THURSDAY, JUNE 6, 1901.

WATER-POWER.

An Outline of the Development and Application of the Energy of Flowing Water. By Joseph P. Frizell. Pp. vii + 563. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1901.)

WATER-POWER, as developed in waterfalls, has been brought prominently into notice in recent years as an important source of power, owing to the facilities afforded by electricity of transmitting it to a distance; so that a small portion of the Niagara Falls and numerous minor falls have been utilised for supplying power economically for electric lighting, traction, and other purposes, to places many miles distant from the falls. The author, however, of this volume desires to direct attention to the more widespread sources of water-power contained in streams and rivers, which can be utilised either by taking advantage of the natural fall by means of suitable works, or by storing up the flow in flood-time in reservoirs formed by constructing dams across the higher parts of river valleys; and the water thus collected can be converted directly into power by using the available fall below the dam, which, however, is reduced in proportion as the water-level of the reservoir is lowered, or it can be employed in supplementing the discharge of the river below the dam during its low stage, so that the flow when used for driving hydraulic motors may never fall below a definite volume. The author points out that whereas in recent times water-power has been to a great extent superseded by steam-power, owing to the cheapness of fuel and improvements in steam engines, timber has already become much less plentiful in the United States, and even coal will in time be exhausted; whilst the sources of water-power will always remain, and have already become more available by the adoption of electrical transmission, which in its turn has led to many notable developments and improvements in the utilisation of power. Undoubtedly vast sources of power produced by the sun's heat are continually running to waste in rivers and streams, as evidenced by the estimate quoted by the author, that the power derivable from the St. Lawrence and its tributaries is nearly equal to that obtainable from all the coal raised yearly in the United States. The difficulty consists in rendering this power economically available, for a high fall and a regular flow furnish the most efficient source of water-power; whereas the fall of rivers is, for the most part, moderate and spread over long distances, and their flow very variable, more especially in the upper part of their course, where the fall is the greatest. It is, therefore, quite natural that waterfalls have been resorted to as a source of water-power, and for transmission to a distance, especially where they occur at some distance from the source of a river, and consequently possess a more regular flow; whereas the utilisation of the more ordinary flow of rivers, except for local purposes, seems destined to have to wait till a considerable increase in the price of fuel and the absorption of the most advantageous sources of water-power render it necessary to turn to less economical supplies. Where a river has a rapid fall for a considerable distance, it may be quite practicable to develop largely its available water-power, by regulating its flow by the construction of a reservoir by means of a dam of moderate height across the upper part of its valley, so as to render its discharge always adequate to actuate turbines placed at suitable points along its course.

After an introductory chapter upon natural water-courses, including a computation of the *flowage*, or raising of the surface and modification of the slope of a stream by a dam put across it, the author treats of the various forms of dams constructed across rivers and streams, in ten chapters extending over 209 pages, embracing in his descriptions fixed weirs and some forms of movable weirs, as well as earthen and masonry reservoir dams, with their methods of construction and some notable failures. Such works, considered here as applicable to the development of water-power, constitute essential constructions for the improvement of rivers for navigation, and for forming storage reservoirs for the water-supply of towns, which have been often described in books and papers relating to these branches of hydraulic engineering; and the author only enters in the latter half of his book upon the consideration of hydraulic motors, and the modes of transmission of the power thus obtained, which more specially appertain to his subject. Three chapters are devoted to the methods of conveying the water to the motors, and the arrangements for the regulation of the supply and the power; whilst the various forms of water-wheels and of turbines are described in two consecutive chapters. Some instances are next given of the utilisation of natural water-powers in the United States; and it is pointed out that the plan formerly sometimes adopted of dividing a considerable fall into two or three parts, so as to command a large area of ground for the mills, is an expensive system in regard to the motors, and wasteful of the power, and that with modern methods of distribution it is expedient to make use of the entire head. The most important and special part of the book, however, is contained in the following five chapters, in which the various methods resorted to for the transmission of power are considered, and some interesting examples of notable power-houses are described. The forms of transmission dealt with are shafting and wire ropes, hydraulic transmission, transmission by compressed air, and electrical transmission. All these methods of transmission and distribution of power have their respective utility, but they differ considerably in the distance to which they can act with efficiency. Thus shafting is useful for transmitting power throughout a mill or manufactory; but beyond three or four hundred feet wire ropes are more economical, and can be employed with advantage up to about a mile. Hydraulic transmission is valuable in storing up power for intermittent working, as required at docks and large canal locks; but its efficiency for driving machines at a distance of about a mile is only 50 per cent. Air compressed by means of water-power has been transmitted considerable distances for boring the headings of long alpine tunnels, which it has also served to ventilate; and compressed air has been used for the transmission of power in a mine in the United States to a distance of three miles; but the changes of temperature produced in the compression and expansion of the air

necessitate special arrangements to avoid considerable loss of efficiency. Electrical transmission, the most modern and most effective method of utilising power at a distance from the place where it is generated, has notably augmented the value of the water-power of falls; for it has enabled the power-house to be established at the source of the power, and the power developed to be distributed to manufactories situated in the most convenient localities, far removed from the generating station. Thus the Telluride Power Transmission Company, at Provo, in Utah, transmits 2000 h.p. by electricity a distance of 55 miles, at the high voltage of 40,000 volts; whilst the Southern California Power Company, possessing a head of water of 750 feet at Santa Ana Canyon near Redlands, develops 4000 h.p., and obtaining a current at 750 volts transforms it to 33,000 volts and transmits it 80 miles to Los Angeles. In the chapter on "The Power-House," the general arrangements of such establishments are explained, and the power-houses at Lachine Rapids, on the St. Lawrence, at Mechanicsville, on the Hudson 18 miles above Albany, and at Sault Sainte Marie, on the rapids between Lake Superior and Lake Huron, are described.

The book is illustrated by two hundred and thirty-two drawings, sections and diagrams, distributed throughout the text, and is furnished with an index; but it does not contain any tables of contents of the twenty-five chapters, beyond a short title at the head of each, or any list of the illustrations. The materials for the volume have been, to a large extent, collected from the most noteworthy records of engineering societies and pages of engineering journals, as well as from plans of works carried out; and the principles involved and the results aimed at have been presented in a condensed and readable form. The book should prove useful in directing attention to the enhanced value of water-power, especially in view of the very important assistance afforded it by electrical transmission.

AN ANGLO-AMERICAN WORK ON THE MARKET GARDEN.

The Principles of Vegetable Gardening. By L. H. Bailey. Pp. x+458. (London: Macmillan and Co. Ltd., 1901.) Price 4*s.* 6*d.* net.

THIS work is one of a "Rural Science Series," edited by an American author, but it is by no means the best. Its principal fault is that in covering too much ground it fails to treat with thoroughness the numerous subjects which are included in the seven chapters described in the table of contents. The most important of these subjects are "The Soil and its Treatment," "Glass" in relation to glass culture, "Seeds and Seedage," the last a word quite new to the industry in England, the meaning of which is not absolutely clear, and "The Management of the Vegetable Garden."

In market garden culture success depends upon approximate perfection in the soil, the seed and the management; for the realisation of profit a further qualification must be added—marketing. Nor does the arrangement of the chapter simplify matters; a number of quotations from other authors, printed in small type, are introduced in order to show the reader what soil to select, but while these authorities do not absolutely agree, the majority select a deep sandy loam. Such a soil may be found under garden cultivation in Bedfordshire and in the potato growing districts of the Vale of York, but before a clay loam with a clay subsoil is condemned the reader should see farm gardening on the London clay and in the Lea Valley.

A large proportion of this important chapter is devoted to "Fertilisers," but stable manure, which is the foundation of early as of heavy crops, and of double and triple crops, is barely mentioned; indeed, excepting in a brief reference to the preparation of hot beds under glass, stable manure is absolutely unmentioned in the copious index. We remember, on visiting the extensive gardens attached to the great experiment station of New York State at Geneva, being informed how much the management owed to an English gardener. The editor of this work would have largely added to its value had he interviewed such a man, or an English market gardener of eminence.

The subject of "Seeds" is more fully treated, but in the whole 50 pages the details for which the practitioner will look are in large part conspicuously absent. The chapter is largely composed of useful figures drawn from the reports of experiment stations, but it has no very direct bearing upon the gardening industry. Nor can we speak more highly of the treatment of the next essential subject, "Management," which might be better arranged and which is abundantly fortified with quotations; there is, indeed, much that is useful, but if a grower seeks advice of a practical character he will not always find it. At the end of the chapter there are some recommendations which are intended to help the gardener to preserve his crops from the attacks of insects and fungi; but when we say that the most destructive of all soil insects, the wire worm, *Elater sp.*, is dismissed in half a dozen lines, we do not misrepresent the extent of the information. The gardener is wisely recommended to make Paris green into a paste, but in this country it is not sold in any other form.

The second part of the book, in which crops are discussed in greater detail, is much better arranged, although the author has adopted a form of classification which, if ingenious, has its difficulties. He groups the plants of the vegetable garden as roots, tubers, bulbs, salads, pulse, solanaceous crops and so on, but this arrangement is quite unscientific; the turnips and the beet, for example, classed as roots, are bulbs, while the potato, if a tuber, is also a member of the solanaceæ. Again, cabbages and the cauliflower are classed as cole crops, but both belong to the same family as the radish and rutabaga or swede turnip, both of which are classed as roots. Here we notice a curious error: "The rutabaga (is) known in England as Swedish turnip and turnip rooted cabbage, and in French as Chou navet." The French equivalent for swede, which is unknown in England as turnip rooted cabbage, is rutabaga. Let us add that although many of the illustrations are exceptionally good, that intended to represent the turnip is ludicrous as applied to the improved plant.

This part of the work is, however, by far the best, treating as it does of many plants peculiar to the United States, as well as of those common to the

gardening of this country, but even here we find scrappiness and irregularity of treatment. To the cultivation of celery, for example, considerable space is devoted, and this is well utilised, whereas the pea is dismissed with a brief discussion, and the potato, of which so much more should be said, receives notice of quite an inadequate character. The author tells us that potatoes are planted in drills 3 to 3½ ft. apart, and that if pieces of tubers are cut to one eye, 8 to 10 bushels will be required to plant an acre; also that the yield averages about 75 bushels—or less than two tons to the acre. These statements, like many others, do not apply to British or to the best American practice. The farmer cropping in the poorer soil of the open field plants 28 to 30 inches apart; he employs 22 to 25 bushels of seed, seldom cutting it, and then only once, whereas a two ton crop would mean financial ruin. For facts relating to the size and selection of seed, the best size of cut sets, the method of box sprouting for early crops and the most economical methods of manuring, we look in vain.

