formed beneath the glass by exhausting the air through a central hole communicating with the spiral groove; the glass disc will then be held firmly in contact with the entire surface of the iron plane, which, however, is free to slide under the glass when undergoing expansion or contraction. I have found by repeated experiments (many years ago) that plate glass (say of ¼ of an inch only in thickness) so held on to an unyielding plane, may be repeatedly struck by the rounded face of a heavy wooden mallet, with the greatest violence, without producing a single fracture, so complete is the support thus afforded.

It is important to bear in mind that a glass disc so held does not rest on its lower edge when placed in a vertical position, nor are the upper portions of the plate allowed to press on, and be supported by the lower ones, as is inevitably the case with a mirror loosely suspended in a sling in the ordinary manner, but on the contrary, every portion of the glass disc is sustained and supported in position by atmospheric pressure, and held flatly and firmly against a corresponding portion of the unyielding iron plane, free from any accumulated downword pressure.

The expansion by heat of plate-glass and cast-iron are in round numbers as 19 is to 22, and the differential amount of this expansion between the extreme range of summer and winter temperatures, would cause the iron to exceed the diameter of the glass by about $\frac{1}{1000}$ of an inch;—this minute sliding motion of the two smooth planes upon each other would not in the slightest degree alter the curved face of the mirror.

The glass disc having been thus finally and permanently attached to the iron plane, the latter would be supported in its cell by bands passing round it as usual, and with a system of triangular supports at the back. The weight of this strong-ribbed hollow cellular plane, of 13 inches in thickness, is only 1,400 lbs., while a disc of equal diameter in speculum metal, if only 4¼ inches in thickness, would weigh about 2,700 lbs.; hence such a compound metal and glass reflector is lighter than a solid cast glass one, and but little more than one-half the weight of a reflector made of ordinary speculum metal, while its thickness being three times as great as the latter, it would, when in use, and also while undergoing the polishing operations, be perfectly free from deflection.

Hitherto I have spoken only of the mode of mounting the glass disc on its iron support; it now remains to convert the flat surface of the glass disc into a shallow concave reflector. For this purpose I have made experiments in turning glass concaves with a diamond-cutting tool mounted on a slide-rest, and I have found that in this way glass affords nearly the same facilities for shaping in the lathe that iron or brass would do under similar conditions; it therefore follows that lenses of all shapes and sizes may be brought approximately to a true figure with very great ease and rapidity.

Satisfied with this result, I am now erecting in my laboratory a lathe of peculiar construction and specially adapted to this purpose with a bed fifty feet in length, and having a fifty-four inch diameter face plate at each end of the mandril. A massive radius-bar or frame of double the intended focal length of the reflector, moves on an adjustible pivot attached to the lathe-bed, while the other end of the radius frame carries a slide-rest in which a diamond-cutting tool is mounted, and by means of which a spherical concavity is rapidly and truly turned over the whole face of the glass disc, and of any desired radius, while a second plate of glass or metal is turned into a convex surface on the other face-plate of the lathe, thus furnishing a convex grinder of the exact same radius as the concave reflector. Special arrangements are made to neutralise any difference in the length of the radius-frame by expansion or contraction during the turning operation, and provision is also made for gauging to the

$\frac{1}{100}$th of an inch the focal length of the convex and concave surfaces under operation.

Although I have heretofore described the cellular casting as having a flat face, it will be obvious that if made into a concave corresponding with the intended focal length of the reflector that much thinner sheets of glass than those before named may be employed by first bending them to the required curve and fitting them by grinding to the concave iron surface, so that a glass reflector can on this principle be made just as large as a plate-glass manufacturer can produce an ordinary thin plate.

A description of the novel arrangements which I employ for grinding and polishing the spherical concave reflector, and its conversion into a paraboloid of revolution would carry me far beyond the already too lengthy remarks I have made, and which had for their primary object simply to show that we may still have good reason to hope that silver-on-glass reflectors of large diameters are within our reach. HENRY BESSEMER

Denmark Hill, January 21

A Telephone Without Magnetism

FOR some time past I have been experimenting with the view of transmitting articulate sounds through wires without the aid of electricity or magnetism.

I have now been quite successful, my experiments proving that the sounds of the human voice can be carried by *vibrations* through considerable lengths of wire.

Last night conversation was carried on with ease between *four* individuals, situated in different rooms. Piano music, singing, laughing, and breathing, were all clearly transmitted to the ear.

The whole distance would be about fifty yards.

The communication was effected by means of a mouth-piece with a vibrating disc in connection with the wire.

Glasgow W. J. MILLAR

Change of Habits in Toads

WHILE prosecuting my field-work as Palæontologist of the United States Geological Survey of the Territories, under the direction of Prof. F. V. Hayden, in Colorado, during last season, I had the opportunity to make some very interesting observations in relation to a change of habits in the common toad (*Bufo americana*). The district referred to is that portion of the great plains which lies immediately adjacent to the eastern base of the Rocky Mountains, and which is traversed by the South Platte River and its tributaries there.

The valleys of these streams are broad and shallow, and the streams heading in the immediately adjacent mountains have an abundant flow of water; so that large tracts of land in all those valleys have been brought under cultivation by irrigation. Irrigation is necessary in all that region, for it lies within that portion of the United States domain upon which the annual rainfall is insufficient for the purposes of agriculture.

With the irrigation of the land came increased and perennial vegetation; with that came increased insect-life, and with that an increase of birds and toads. The irrigating ditches are everywhere numerous, and during the season of growing crops they are frequently visited by men to regulate the flow of water to the land.

This and other circumstances disturb the toads that frequent the shades of the herbage which grows upon the borders of the water. It is no uncommon thing for toads as well as frogs, to jump into the water when disturbed, but the habit of the former is to make a shallow dive, rise immediately to the surface, and swim upon it by a sweeping curve to the shore again, not resting until the brink is gained, upon which they tarry a while before coming upon the land.

Frogs, on the contrary, when disturbed, make a strong dive directly to the bottom, upon which they lie prone, with the legs flexed against the body, and into the mud of which they settle themselves a little. Here they remain and exhaust the patience of one who may attempt to wait for them to rise. Now the toads in this irrigated region have adopted precisely these common habits of the frogs when disturbed upon the borders of the ditches, as I repeatedly witnessed. I regard this as the resumption of an instinctive trait that has been potentially transmitted from a former race of Anourans that were less differentiated than frogs and toads are now from each other; and that the lately introduced change of physical conditions in the region has caused the toads to resume habits which the frogs have never abandoned.

Washington, D.C., January 6 C. A. WHITE

Talking Photographs

THE article from the *Scientific American* on the phonograph which is quoted in NATURE, vol. xvii. p. 190, concludes as follows:—"It is already possible, by ingenious optical contrivances, to throw stereoscopic photographs of people on screens in full view of an audience. Add the talking phonograph to counterfeit their voices and it would be difficult to carry the illusion of real presence much further."

Ingenious as this suggested combination is, I believe I am in a position to cap it. By combining the phonograph with the kinesigraph I will undertake not only to produce a talking picture of Mr. Gladstone which, with motionless lips and unchanged expression shall positively recite his latest anti-Turkish speech in his own voice and tone. Not only this, but the life-size photograph itself shall move and gesticulate precisely as he did when making the speech, the words and gestures corresponding as in real life. Surely this is an advance upon the conception of the *Scientific American!*

The mode in which I effect this is described in the accompanying provisional specification, which may be briefly summed up thus: Instantaneous photographs of bodies or groups of bodies in motion are taken at equal short intervals—say quarter or half seconds—the exposure of the plate occupying not more than an eighth of a second. After fixing, the prints from these plates are taken one below another on a long strip or ribbon of paper. The strip is wound from one cylinder to another so as to cause the several photographs to pass before the eye successively at the same intervals of time as those at which they were taken.

Each picture as it passes the eye is instantaneously lighted up by an electric spark. Thus the picture is made to appear stationary while the people or things in it appear to move as in nature. I need not enter more into detail beyond saying that if the intervals between the presentation of the successive pictures are found to be too short the gaps can be filled up by duplicates or triplicates of each succeeding print. This will not perceptibly alter the general effect.

I think it will be admitted that by this means a drama acted by daylight or magnesium light may be recorded and reacted on the screen or sheet of a magic lantern, and with the assistance of the phonograph the dialogues may be repeated in the very voices of the actors.

When this is actually accomplished the photography of colours will alone be wanting to render the representation absolutely complete, and for this we shall not, I trust, have long to wait.

WORDSWORTH DONISTHORPE

Prince's Park, Liverpool, January 12

Sun-spots and Terrestrial Magnetism

I BEG to direct Prof. Piazzi Smyth's attention to an article in the *Annuaire du Bureau des Longitudes* for 1878 by M. Faye, entitled "La Météorologie Cosmique," in which this distinguished astronomer and meteorologist says:—"La période des taches, portée à $11^{ans}\cdot1$ par M. Wolf n'étant pas égale à celle des variations magnétiques ($10^{ans}\cdot45$), ces deux phénomènes n'ont aucun rapport entre eux." It thus appears rather premature to suppose that the sun-spot cycle and the terrestrial magnetic diurnal oscillation cycle are intimately connected. A. W. DOWNING

Greenwich, January 21

Great Waterfalls

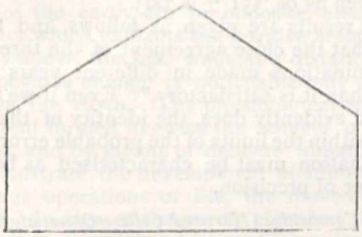
IN reply to Mr. Guillemard's inquiry in NATURE (vol. xvii. p. 221) he will find some account of the Kávari or Cauvery Falls in the "Mysore Gazetteer," recently compiled under orders of the Indian Government, vol. ii. pp. 271–273 (Bangalore, 1876). A copy is doubtless to be seen at the India Office Library.

Edinburgh, January 21 W. W. HUNTER

Mechanical Analysis of the Trevelyan Rocker

ALMOST every physical cabinet possesses one of Trevelyan's rockers, and yet it is rare to find one which always works well and gives complete satisfaction. Some two years ago having experienced this difficulty in New York, where I was then Professor of Physics, I requested Mr. Robert Spice, F.C.S., of 230, Bridge Street, Brooklyn, U.S., a very skilful constructor of acoustic instruments, and a thorough physicist, to make for me several of these rockers and ascertain, if possible, the conditions

of success. After many experiments with rockers of different sizes and angles, Mr. Spice obtained a formula by which a perfectly satisfactory rocker can be constructed, as several trials since then, both in America and Europe, have convinced me. Believing that there are many other professors who feel interested in this matter I communicate to the readers of NATURE, at Mr. Spice's request, his analysis of the rocker.



Let A B C D be the principal section of the rocker. Draw an indefinite base-line through the points C and D. From the point B let fall the perpendicular B E, and from F the perpendicular F D.

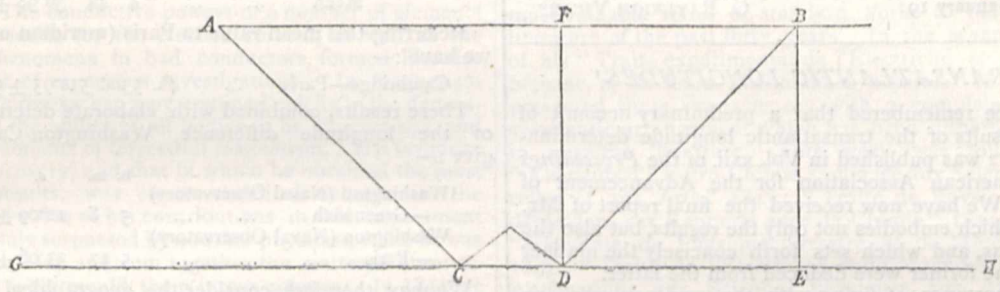
When the lead support raises (by expansion) the point D the point C becomes the fulcrum, and the line D E represents the complimentary arm of an imaginary lever C D E of the third order. In proportion as the distance C D is very small in comparison with the distance D E, in a like proportion will greater force be required to raise the rocker, and *vice versa*.

By experiment on a right-angled prismatic rocker (*i.e.* if the lines A C and B D be produced the angle at their intersection would be a right-angle) it was found that the most certain and pleasing effect was obtained when the distance C D was to the distance D E as 2 : 5.

In the case of a right-angled rocker as above, of course the distance D E = the distance D F.

By making the rocker-angle less than a right-angle, the distance D F would exceed the distance D E. This, it is believed, would be an advantage, as the leverage would remain constant and the additional weight would have the effect of raising the note.