We notice with pleasure from the quotations made that in the United States details are collected in relation to the area of land devoted to various market garden crops. The figures, and they relate to 1891, are in some cases remarkable; thus, asparagus covered 37,970 acres, whereas potatoes were grown on only 28,000. Similarly, the area devoted to seed production is shown in relation to 40 varieties. Again, 25 pages are devoted to a list of works by other authorities, with descriptive notes, and bulletins issued by the various experiment stations upon subjects connected with vegetable gardening. All this is useful to the American reader. One of the most practical remarks in the book is that in which the author says that if a man is only a plant grower and not a good business man he will probably be a slave to the salesman, but where the grower occupies a large area and possesses sufficient capital to work it he can dictate to the market.

We are sorry not to be able to give this work unqualified praise; it is admirably printed and illustrated, and will afford help to those who possess a knowledge of principles. We would conclude, however, with the remark that the principles which we recognise in England are identical with those which are taught in the United States, and we venture to believe that our practice and that followed in the Northern States have more in common than the practices of the farmers and gardeners of the north and south. The author does not fully comply with these requirements. It is true that a student may refer to a work of the same series on "Soil," but we think the author would have acted wisely had he devoted a short chapter to a description of soil, its varied character and composition, how it is improved by culture, and why it is adapted to particular crops. Similarly, a definition of the principles which underlie the practice of manuring might have found a place—and above all, for gardeners know a great deal more about the management of dung than of artificial fertilisers, the importance of chemical manures and the *rôle* they play might have been more fully recognised. Although, therefore, the book is written primarily for the American reader, there is no reason why it should not have been made as interesting and instructive to the great constituency on this side of the Atlantic.

LIBYANS AND EGYPTIANS.

Libyan Notes. By D. Randall-Maciver, M.A., and A. Wilkin, B.A. Pp. 113; 25 plates. (London: Macmillan and Co., Ltd., 1901.) Price 20*s.* net.

THE volume before us is, as the writers say, the result of an expedition to Algeria undertaken in the year 1900 with the view of obtaining such information as would lead to the solution of the vexed question of the early connection of the Berber tribes with Egypt. This handsome publication contains fifteen chapters, which are illustrated by a large number of beautifully executed plates, and deals in an exhaustive manner with subjects which appeal as much to the anthropologist in general as to the Egyptologist in particular. The writers begin their observations by references to the pictures of the Libyans which are found painted in Egyptian tombs, and from which we learn that this people had fair skins and beards and blue eyes; such pictures belong to the period of the XVIIIth and XIXth dynasties, but it does not follow that they represent, either physically or racially, the North African race or races which formed the indigenous substratum in the ancient Egyptian. Indeed, so long as M. J. de Morgan hesitates to apply the term Libyan to the predynastic Egyptians, less well informed mortals should hesitate before doing so.

The second chapter of the work gives a number of general observations on the Berbers, and we may remark in passing that the criticisms made by the writers on the Arabs show that they know little or nothing of the greatest branch of the Semitic race; nothing but youth and ignorance and prejudice can be pleaded in extenuation of them. We confess at the outset that we have no faith in the judgment, not to say scholarship, of writers who intrude personal opinions of the kind in a work which professes to be scientific. Chapter iii. deals with the political and social organisation of a Berber people, and chapters iv.-vi. with the Shawîya people and their manners, customs, &c.; the section on pottery is very interesting. Three chapters (vii.-ix.) are devoted to the description of the Kabâ'il, their country, houses, industries, &c., and this is followed by a dissertation wherein the "New Race" and Kabyle pottery are compared; the writers think that the modern Kabyle pottery is a survival of ancient Libyan pottery, and that because it is almost identical with that of pre-dynastic Egypt there must have been a close connection between the two countries in the most ancient times. There is a good deal of guessing in argument of this kind, and their assertion that the "hieroglyphic language is Semitic" is as bold and just as true as the criticisms of the writers on the Arabs and their character. They do not make this assertion except on the authority of Dr. Erman, who is a good Egyptian scholar, but then Dr. Erman is not a Semitic scholar in any sense of the word, and he has never shown that he has any competent knowledge of *any* Semitic language; on the other hand, Semitic scholars who have studied Egyptology *ad hoc* declare that the old language of the hieroglyphic inscriptions is not Semitic, and until we see further proofs adduced we shall hold that the Semitic scholars are right.

The chapter on rude stone monuments in Algeria summarises a good deal of general information obtained by the writers and others, and it is interesting to note that

Messrs. Randall-Maciver and Wilkin think that the burial practice of the Libyans links them to the early European races and to the Amorites of Syria ; but it isolates them completely from the inhabitants of Egypt of any period, whether early or late. Moreover, they assert, as the result of their craniological investigations, that connection of culture gives little or no ground for inferring identity of race between the Egyptians and Libyans ; and although they admit that the prehistoric Egyptians—by which they mean the Egyptians of the first three dynasties !—were a mixed race, they declare in no uncertain voice that this mixed race as a whole was not Berber. This conclusion is based on the difference between the cephalic index of the Egyptians and that of the Berbers, and is supported by a number of carefully constructed tablets drawn up on a system which we think is new. The supporters of the theory that the Egyptians were of Libyan origin will be somewhat disturbed by such deductions, but the last word on the subject has not yet been spoken, and it must be frankly admitted that such ingenious arguments and speculations as those set forth by such industrious writers as Messrs. Randall-Maciver and Wilkin only serve in the end to show the general reader how very little is really known about such remote times as those to which they relate.

"Libyan Notes" is an interesting book, not so much for the conclusions arrived at by the authors as for the facts and references to the works of older writers, and the plates contained in it. The "notes" are brightly written, and, as we should expect from Oxford men, some attention has been paid to the style of the English used in their composition. Unfortunately, they do not advance our knowledge of the difficult subjects discussed, and it is hard not to feel that the writers have unconsciously tried to make their facts "square" with too many theories about the origins of civilisation in Southern Europe and Northern Africa. A little more attention might have been given with advantage to the Arabic words and names, especially if quantities are marked ; spelling like Hâjji (p. 7), Djemâa (pp. 18, 19), Oukil (p. 20), Zaouïa (p. 21), &c., disfigure the book.

OLD WEATHER RECORDS.

Meteorologische Beobactungen vom xiv. bis xvii. Jahrhundert. Mit einer Einleitung. Herausgegeben von Prof. Dr. G. Hellmann. Pp. 127. 4to. (Berlin : A. Asher and Co.)

THIS volume is the thirteenth of the series of reprints of texts and charts concerning meteorology and terrestrial magnetism published in Berlin under the editorship of Dr. Hellmann. The editor's previous achievements in the bibliography of meteorology are so conspicuous that it will not surprise any one to find that he has selected and arranged extracts from the earliest regular meteorological records in such a way as to produce a most interesting volume. His investigations have incidentally led to considerable additions to our store of knowledge of the meteorology of Europe during the centuries referred to, for inquiry among the libraries has proved the existence of a number of useful weather registers in the margins of old calendars. These doubtless owe their origin, as Dr. Hellmann suggests, to the curious combination of the dearness of paper and the prevalence of the notion of referring weather changes to astronomical causes not exclusively solar, a notion not even yet quite extinct. The index of meteorological observations in the fifteenth, sixteenth and seventeenth centuries accordingly occupies as much as twenty-six pages and becomes an important work of reference for the study of secular changes of climate.

The selection of extracts is thoroughly cosmopolitan. By the exercise of a little ingenuity Dr. Hellmann manages to include with the extracts from observations made in all parts of Europe, in America and on the seas, some information about the meteorological observations of the Chaldeans lately brought to light by Mr. R. Campbell Thompson's publication of the reports of the magicians and astrologers of Nineveh and Babylon. He has something to say too about Theophrastus' book of the winds, which has been translated by Mr. J. G. Wood, and also about some early rainfall measurements in Palestine on the authority of the Mishnah.

The extracts themselves begin with a weather journal for 1343, written in Latin by William Merle, of Driby (Lincolnshire), preserved in the Bodleian Library, and end with observations made in a voyage to China, A.D. 1700, by Mr. James Cunningham, F.R.S., a ship's log originally printed in the *Philosophical Transactions*. Among the names of other observers are Martin Biem, of Krakau (1502) ; Aventin, of Munich (1511) ; Pietramellara, of Bologna (1524) ; Palomino, of Jodar, Spain (1556) ; Tycho Brahe (1582) ; Kepler (1623) ; Marggraf, Brazil (1640) ; Campanius, of New Sweden, N. America (1644) ; the Florentine observers (1655) ; John Locke, of Oxford (1666) ; and Robert Plot, of Oxford (1684), who gives the earliest extant diagram of barometric changes. Among the early marine observers are Columbus (1535) ; John Davis (1506) ; Francis Drake (1596) ; Henry Hudson (1608) ; Abel Janszoon Tasman (1642) ; Friedrich Martens, an arctic traveller (1671) ; and Edmund Halley (1699), the first 'modern' writer on the general circulation of the atmosphere, whose observations were made on a special voyage of investigation of the ocean winds in the *Paramour Pink*, a vessel placed at his disposal by King William III.

The book is full of interest not merely historical. In view of the difficulty of consulting the originals for the purposes of inquiry into such questions as the periodicity of weather changes, it seems a pity that the material is not reprinted in full instead of by extract. But such a reprint would form an entirely different kind of book.

The volume, like its predecessors in the same series, is a sort of *édition de luxe ;* it is beautifully printed on hand-made paper and the facsimile reproductions are excellent.

OUR BOOK SHELF.

Le Coton. By Prof. H. Lecomte. Pp. viii +494. (Paris : Carré and Naud, 1900.)

THIS is largely a work of compilation, and not the result of original research or experiment. In the first part, the methods of cotton culture and the chemical composition and physical structure of the fibres are dealt with. Comparisons are also made between the properties of different cottons and the uses and applications of the by-products, such as cotton-seed oil and its manufacture. The extent

to which cotton is now being grown in the United States forms several chapters of considerable interest to those concerned in the extraordinary development of the cotton industry. The other countries of America in which cotton culture is practised are next referred to, such as Mexico, Brazil and Peru. Egyptian cotton, which is largely esteemed, according to the writer, has been principally developed during the last half of the 19th century.

Allusion having been made to the historical use of cotton in eastern countries, Madagascar and Persia, the cotton-growing districts of Asia are then referred to.

Some interesting information is supplied on the baling of cotton as effected in different countries, and on the principal cotton markets of the world.

In the second part of the book the writer reviews the general history of the development of the various branches of the cotton industry, following with an analysis of the trade and its growth as known in France. Similarly, with the progress in England, Austria and Russia, and the remarkable development in Japan.

The work is purely one for the statistician, only being of indirect utility to those engaged in the manufacture of cotton fabrics, or in any way users of the cotton plant. Still, to those who wish to have a comprehensive survey of the remarkable increase in the culture of the cotton plant in countries widely differing from each other in climate and customs, the book will be found invaluable.

ROBERTS BEAUMONT.

Taxidermy; Comprising the Skinning, Stuffing and Mounting of Birds, Mammals and Fish. Edited by P. N. Hasluck. Pp. 160. 12mo. Illustrated. (London: Cassell and Co., Ltd., 1901.)

THE foundation of this little treatise is a series of articles by Mr. J. Fielding-Cottrill—occupying, it is said, nearly twenty thousand columns—which have appeared from time to time in *Work*, and have been brought into their present form by the editor of that journal. In his preface the editor avoids any mention of the class of workers for whom the volume is primarily intended, and it is not easy to infer this from a study of its contents. Certainly the professional taxidermist, who has at his command works of the class of Mr. J. Rowley's "Art of Taxidermy" (reviewed in NATURE for 1898), has nothing to learn from the present handbook, and it is difficult to imagine in what way the ordinary amateur is likely to be interested in the mounting of animals of the size of a waterbuck (p. 49).

It is not as if the author (or editor) had any new ideas to communicate with regard to the mounting of such mammals. On the contrary, although he confuses his readers with an unnecessarily complex system of measurements to be taken before skinning, he is really far behind advanced modern methods in his system, which bears no comparison with that adopted by many Continental and American taxidermists. Indeed, mediocrity may, in our opinion, be regarded as the leading feature of the book; and nowadays we require something beyond this, at least for those workers who attempt the mounting of big game.

As regards the skinning and stuffing of ordinary birds and the smaller mammals, the methods and descriptions are, in an old-fashioned way, well enough; and had the editor restricted himself to work of this nature not much fault could be found with his attempt.

One thing we are glad to notice, namely, that the author advocates painting stuffed fish in imitation of their natural colours instead of being content with the faded scarecrows still to be seen in some of our museums. Whether, however, the methods, both of mounting and colouring, advocated by him would result in the production of specimens bearing any real resemblance to their living prototypes could be decided only by actual inspection of the work.

R. L.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations aboard Ship. Mathematical, Theoretical and Practical. By Commander T. A. Lyons, U.S. Navy. Vol. i. Pp. xv+556. (New York: Wiley and Sons. London: Chapman and Hall, Ltd.) Price 25*s.* 6*d.*

THIS first volume, which is to be followed by a second devoted to ships' compasses, takes a wide sweep over physical science generally. Sound waves, light waves, kathode rays, Röntgen rays and Hertzian radiation are treated in a vigorous popular style, special attention being devoted to the functions of the ether which pervades all space. No preliminary knowledge is assumed, common language is preferred to technical, and much information of quite recent date is given—a notable instance being the information regarding atmospheric electricity obtained by kite-flying. The reader never feels himself snubbed as an ignorant person who must be content with elementary knowledge, but is freely admitted to the most sacred arcana.

On the other hand, little attention is paid to precision in the use of scientific language, and both grammar and logic are sometimes loose. Moment of inertia is spoken of as potential energy, and we are told that the field of a current can be measured in dynes; also that the moment of a magnet and the strength of a pole can each be expressed in dynes. On p. 152 the extraordinary statement is made that a steel magnet of suitable strength suspended by a thread between the poles of an electromagnet sets equatorially. As a matter of historic criticism, the discovery of "the dip" is claimed for Peter Peregrinus, simply because he observed that a suspended needle dipped when held over either end of a horizontal magnet.

About a third of the volume deals with magnetism, especially terrestrial magnetism and the instruments for measuring it—a subject with which the author appears to have much practical familiarity, being, it would appear, the founder of the Magnetic Observatory at Washington.

The Steam-Engine Indicator. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. Pp. 153. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1900.)

A USEFUL little treatise, easy to read and understand, and well illustrated. It has some defects. The error due to stretching of the cord is thought to be merely a cutting away of the two ends of the diagram, whereas the whole diagram is altered on account of the continuous change of length of the string as the pulling force alters through inertia of the paper barrel and friction. Again, friction of pencil on paper always keeps the diagram *larger* than it ought to be; the author says that it *reduces* the area. Too much space is devoted to the theory of the planimeter and other matters. The important relationship between natural period and time of revolution of engine is not touched upon.

Progress of Invention in the Nineteenth Century. By Edward W. Byrn, A.M. Pp. vii + 476. (New York: Munn and Co., 1900.)

THE author describes scientific discovery and invention from the point of view of a man familiar with the American patent office. Henry, and not Sturgeon, is therefore the inventor of the horse-shoe electro-magnet; Morse, and not Cooke, is the inventor of the telegraph. He has the patent office official's knowledge of science. He bursts into rhapsody only at the beginning and ending of chapters. He gives in each chapter bits of the history of an industry, not very satisfying because very incomplete. But each chapter is readable, being somewhat like an article in an illustrated magazine intended for general readers.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vitrified Quartz.

I THINK Dr. Joly has misunderstood the abstract of my lecture. It is impossible not to feel confident that a transparent solid which has a very low coefficient of expansion, which expands very regularly up to 1000° C. and returns very exactly to its original volume when it is re-cooled, which remains unfused at 1500°, and which bears great and sudden changes of temperature with impunity, must, in the absence of any other really satisfactory material, prove very useful in its applications in thermometry.

The fact that "quartz fibres" are spoilt when they are reheated was well known before Dr. Joly read his paper on the subject. I believe it was first observed by Mr. Boys, and it is more than once referred to by Mr. Threlfall in "Laboratory Arts" (see pp. 116 and 119); but I do not find that vitreous silica in larger masses is equally sensitive, provided that it is protected, when hot, from the action of basic oxides; in contact with these it quickly becomes rotten when heated. This last fact suggests an explanation of the defect observed in the fibres. "Quartz fibres" are spun from vitreous silica in the plastic state when it is in contact with air which teems with dusty particles the dimensions of which are by no means negligible in comparison with those of the very attenuated fibres. Therefore it seems not unlikely that the fibres consist of less pure silica than larger masses of the material.

Those who work in silica should take care to use Brazil crystal as free as possible from alkali, for its melting point and other qualities may be expected to depend largely on its purity, and rock crystal from all sources is not equally pure.

Clifton, Bristol. W. A. SHENSTONE.

A Raid upon Wild Flowers.

IN the last number of NATURE (p. 118) you quote with approval the field studies in natural history, of which the Essex Technical Instruction Committee has issued a programme. I will ask space to state the grounds which lead me to regard this programme as an injury both to natural history and to education.

The teachers of Essex are invited to make a systematic raid upon our wild flowers, and especially upon such as are tending to extinction. They are to collect, name and dry, not only single specimens, but duplicates for "special fascicles." Local guides are to direct them to the last retreats of the rare plants of the New Forest. Nothing is more to be desired, in my opinion, than that the party may fail to discover the things which they most covet.

This eradicating scheme is utterly useless for scientific and educational purposes. There is no science in all this drying and naming. It is enough to condemn the programme as an educational project that novices, knowing little or nothing of field-botany, are set to study the subspecies of brambles! Two pages (14, 15) contain promising headings, but if the work is to be carried out in the spirit of the rest of the programme, this too will end in nothing better than schedules and fascicles and names.

I should be delighted to learn that the Essex Technical Instruction Committee had abandoned the whole scheme as destructive and educationally barren. L. C. MIALL.

P.S.—I have just been assured (June 4) that only advanced students will be allowed to see the rare plants of the New Forest; it is not stated whether they will be allowed to gather them. There was no such restriction in the printed programme. My other objections remain.—L. C. M.

THE programme criticised by Prof. Miall is unofficial so far as the Essex Technical Instruction Committee is concerned. It was not considered by the Committee or by any sub-committee before publication. It is needless to say that, although I am myself a member (co-opted) of the Committee, I am thoroughly in accord with the general spirit of the above criticisms. On carefully considering the programme in detail I am, however, bound to point out that there are several misconceptions in Prof. Miall's letter. The programme was drawn up by the Staff Instructor in Biology, Mr. David Houston, and he is alone responsible for its contents. He will, I am sure, be able to give a satisfactory explanation concerning many of the charges brought against his scheme. My only object in availing myself of the courtesy of the Editor is to remove the impression that the programme is officially authorised by our Committee.

R. MELDOLA.

The Reported Earthquakes in the Channel Islands and South Devon on April 24.

IN a recent letter to NATURE, the Hon. Rollo Russell refers to some supposed earthquakes felt along the coasts of the English Channel on April 24. As accounts of them have also appeared in several London and provincial papers, it may be worth while to state briefly the results of my inquiries.

The disturbances bear a strong resemblance to those caused by the firing of distant heavy guns. Between about 1 and 1.45 p.m. five shocks were felt in Guernsey, and eight at Paignton in South Devon. They were of very short duration; windows were shaken, but there was no perceptible tremor of the ground. Observers in Guernsey compared the sounds to thunder or the firing of very heavy guns; but those on the English coast seem to have been generally unconscious of any sound. Yet the impression of an observer at Salcombe was that a cannon had been fired to the south, but "too far away to bring the noise."

Trials with heavy guns are said to have been made along the coast of France on April 24. I have not succeeded in ascertaining the place or time of the firing; but that the report assigns a possible cause of the supposed earthquakes will, I think, be evident from the above account. CHARLES DAVISON.

Birmingham, May 29.

Foreign Oysters acquiring Characters of Natives.

MAY I call attention to some curious facts with regard to oyster culture? I do not know whether the evolution they undergo is brought about by Lamarckian factors, or whether it is brought about by natural selection, but no doubt a correct interpretation could be given by some of your readers.