The length of the rocker should be equal to twice A B. The length of the handle should be four times A B. Finally, in practice, the angles C and D are slightly flattened, by filing, to prevent adhesion to the lead by sinkage, also to gain a larger heating surface.



The lead should have the form shown in the section below, and should weigh from three to four pounds.

SAMUEL H. FRISBEE

11, rue des Récollets, Louvain

No Butterflies in Iceland

A FEW months ago, at a meeting of the Linnean Society, Mr. McLachlan, when speaking of the various species of butterflies brought to England from the far north by the last English Arctic expedition, mentioned incidentally that there were no butterflies in Iceland.

On looking up some old books on the subject, in which I had the most able assistance of Mr. Erickr Magnussen, of Cambridge, we found at folio 602 of a book entitled, Olaffson (Eggert) Reise giennem, Island. Sorö, 1772.

LEPIDOPTERA.

L. phalænæ.
,, *maxima.*
,, *fluctuata.*
,, *geometra.*
,, *tota aurea.*

Again, in a work by R. Mohr, 1786, folios 90-91, under the head "Lepidoptera," we have—

L. phalænæ.
,, *graminis.*
,, *betularia.*
,, *olevacea.*
,, *lucerina.*
,, *vaccinii.*
,, *fluctuata.*
,, *pratella*, &c., &c.,

all of which are named as butterflies of Iceland.

Mr. McLachlan is a very high authority, and not at all likely to assert as a fact that there are *now* "no butterflies in Iceland," unless it were true.

The only possible way in which these perfectly opposite authorities can be reconciled (unless we throw aside those of a hundred years ago as worthless), is to suppose that in the interval the butterflies and their larvæ have been destroyed—not an impossible circumstance in Iceland, which has been almost, if not wholly, covered with poisonous volcanic ashes from time to time.

JOHN RAE

Kensington, January 18

The Great Pyramid

I HAVE been reading in Mr. Piazzi Smyth's book on this subject ("Our Inheritance," &c.). From the measurements made or cited by the author it appears tolerably clear that if the vertical height of the pyramid, as originally built, be taken as 1, the total length of the four base lines will be twice 3·14159, &c., the number which expresses the circumference of a circle whose diameter is 1. At first sight this statement seems startling, but I think it may readily be acceded to, and that neither Mr. P. Smyth nor anyone need believe that by inspiration or otherwise, the architect knew the above relation of diameter to circumference, or was a circle-squarer in any special sense. I conceive the architect to have done something like the following:—Deciding first upon the vertical height of his intended pyramid, he took a cord, equal in length to that vertical height, and with it as a radius described a circle on level ground. Along the circumference of this circle he laid another cord, the ends of which met and were fastened together. The circle being thus formed, he drove four pegs, at equal distances inside the cord, so as to stretch it out into a square. The square thus formed gave the lines for the base of the pyramid; and it is obvious that thus the ratio of diameter to circumference would necessarily be built into the pyramid, however ignorant the architect might be. Working drawings (actual size) of surfaces, angles, chambers, passages, and other things would easily be laid out on the ground. The dimensions of the so-called King's chamber, and of a coffer or stone chest therein, which appear to involve the above ratio of 1 to 3·14159, &c., were, I think, arrived at by a somewhat similar process of construction.

Now as to the religious aspect of the case and an easy bit of "development." A cone is a well-known ancient religious symbol (of the kind denounced by Mr. P. Smyth as unclean),

and no doubt cones had been erected before the time of Cheops, and had their meaning and uses. Probably they were first made of earth, and the circular base would no doubt be set out by a cord, as above described. Cheops, by his architect, squared the circular base, getting thereby lines much better adapted to stone work, whilst still keeping the old sacred emblem, though in a developed form. It may, I believe, be traced down to many modern forms not often suspected of bearing any relation to it.

Belper, January 17 J. G. JACKSON

Acoustical Effects of Atmospheric Pressure

ON tapping an ordinary bell-jar receiver after exhaustion, the following was noticed. The note derived from percussion after exhaustion was sensibly of a higher grade than that obtained from the glass containing air. On gradually letting the air in, the note sank directly as the amount of air so introduced. We conclude that the phenomena here recorded are connected with the atmospheric pressure, and that the note yielded is a function of the atmospheric pressure. Can any of your readers suggest a method for the investigation of the observed facts, if no investigations have been before made on the subject.

Rugby, January 19 G. RAYLEIGH VICARS

TRANSATLANTIC LONGITUDES[1]

IT will be remembered that a preliminary account of the results of the transatlantic longitude determination of 1872 was published in Vol. xxii. of the *Proceedings* of the American Association for the Advancement of Science. We have now received the final report of Mr. Hilgard, which embodies not only the results, but also the observations, and which sets forth concisely the manner in which the former were deduced from the latter.

The importance of fixing with the greatest precision achievable, the longitude of some point in the coast survey triangulation with reference to Greenwich, led the U.S. Government promptly to make use of the means afforded by the completion of the Atlantic telegraph cable from Ireland to Newfoundland.

The first telegraphic longitude determination through it, made under the direction of Dr. B. A. Gould, in 1866, although it surpassed in exactness all results obtained by different methods was subject to a small but indeterminate correction, the "personal equation" between the American and the standard Greenwich observer.

Use was therefore made of the French cable in 1870 to make another determination under different circumstances, and under the charge of Mr. Dean the longitude difference between Brest and Cambridge, U.S., as before, was obtained; but as at that time no cable was in operation between Brest and England, the connecting link, Brest-Greenwich, remained undetermined until 1872, when Mr. Hilgard took charge of the work necessary to supply this deficiency, and since the opportunity was afforded, to repeat the Transatlantic determination. This time an intermediate station, St. Pierre, on the American side, was introduced, thus varying still more the conditions under which this third determination was made.

The general plan of operations was to unite at Brest time signals from St. Pierre, Greenwich, and Paris. The co-operation at the last-named stations of the Astronomer-Royal, Sir G. B. Airy, and of M. Delaunay, and the generosity of the telegraph companies, enabled Mr. Hilgard to finish the work successfully in September of that year.

We can only advert briefly to one or two points of interest. The accordance of the results appears to have been due in a great measure to the attention given to the accurate determination of the relative personal errors of the observers, which gave also indirectly the "personal equation" correction, lacking in the longitude determination of 1866.

[1] Final Report on the Determination of 1872, with a Review of Previous Determinations. By J. E. Hilgard. From the United States Coast Survey Report for 1874.

Incidentally, the "wave-time" of the cable signals was deduced, and on the assumption of equality in time in either direction, the resulting wave-time from Brest to St. Pierre, through a length of cable equal to 2,979 statute miles, is given as os.·351 ± s.·003.

The final results are given as follows, and the author remarks "that the close agreement of the three independent determinations made in different years is no less surprising than it is satisfactory." Even if we assume, as Mr. Hilgard evidently does, the identity of the results as accidental within the limits of the probable errors assigned, the determination must be characterised as being of the highest order of precision.

Longitude of Cambridge (*Harvard College Observatory dome*) *west of Greenwich* (*meridian*) :—

	h.	m.	s.	s.
1866	4	44	30·99	± 0·10
1870			30·98	± 0·06
1872			30·98	± 0·04
Mean	4	44	30·98	± 0·04

Referring this mean value to Paris (meridian of France) we have :—

Cambridge—Paris ... 4h. 53m. 518·95 ± os. ·06

These results, combined with elaborate determinations of the longitude difference, Washington-Cambridge, give :—

	h.	m.	s.	s.
Washington (Naval Observatory) —Greenwich	5	8	12·09	± 0·05
Washington (Naval Observatory) —Paris	5	17	33·06	± 0·07

We may, therefore, consider the geographical position of the Washington Observatory as one of the best determined in reference to others.

One of the incidental but highly important results of this expedition is the longitude difference Greenwich-Paris, the accuracy of which was checked by the conditions involved in the closing of the longitude triangle Greenwich-Paris-Brest. The result, 9m. 20s.·97 must now supersede the value obtained by Mr. Leverrier in 1854, which it exceeds by nearly half a second.

ANTOINE CÉSAR BECQUEREL

IT is with regret that we record the death of the noted French physicist, Prof. Becquerel, which occurred on January 18, in Paris. Antoine César Becquerel was born at Châtillon-sur-Loing, in the Loiret department, March 8, 1788. After completing a course in the Paris Polytechnic, he entered, in 1808, the Imperial Engineer Corps. It was no time of idleness for young officers, and he was shortly in active service, taking part in the entire Spanish campaign under General Luchet. Here he was present at the sieges of Torbosa, Tarragona, Lagonte, and Valencia, and manifested such marked abilities that in 1812 he returned to Paris to receive the rank of captain, and be presented with the Cross of Chevalier of the Legion of Honour, from Napoleon's own hands. In the following year he was sent by the Emperor to complete the fortifications on the German frontier. At the fall of the empire, in 1815, he resigned his position as chief of battalion in the Engineer Corps, and devoted himself exclusively to physical and chemical research, accepting a position as teacher in the Musée d'Histoire Naturelle, of Paris. In 1837 he was made professor in this institution and occupied this position up to the time of his death. Shortly after entering upon his scientific career he commenced the remarkable series of investigations in electricity and magnetism which have been uninterruptedly continued during the past half-century, and have linked his name closely with every branch of these two leading departments of physics. In thermo-electricity Becquerel carried out a large number of experiments on the

currents caused by heating both a single metal and two metals in contact, and formulated the well-known thermo-electric series, bismuth, platinum, lead, tin, gold, silver, copper, zinc, iron, and antimony. In his studies on atmospheric electricity he proved that the water of the ocean and the solid crust of the earth are in opposite electrical conditions, a fact which explains the positive state of the air immediately above the sea, while at a distance from the ocean the positive change is noticeable only at a certain height above the earth. The physiological effects of the electric current formed likewise the subject of numerous observations, and by means of delicate apparatus he was able to demonstrate the development of minute currents by the various operations of life, the movement of the muscles, &c. In view of the purely chemical character of these operations these observations harmonised perfectly with the theory which he advanced that electric currents were produced by all chemical unions and decompositions.

The effects of electricity on the colours of flowers, he showed to consist chiefly in a mechanical bursting of the cells containing colouring matter, and not in a chemical change. The conductive powers of a number of elements and compounds for the electric current, as well as the thermal phenomena in bad conductors, formed likewise the subject of numerous investigations. In magnetism Becquerel's researches were confined chiefly to the demonstration of the ability of all bodies to be magnetised, and to the phenomena of terrestrial magnetism. His favourite field of discovery, and that in which he obtained the most brilliant results, was electro-chemical action; in the variety and value of his contributions in this department he is certainly surpassed by no other physicist, while he was the first to grasp and sum together the scattered observations, and fairly mould them into a science. In 1834 he observed the deposition of metal on the negative electrode when the two poles of a pile were introduced into solutions of the salts of various metals. Shortly after he discovered that by using feeble currents the metal could be deposited very evenly and equally on the surface of the electrode, and that the two solutions required for the purpose could be kept from mingling by the use of gold-beater's skin or animal membranes, without hindering the current. These facts were at once made use of by De la Rive, of Geneva, who based on them his technical process of gilding in 1840. Although not the first to make the practical application of his discoveries, Becquerel rapidly improved the methods derived from them, and contributed in swift succession an enormous number of facts which serve as the fundamental principles of the art of galvano-plastic. These are to be found in a compact state in Smee's Elements of Electro-metallurgy. Becquerel's famous *Oxygen-circuit*, discovered at this time, made his name known at once to a large circle, on account of its simple, practical quantities. It consists of a glass tube covered at one end with linen, which supports a layer of kaolin, and designed for the solution of the metallic salt to be reduced. This is placed in a vessel containing a dilute acid, and the object to be electro-plated is immersed in the solution after being connected by a wire with a platinum plate in the acid. The action begins instantaneously, and is both rapid and regular. Another well-known apparatus is his *depolariser*, an arrangement designed to obviate the reverse currents produced by the gaseous deposits on platinum electrodes, and consisting essentially in a continuous shifting of each of the plates to the liquid of the other, so that they have no opportunity to become polarised. The oxygen-circuit, with its gentle regular current, was used by Becquerel for the decomposition of a large variety of chemical compounds. Among the more noteworthy preparations by its action can be mentioned aluminium, silicium, beryllium, sulphur, and the various earthy and metallic phosphates. Equally extensive were the preparations of crystalline salts, notably those occurring in nature, by the action of the electric current on mixed solutions or on solutions of soluble salts in contact with insoluble substances. During the past ten years his attention has been almost exclusively devoted to the novel and remarkable electro-capillary phenomena first observed by him in 1867. These can be observed in their simplest form when a cracked test-tube containing a solution of cupric sulphate, for example, is immersed in a solution of sodic sulphide. A deposition of metallic copper takes place at once on the crack. This elementary fact has been elaborated in a variety of directions with numerous solutions, and the laws regulating the development of electric currents by capillary action partially enunciated. The study of these phenomena is, however, still in its infancy. Becquerel regarded them as explanatory of the deposition of metals in veins in the rocks and of many physiological reactions taking place in the vegetable and animal tissues. A very detailed account of the experiments is to be found in vol. xxxvi. of the *Mémoires de l'Institut*.