The facts are as follows:—Oysters of the species *Ostrea edulis*, one year old, are brought from Brittany, in France, and transplanted at Hayling Island. After two years on the Hayling beds they are transferred to Whitstable. While they are at Hayling they acquire the characteristics of flavour, and texture and colour of shell of the oysters native to Hayling, yet they are distinguishable as originally from Brittany. When they are transferred to Whitstable they acquire the characteristics of Whitstable, yet they are distinguishable as originally from Hayling and Brittany, and are quite distinct from oysters native to Whitstable. Sometimes they have been brought direct from Brittany and laid at Whitstable for three or four years, and, although all the new growth they acquire is characteristic of Whitstable, yet they are distinct from Whitstable natives, and can be easily detected by experts.

Now the curious point is this: these oysters are known to spawn at Whitstable, yet oysters "spat" from this spawn have never been found. There are found, however, especially the last few years, immense quantities of oysters which resemble the ancient native oysters of Whitstable, and are declared by experts to be Whitstable natives, yet differing from them slightly in coarseness of shell and greater growing power, and in being more susceptible to cold weather than the ancient Whitstable natives. Amongst oyster experts these oysters are considered to be the offspring of the oysters originally brought from Brittany, and this opinion is supported by the fact that when these oysters spawn at Hayling the spat from them resemble in every way the oysters native to Hayling. Can the oysters that become changed in this way be considered to have acquired their new characteristics by Lamarckism or by natural selection?

London, May 22. J. M. TABOR.

The Cape Viper.

TO-DAY the Cape viper (*Causus rhombeatus*) laid several eggs. The keeper says this has happened before. As Causus is one of the Viperidæ, and as the Viperidæ (except Atractaspis) are, as their name implies, viviparous, or, to be accurate, ovo-viviparous, it would be interesting to know whether this is a freak, or whether the Causidæ are oviparous in their native state.

CLAUDE E. BENSON.

5 Elvaston Place, Queen's Gate, S.W., May 15.

SOME SCIENTIFIC CENTRES.

I.—THE LEIPZIG CHEMICAL LABORATORY.

LEIPZIG is a city which boasts many traditions; it is associated with some of the most distinguished names in nearly every department of intellectual life; and its University justly takes a place among the leading schools of Europe. To us there is a sense of fitness in the thought that the school which produced a Wagner and a Goethe should have numbered among its teachers two men who have left a mark in the history of the development of organic chemistry. These men are Hermann Kolbe and Johannes Wislicenus; both of them famous as teachers and experimenters, and each of them associated with a theory the importance of the effect of which on the growth of their science it would be difficult to overestimate.

Wislicenus succeeded Kolbe in the chair at the University of Leipzig, and Wislicenus still works in the laboratory which was made famous by his predecessor; he is the oldest survivor of that generation of workers who laid the foundations of organic chemistry, and as such and as a mark of esteem by one of his old pupils, his laboratory has been chosen as the first of the present series.

The laboratory in Liebig Strasse, which has been the scene of so many classical researches, was built by Kolbe, who commenced to work there in the autumn of 1868.

His name was already famous in connection with his earlier work on the determination of the nature and chemical constitution of organic radicles, in which he was materially assisted by the researches of Frankland. But it was in Leipzig that his most brilliant experimental work was carried out; it was there that, in conjunction with Drechsel, he synthesised oxalic acid from carbon dioxide and potassium, and, assisted by Basaroff, obtained carbamide by the interaction of carbon dioxide and ammonia. Among the early achievements which have invested the present laboratory with such historic interest, and entitle Kolbe to a place among the "wahre Bearbeiter," of Berzelius—to whom, indeed, as well as to Liebig, Wöhler and Bunsen, he used to ascribe his inspiration—must be mentioned the synthesis of isosuccinic acid, the production of nitromethane from chloracetic acid, and the famous reaction for obtaining salicylic acid by the action of carbon dioxide upon sodium phenate, in which he disclosed the singular fact that the use of potassium phenate resulted in the formation of the isomeric para-hydroxybenzoate.

Kolbe died on November 24, 1884. He was not mourned by all who knew him, for his pen had made him not a few enemies; his violent attacks on the "Structurchemiker," and his description of Kekulé's theory of the benzene ring as "wilde Phantasien ohne reelle Basis," have become part of the history of chemistry; while his allusion to the since illustrious van 't Hoff in the words "Ein Dr. J. H. van 't Hoff, findet wie es scheint, an exakter chemischer Forschung keinen Geschmack. Er hat es bequemer erachtet, den Pegasus zu besteigen, und in seiner 'La Chimie dans l'espace' zu verkünden, wie ihm auf dem durch kühnen Flug erklommenen chemischen Parnass die Atome im Weltraume gelagert erschienen sind," was almost worthy of Swift himself.

Wislicenus was appointed director of the laboratory in October, 1885, and effected several alterations in its interior to increase the facilities for work. The number of students rapidly increased till it reached the maximum that the building could accommodate; and in spite of the counter attractions of the Physical Chemistry Institute, which was opened in 1871, the popularity of the first laboratory never waned. At the present time there are 174 students working there, of whom 50 are engaged in carrying on research under the direction of Prof. Wislicenus and his assistants.

Before going on to describe the researches which have maintained the traditions of the laboratory, a brief glance at the career of Johannes Wislicenus will assist us in forming some idea of the nature and variety of his experience.

Born in 1835 in Saxony, the son of a pastor, he received his education first at a school in Halle, and then in 1853 at the University of the same town, where he commenced to study science. But those were the years of revolutions, and in the following autumn his father was forced, on account of his political opinions, to fly to America; there the young Johannes obtained an appointment as assistant to Prof. Horsford at Harvard University, and one year later was made lecturer at the Mechanics' Institute, New York, with a laboratory at his disposal.

In 1856 he returned with his family to Europe, resumed his interrupted studies at the University of Zurich, and later on at Halle; in 1860, he "promovirte, and was appointed 'Privat-docent' at the Zurich Polytechnic." In 1865 he was called to the chair of chemistry at Zurich University, and six years later became director of the Polytechnic. The years 1872-1885 were spent as professor at Wurzburg, where he succeeded Ad. Strecker. On the death of Kolbe the vacant chair at Leipzig was offered him and accepted; and there is a curious irony in the thought that his first work there should have been directed towards the extension of the theory of that van 't Hoff whom his predecessor had regarded with such contempt.

The work of Wislicenus has been confined almost entirely to the domain of organic chemistry. He entered the field when the "Radical Theory" of Kolbe and Frankland had taken a firm hold on the minds of the newer school of chemists.

One of the first problems he attacked was the constitution of lactic acid; while still at Zurich he effected its preparation artificially from propionic acid as well as from aldehyde (*Liebig's Ann.* 1863, cxxviii, 11; cxxxiii, 257; and cxlvi, 145). Later on he succeeded in establishing the identity of structure for the two different substances fermentation- and para-lactic acids (*Liebig's Ann. Chem.* 1872, clxvi, 3; and clxvii, 302). The structural theory alone was thus insufficient to explain such cases of metamerism. He was impelled, therefore, even as early as 1873, to the conclusion that the cause of the difference between the two acids must be looked for in the spacial relations of the atoms in the molecule.

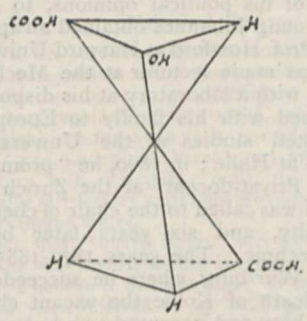
But his attention was for a time diverted from this topic by the classical researches which he was carrying out on acetoacetic ether; his chief papers on the subject appeared in 1877 (*Ann. Chem. Liebig*, clxxxvi, 163; cxc, 257; 1881, ccvi, 308). He studied in detail its reactions, mode of preparation and decomposition, and showed it to be the most valuable synthetic agent then known. His work was of the utmost value in throwing light on the still debated constitution of the substance; in it he was assisted by several English students who have since attained eminence.

Wislicenus was now the occupant of the Leipzig chair; after several papers of lesser importance had appeared, he challenged the attention of the world by the publication, in 1887, of the famous memoir: "Über die raümliche Anordnung der Atome in organischen Moleculen." In this he put forward an explanation of what he termed geometrical isomerism, which was an extension of the hypothesis formulated independently by Le Bel and van 't Hoff in 1874. According to this hypothesis "the centre of gravity of a carbon atom was regarded as situated in the centre of a tetrahedron, and its four affinities at the four corners." When two atoms were linked together, van 't Hoff, and after him Wislicenus, assumed that both were capable of rotating in opposite directions about a common axis; this possibility ceased, however, with a double or treble linking of the carbon atoms. Wislicenus further called into play the action of certain "specially directed forces, the affinity energies," which

determine the relative positions of the atoms to one another in the molecule.

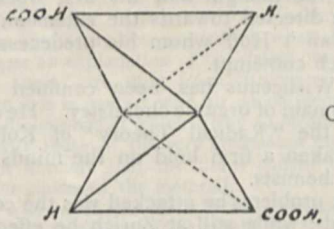
Space will not permit of any detailed discussion of this theory; a single example must suffice to illustrate the manner in which it was applied by Wislicenus.

By heating malic acid to 150° on an oil bath, it is converted almost entirely to fumaric acid; this he explained by the diagrams



$= H_2O +$

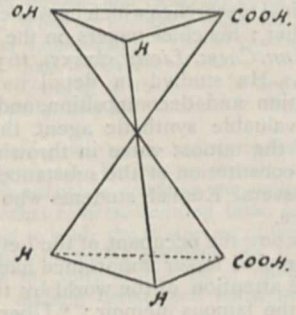
Malic Acid.



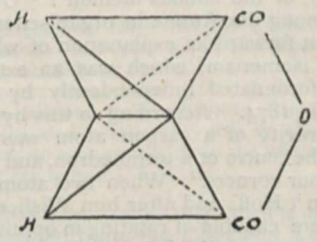
COOH

Fumaric Acid.

If the malic acid be heated from 170—200°, small quantitities of maleic anhydride are formed, though even at this temperature the greater part is converted as before to fumaric acid; this, according to the theory, is due to the existence in the malic acid at the higher temperature of a certain number of molecules in which the atoms have swung round and assumed the positions indicated below; from which the formation of maleic anhydride might be predicted:



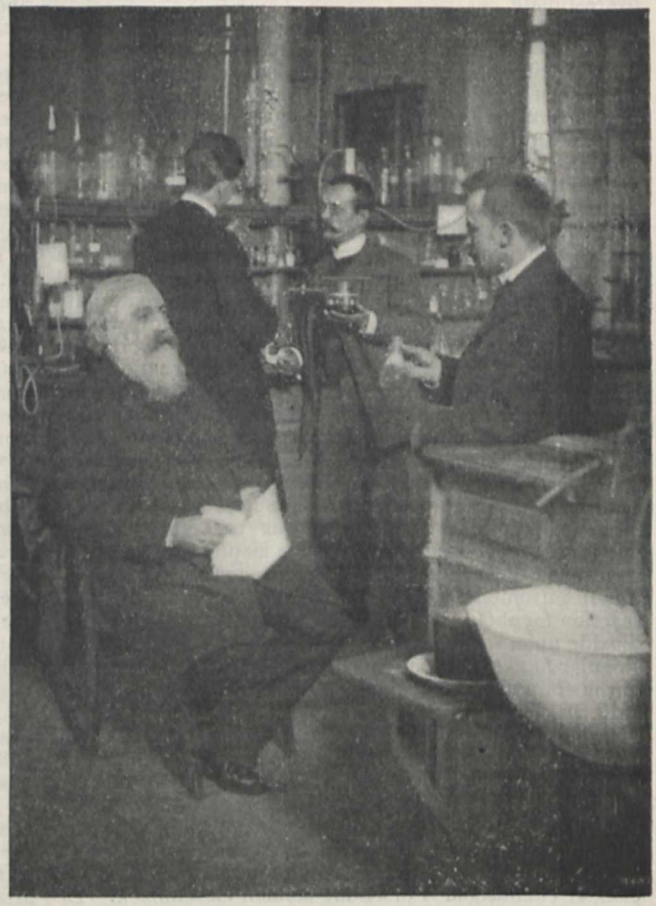
$= 2H_2O +$



Maleic Anhydride.

In the same way Wislicenus applied his theory to all the other reactions of maleic and fumaric acids, to the tolane dichlorides and dibromides, mesaconic and citraconic acids, the crotonic acids, &c; among all the cases he considered, there were only two facts not in consonance with those demanded by the theory; these were (1) the partial conversion of maleic into fumaric acid by the action of bromine, and (2) the production of dibromfumaric acid by the addition of bromine to acetylene-dicarboxylic acid.

In the following year (1888) he published a series of papers (*Liebig's Ann. Chem.* 1888, ccxlvi, 53; ccxlviii, 1; 1889, ccl, 224; cclxxii, 1) containing the results of a large number of experiments (carried out by himself and his pupils) with the object of investigating the nature, constitution and relationships between maleic and fumaric acids, acetylene-dicarboxylic acids, the



Wislicenus in his laboratory.

α-chlorpropylenes, the crotonic acids, the tolane dichlorides, &c.; all of these tended to support the hypothesis he had put forward. In the case of the two apparent exceptions alluded to above, he showed that in the first case the action is far more complicated than at first appears, the conversion of the maleic into fumaric being wholly accounted for by the formation of hydrobromic acid in the course of the reaction, which would suffice to bring about the change. Similarly in the second case, by preventing the formation of hydrobromic acid, the reaction is that demanded by theory, viz., the formation of dibrom maleic acid. Thus the exceptions strengthened rather than weakened the argument.

It is only fair to call attention to the fact that Michael, who has devoted considerable time to the investigation of the subject, has obtained results which in many cases

are not explained by the theory of Wislicenus and van 't Hoff (*Journ. Prac. Chem.* 1895, [2], lii, 365–372); but, as was shown in the celebrated controversy with Fittig (*Liebig's Ann.* 1892, cclxxii, 1-99) over the brom-additive products of angelic and tiglic acids, the conditions of the experiment play such an important part in determining the nature of such reactions that the bearing of the results on the validity of the theory must be accepted with a certain amount of reservation. The matter is still the subject of discussion; for the present we can only quote the words of an illustrious chemist, who said that "unter allen sonst vorgebrachten Erklärungs-versuchen lehrt kein einziger auf gleich einfach und gleich umfassende weise die beobachteten Thatsachen verstehen."

Wislicenus has of late been engaged in the application of the theory of spacial relations to the formation of ring compounds, his synthesis of cyclo-pentanone from the calcium salt of adipic acid serving as a starting point in the preparation of the simplest five-ring compounds. Especial interest attaches to the investigation of suberone, which was shown to be a seven carbon ring; for the theoretical consideration of von Baeyer (*Ber.* 1885, xviii, 2277), in addition to those already referred to, would make us regard a seven carbon ring as unstable as a four.

Wislicenus is one of the forty foreign members of the Royal Society, and was awarded the Davy medal in 1898. Still working with all the vigour of an enthusiast, lecturing both in summer and winter at eight o'clock, making frequent tours through the research laboratories with his note-book and cigar, and listening patiently to the "Ausländer" who bury their unsuccessful experiments in the mysteries of the German language, he attracts students of every nationality, for he has a personality which makes its influence felt; and those who have enjoyed the privilege of working under him have lost none of their respect for a distinguished teacher in their appreciation of his kind hospitality and generous spirit.

THE CENTENARY OF THE DISCOVERY OF CERES.

A HUNDRED years have passed since Piazzi, at Palermo, opened a new era in observational astronomy by the discovery of the first of the many small planets that circulate between the orbits of Mars and Jupiter. This welcome, but not unexpected, addition to the known members of the solar system gave an increased interest to the routine of observation, supplied fresh reasons for the preparation of accurate star catalogues, and quickened the researches of practical astronomy, a little overshadowed by the brilliancy of the results won on the physical side by the French mathematicians of the last century. It is true that within the space of time which has elapsed since Piazzi used to such good purpose the altazimuth of Ramsden, the history of astronomy has had to record, not only the growth, but also the decrease, of interest which has been a consequence of the rapid discovery of similar objects. Nevertheless, Piazzi's discovery was fortunate and fructiferous, and we willingly associate ourselves with those of his countrymen who have recently sought to do honour to his memory and to demand due recognition for his services. We are reminded, in a recent number of *Memorie della Societa degli Spettroscopisti Italiani*, that though the story of the discovery of Ceres may have been frequently told and is very well known, yet there are features connected with it of which we may well be reminded. For eight years with untiring diligence did Piazzi patiently work, before he made the discovery which has rendered his name a household word and endeared his memory among his countrymen. Doubtless he himself considered his star catalogue a far greater work, and so posterity will esteem it; but the renown that attaches to such a discovery is immediate and, in a sense, abiding. To appreciate fully what it meant at the time, we must recall the confidence and the agitation which were connected with the so-called Bode's law. The evidence such a formula offered of the existence of an undiscovered planet may not appear now very convincing, but the confidence with which it had been received had been strengthened by the comparatively recent discovery of Uranus, and astronomers, among whom may be reckoned Schrœter and De Zach, were banded together with the firm determination to discover the missing link in the chain of planetary distances. Piazzi, according to Grant, stood outside this company of eager astronomers, but the late Admiral Smyth, who had exceptional information from his personal acquaintance with Piazzi, gives him a place in the circle. In any case it was due to systematic work diligently pursued by the Palermo astronomer that the prize was won.

But, as pointed out by Prof. Angelitti and others who have taken part in the centennial celebrations, the indirect results of the discovery have far outweighed the immediate. Among these may be reckoned the earlier publication of the "Theoria Motus" of Gauss, and especially those chapters which deal with the computation of an elliptic orbit from observations that embrace only a short interval of time. This classical work has remained for a century, the model on which all similar calculations have been based. Alterations of detail have been introduced from time to time bearing upon special parts of the work, but practically the method followed to-day is the method that Gauss evolved to rescue and identify the discovered planet of Piazzi from the stars by which it is surrounded and which it so much resembles. It is well known that Ceres, as the small planet was called, was followed by Piazzi only from January 1 to February 11. Oriani and Bode, to whom Piazzi forwarded his observations, do not appear to have seen the planet in the first year of its discovery, and Gauss' researches and the success that attended them rest entirely on the labours of the original discoverer.

It is not out of place to recall how the discovery of small planets and the eagerness with which they were sought in the middle of last century gave a great impetus to the construction of accurate maps of the heavens. The Berlin charts led to the ready recognition of Neptune, while the ecliptic charts of Hind, of Peters, of Chacornac and of a host of others who engaged in the work, added greatly to our knowledge of the configuration of the heavens and the arrangement of the stellar universe. And it must be remembered that one of the first, if not the first, valuable application of photography to astronomy had for its aim the rapid delineation of such charts originally devised for the detection of small planets. To the fruitfulness that has followed this peculiar direction of thought it is not necessary to refer more particularly, but it would not be difficult to show that the discovery of small planets, originating in the small observatory of Palermo, has exercised an enormous influence on the methods of observation now so generally pursued.

We need do no more here than barely refer to the important part that the group of small planets has played in the oldest of old problems, that of the distance of the Sun. Let the bulky volumes that Sir David Gill has sent from the Cape speak of the work that small planets have furnished to the astronomer in this chapter of his science. And now, practically a century after Piazzi taught us how the space between Mars and Jupiter is crowded with cosmical matter, we find astronomers of all nations cooperating on the systematic observation of one of these small bodies, only intent upon bringing the new material to aid more efficiently in the serivce of the old. Small planets have played, and in the future will continue to play, a part in the onward progress of astronomy, and

for this reason we think Italian men of science are well advised to insist upon the recognition of the services of their famous countryman, and they may be assured that all who value solid work diligently performed will give a grateful thought to the unostentatious astronomer of Palermo, who devoted himself with skill and patience to the laborious, and perhaps unappreciated, work of cataloguing the stars. W. E. P.

SYNTONIC WIRELESS TELEGRAPHY.