Despite his manifold experimental investigations, Becquerel was an indefatigable author, and contributed a most valuable series of standard works to the physical literature of the past forty years. In the seven volumes of his "Traité expérimental de l'Électricité et du Magnétisme, et de leurs Phénomènes naturels," 1834-40, he presented these two sciences with a completeness and systematic arrangement which has been hitherto wanting in physical literature. This work was followed by "Éléments d'Électro-Chimie appliquée aux Sciences naturelles et aux Arts," 1843; "Traité de Physique considérée dans ses Rapports avec la Chimie," 1844, 2 vols.; "Éléments de Physique terrestre et de Météorologie," 1847; "Traité de l'Électricité et du Magnétisme; leurs Applications aux Sciences physiques, aux Arts, et à l'Industrie," 1856, 3 vols.; Résumé de l'Histoire de l'Électricité et du Magnétisme," 1858; and "Des Forces physico-chimiques et de leur Interprétation dans la Production des Phénomènes naturels," 1875.

In 1829 Becquerel was elected a member of the French Academy, and received in 1874 the Medaille Cinquantenaire, although he had been but forty-five years a member. His scientific communications are to be found in the *Comptes Rendus* of the Academy and in the *Annales de Chimie et Physique*. The Royal Society elected him as a corresponding member a number of years ago, and he was one of the three French *savants* who have been recipients of the Copley Medal. In 1865 Napoleon III. decorated him with the Cross of Commander of the Legion of Honour.

Prof. Becquerel leaves behind him a son, Edmond Becquerel, Professor of Physics in the Conservatoire des Arts et Métiers, who has assisted his father for a long series of years in the compilation of his numerous works, and whose researches in electricity fairly rival those of the latter. The funeral ceremonies took place on Monday in the church of St. Medard, at Paris.

DAVYUM[1]

ABOUT the middle of this year (1877) I succeeded in isolating a new metal belonging to the platinum group. I named it Davyum, in honour of Sir Humphry Davy, the eminent English chemist.

The platiniferous sand from which it has been extracted[2]

[1] From an article by Sergius Kern in *La Nature*.

[2] The sand treated had the following composition:—

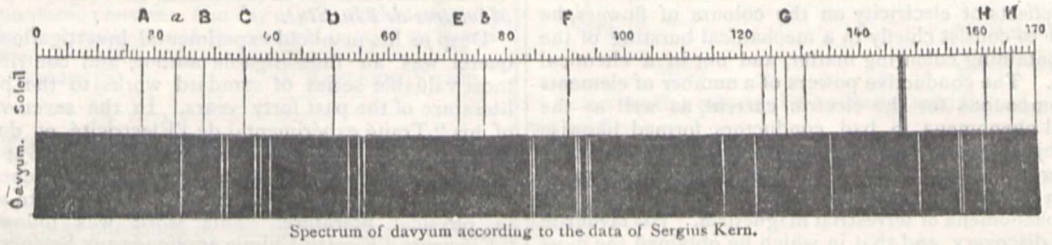
Platinum	80·03
Iridium	9·13
Rhodium	0·61
Osmium	1·35
Palladium	1·20
Iron	6·45
Ruthenium	0·23
Copper	1·02
	100·09

was treated, for the separation of the metal, by the analytical method of Prof. Bunsen. The mother-liquor obtained after the separation of the rhodium and iridium was heated with an excess of chloride of ammonium and nitrate of ammonium. A dark red precipitate was obtained after calcination at red heat. It yielded a greyish mass resembling spongy platinum. The ingot resulting from 600 grammes of mineral weighed 0·27 kil.

The metal was dissolved in aqua regia, in order to examine the action of different reagents on the solution. Potash gave a clear yellow precipitate of the hydrate of davyum, which is easily attacked by acids, even by acetic acid. The hydrate of davyum dissolved in nitric acid gave a brownish mass of nitrate of davyum; by calcining this salt a black product is obtained, which is probably the monoxide.

The chloride of davyum, dissolved in a solution of potassic cyanide, gave, by gently evaporating the solution, beautiful crystals of a double cyanide of davyum and potassium. In this salt the potassium may be replaced by several metallic elements. The cyanodavic acid is very unstable; it is isolated by passing a current of sulphuretted hydrogen through a solution of the double cyanide of lead and davyum. Sulphuretted hydrogen produces, in the acid solutions of davyum, a precipitate of sulphide of davyum, which is easily attacked by the alkaline sulphides, yielding probably a series of sulpho salts.

A concentrated solution of chloride of davyum yields, with potassic sulpho-cyanide, a red precipitate, and when gently cooled, produces large red crystals. If the same precipitate is calcined the sulpho-cyanide of davyum takes the form of a black powder. These reactions show that this salt is allotropic.



Spectrum of davyum according to the data of Sergius Kern.

The chloride of davyum is very soluble in water, alcohol, or ether; the crystals of this salt are not deliquescent. The calcined salt gives the monoxide as a residue. Chloride of davyum forms double salts with the chlorides of potassium and ammonium. They are insoluble in water and very soluble in absolute alcohol. The double salt of sodium and davyum is almost insoluble in water and alcohol; this reaction is very characteristic, because many sodic salts of the platinum group are very soluble in water.

This chloride of davyum is the only one which exists, as the second product, containing more chlorine, is decomposed during the evaporation of the solution, disengaging chlorine.

I have made some new researches on the density of melted davyum; three experiments gave the following numbers:—9,383 9,387, 9,392 at 24°. These results agree very sensibly with those of my first researches; the density of davyum given in my first note to the Academy being 9,385 at 25°.

M. Alexejeff has undertaken the determination of the equivalent of davyum; but as the quantity of davyum which I possess is very small, exact researches are difficult. Preliminary experiments have shown that the equivalent is greater than 100, and probably about 150-154.

Some new platiniferous sands, which are to be placed at our disposal, will yield a sufficient quantity of the new metal for additional experiments. We hope to have in time nearly 1·2 gr. of davyum.

Finally I have investigated the spectrum of davyum by vaporising the metal in powder between the carbons of the electric lamp. The spectroscope at my disposal is not powerful enough to show precisely all the secondary lines. This is why I have only indicated the principal lines easily visible in my spectroscope.[1]

THE GREAT DETONATING METEOR OF NOVEMBER 23, 1877

HAVING fully discussed the whole of the accounts of the great meteor that have reached me, consisting of some ninety direct communications and forty or fifty newspaper cuttings, I have the pleasure to forward to NATURE a condensed description of it.

The points of most importance to be determined are—1. The true orbit which is obtained from a knowledge of the radiant and velocity of motion. 2. The height at which it first became luminous, as our knowledge of the real extent of the earth's atmosphere depends exclusively upon such determinations. 3. The height at which it exploded and came to an end. That this last is connected with the physical condition and constitution of the body cannot be doubted. The brightness of meteors seems always to depend upon the distance they penetrate into the air. Generally, when they get below 30 or 40 miles, they are very remarkable.

The Greenwich mean time was 8h. 24m. 30s. on November 23.

There are but few descriptions of the path of the great meteor in question from which to derive the radiant point. Five of the fully-described tracks meet almost exactly in R.A. 62°, N.P.D. 69°. The others tend to support this position rather than to alter it, but many are, as is usual, extremely wild, passing 20°, and even 30° from it. To an observer situated near the middle of the north coast of Wales, this radiant would bear south 74° E., at altitude 37°.

The meteor first came visible to Mr. T. B. Barkas, at Newcastle-on-Tyne, to another observer at Tynemouth, to the Rev. G. Iliff, at Sunderland, and Mr. E. Pikard, at York, at the great height of 96 statute miles. The observers agree very closely. It is probable, of course, that had any one been actually looking in the right direction, it might have been seen a little earlier when it was still higher. A height exceeding 90 miles is certain. The meteor was then vertically over a point 13 miles north of Derby, and its appearance was that of an ordinary shooting star. Descending in the air at the inclination of 39° to the surface of the earth, when 48 miles exactly over Liverpool, it became intensely brilliant, so suddenly, that many observers speak of this as the first explosion.

It was at this instant that it attracted universal attention. People as far distant as Essex, Roscommon, Edinburgh, Bristol, and Queenstown, 200 miles from it,

[1] *Comptes Rendus* and *Chemical News*.

describe it as being nearly as large as the full moon and greatly exceeding it in brilliancy. An observer at Ashby-de-la-Zouch first noticed his shadow, and those of neighbouring trees thrown *towards* the moon, then shining brilliantly in the east. Persons much nearer the scene, sitting in rooms with the blinds down, were frightened by the flood of light that suddenly found its way in. The meteor exploded with great violence at the height of 14 miles over the Irish Sea, 20 miles N.N.W. (true) of Llandudno. The total length of path was 135 miles, which was traversed in about 8 seconds of time, or with a velocity of 17½ miles per second, as determined from twenty-three estimations of its duration.

The streak left in the air extended for 40 miles along the track, and was not less than 2,000 feet in diameter.

The violence of the explosion was such, that at Bangor, Beaumaris, Conway, and Llandudno, doors and windows rattled, and people ran out to see what was the matter. As far as Chester the sound resembled "thunder not very far distant," or "a salvo of artillery."

It is a fact worthy of thoughtful consideration that the body which was capable of producing this convulsion, probably exceeding the discharge of the 81-ton gun in the proportion of a hundred to one, was converted into impalpable powder in eight seconds of time, merely by the rapidity of its transmission through very attenuated air. After the explosion nothing remained but dully incandescent dust or ashes, which slowly fell a short distance *vertically* downwards. That is to say, there was not one remnant sufficiently heavy to continue in the same direction, or to retain the original velocity, because such a remnant would have been visible itself as a bright meteor. A momentum which, estimated in foot-tons, would reach some enormous figure, was instantaneously reduced to nothing, or, rather, converted into atmospheric waves—and dust!

The exact position and height of the explosion is fixed by the singular observation of Mr. Petty, at Llandudno (NATURE, vol. xvii. p. 183), who did not even see the meteor itself, but its light on the hearthrug coming through a chink in the blind.

Mr. J. Ismay, the superintendent of telegraphs at Liverpool, who observed the explosion from the beach at Llandudno, measured the sound-interval, and found it between 2 min. and 2 min. 15 secs. From the spot where I have assumed the explosion took place to his position is 25 miles, which sound would traverse in two minutes exactly.

The orbit deduced from the apparent position of the radiant point is—

$$i = 0$$
$$\pi = 153^\circ$$
$$q = \cdot 47$$

Motion direct.

The relative velocity obtained by assuming a parabolic orbit is 19 miles per second, agreeing very closely with that found by observation.

If the longitude of the radiant be diminished 3° or 4°, the orbit is so far modified as to almost coincide with that of the comet of 1702. The comet was not very well observed. The meteor belonged to the well-known shower of *Taurids*, first discovered by Mr. R. P. Greg, encountered by the earth with great regularity about November 21–23. In 1877 it appears to have been very prolific of bright and of detonating meteors.

G. L. TUPMAN

OUR ASTRONOMICAL COLUMN

THE COMETS OF 1618.—The year 1618 presented a phenomenon which is perhaps unique in the history of the appearances of comets, two of these bodies having been conspicuously visible at the same time in certain parts of he earth, and for several days, at least, in the same quarter of the heavens, with trains of thirty or forty degrees in length, and upwards. Cometographers previous to Pingré had been much exercised with reference to the comets of this year; Comiers, in "La Nature et Prestige des Comètes," had supposed that six comets in all were observed in 1618; this number was reduced by Pingré to three, which appears to have been beyond doubt the correct number, though another cometographer, Struyck, disputed the distinctness of Pingré's second.