MR. MARCONI'S lecture on "Syntonic Wireless Telegraphy," recently delivered before the Society of Arts, gives an admirable and most interesting description of the system which he has developed and of the steps by which the development has been effected. "I have come to the conclusion," said Mr. Marconi, "that

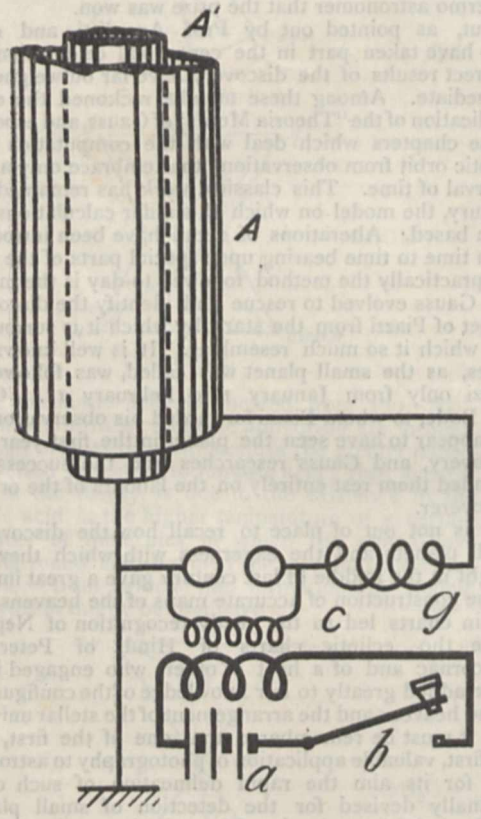


FIG. 1.

the days of the non-tuned system are numbered." If this prophecy be correct the non-tuned system has had, as was indeed expected, but a short life; but even in the few years that it has been in use it has accomplished much, having already to a certain extent greatly increased the pleasure and, above all, the safety of travelling by sea. There can be no better evidence of the general utility of wireless telegraphy than that the time has already arrived when the imperfections of the untuned system are making themselves felt. To quote Mr. Marconi again, "The ether about the English Channel has become exceedingly lively, and a non-tuned receiver keeps picking up messages from various sources which very often render unreadable the message one is trying to receive." That this confusion of messages would sooner or later occur many prophesied in the early days of the art, but few, we think, seriously believed that it would come about so soon. Fortunately, now that the evil is beginning to be felt, Mr. Marconi is ready with the remedy, a well-worked-out and trustworthy system of tuned transmitters and receivers.

The original form of Mr. Marconi's transmitting arrangement is too well known to need illustration: it consisted of an induction coil the secondary terminals of which were connected to a spark gap between two brass balls, one of these being earthed and the other connected to a long aërial conductor. Such a transmitter has a very low electrical capacity, and its radiating power is comparatively great. As a result, the oscillations which take place are considerably damped, and all the energy is radiated in one or two strong swings. Any receiving apparatus in the neighbourhood which is sufficiently sensitive will respond to these radiations even although its natural time of vibration differs greatly from that of the transmitter. Selection of messages with this arrangement is possible, to a limited extent, by using aërial conductors of considerably different lengths and

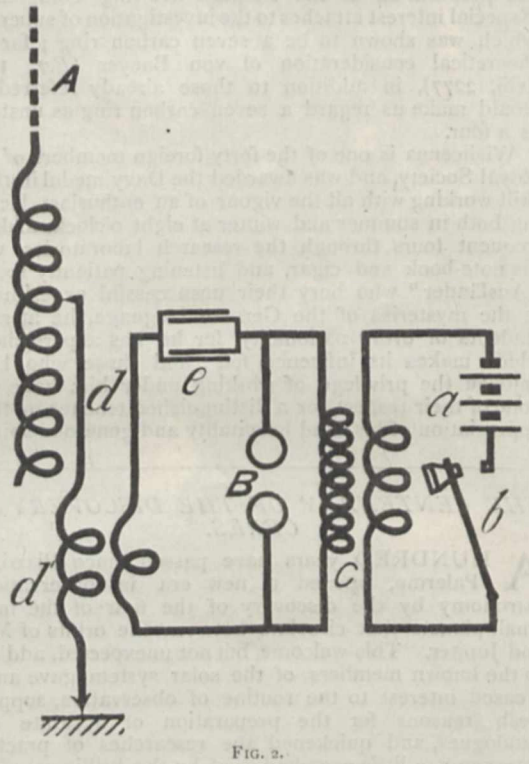


FIG. 2.

by winding the induction coils on the receiving apparatus with the length of wire necessary for correct resonance. But although this answers when the two or more transmitting stations are at different distances from the receiving station, it has been found not to work satisfactorily when the distances are equal.

It is necessary, therefore, to employ some form of radiator in which the oscillations are less damped and which will therefore emit a train of waves instead of one or two strong vibrations. These feebler impulses, falling in succession upon a receiver having the same time of vibration, will get up a swing sufficiently strong to break down the high resistance of the coherer. If, however, the receiver is not in tune, the impulses will not tend to get up any swing, and, being individually too feeble to break down the coherer's resistance, no signal will be recorded. Such a radiator can be constructed as shown in Fig. 1, in which the aërial conductor takes the form of two concentric cylinders, the inner, A', being connected to earth and to one side of the spark gap, and the outer,

A, being connected through an inductance, g, to the other side of the spark gap. Mr. Marconi finds it essential that the inductance of the two conductors A and A′ should be unequal, the larger inductance being preferably joined to the non-earthed conductor A. Such an arrangement proves both a persistent vibrator and a good radiator, thus enabling selective signalling to be easily carried on over considerable distances with quite short heights of cylinder. Very good results were obtained between the Isle of Wight and Poole, a distance of three miles, with cylinders 1·5 metres in diameter and only 7 metres high.

Another very good syntonised transmitting and receiving system which has been devised by Mr. Marconi is shown in Figs. 2 and 3.

In this the terminals of the spark gap, B, are connected to a closed circuit containing inductance and capacity; such a circuit is a very persistent oscillator, but a bad

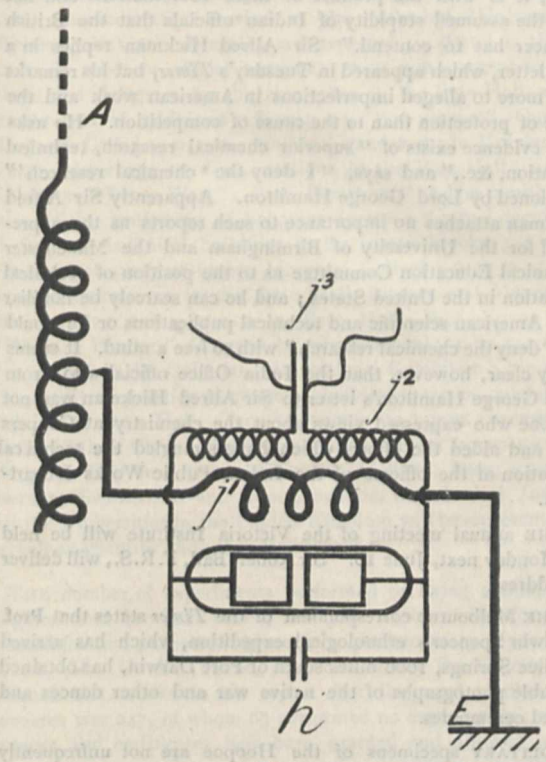


FIG. 3.

radiator and absorber. There is, therefore, combined with it a good radiating circuit, consisting of the vertical conductor, A, which is earthed through an adjustable inductance, d. The vibrations set up in the primary circuit connected to the spark gap induce oscillations in the radiating circuit, the mutual action being increased by winding a part of the radiating circuit around the primary circuit (at d'), as in a transformer. The two circuits are carefully tuned by adjusting either the capacity, e, or the inductance, d, or both. In the receiving apparatus (Fig. 3) the connections are similar; the aërial wire is connected to earth through an adjustable inductance, part of which, j^1, is wound as the primary of a transformer of which the secondary, j^2, is connected to the coherer; an adjustable capacity, h, is connected across the coherer in order to obtain better tuning. It will be seen that with this arrangement of transmitting and receiving stations there are four distinct circuits, two at each station, which have all to be in tune. Using this system Mr. Marconi has been able to attain very satisfactory syntony even although the same vertical wire be used for the different sets of signalling apparatus, which would be connected to it, in such a case, through inductances of different values.

A still further improvement is effected by combining the two methods described above; in this case the connections are made as shown in Fig. 4, which does not require any further explanation.

Mr. Marconi concluded his lecture with an account of some of the achievements already made with wireless telegraphy. The development has been so rapid under his able guidance that one feels that almost as one writes the systems being described are becoming out of date. Perhaps before long Mr. Marconi will have succeeded, by the use of suitable mirrors and lenses, in guiding the radiation in a definite direction, and thus

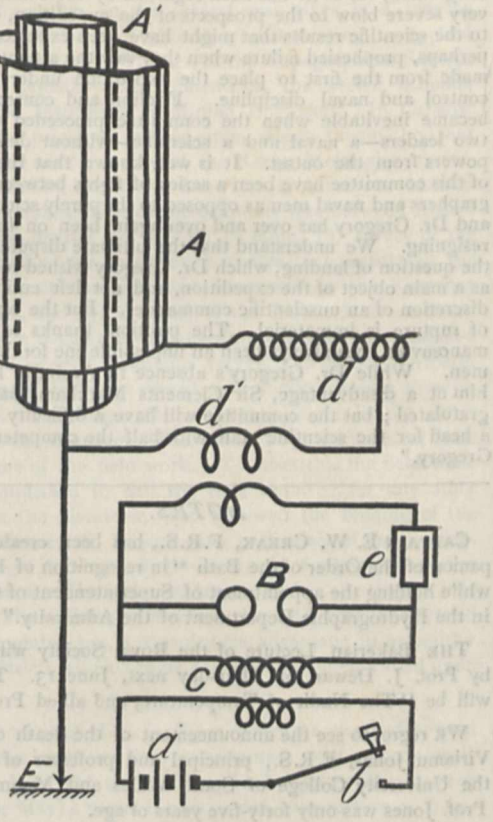


FIG. 4.

have effected a great gain in efficiency. But whether this should prove practicable or not, Mr. Marconi is to be congratulated on the brilliant success of his efforts, and deserves the gratitude of all for having worked out so admirable a system for increasing the safety and convenience of those "that go down to the sea in ships, that do business in great waters."

THE ANTARCTIC EXPEDITION.

TO our great regret the officers of the Royal Society have not yet, so far as we know, made any statement regarding the hopeless condition of affairs which has arisen in relation to the Antarctic Expedition in consequence of the recent action of the Council.

It will be of interest to our readers to observe, in the paragraph we quote below, from *Science* of May 24, the manner in which the management of the Antarctic Expedition is regarded by the scientific men of another

nation. The writer has made a natural mistake in supposing that the expedition is under naval control and will sail under naval discipline. This of course is erroneous. The Admiralty has no responsibility and the expedition must be regarded as a private venture. As it stands at present, the expedition is to leave our shores without a man on board who has had any experience in the conduct of a scientific expedition of any importance; and without a commander who has had any experience in the control of a ship. Can the Royal Society bear the onus of responsibility which such a so-called "scientific" expedition will entail upon them?