The first comet was discovered at Caschau, in Hungary, on August 25, and two days later by Kepler, at Lintz, where it rose in the morning about three o'clock, with a tail directed towards the west. Kepler observed it on several occasions, and for the last time on the morning of September 25, and from his rough indications of its positions Pingré calculated the elements which figure in our catalogues, and which it will be found represent the track of the comet pretty nearly; there can be no confusion between this object and the second or third comets of the year.

The third comet, as Pingré remarks, "eut autant d'observateurs qu'il y avoit alors d'astronomes en Europe." It was first seen in Europe in the last days of November, and was observed by Cysat at Ingoldstat till January 21, he having used optical aid, though other observers lost it at the beginning of the month, or even earlier. The elements, first calculated by Halley, were more accurately investigated by Bessel, whose orbit, published in 1805, agrees with the observations as closely as the errors, with which they are obviously affected, will allow. There is no difficulty, therefore, in fixing upon the position of the third comet, with sufficient approximation in the month of November previous to its discovery in Europe.

It appears to have been one of the finest comets of the seventeenth century, apparently hardly exceeded in the imposing character of its appearance by the celebrated comet of 1680. The tail gradually increased in length until, on the morning of December 10, the Danish astronomer, Longomontanus, estimated its extent at 104°, with marked coruscations.

The second comet of 1618, according to Pingré, to which these remarks are intended more particularly to refer, was discovered in Silesia, and also at Rome, on the morning of November 11, as Kepler tells us (*De Cometis lib. I.*). The nucleus was lost in the twilight, but the tail was visible from 4h. 20m. to 6h. 40m. at Rome. On the following mornings the tail was seen at other places in Europe, and by Kepler himself at Lintz, at 5h. 30m. A.M. on November 20; he then describes it as a train of milky-white light, passing below the stars in the quadrilateral of Corvus, and reaching the extremity of Crater. He saw this train for the last time on the morning of November 29, when "inter atras nubes et ventos vehementes, cum campi essent picti nivula, apparuit tamen tractus iste secundi cometæ, sed valde dilutus nec æquans albedinem nubium a luna illuminatarum." This was at 5 A.M., and an hour and a half later, the clouds having somewhat dispersed, he obtained his first view of the third comet, which was then in longitude 221°, with between 9° and 10° north latitude. Thus we see that Kepler saw both comets on the same morning, though he failed to detect the nucleus of the second in the strong twilight; and it may be added that Blancanus, at Parma, had similar experience.

In more southern latitudes the second comet was pretty favourably situated for observation, and its nucleus was observed. Figueroes, ambassador of Spain, at Ispahan, and the Jesuits at Goa, saw both comets simultaneously, and determined positions of the nucleus of the second. Riccioli mentions that Father Kirwitzer, an Austrian, was sent out to China, and died at Macao in 1626, adding that he wrote of observations made in India on the comets of 1618.

In a communication to Baron de Zach early in 1821, Olbers states that Brandes had sent him a work by this Father Kirwitzer, which it appeared had become very scarce, containing observations of the second comet of 1618, but so disfigured by faults either in copying or printing, that he had found it impossible to deduce from them a tolerable orbit. According to these observations "la comète sautille d'un jour à l'autre ça et là dans le ciel, tantôt en avant, tantôt en arrière, de sorte qu'à peine peut-on reconnaître quelle a été la vraie direction de son mouvement." Kirwitzer, who had observed the comet from November 14, reports that on November 26 he was joined in the observations by Father Schall, and Olbers drew attention to the fact that in Zach's *Monatliche Correspondenz*, vol. xxviii., it had been stated that fourteen volumes of Schall's manuscripts were in existence in the library of the Vatican, and engaged Zach to use his interest towards having them examined. This was soon after effected by Conti, but unfortunately no allusion to the second comet of 1618 was found in them, indeed these manuscripts proved so worthless, that Zach considered them "que de la poudre chinoise jetée aux yeux européens." It does not appear that a more accurate copy of the Goa observations has been found since Olbers wrote on the subject. There are two works by Kirwitzer in the British Museum, but they afford no assistance. It thus happens that there is as yet no orbit of the comet in question.

In a further note we shall briefly recapitulate other circumstances in the history of the comet, and examine one or two points in which the known elements of the third comet assist in establishing the absolute distinctness of the second, notwithstanding the idea advocated by Kepler that a comet had divided into two—and which led Pingré to say of him—*aliquando bonus dormitat Homerus*.

METEOROLOGICAL NOTES

CONTRIBUTION TO THE CLIMATOLOGY OF THE SPANISH PENINSULA.—An interesting and able contribution to the climatology of the Spanish Peninsula has been made by Dr. Hellmann in a discussion of the humidity and clouds of that region, published in the Dutch *Meteorological Year-Book* for 1876, being one of the results of the author's recent prolonged meteorological tour in the Peninsula. One of the broad results arrived at is this: the small variation in the annual humidity of places on the west coasts of Europe, as contrasted with the large variation in the humidity of the east coasts of Asia, together with the striking climatic contrasts resulting therefrom is essentially, though less intensely, reproduced in the climates of the Peninsula of the west bordering the Atlantic as contrasted with those of the east washed by the Mediterranean. As regards the relative humidity of the air, the climate is moister in May than it is immediately before and after, and it is interesting to observe that thunderstorms, rain, and cumulus, cirro-cumulus, and cumulo-stratus clouds show an increase in May as compared with March and April on the one hand, and June and July on the other. The annual variation in the relative humidity increases from about four to nine per cent. on the coasts, to about forty per cent. at such inland places as Madrid and Campo Maio. Those who are familiar with the weather-maps of Europe are aware how often atmospheric pressure is so distributed as to give rise to winds blowing outwards from the Peninsula to the ocean in all directions, being easterly on the west coast, southerly on the north, westerly on the east, and northerly on the south. They are everywhere dry winds, and are known in the various provinces as the *Terral*, or land-wind. The desert-wind of the Spanish Mediterranean coast is the *Leveche*, and not the *Solano*, as it is almost universally stated to be by non-Spanish writers. The Solano is, as its name implies, a simple east wind which blows everywhere over the east coasts, and is a rain-bringing wind, but in no sense a desert-wind, malignant and prostrating in its effects. The true desert-wind is known by the name of the Leveche, which is usually loaded with fine sand and dust, and is hot and stifling, is productive of violent headaches, and prostrates even the most robust with a feeling as if every member of the body were oppressed under a load of lead. Dr. Hellmann describes the effects of the passage of one over a vineyard in August, 1876, the appearance being as if a scorching flame had passed over it. The Leveche is felt on the coast only from Cabo de Nao, to Cabo de Gata in the south, and in a less severe form as far as Malaga; but it extends inland no farther than from forty to fifty miles.

CLIMATOLOGY OF THE FIJI ISLANDS.—A valuable contribution to this subject from data collected by the Meteorological Office has appeared in the *Quarterly Journal* of the Meteorological Society for July, 1877. From the position of the Fiji Islands in the South Pacific, the climate is strictly tropical, the year being divided into a hot moist season, extending from November to April, and a cool dry season from May to October. The prevailing winds are S.E. and E., but during the hot season, particularly from January to March, N.E. winds prevail. These N.E. winds are, in Mr. Strachan's opinion, probably due to the heated land of the large island, Viti Levu, giving rise to a wind of aspiration. The annual rainfall on an average of six years was 110 inches. The heaviest falls occur in the summer months of January, February, and March, when thunderstorms are frequent, and in the same months hurricanes occur, though frequently several years pass in succession without the occurrence of any hurricane. In the cool season the rainfall, though considerable, is reduced in amount and frequency, and in all seasons there is a considerable difference as regards moisture and rainfall between the windward and lee sides of the different islands, the effect being strikingly shown by the difference of vegetation. The working out of this question of the distribution of the rainfall by such a multiplication of gauges over the islands as has been so successfully done in the Mauritius and Barbadoes, is most desirable from the scientific and practical importance of the subject. The mean annual temperature is about 77°·5, and the difference between the hottest and the coldest months scarcely reaches 5°. In the wet season atmospheric pressure is about 29·870 inches, and vapour tension 0·860 inch, but in the dry season 30·020 inches, and 0·700 inch, thus showing considerable variation through the year in the pressure and vapour tension of a climate characterised by comparatively so little variation as that of Fiji.

EXTENSION OF VOLUNTEER WEATHER SERVICE IN THE UNITED STATES.—We are greatly gratified to see that the marked success which has attended the volunteer weather service in the State of Iowa, so vigorously prosecuted by Dr. Hinrichs, and which now numbers about 100 observers, is leading other states to adopt a similar system. Prof. Francis E. Nipher, of the Washington University of St. Louis, has already secured the services of fifty-five observers, chiefly in the northern and western parts of Missouri, for the regular observations, particularly of rainfall, but also, where possible, of temperature pressure and humidity; and for observations of irregularly recurring phenomena, such as storms, the aim being to collect together as full and accurate an account of the different phases of these phenomena as it is possible to make, particularly their commencement, culmination, and termination. The investigation of the climatology of the state is also to be undertaken. The observations are to be according to local time. Regular reports will be furnished to the newspaper press. The work is under-

taken under the auspices of the university, and it is not intended that it supersede, as regards this State, the work of the central office at Washington (D.C.), but to supplement that work in collecting data for a more satisfactory treatment of the climatology and storms of that state. We strongly commend this scheme, and earnestly hope that Prof. Nipher will succeed in extending his network of stations till all parts of the state be adequately represented, especially since telegraphic stations everywhere are by far too few to meet the requirements of the more important and pressing problems of meteorology. We have the further satisfaction in learning that a similar weather service is contemplated in the State of Kentucky.

HIGH TEMPERATURE OF NOVEMBER LAST.—M. Brounoff, of the St. Petersburg Physical Observatory, publishes in the Russian *Golos*, December 10, an interesting note as to the unusually high temperature of St. Petersburg during November last. The mean temperature of that month was as high as 39°·4, or 10°·3 higher than the mean temperature deduced from ninety years' observations, and 4°·9 above the very high mean temperature of November observed at St. Petersburg in 1851. Throughout the month the thermometer never fell below 32°·0. It is worthy of notice that during all the other months of this year the temperature was lower than the means deduced from ninety years' observations. An unusually high temperature prevailed in November over nearly the whole of Europe and Western Siberia, except North Scotland, Southern Italy, the middle Danube, and the two shores of the Caspian. The highest above the average, 15°·7, was observed at Archangel, and the line of 9°·0 runs from the Upper Volga to Stockholm, and thence straight north. The proximate cause of such unusually high temperature was the abnormal predominance of barometrical minima with south-westerly winds, which passed over Europe during November last. Thus, the number of these minima in November has been forty-two during the last five years, whereas there occurred thirteen during November last, the one thus following the other almost without interruption.

TEMPERATURE OF VIENNA.—Among other points treated in a recent paper by Dr. Hann to the Vienna Academy, "On the Temperature of Vienna, according to a Hundred Years' Observations," is the influence of the frequency of sun-spots on the mean temperature of summer, winter, and the year. Neither in the temperatures arranged according to the separate cycles of sun-spot frequency, nor in the averages of these from all the nine cycles (1775 to 1876) is there recognisable a distinct periodicity of the heat variations, which can be connected with the period of sun-spot frequency. Placing in the individual cycles the averages of every three years' temperatures, corresponding to the minimum and maximum of the spots, opposite each other, it is found that in five cycles out of nine the minimum years have indeed a considerably greater heat than the corresponding maximum years. But in three cycles precisely the opposite is the case, and in one cycle the difference is almost *nil*. Dr. Hann further inquires whether one may with any probability draw inferences from the temperature character of one season with regard to that of the next, and the next again. He finds that if the temperature-anomaly of one season reach a considerable amount (a divergence of 1° C. or upwards), the probability that the following season will diverge in the same sense from the average value is 0·68; the probability that a very cold or warm winter will be followed by a cold or hot summer respectively, is even 0·70. On the other hand, the probability of an agreement of the temperature-anomaly of a winter with that of the previous summer is only 0·45. In his paper Dr. Hann also gives a comparison of the temperatures of the meteorological and astronomical observatories.