"Dr. J. W. Gregory, who was appointed scientific leader of the British Antarctic Expedition and as such recently contributed to NATURE a plan of the scientific work, has now stated that he cannot accept service under the regulations laid down. This resignation, for so it has been regarded by the committee, is a very severe blow to the prospects of the expedition, or at least to the scientific results that might have been expected. Some, perhaps, prophesied failure when they saw the attempt that was made from the first to place the expedition under Admiralty control and naval discipline. Friction and consequent heat became inevitable when the committee proceeded to appoint two leaders—a naval and a scientific—without defining their powers from the outset. It is well known that the meetings of this committee have been a series of fights between the geographers and naval men as opposed to the purely scientific men; and Dr. Gregory has over and over again been on the point of resigning. We understand that the ultimate dispute was over the question of landing, which Dr. Gregory wished to have fixed as a main object of the expedition, and not left entirely to the discretion of an unscientific commander. But the actual cause of rupture is immaterial. The position, thanks to the naval manœuvres, has always been an impossible one for the scientific men. While Dr. Gregory's absence in Australia has placed him at a disadvantage, Sir Clements Markham may be congratulated; but the committee will have a difficulty in finding a head for the scientific staff with half the competence of Dr. Gregory."

NOTES.

CAPTAIN E. W. CREAK, F.R.S., has been created a Companion of the Order of the Bath "in recognition of his services while holding the appointment of Superintendent of Compasses in the Hydrographic Department of the Admiralty."

THE Bakerian Lecture of the Royal Society will be given by Prof. J. Dewar, on Thursday next, June 13. The subject will be "The Nadir of Temperature, and allied Problems."

WE regret to see the announcement of the death of Prof. J. Viriamu Jones, F.R.S., principal and professor of physics in the University College of South Wales and Monmouthshire. Prof. Jones was only forty-five years of age.

THE subjects of two of the evening discourses to be delivered during the forthcoming meeting of the British Association at Glasgow have been decided. Prof. W. Ramsay will lecture on "The Inert Constituents of the Atmosphere" on Friday, September 13, and Mr. Francis Darwin will lecture on "The Movements of Plants" on Monday, September 16. As already announced, the lecture to workmen on Saturday, September 14, will be delivered by Mr. H. J. Mackinder.

AN International Congress of Historical Science will be held at Rome in April of next year. There will be a section for the history of science, including especially medical science, and all who are interested in this or other sections of the work of the Congress are invited to communicate with Prof. P. Giacosa, Istituto di Materia Medica, Corso Raffaello 30, Turin.

PROF. WILLIAM GALLOWAY, professor of mining at the University College of South Wales, at Cardiff, has been appointed to investigate on behalf of the Government the cause of the Senghenydd explosion. Prof. Galloway has stated to a correspondent that it was unquestionably a coal-dust explosion, but more he could not say at present. As to the scope of the inquiry, he said specific points had been suggested by the Home Secretary, and the object of the scientific investigation would be to devise means to prevent a recurrence of the accident.

LORD GEORGE HAMILTON has written to Sir Alfred Hickman, M.P., ex-president of the British Iron Trade Association, explaining why certain contracts were placed by Indian railway companies with American firms. In the course of his remarks he says:—"You seem to think that orders have only gone abroad because those who gave them did not understand their business. I wish that it were so. The competition we have to face is founded on something much more formidable and substantial. Chemical research, concentration of capital, thorough technical education, improved industrial organisation have made in recent years greater advance in America than here; it is with the product of these combinations and not with the assumed stupidity of Indian officials that the British engineer has to contend." Sir Alfred Hickman replies in a long letter, which appeared in Tuesday's *Times*, but his remarks refer more to alleged imperfections in American work and the value of protection than to the cause of competition. He asks what evidence exists of "superior chemical research, technical education, &c.," and says, "I deny the 'chemical research'" mentioned by Lord George Hamilton. Apparently Sir Alfred Hickman attaches no importance to such reports as those prepared for the University of Birmingham and the Manchester Technical Education Committee as to the position of technical education in the United States; and he can scarcely be familiar with American scientific and technical publications or he would not "deny the chemical research" with so free a mind. It seems pretty clear, however, that the India Office official who wrote Lord George Hamilton's letter to Sir Alfred Hickman was not the one who expressed views about the chemistry at Coopers Hill and aided the efforts which have strangled the technical education of the officers of the Indian Public Works Department.

THE annual meeting of the Victoria Institute will be held on Monday next, June 10. Sir Robert Ball, F.R.S., will deliver an address.

THE Melbourne correspondent of the *Times* states that Prof. Baldwin Spencer's ethnological expedition, which has arrived at Alice Springs, 1000 miles south of Port Darwin, has obtained valuable photographs of the native war and other dances and sacred ceremonies.

SOLITARY specimens of the Hoopoe are not unfrequently seen on Lundy Island in the spring. A correspondent asks whether any reader of NATURE can explain their appearance or give any information about their nearest abiding place.

WE learn from *Science* that at the recent annual meeting of the American Academy of Arts and Sciences it was unanimously voted to award the Rumford medal to Prof. Elihu Thomson "for his inventions in electric welding and lighting." The Academy has granted to Prof. Theodore W. Richards, of Harvard University, the sum of 500 dollars from the income of the Rumford fund in aid of a research upon the Thomson-Joule effect.

AT the annual meeting of the Institution of Electrical Engineers on Thursday last, it was announced that the council had awarded the following premiums, among others, for papers and communications:—The Institution premium, value 25*l.*, to Mr. M. O'Gorman for his paper entitled "Insulation on Cables"; the Paris Electrical Exhibition premium, value 10*l.*, to Mr. W. Duddell for his paper entitled "On Rapid Variations of the Current through the Direct-Current Arc"; the Fahie premium,

value 10*l.*, to Mr. A. C. Eborall for his paper entitled "Some Notes on Polyphase Substation Machinery"; and an extra premium, value 10*l.*, to Mr. J. S. Highfield for his paper entitled "Storage Batteries in Electric Power Stations controlled by Reversible Boosters." Salomons scholarships, value 50*l.* each, have been awarded, one to Mr. J. D. Griffin and one to Mr. H. A. Skelton. The sum of 2000*l.*, bequeathed by the late Prof. Hughes to found the David Hughes scholarship in the Institution, has been received from the executors, and the council has determined that, for the present, the manner of award shall be the same as that of the Salomons scholarship. Mr. C. J. Hopkins has been selected as the David Hughes scholar for the present year, the amount of the scholarship being 50*l.*

THE celebration of the ninth jubilee of the University of Glasgow will commence on Wednesday next. The following programme has been arranged:—Wednesday, June 12, 10.30 a.m., commemoration service in the cathedral (University officials, guests and delegates are expected to attend in their academic robes or official costume); 2.30 p.m., reception of guests and delegates by the chancellor in the Bute Hall, and presentation of addresses; 8.30 p.m., "at home," Queen Margaret College; 9 p.m., students' gaudeamus in University Union. June 13, 10 a.m., orations in the Bute Hall: Lord Kelvin on "James Watt"; Prof. Smart on "Adam Smith"; followed by conferring of honorary degrees; 3 p.m., opening of the new botanical buildings by Sir Joseph Hooker; 4 to 6 p.m., garden party at Queen Margaret College; 9.30 to 11.30 p.m., conversazione in the Bute Hall, Library and Museum. June 14, 11 a.m., oration in Bute Hall: Prof. Young on "William Hunter," followed by organ recital; 3 to 5 p.m., "at home" in Art Galleries, International Exhibition; 7 p.m., banquet by corporation in municipal buildings; 9 p.m., students' ball in the Bute Hall. June 15, 10 a.m. to 5 p.m., excursion on the Firth of Clyde. Delegates will be present from Austria-Hungary, Belgium, France, Germany, Holland, Italy, Russia, Sweden, Switzerland and from Australia, Canada and India. All the Universities in the United Kingdom will be represented, as well as scientific and other institutions.

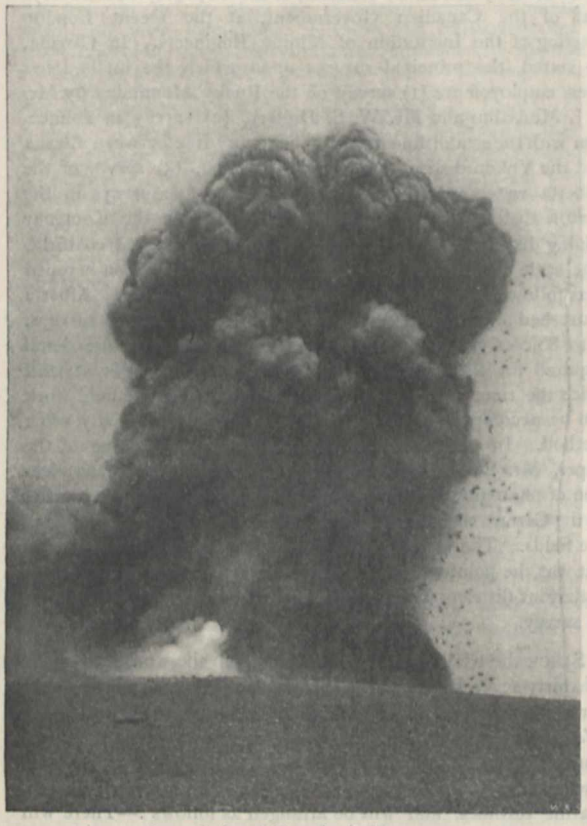
THE number of experiments performed on living animals in England and Scotland during the year 1900, under licences granted for that purpose, is given in a parliamentary paper just issued. Mr. G. D. Thane, inspector under the Cruelty to Animals Act, states in his report that the total number of licensees was 247, of whom 63 performed no experiments; that licences and certificates had been granted and allowed only upon the recommendation of persons of high scientific standing; that the licensees were persons who, by their training and education, were fitted to undertake experimental work and to profit by it; and that all experimental work had been conducted in suitable places. The total number of experiments was 10,839, few of which were in any serious degree painful. The experiments performed under licence alone, or under the certificate "permitting experiments in illustration to lectures," together amounting to 1299, were unattended by pain because the animal was kept under an anæsthetic during the whole of the experiment, and must, if the pain was likely to continue after the effect of the anæsthetic had ceased, or if any serious injury had been inflicted on the animal, be killed before it recovered from the influence of the anæsthetic. In 586 additional experiments the operations were performed under anæsthetics, from the influence of which the animals were allowed to recover. The operations were performed aseptically, and the healing of the wounds, as a rule, took place without pain. If the antiseptic precautions failed and suppuration occurred, the animal was required to be killed. These operations as now practised were seldom, if ever, followed by pain. It is stated that in a large proportion of the inoculations the result was negative—that was, the animal did not exhibit any ill effects, and therefore did not suffer any pain. That was especially the case with many inoculations for purposes of diagnosis, with the great majority of the inoculations performed for the testing of articles of food, and with many of the inoculations made for the purpose of standardising antitoxic serum—namely, those cases in which the antitoxin was sufficiently powerful to neutralise the amount of toxin injected, so that the latter had no action. Only a small proportion of the inoculations practised were followed by disease or poisoning.