GEOGRAPHICAL NOTES

MR. STANLEY.—Mr. Stanley arrived in London on Tuesday. From the time that he emerged at Emboma from his ever-memorable dash into the unknown region west of Nyangwé to his arrival at Folkestone, his journey homewards has been a well-earned ovation. Everyone, from the Governor downwards, at the Cape vied in doing him honour; at Cairo the Khedive conferred upon him two of the highest orders of merit; at Rome he received the Victor Emmanuel Gold Medal of Merit, arriving too late, alas! to receive it from the hands of its donor, though it was accompanied by a sealed letter from the late King, speaking in high terms of Mr. Stanley's discoveries and his services to humanity and civilisation; Turin, Milan, and Naples sent welcomes to him; at Marseilles the Geographical Society, the Chamber of Commerce, and the Municipality presented him each with a medal; at Paris the Geographical Society fêted him in splendid style, the President of the Republic sending his representative the Minister of Public Instruction presenting him with the high honour of the palms of Officier de l'Instruction Publique, and the President of the Geographical Society telling him he should be gold medallist of the Society for 1878. We expressed confidence last week that our own Geographical Society would lead the movement in this country for giving Mr. Stanley a reception worthy of the great work he has achieved, and we rejoice to see that our confidence has been justified. The Society are to invite Mr. Stanley to dinner, and also to read a paper on his discoveries, "at St. James's Hall or elsewhere." We feel sure that St. James's Hall will be quite inadequate for the accommodation of all who will wish to see and listen to the story of one of the greatest of pioneer-explorers; so that, after all, the announcement made in the *Times* last week, that the Albert Hall was to be taken for the purpose, is likely enough to be correct. There will certainly be no difficulty in filling it. Everyone will wait with impatience the publication of Mr. Stanley's work; for although a fair idea of what he has done has been obtained from his occasional letters in the *Telegraph*, there must be many things to tell that could not be set down in the circumstances under which these letters were written.

THE MARQUIS ANTINORI.—From another telegram received by the Geographical Society at Rome, it appears that the Marquis Antinori, contrary to his first intention, does not return to Italy, but has started again with his companions on a new tour southward from Shoa. Signor Martini alone comes home with the scientific collections.

AFRICAN EXPLORATION.—Reports from Berlin state that in the budget for the current year the sum of 100,000 marks (5,000*l*.) is asked for the continuation of the exploration of Central Africa. This is considerably more than in the preceding years; the rise in the sum demanded is justified by reference to the efforts of German private societies and scientific men.

THE NORTHERN PAMIR.—The last number of the *Izvestia* of the Russian Geographical Society contains some new and valuable information on the little-known tracts of the Northern Pamir, which have hitherto been a blank on our best maps. This information has been compiled from notes taken last summer by M. Korostovtseff during his journey to the Alai Valley and the Northern Pamir highlands. The valley of Alai, visited first by M. Fedchenko, runs north-east and south-west for forty-five miles, and is from thirteen to twenty miles wide. It is inclosed between high mountains, the Kaupmann Peak reaching 25,000 feet. Forests are found only in the north-eastern part of the valley (11,000 feet above the sea) which is part of the dominions of the Khan of Kashgar, while the south-western part (8,000 feet high),

watered by the Kyzyl-su River, is covered with luxurious Alpine pasturage, and therefore becomes in summer the feeding ground for immense herds of cattle belonging to the Fergana, Kashgar, Shungan, and Karateghin Kirghizes. A sandy cleft, Tash-kurgan, leads from the Alai Valley to the Pamir Highlands. After a journey of forty-five miles along this cleft, and after having crossed the Kyzyl-art Pass, 14,017 feet high, M. Korostovtseff reached the salt-lake, Kara-kul, twenty-seven miles long and twelve miles wide, 13,194 feet above the sea-level. Its sandy banks are quite bare, and the surrounding stony hills bear no traces of vegetation ; it is only close by the deep-blue waters of the lake that the traveller discovers here and there a low and dry bush. Thence M. Korostovtseff turned south-east, entered the cleft Alabaital, and reached, by a gentle slope, the pass of the same name, 15,314 feet high, whence he had to descend on the very steep southern slope, to the valley of the Chan-su River, quite bare and covered with snow-white deposits of salt. The valley of a rivulet, Uz-bel, tributary of Chansu—a sandy desert twenty miles long—and the Uz-bel Pass, 15,195 feet high, were followed east to reach the valley of Sary-kol, 14,300 feet above the sea-level, and covered with a very scarce vegetation ; here some small rivulets give rise to the Kashgar-daria River. Thus the general characters of the northern part of the Pamir table-land are high valleys, flat, open, bare, and sandy, never descending below some 13,000 feet, with blue salt lakes and salt deposits on their dry bottom ; relatively low mountains, the passes between which are only some 1,000 or 2,000 feet above the bottom of the valleys, the peaks being covered with perpetual snow when they exceed an altitude of 15,000 or 16,000 feet ; no inhabitants, and a very scarce vegetation. Such is the hitherto mysterious "roof of the world" (Pamir). From Sary-kol M. Korostovtseff was compelled to return. He died a short time after his return, without being able to publish the results of his most interesting journey or describe the valuable collections he obtained.

THE "NERTHUS" OF TACITUS.—Dr. Michelsen, of Schleswig, has just published a pamphlet in which he discusses that remarkable and often-mentioned Nerthus-island, which, according to the description of Tacitus, with its sacred lake and forest, formed the centre of a divine service of seven closely connected communities. Formerly the island of Rügen, or the so-called "Land Oldenburg," was thought to be the island in question. Dr. Michelsen, however, points out that the island of Alsen is the one meant by Tacitus. He states that the name signifies "sanctuary" or "temple-island," and that the sacred lake and forest still exist in the north-west of Norburg on the Alsensund, under the names of "Hellewith and Hellesö" (*heilige Wald und heilige See* —holy wood and holy sea). The inhabitants of that district still call the village of Hellewith, situated near the forest, Hellod (*heiliges Eigen*—holy own) ; and in the existing remains of the old forest there is a well-preserved sacrificial altar consisting of enormous blocks of granite. Dr. Michelsen gives a number of other interesting proofs for the correctness of his conjecture, and also remarks that he has partly discovered the names of the seven Nerthus people in villages of the Sundewitt district.

VENEZUELA.—In the January session of the Berlin Geographical Society, Dr. Sachs gave a description of his recent journey to Venezuela, for the purpose of studying the gymnotus in its native haunts. Humboldt's sketch of the Llanos was completed and corrected in some points. This great plain, formerly an inland sea, is 600 feet above the sea in its upper part, and but 200 in its lower part, a difference which accounts for the fact that the grass, but 1 to 2 feet in height in the upper portion, rises above the head of the river in the lower region. The decrease in the number of cattle on the Llanos of late years has led to a rapid extension of the arboreal growth. The Llaneros are a peculiar people, arising from a mixture of the white, red, and black races, and standing on a low grade of civilisation, their religion consisting in the adoration of a few saints, and marriages being rare. Humboldt's familiar description of the capture of the electric eel, by driving horses into the streams frequented by it, as the customary method in the land, is regarded as resting on an error. No one in the region was acquainted with it, and it was found impracticable to carry out. The scientific results of Dr. Sach's observations will be published shortly.

THE INDUS.—The course of the Indus river from the point where it leaves Cashmere down to where it enters English territory, about 120 miles below Darband, has recently been explored in detail by a Punjaub surveyor, and our geographical knowledge of the river has thus been considerably augmented, while valuable topographical material has been obtained. Of course Capt. Carter had previously determined, in a general way, the course of the river in the districts named, by his trigonometrical measurements of the heights of the mountain summits on both banks of the Indus.

NEW GUINEA.—Dr. E. T. Hamy, in the just issued November part of the *Bulletin* of the Paris Geographical Society, describes in considerable detail the results of his examination of an old map of New Guinea, for the purpose of showing how much had been done for its discovery by the Spanish navigators of the sixteenth and seventeenth centuries (1528–1606). The map, which serves as the basis of Dr. Hamy's paper, is contained in the atlas of Pierre Martier, published at Amsterdam in 1700. The data for this and other maps in the atlas had been collected by Frémont d'Ablancourt while in Portugal, and the many names on New Guinea would show that by the sixteenth century its coasts had been pretty well explored all round, though its shape is very inaccurately laid down.

NOTES

WE give some account to-day of the life and work of the late M. Becquerel, and next week we hope to do the same for M. Regnault, who died two days after M. Becquerel, in his 68th year. M. Victor Regnault was born at Aix-la-Chapelle, in 1810. He was Professor of Physics in the College of France, and of Chemistry in the Polytechnic School ; he also held for some time the Directorship of the Porcelain Manufactory of Sèvres. His researches in the several branches of physics and chemistry published in the *Memoirs* of the French Academy of Sciences, and many other scientific journals, are numerous, and of the greatest value. Of these perhaps his publications on the expansion of elastic fluids, the determination of the densities of gases, the measurement of temperatures, and the determinations of the specific heats of liquids, solids, and gases, are the most important, and have brought his name most prominently before the world. He has also written many valuable papers on physiological questions. M. Regnault was elected a member of the Academy of Sciences in 1840, and in 1850 was created an officer of the Legion of Honour.

THE Council of the Royal Society of Edinburgh have awarded the Neill medal to Dr. Ramsay Traquair, for his paper on the Structure and Affinities of *Tristichopteris alatus*, Egerton, being one of an important series of contributions to the knowledge of the structure of recent and fossil fishes.

WE are informed that the Pennsylvania Railway Company are disposed to grant very favourable terms to any European astronomers who, in their private capacity, may wish to go to America to observe the approaching eclipse of the sun. It is stated that for less than half the usual fares astronomers will be conveyed from New York, Washington, or Baltimore to Denver. We

hope, however, to be able in an early number to publish definite information on the matter.

THE German Military Department, always on the watch to make use of the latest scientific discoveries, has naturally devoted its attention at once to the telephone. In the last number of the *Militair Wochenblatt* we notice a report on the practicability of its use in warfare for maintaining communication with pickets and outlying posts. The experiments were carried out at a temperature of −3° C., and during a violent wind, and showed most conclusively its availability for the purposes in question.

IT is gratifying to know that at last Cleopatra's Needle has safely reached the Thames. It is proposed to moor the ingeniously-constructed vessel containing the obelisk at a convenient part of the Thames embankment for some days, to enable the public to inspect it.

THE lately formed society for the protection of the interests of chemical manufactures in Germany, begins with the present year the publication, at Berlin, of a monthly organ entitled *Die chemische Industrie*, under the editorship of Dr. Emil Jacobsen. It is intended to make it a complete record of everything of interest in the department of technical chemistry.

THE Academy of Sciences will hold its anniversary meeting next Monday, when M. Bertrand will deliver an *éloge* of Lame, a member of the Academy of Sciences and a physicist, who died twenty years ago. He had travelled in Russia like Becquerel, but not as an officer belonging to an invading force. He had been appointed by the Russian Government to establish the Military School of Odessa.

THE second part of Signor Mantegazza's studies on the Ethnology of New Guinea is published in the December number of his *Archivio*, illustrated by a number of plates.

A GEOGRAPHICAL Society has been formed at Metz, based on the model of those in other German cities.

THE German Patent Office reports that it has received during the past year 6,424 applications, a larger number than any other country can boast of except the United States.

THE Association for the Improvement of Geometrical Teaching held its annual meeting at University College, Gower Street, on Friday, January 11, and at this meeting, in addition to proceeding with the work already taken in hand, it was resolved that sub-committees should be appointed to draw up syllabuses of solid geometry and of higher plane geometry, and also that the Association should take into consideration the subject of geometrical conics, with a view to expressing its opinion on the best order of teaching it. The president (Dr. Hirst, F.R.S.) delivered an address, and subsequently tendered his resignation of the presidentship on the ground of the pressing nature of his other duties; the Rev. E. F. MacCarthy, one of the secretaries, also was obliged, for a like reason, to resign his office. The vacancies were filled up by the election of Mr. R. B. Hayward, F.R.S., as president, and of Mr. R. Tucker as secretary (in conjunction with Mr. R. Levett, the principal originator of the movement). Mr. J. M. Wilson and Dr. Jones were re-elected vice-presidents. Mr. H. G. Watson, Clifton College, was elected Treasurer in the room of Mr. H. Weston Eve.

IT appears that beer is adulterated to a great extent with glycerin. An easy and exact method of its determination in this connection is wanting, and a prize of 3,000 marks has been offered by the *Verein für deutschen Gewerbfleiss* for the best solution of this problem.

THE *Deutsche ornithologische Gesellschaft* was lately requested by the Chancellor of the Empire to express its opinion on a proposed law for the protection of birds. A duly appointed commission under the presidency of Dr. Brehm, has recently presented a report on this subject, in which the contemplated law is regarded as unnecessary. There is at present, according to their information, no general diminution in the number of useful birds, and where a local disappearance has been observed, it is to be traced to the present development of the agriculture and forestry of the land, and is not due to the direct attempts of man.

THE German botanist, Regel, has discovered in the Himalayas a variety of wild onion, which he regards as the original source of our ordinary garden onion. It is called *Allium cepa sylvestre*.

BERLIN is becoming the centre of an extensive system of subterranean telegraphic lines radiating in various directions. Cables have been already laid, or are in process of being laid, on the routes Berlin-Cologne, Berlin-Frankfort, Berlin-Strassburg, Berlin-Breslau, Berlin-Königsberg, and Berlin-Hamburg and Kiel. As a glance at the map will show, the military element plays an important part in the selection of these routes. Most of the lines are buried alongside the substantial roadways which traverse the empire. The work of excavation is carried on rapidly by means of enormous portable engines which dig a trench one metre in depth and half a metre broad, lay in it the cables (generally two in number, containing each seven wires), and cover them by a continuous movement.

A DOG-FISH became entangled in the net of some French fishermen near Cape Agde lately, and after having dragged their boat about during the entire night at the rate of twelve miles an hour, was finally captured and brought to land. It measured over sixteen feet in length and weighed about 2,500 lbs. Its enormous stomach contained the head, feet, and several other portions of a mule, as well as two half-digested tunny-fish.

WE notice in the last number of the *Journal* of the Russian Chemical and Physical Societies (vol. ix. No. 9), two interesting chemical papers by M. Eltekoff, on the regularity of elimination of the elements of the haloid-hydric acids from chlorates of hydro-carbonates, and on the structure of different amylenes which are found in the amylene supplied by trade.

PROF. C. HERMANAUZ, of Vienna, died recently in Japan, while engaged on a voyage round the world, chiefly for th purpose of agricultural observation.

FEW national scientific associations have grown so rapidly e the French Association for the Advancement of Science. Although but in its seventh year, we notice from the recently issued report of the secretary that the number of the members is already nearly 2,400. In this short time the association has accumulated a capttal of 223,000 francs, and has granted 26,000 francs to various scientific objects. Each member pays annually 20 francs, and receives a handsome copy of the report. The last issued (for the Session of 1876) forms a bulky volume of 1,200 pages, illustrated by seventeen well executed plates. According to the statutes, Paris is excluded from the place of session, on much the same ground that London is never chosen by the British Association. The present year forms, however, an exception, on account of the Exhibition, and Paris will welcome the Association far the first time.

IN the eighth number of the *Journal* of the Russian Chemical Society is a paper by Prof. Meorshutkin on the influence of isomerism on the formation of ethers between acids and alcohols (NATURE, vol. xvii. p. 151) (also published separately in French); a note by M. Ziloff, on the influence of the medium on the electro-dynamical induction; a paper by M. Borgmann, on thermo-electricity; and a note by M. Kraevich, on his new portable barometer, which is intended to avoid the usual boiling of mercury in barometrical tubes, and was highly approved some

time ago by officers of the Russian general staff, who have had the opportunity of making use of it on travels.

M. CHIKOLEFF, who has made, at St. Petersburg, several experiments on electrical lights, by order of the Ministry of War, confirms, in the ninth number of the *Journal* of the Russian Chemical and Physical Societies, the results of the experiments of Tyndall. He observes also, that a galvano-plastic copper coating of the carbon proves to be very useful.

AT a recent lecture held at the Rudolphinum, at Vienna, before a large audience, Dr. E. Lewy proved that the human skin is completely impenetrable for the chemical contents of mineral waters, and that therefore the explanation of the effects of baths in these waters, at the numerous bathing-places, has to be sought exclusively in the domain of physics and not in that of chemistry. This important discovery annuls all common views regarding the bathing cures effected by the various mineral springs, and explains in the simplest manner that, from a chemical point of view, the action of the most different waters must be one and the same.

THE French Government has recently appointed a mixed commission of leading scientific men and engineers for the purpose of making a thorough examination into the best means of preventing the explosions of firedamp in coal-pits. Among its members are MM. Daubrée, Berthelot, Thénard, and Hébert, of the Academy of Sciences, Professors Bert, Burat, Haton de la Goupillière, Fouqué, and other well-known names. Although the French mines have suffered comparatively little in this direction, the terrible disasters in our English mines have taught the necessity of throwing about the miner's dangerous occupation the utmost safeguards at the command of modern science, and an active and thorough programme is being prepared by the Commission.

A REQUISITION has been sent to the French Ministry by the Société de Physique, asking that it should be incorporated, or "reconnue comme d'utilité publique." It is stated that a favourable reply may be expected from M. Bardoux.

AT a recent meeting of the French Physical Society, M. Duter presented magnets obtained by subjecting circular steel plates to the action of an electro-magnet terminated with a conical point applied to the centre of the disc. In these magnets the neutral line is a concentric circle of the disc, with radius $\frac{R}{\sqrt{2}}$. To study the free magnetism distributed over them, M. Duter used a small soft iron cylinder (a few centigrammes in weight), fixed in the centre to the rod of an areometer floating in water. The force of detachment of this was estimated by the weight of water which had to be let off from the cylindrical vessel containing the areometer before the contact was detached. The precise instant of contact and detachment was indicated by an electric signal. M. Duter thus demonstrated experimentally that the quantities of free austral and boreal magnetism were equal in the two portions (of contrary name) in the same plate. He sought to represent by an empiric formula, the results relative to forces of detachment for plates of different diameter. These forces depend simply on one specific coefficient variable with the nature of the steel and with the thickness.

THE influence on the animal organism of breathing pure oxygen gas of density corresponding to ordinary atmospheric pressure, has not hitherto been adequately determined. The Royal Society of Göttingen, therefore, offer a prize for new researches on the subject, made both on homoiothermal, and, as far as possible, on poikilothermal animals; in these researches, while certain externally visible phenomena in the animal will have to be considered, special attention is desired to be given to the nature of the blood and the exchange of material (excretion of carbonic acid, and nature of urine). The oxygen used should be carefully freed from all foreign matters apt to occur in manufacture; while a limited (and perhaps hardly avoidable) admixture of atmospheric nitrogen would not compromise the results. In the mathematical class, the Göttingen society desires (and offers a prize for) new researches on the nature of the unpolarised light-ray, "fitted to bring the conceptions of natural light of any origin, near (in definiteness) to those which theory connects with the various kinds of polarised light." (For further particulars see the Society's *Nachrichten*, No. 26, 1877.)

HITHERTO water has been regarded as possessing a greater specific heat than any other body, with the exception of hydrogen. In a recent session of the Vienna Academy M. E. Lecher communicated the results of experiments showing that in this respect water alone is surpassed by various mixtures of methylic alcohol and water, which will accordingly take the second position in regard to hydrogen.

THE Report of the Berlin Academy of Sciences for September and October, which has just appeared, contains, among other papers, "Comparison of the Tidal Heights in the East Sea from 1846–1875," by H. Hagen; "Anatomy of the Appendicularia," by Prof. Virchow and H. Langerhaus; "Atomic Weight of Molybdenum," by Prof. Rammelsberg; "Movement of the Electricity in Submarine and Subterranean Telegraphic Wires," by Prof. Kirchhoff; and "Catalogue of the Fishes and Amphibia from Chinchoxo (Africa), presented to the Berlin Zoological Museum by the *Afrikanische Gesellschaft*," by Prof. Peters.

THE electromotive force produced by the flow of water through capillary tubes has lately been investigated both by M. Haga at Strassburg University, and by Mr. J. W. Clark at Heidelberg (*Pogg. Ann.*, No. 11, 1877). Both observers used a quadrant electrometer instead of a galvanometer (as in former experiments with diaphragms and capillary tubes) to measure the difference of potential. This difference, according to M. Haga, is proportional to the pressure, independent of the length of the tubes, dependent on the nature of the inner surface of the tubes, increases with the resistance of the water, and probably also with the temperature. Mr. Clark finds (1) that the narrower the tube the greater is the electromotive force when liquids are forced through. (2) In very narrow tubes the electromotive force is independent of the length; in wider tubes it decreases with the length. (3) If the inner tube-surface be coated with different substances, different electromotive forces are obtained, whose amounts entirely agree with Quincke's former results with regard to diaphragm currents. (4) The electromotive force decreases with the time; and this whether still water or flowing water occupy the tube between the experiments. If the tube be cleaned anew with sulphuric acid and distilled water, the original electromotive force is re-established. (5) The seat of the electromotive force is the limiting surface of the liquid and the solid tube-wall.

THE Russian newspaper published in Turkestan reports that the scientific explorations in the Semirechensk District were continued uninterruptedly during the year 1877. Special attention was bestowed upon the investigation of the line of coral reefs which remained from the prehistoric Central Asian Sea. This line extends from the Dalashik Mountains over the Tuluk Tau and Temirlik Tau, and further eastward as far as the frontier of the Kuldsha District. Large quantities of the finest corals and beds of fresh-water shells were found; marine shells were discovered only in small quantities. The silurian formation of these districts may now be considered as proved beyond doubt.

THE new ethnological museum opened at the Hôtel des Invalides, Paris, contains a collection of warriors belonging to several nations and tribes, civilised and uncivilised. These models

have been executed in an artistic manner and give a clear idea of the variety of destructive agencies resorted to by mankind for warlike purposes.

We have received a useful little manual of dates, "Drury's Chronology at a Glance" (Hardwicke and Bogue), containing much well-packed information. In the next edition the author should omit all expression of opinion on events and men, and utilise the space for additional information.

In the January number of Petermann's *Mittheilungen*, Dr. Mohn describes in detail the results as to soundings and temperatures of the Norwegian North Sea Expedition of 1876. Dr. Oscar Drude has an important article on the geographical distribution of palms, and a detailed programme is given of the new expedition of Gerhard Rohlfs, to which we referred last week. A brief sketch is given of the ten-years' exploration in South America of Doctors Reiss and Stübel, some of the results of which have appeared at various times in *Globus* and elsewhere, but the full details of which will necessarily take some time to publish.

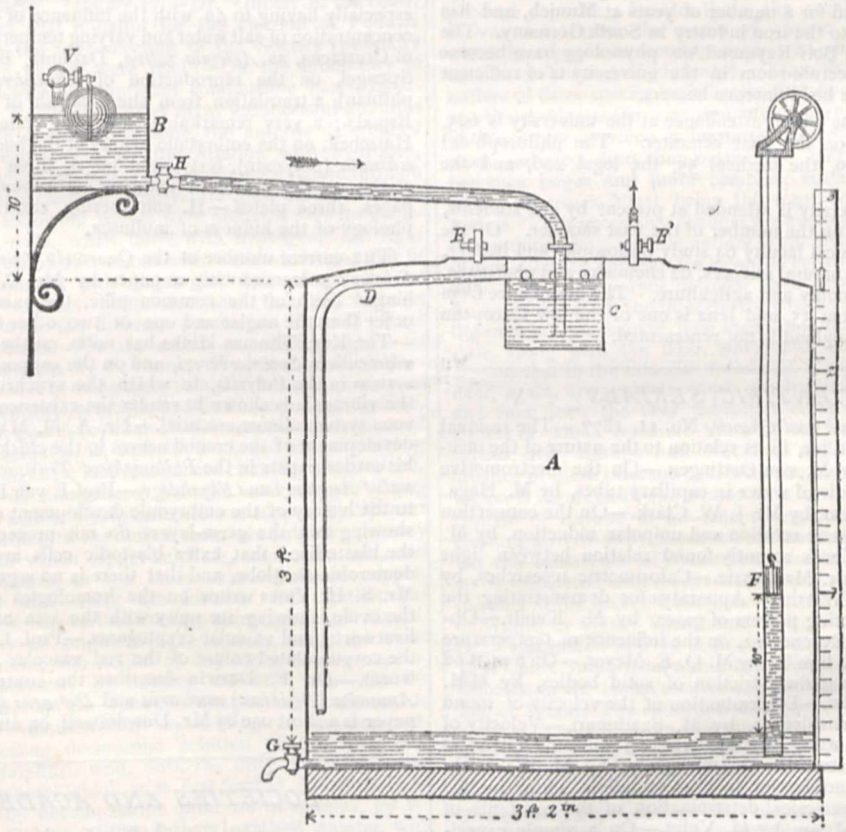
Dr. Radde, in a letter from Tiflis to Dr. Petermann, speaks of the brothers Brotheus, from Helsingfors and Wasa, who spen last summer in botanising in the Caucasus, taking back with them a varied collection of mosses and a rich herbarium of phanerogams.

The additions to the Zoological Society's Gardens during the past week include a Javan Chevrotain (*Tragulus javanicus*), a Stanleyan Chevrotain (*Tragulus stanleyanus*), from Java, pre sented by Mrs. Leslie Walker; a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-East Africa, presented by Madame Patey; an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Mr. Mark Whyley; three Summer Ducks (*Aix sponsa*) from North America, presented by Lord Braybrooke; two Mandarin Ducks (*Aix galericulata*) from China, two White-bellied Storks (*Abdimia sphenorhyncha*) from West Africa, purchased; two Silky Cow Birds (*Molothrus bonariensis*) from South America, a Superb Tanager (*Calliste fastuosa*), two Violet Tanagers (*Euphonia violacea*) from Brazil, deposited.

NEW FORM OF GAS-HOLDER

Having found the necessity of a gas-holder which should yield a steady flow of gas and be under control from the lecture-room, at some distance from the only available spot where the gas-holder could be placed, I devised the following plan, which was carried out for me by Mr. Yeates, to whom I am indebted for one or two excellent suggestions. The arrangement is, I believe, novel, it is inexpensive, and it answers admirably; it may, therefore, be of convenience to put before some of your readers the following sketch, which needs but little explanation:—

A is a bell-shaped, gas-tight holder of galvanised iron or stout zinc. B is a water-supply cistern with adjustible ball-cock valve, in fact, an ordinary kitchen boiler supply-cistern, in connection with the water-main through V. C is a small reservoir fixed to



the dome of the gas-holder; when filled, once for all, the water overflows into the holder; to avoid splashing it is better to convey a pipe, D, near to the bottom of the holder. The water-pipe from the cistern, B, passes air-tight into the gas-holder, and is furnished with a cock, H, to shut off the pressure when necessary. The pressure on the gas within the holder obviously depends on the difference of the water-level in the cisterns B and C. To give a brilliant lime-light some ten inches head of water is required. This corresponds to about 2 cwt. on the usual wedge-shaped gas-bag. To give a sensitive flame with a steatite gas-jet having an orifice the size of No. 19 wire, B W G (0·04 inch diameter), a pressure of some nine inches of water is required. The depth of the cistern, B, allows the ball-float a range of adjustment, and hence of gas-pressure, of some six inches.

E E′ are cocks for the entrance or exit of gas, and F is a float marking the quantity of gas in the holder.

When the gas has all been expelled from the holder it is full of water, and hence conveniently ready for refilling with gas. For this purpose the cock H is closed, and G partially turned on; the water escapes as the gas enters E. A delivery tube is carried from E′ to the lecture table, and can, of course, be used as an entrance as well as an exit pipe. After the holder is filled with gas, G is shut off and H and E′ are turned on. All is now ready for use, for as soon as the cock at the burner attached to the lantern or other arrangement in the lecture-room, is turned on, the gas is displaced from the holder by the entrance of a corresponding quantity of water from the cistern B. No weights are required to be taken on and off, an equable flow of gas is secured, the turning on of the gas-cock in the lecture-room puts the whole apparatus in action, and the employment of a single cylinder considerably diminishes the original cost of the gas-holder.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE

BERLIN.—The Prussian budget contains provisions for four new professorships in the university, including two in medicine, one in philology, and one in botany. The appropriations for most of the laboratories, &c., in connection with the university have likewise been notably increased. The "Gewerbe-Akademie" is to receive an important addition in the shape of a department for the examination of iron, in which the physical and mechanical properties of the various sorts of Prussian iron—unwrought as well as manufactured—can be thoroughly tested, and officially approved. A similar institute, and the only one hitherto in Germany, has existed for a number of years at Munich, and has been of great value to the iron industry in South Germany. The lectures of Prof. Du Bois-Reymond on physiology have become so popular that no lecture-room in the university is of sufficient size to accommodate his numerous hearers.

INNSBRUCK.—The winter attendance at the university is 605, an increase of 27 on the past semester. The philosophical faculty includes 159, the medical 55, the legal 206, and the theological 185.

JENA.—The university is attended at present by 488 students, a diminution of 102 on the number of the past summer. Of the 219 in the philosophical faculty 64 study philosophy and history, 73 mathematics and natural sciences, 62 chemistry and pharmacy, and 20 political economy and agriculture. The attendance from foreign countries is but 35, and Jena is one of the few European universities where England is not represented.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 11, 1877.—The residual charge of the Leyden jar, in its relation to the nature of the insulating substance, by M. von Oettingen.—On the electromotive force produced by flow of water in capillary tubes, by M. Haga.—On the same subject, by Mr. J. W. Clark.—On the connection between electromagnetic rotation and unipolar induction, by M. Edlund.—On Dr. Kerr's recently-found relation between light and electricity, by Mr. Mackenzie.—Calorimetric researches, by MM. Schuller and Wartha.—Apparatus for demonstrating the different heat-conducting powers of gases, by M. Kundt.—Observations by Adolf Rosencranz, on the influence of temperature on internal friction of liquids, by M. O. E. Meyer.—On a method of investigating the gliding friction of solid bodies, by MM. Warburg and v. Babo.—Determination of the velocity of sound by the method of coincidences, by M. Szathmari.—Velocity of wave motion in soft string, by M. Abt.—Studies on chemical volumes, by M. Ostwald.—On miargyrite, by M. Weisbach Lime, strontium, and baryta in the crystalline state, by M. Brügelmann.—On numerical determination of the constants of Weber's fundamental law, by M. Voigt.—On a simple experiment for subjectively showing the reversal of the coloured lines of flame-spectra, especially the sodium line, by M. Günther.—On completeness of exclusion of aqueous vapour from air-pumps by M. Laspeyres.—On the applicability of fatty gases in blow-pipe operations, by M. Lohse.

Kosmos, July, 1877.—O. Caspari, on the philosophy of Darwinism.—Prof. Haeckel, in discussing Bathybius and the Monera, is very little inclined to give up the organic nature of Bathybius.—G. Jäger, on Heredity, part 2.—Carus Sterne (Dr. Krause) on the taming of the old by the young, discusses the influence of children from the Darwinian standpoint. He calls Bret Harte "probably the psychologist of deepest insight in our time."—Fräulein von Hellwald writes on the speechless primitive man.—Fritz Schultze on the origin of the culinary art.

August, 1877.—Mr. Darwin's biographical sketch of a little child is translated here.—Fritz Müller contributes observations on Brazilian butterflies on evolutional principles.—A. Dödel-Port writes on the colour and size of Alpine flowers—A. Lang, on Lamarck and Darwin, part 4, considers Lamarck's views on the relation of organic to inorganic nature.—Hugo Magnus treats on the development of the colour sense.

September, 1877.—Otto Caspari continues his discussion of the Darwinian philosophy, dealing with the problem of evil, the idea of individuation, the conditions of pleasure and disgust.—Prof. Jäger treats of colour and the colour-sense.—Prof. Krause discusses the origin of the legend of Iphis (Ovid, "Metam.," book ix.) with regard to its bearings on a morphological question.—Dr. A. Lang, in his fifth paper on Lamarck and Darwin, comes to Lamarck's theory of descent.—A comprehensive notice of Darwinian literature up to the present time is given by Dr. G. Seidlitz.

October, 1877.—Dr. B. Vetter, on design in nature.—H. Müller, on the variation in size of the coloured envelopes of flowers in relation to natural selection; a valuable paper.—Prof. Jäger, the origin of organs. Part III., locomotive organs.—Fritz Müller, on Brazilian butterflies, Part 2.—Dr. F. Weinland, on the language of primitive man.

Zeitschrift für wissenschaftliche Zoologie, vol. xxix., Part 4.—W. Schmankewitsch, on the influence of external conditions on the organisation of animals. This is a long and valuable paper, especially having to do with the influence of different degrees of concentration of salt water and varying temperatures on a number of Crustacea, as *Artemia saliva*, Daphnia, Branchipus.—J. W. Spengel, on the reproduction of *Rhinoderma darwinii* (amphibian), a translation from the Spanish of X. Jimenez de la Espada; a very remarkable case of a male brood-cavity.—B. Hatschek, on the embryonic history of the budding of *Pedicellina echinata* (polyzoan), forty-eight pages, three plates.—A. Wierzejski, on the crustacea parasitic on cephalopods, twenty-one pages, three plates.—H. von Ihering, contribution to the morphology of the kidneys of mollusca.

THE current number of the *Quarterly Journal of Microscopic Science* commences with a paper by Mr. C. S. Tomes, on the hinged teeth of the common pike, the existence of which, in other than the angler and one or two other fish, was unknown.—The Rev. Thomas Hinks has notes on the movements of the vibracula in *Cabĕrea boregi*, and on the supposed *common* nervous system in the Polyzoa, in which the synchronous movement of the vibracula is shown to render the existence of a common nervous system almost essential.—Dr. A. M. Marshall describes the development of the cranial nerves in the chick, in continuation of his earlier papers in the *Philosophical Transactions* and the *Journal of Anatomy and Physiology*.—Prof. E van Beneden contributes to the history of the embryonic development of the Teleosteans, showing that the germ-layers do not proceed exclusively from the blastodisc; that extra blastodic cells are developed on the deuteroblastic globe, and that there is no segmentation cavity.—Mr. S. H. Vines writes on the homologies of the suspensor of the ovule, showing its unity with the seta and foot of mosses, liverworts, and vascular cryptogams.—Prof. Lankester describes the corpusculated nature of the red vascular fluid of the earthworm.—Dr. F. Darwin describes the contractile filaments of *Amanita* (*Agaricus*) *muscaria* and *Dipsacus sylvestris*.—The last paper is a short one by Mr. Dowdeswell, on atmospheric bacteria.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, January 10.—Lord Rayleigh, F.R.S., president, in the chair.—Mr. F. B. W. Phillips was elected a member, and Mr. R. R. Webb was admitted into the Society.—The following papers were read:—Mr. J. Hammond, on the meaning of the differential symbol D^n, when n is fractional. (Prof. Cayley gave a few references to papers on the subject by Riemann, Schroeter, and others, and expressed his

opinion that the matter had not yet been satisfactorily settled.) —Prof. Lloyd Tanner, on partial differential equations with several dependent variables.—Lord Rayleigh, on the relation between the functions of Laplace and Bessel (in § 783 of Thomson and Tait's "Natural Philosophy," a suggestion is made to examine the transition from formulæ dealing with Laplace's spherical functions to the corresponding formulæ proper to a plane). It is evident at once, from this point of view, that Bessel's functions are merely particular cases of Laplace's more general functions, but the fact seems to be very little known.—Mr. Ferrers, in his elementary treatise on Spherical Harmonics, makes no mention of Bessel's functions, and Mr. Todhunter, in his work on these functions, states expressly that Bessel's functions are not connected with the main subject of the book. The object of the present paper was to point out briefly the correspondence of some of the formulæ. The author showed that the Bessel's function of zero order (J_0) is the limiting form of Legendre's function, $P_n(\mu)$, when n is indefinitely great and μ (= cos θ) such that $n \sin \theta$ is finite, equal (say) to Z. This was proved by taking Murphy's series for P_n (Todhunter, § 23). In like manner Bessel's functions of higher order are limits of those Laplace's functions to which Todhunter gives the name of associated functions. A theorem was found for the general functions corresponding to the relation subsisting between three consecutive Bessel's functions [viz., $\frac{1}{2} Z\{J_{m-1}(z) + J_{m+1}(z)\} = m J_m(z)$]. Prof. Cayley stated that the results obtained were very interesting).—Mr. S. Roberts gave some results bearing upon his paper read at the December meeting.—Prof. Cayley gave an expression for the surface of an ellipsoid communicated to him by Prof. Tait.—The Chairman, Professors Cayley, Tanner, and Mr. Webb spoke upon the subject.

Chemical Society, January 17.—Dr. Gilbert in the chair. —It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (February 7).—The following papers were read:—On the luminosity of benzol when burnt with non-luminous combustible gases, by E. Frankland and L. T. Thorne. After many unsuccessful attempts to burn benzol with a smokeless flame, the authors determined the luminosity of benzol vapour after dilution with hydrogen, carbonic oxide, and marsh-gas. These gases were passed through a benzoliser kept at a constant temperature and burnt in a fish-tail burner. The following results were obtained:—1 lb. avoirdupois of benzol gives, when burnt with hydrogen, the light yielded by 5·792 lbs. of spermaceti with carbonic oxide, that of 6·100 lbs. of spermaceti with marsh-gas, that of 7·7 lbs. of spermaceti. The authors point out that this difference is probably due in part to the different pyrometric thermal effects of the gaseous mixtures.—On the action of reducing agents on potassium permanganate, by F. Jones. Hydrogen reduces permanganate, sesquioxide of manganese being formed; ammonia produces in addition a nitrate, a nitrite, and free nitrogen; phosphine, arsine, and stibine give somewhat similar reactions; oxalic acid forms manganese sesquioxide, carbonic acid, and oxygen; strong solutions of permanganate and manganese chloride, when mixed, form sesquioxide of manganese, chlorine and oxygen being evolved.—On the action of sulphuric acid on copper, by Spencer Pickering. According to the author there are only two primary reactions, in one of which copper-sulphate, sulphurous acid, and water are the products, in the other subsulphide of copper, copper sulphate, and water are formed. The author has studied the action at various temperatures and has investigated the quantity of sulphuric acid actually used, the effect of an electric current, the action of impurities in the copper, the variations produced by diluting the acid, &c.—On the analysis of sugar, by G. Jones. The author proposes to estimate sucrose volumetrically by adding a 0·1 per cent. solution to a boiling decinormal solution of permanganate, acidulated with sulphuric acid, until the dirty-brown hydrated peroxide of manganese, which is at first formed, is reduced and dissolved.—On the decomposition products of quinine, by W. Ramsay and J. Dobbie. The authors oxidised quinine with permanganate and obtained a new acid, which they have identified with Dewar's dicarbopyridenic acid, and a red amorphous substance. The same acid was obtained by oxidising Marchand's quinetin.

Geological Society, December 19, 1877.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Messrs. William Fream, J. G. Hochstätter Godfrey, Herbert Goss, and John Fowke Lancelot Rolleston were elected Fellows of the Society. —The following communications were read:—On *Argillornis longipennis*, Owen, a large bird of flight, from the eocene clay of Sheppey, by Prof. Owen, C.B., F.R.S. In this paper the author described some remains of a large bird obtained by Mr. W. H. Shrubsole from the London clay of Sheppey (already referred to in NATURE), consisting of parts of fractured humeri belonging to the right and left sides of the same species or perhaps individual, and including the head of the bone, with portions of the upper and lower parts of the shaft. The texture of the shaft, the thinness of its bony wall, and the large size of the cavity recall the characters of the wing-bones of the large cretaceous pterodactyles. The author concluded that the bones obtained by Mr. Shrubsole furnished indications of a new genus and species of flying birds, for which he proposed the name of *Argillornis longipennis*. He regarded it as probably a long-winged natatorial bird, most nearly related to *Diomedea*, but considerably exceeding the Albatross (*D. exulans*) in size.—Contributions to the history of the deer of the European miocene and pliocene strata, by Prof. W. Boyd Dawkins, F.R.S. The author commenced by referring to the difficulties attending the study of the European miocene and pliocene deer, and indicated that the majority of the known antlers may be referred to two categories—an earlier or capreoline, and a later or axidine type. To the Capreoli he referred the following species:—*Dicroceros elegans*, Lart. (= *Prox furcatus*, Hemel), *Cervus dicranoceros*, Kaup (including *C. anoceros* and *trigonoceros*, Kaup), and *Cervus Matheronis*, Gerv. (= *C. bravardi*), from the miocene, and *Cervus australis*, Gerv., and *C. cusanus*, Croizet and Jobert, from the pliocene. To the Axeides belong *Cervus Perrieri*, Cr. and Job. (including *C. issiodorensis* and *pardinensis*, of the same authors), *C. etneriarum*, Cr. and Job. (= *C. rusoides*, Pom., and *C. perollensis* and *stylodus*, Brav.), *C. suttonensis*, sp. n., and *C. cylindroceros*, Brav. (including *C. gracilis*, Brav.), all from pliocene deposits. Besides these, the author noticed a species *insertæ sedis* under the name of *Cervus tetraceros*, Dawkins, which he regards as coming nearest to the Virginian deer, or cariacou (*Cariacus virginianus*). From the examination of the antlers of these species he indicates that in the middle miocene age the cervine antler consisted of a simply forked crown, whilst in the upper miocene it becomes more complex, although still small and erect, like that of the roe deer. In the pliocene it becomes larger and more complex, some forms, such as the *Cervus dicranios*, Nesti, being the most complicated of known antlers. The successive changes are analogous to those observed in the development of the antlers of the living deer with increase of age. In the miocene we have the zero of antler-development, and the capreoline type is older than any other. The nearest living analogue of the miocene deer is, according to the antler, the muntjak (*Styloceros*), now found only in the oriental region of Asia, along with the tapir, which also co-existed with *Cervus dicranoceros* in the miocene forests of Germany. The pliocene deer, again, are generally most nearly allied to the oriental axis and rusa deer, the only exception being *Cervus cusanus*, the antlers of which resemble those of the roe, an animal widely spread over Europe and Northern and Central Asia. The alliance of these pliocene deer with those now living in the Indian region is regarded by the author as a further proof of the warm climate of Europe in miocene times, confirmatory of the conclusions arrived at by Saporta from the study of the vegetation.—On the occurrence of *Branchipus* (or *Chirocephalus*) in a fossil state, associated with *Archæoniscus*, and with numerous insect-remains in the eocene freshwater limestone of Gurnet Bay, Isle of Wight, by Henry Woodward, F.R.S. The remains of crustacea and insects noticed in this paper were obtained by Mr. E. J. A'Court Smith from a thin bed of limestone belonging to the Osborne or St. Helen's series at Thorness and Gurnet Bay in the Isle of Wight. The collection is the result of about twenty years' work. The insect-remains comprise about fifty specimens of diptera, including wings of tipulidæ and culicidæ, and the pupa apparently of a gnat, one wing of a hemipterous insect, and a flattened homopterous insect identified by Mr. F. Smith with *Triecphora sanguinolenta*; two specimens referred to the lepidopterous genus *Lithosia*; only three orthoptera, one a *Gryllotalpa*, the other two belonging to a grasshopper; thirty-five hymenopterous wings, thirty-three of which are referred to ants of the genera *Myrmica*, *Formica*, and *Camponotus*; twenty-three examples of neuroptera referred to *Termes*, *Perla*, *Libellula*, *Agrion*, *Phryganea*, and *Hemerobius*; and twelve of coleoptera, including species of *Hydrophilus*, *Dyticus*, *Curculio*, *Anobium*, *Dorcus*, and *Staphylinus*. There were also two spiders. Several species of bivalved entomostraca have also been obtained from

these deposits, and identified by Prof. Rupert Jones. Of the branchipod crustacean both sexes are fossilised and beautifully preserved, the males showing their large clasping antennæ, and the females their egg-pouches, with large and very distinct disc-like bodies representing the compressed eggs. Dr. F. Goldenberg notices a fossil from the coal-measures of Saarbrück which he regards as a branchipod, and describes and figures under the name of *Branchipusites* (rectè *Branchipodites*) *anthracinus;* but this interpretation of it is at least doubtful. The author names his species *Branchipodites vectensis.* The isopods accompanying this species are referred to the genus *Archæoniscus*, M.-Edw., and one of them is identified with the *Palæoniscus brongniarti* of Milne-Edwards. The other is probably a new species, perhaps nearly allied to the existing *Sphæroma serratum.*—The chronological value of the pleistocene deposits of Devon, by W. A. E. Ussher, F.G.S., of H.M. Geological Survey.

Entomological Society, January 16.—Anniversary Meeting.—Prof. J. O. Westwood, M.A., F.L.S., president, in the chair.—The following gentlemen were elected members of the council for the present year, viz. :—Henry Walter Bates, F.L.S., F.Z.S., G. C. Champion, W. L. Distant, J. W. Douglas, Rev. A. E. Eaton, M.A., E. A. Fitch, Ferdinand Grut, F.L.S., George Lewis, R. Meldola, F.R.A.S., F.C.S., Ewd. Saunders, F.L.S., Frederick Smith, J. Jenner Weir, F.L.S., Prof. J. O. Westwood, M.A., F.L.S.—Henry Walter Bates, F.L.S., F.Z.S., was elected president, and Messrs. J. J. Weir, treasurer, F. Grut, librarian, and R. Meldola and W. L. Distant, secretaries.—An address was read by the outgoing president, in which reference was made to many of the less accessible entomological memoirs of the past year. The address was ordered to be printed, and the meeting terminated with a vote of thanks to the officers of the Society.

PARIS

Academy of Sciences, January 14.—M. Fizeau in the chair.—The following papers were read :—On the presence of oxygen in metallic silver, by M. Dumas. He shows that in the numerous experiments where silver has been used in determination of equivalents, the chemists who, after careful purification, converted it into minute grains after fusion in presence of borax, nitre, and air, have made it liable to absorb oxygen varying from 50 to 200 cubic centimetres per kilogramme. Hence much discrepancy.—On the formation of oxygenated water, ozone, and persulphuric acid during electrolysis, by M. Berthelot. The oxidising substance formed in electrolysis of sulphuric solutions is not oxygenated water, as commonly supposed, nor ozone in simple solution, but (as proved by the fact of its not being formed in other solutions, and by its reactions positive and negative) persulphuric acid. It is formed with absorption of heat. The three substances named may be simultaneously formed in electrolysis. The ozone may be changed into oxygenated water by means of ether; the oxygenated water may be changed into persulphuric acid by concentrated sulphuric acid; and persulphuric acid liberates gradually in the cold state the whole of its oxygen at the ordinary state without presenting any finite tension of dissociation.—On the stability of ozone, by M. Berthelot.—Experimental researches on the fractures traversing the earth's crust, especially those known as joints and faults, by M. Daubrée. One end of a long rectangular plate of the substance to be examined was seized between wooden jaws, and the other end by a wrench which gave torsion. The nature of the fractures (in gypsum and glass) are described; geological deductions will follow in another paper.—On the recent tornado of Ercildoun (Chester Co., Pennsylvania), by M. Faye. He finds evidence in it that these great gyratory movements arise in the upper currents and travel with them; they are propagated downwards to the ground.—On a new bed of Adamine, by M. De Cloizeaux. This hydrated arseniate of zinc, found previously only at Chanarcillo, Chili, and in a mine of the Garonne, has now been found among the zinc ores of Laurium.—Note on the official report of last *séance*, by M. Pasteur.—The vibrations of matter and waves of ether; probable consequences of the fact which serves as base of the mechanical theory of heat, by M. Favé. *Inter alia*, the author gives an interpretation of the law of radiation and absorption, slightly differing from that given by Prof. Stokes.—On the liquefaction of gases, by M. Cailletet. Inclosing in the glass tube dry air freed from carbonic acid, he cooled with protoxide of nitrogen the upper part of the tube only. When the pressure was 200 atmospheres, streams of liquid (air) were seen flowing down the lower parts. When they met the mercury they seemed to turn back. At 310 atmospheres, the mercury being in contact with the cooled part of the tube, was frozen, and on quickly removing the refrigerating apparatus it was seen to be covered with what was probably *frozen air.*—Observations of the solar protuberances during the first six months of 1877, by P. Secchi. The figures are simply tabulated.—P. Secchi presented a copy of his new work (in Italian) entitled "The Stars; Essay in Sidereal Astronomy."—On telephony, by M. Breguet. The variations in conductivity of retort carbon have been utilised by M. Salet in a similar way to that of MM. Garnier and Pollard (see last week's report) with graphite, and with better results.—Study of the ultra violet solar spectrum, by M. Cornu. The first part of the memoir presented treats of the ultra violet spectrum from the line *h'* to the line O, observed with ordinary spectroscopes having glass objectives and prisms; the second part, from O to U, the ultra violet extremity observed photographically with a spectroscope with objectives of quartz and prism of Iceland spar. The limitation of the ultra violet spectrum is found to be caused by, and to vary with, the aqueous vapour in the atmosphere. The *maxima maximorum* of extent is at the summer solstice; but with equal height of the sun the spectrum is incomparably more extensive in winter than in summer.—On the fertility of volcanic soils, by M. Truchot. Phosphoric acid is the chief element of it.—Liquefaction of hydrogen, by M. Pictet.—On the question of the special conditions of contour of elastic plates, by M. Boussinesq.—On an industrial application of Gauss's theorem regarding the curvature of surfaces, by M. Levy.—On the function arising from development of the expression $(1 - 2ax + a^2a^2)^{\frac{-2l+1}{2}}$, by M. Escary.—On a theorem of M. Chasles, by M. Serret.—On the function of Jacob Bernouilli and on the interpolation, by M. Lipschitz.—On the preparation of curare, by M. Jobert.—Palæontological contributions, by M. Meunier.—Effect of a low temperature on a mixture of oxygenated water and sulphuric acid, by M. Boillot.

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