SINCE the publication in NATURE (vol. lvii. p. 563) of an article upon photographic surveying, much progress has been made in the application of the methods of photography. Valuable information on the subject was given in a lengthy paper on the field-work of photographic surveying as applied in Canada, by Mr. A. O. Wheeler, of the Topographical Surveys staff of the Canadian Government, at the recent London meeting of the Institution of Mining Engineers. In Canada, he stated, the principal surveys upon which the method has been employed are (1) survey of the Rocky Mountains by Mr. J. J. McArthur and Mr. W. S. Drewry, (2) survey in connection with the establishment of the boundary line between Alaska and the Yukon district by Mr. W. F. King, (3) survey of the Alberta watershed for irrigation purposes, (4) surveys in the Yukon district, on the Columbia River and in the Kootenay mining district, and (5) a survey of the Crow's Nest coalfield. The scale upon which the Canadian surveys have been mapped is as follows:—Rocky Mountains survey, 1 to 20,000; Alberta watershed and Crow's Nest survey, 1 to 30,000; Alaska surveys, 1 to 80,000. The larger the scale the greater is the detail required for the drawing. The office work occupies at least twice the time of the field work. To offset this the field work can be accomplished in half the time required for any other method. In the discussion that followed the reading of the paper, Mr. Bennett H. Brough gave particulars of the application of photographic methods to the survey of mining properties in the Carrara marble district, in Mexico and in the Styrian iron ore fields. The rapidity with which the field work was carried out was, he pointed out, a conspicuous advantage in unhealthy malarious districts which a mine surveyor was often called upon to survey.

SINCE the trials of H.M.S. *Viper*, when the wonderful speed of thirty-seven knots per hour was attained, until quite recently further data have not come to hand; but (says *Engineering Magazine* for May) a vessel is now under construction at Dumbarton (Messrs. W. Denny and Bros.) 250 ft. long, 30 ft. beam, and 17 ft. 9 in. depth, which will be propelled by Mr. Parsons' marine turbines, and will be arranged as follows:—There will be three (for going ahead) turbines, each on its own shaft, the high pressure turbine will drive the centre shaft and the two low pressure turbines the two outer shafts. The two "astern" turbines (which propel the ship backwards) are placed inside the exhaust ends of the two low pressure turbines. By this arrangement in going "ahead" steam is expanded five times in the high pressure turbine and again twenty-five times in the two low pressure turbines, giving a total expansion of "125-fold" instead of about "16-fold" which is obtained with triple expansion reciprocating engines. The vessel under construction is for passenger traffic, which necessitates a regular high speed, and there is no doubt that with a ship of this class the best and the most useful results will follow, and not only will she be the pioneer of Mr. Parsons' marine compound turbine in the mercantile marine, but also she will embody all the advantages claimed over ships driven with reciprocating engines, which may

be summed up as follows:—(1) Increased speed for the same boiler-power; (2) absence of vibration; (3) increased cabin accommodation (due to the smaller space required for machinery); (4) less upkeep in machinery and smaller engine-room staff. Time alone will prove the increased speed of this vessel and the validity of these advantages claimed over her commercial predecessors.

AN interesting description of the period of activity of Vesuvius in April and May of last year is given by Prof. R. V. Matteucci in the *Bollettino* of the Italian Seismological Society (vol. vi. No. 7), and one of the illustrations accompanying the paper is here reproduced. The eruption commenced on April 24, and lasted a month. There was no lava flow, but the explosions in the crater were very strong, and reached a maximum on May 9, when they were distinctly heard over almost the whole of Campania. The greatest height reached by the volcanic bombs and scoriæ was about 540 metres from the bottom of the crater,



An explosion of Vesuvius in May, 1900.

and the largest block ejected had a volume of about twelve cubic metres and a weight of nearly thirty tons. The volume of material thrown out by the volcano during the months of April and May was estimated to have been about half a million cubic metres. For three days Prof. Matteucci remained near the crater of Vesuvius, and on one occasion was fortunate enough to witness an explosion which surrounded him with falling scoriæ and lapilli without injuring him, though the eruption destroyed his photographic apparatus. His observations upon the appearance of the crater during incandescence and the character of the volcanic products are of much interest.

AN aid to the scientific pursuit of photography is afforded by the "Chapman Jones Plate Tester" produced by Messrs. Sanger Shepherd and Co. This new photographic accessory consists essentially of a series of graduated transparencies, a colour sensitometer, and a series of colours—each including one definite region of the spectrum. All these are on one plate and are arranged to show at a glance (1) sensitiveness of ordinary plates, (2) the added sensitiveness of isochromatic plates, (3) the further added sensitiveness of red sensitive plates, this last, being in two parts, distinguishing between the more and the less refrangible than the Fraunhofer line C. The graduated series gives a quantitative value to the colour tests; without it a series of exposures would be necessary, and the result even then would be indefinite. By a single exposure and development the screen gives a quantitative expression of all the properties of photographic plates that are generally of use. Moreover, the record thus obtained can be preserved for more critical examination at any future time, when exact measurement with a photometric arrangement or opacity meter will give results probably as accurate as could be obtained by any method of testing. A plate tester having these joint merits of simplicity and accuracy should prove of service to photographers who base their art upon scientific principles.

"PROSPECTING for Gold in County Wicklow" is the title of a paper by Mr. E. St. John Lyburn in the *Proceedings* of the Royal Dublin Society (vol. ix. new ser. part 4, 1901). The author gives the results of numerous assays of samples of quartz, grit, &c., and in one instance records 4 dwts. per ton from a specimen obtained near the summit of Croghan Kinshelagh. The owner of the estate unfortunately objected to prospecting and Mr. Lyburn had to abandon his work without settling whether or not Wicklow contains gold in payable quantity in the rocks. He observes that panning for gold is secretly carried on in the county and is apparently lucrative to those interested; and he urges further researches on Croghan Kinshelagh mountain, more especially at the junction of the diorite rocks and the Silurian formation.

THE Jurassic Brachiopoda of Cutch form the subject of an important monograph by Dr. F. L. Kitchin (*Mem. Geol. Surv. India*, ser. ix. vol. iii. part 1, 1900). The task undertaken by the author was one not unattended by difficulties, as many years have elapsed since the fossils were collected, and their geological horizons were not in all cases satisfactorily determined. He has, however, received much aid in deciding these matters from Prof. J. F. Blake, who not very long ago personally studied the region. A superficial glance at the plates would lead one to suppose that many British species of Inferior Oolite and Great Oolite Brachiopoda were represented, such as *Terebratula Phillipsi*, *T. globata*, *T. maxillata*, &c.; but although there are forms which appear to show affinity to British species belonging to different Jurassic divisions, yet such forms occur together in Cutch strata, and correlation becomes impossible when the forms on one horizon suggest Bajocian, Bathonian and Callovian ages. Most of the specimens now figured by Dr. Kitchin receive new names, even where the resemblance to a European form is great. This has been done in the belief that the application of the term "variety" is not admissible in cases where the direct relationship to the "species" either cannot be definitely proved or does not appear highly probable. It is satisfactory to learn with regard to Brachiopoda "that to a certain degree, the larger the number of individuals with which we have to deal, the fewer 'species' shall we find them to represent." It would have been better if the author had had the benefit of a series of specimens from a more clearly established stratigraphical sequence, but that he has made the best use he could of the material will not be questioned, and his illustrations are excellent. The fauna as a whole has a distinct facies and is without precise parallel in the European area.

THE Annual Report of the Royal Alfred Observatory, Mauritius, for 1899 has been issued. The chief meteorological feature of the year was the abnormal distribution of rainfall with regard to seasons. The greatest defects occurred in January and December, and the greatest excess in September. The mean rainfall at sixty-eight stations was 76·80 inches, the average amount being 79·23 inches. In possible connection with this we may mention that the deaths from plague were considerable in the months of October to December, following (as in Bombay) the coldest season and an exceptionally wet winter. The report is entirely satisfactory in all respects save one—for want of proper provision for the library, many valuable works are destroyed by rats and other vermin. The director is naturally seriously concerned at this unsatisfactory state of things.

CONSTANTLY increasing attention is being paid to practical entomology in the United States, and we have just received two new parts of the *Bulletin* of the New York State Museum, both of which relate primarily to agricultural entomology. No. 36, vol. vii. (March 1901) contains the sixteenth Report of the State Entomologist on injurious and other insects of the State of New York; and No. 37, vol. viii. (September 1900) contains an illustrative descriptive catalogue of some of the more important injurious and beneficial insects of New York State. These are both by Dr. Ephraim Porter Felt, State Entomologist, and are similar in character to other American Reports which we have recently noticed. We may call attention to two special points in these. The State of Massachusetts seems to be relaxing its campaign against the gipsy moth in despair, and its spread to other States is greatly dreaded. After all the nonsense written in the popular papers about the "kissing bug," it is amusing to find that, according to Dr. Felt, it is neither more nor less than our own wheel bug, *Opsicoetus* (or *Reduvius*) *personatus*, which is common in Europe in outhouses, &c.

THE *Bulletin* of the American Museum of Natural History for 1900 (vol. xiii.) contains an unusual amount of matter interesting to the student of vertebrates, both living and fossil. Some of these papers, such as Prof. Osborn's studies of the European and American fossil rhinoceroses, have been already noticed in these columns, owing to the fact of separate copies having been received. The volume opens with an account, by Dr. J. A. Allen, of the caribou, or reindeer, recently described by Mr. Seton-Thompson under the name of *Rangifer montanus*. The author confirms the distinctness of this form, which is from British Columbia and the North-west Territories, and compares it with other American reindeer, giving a number of excellent photographs of antlers.

IN another communication Dr. Allen gives some interesting notes on the so-called wood-bison of the neighbourhood of the Great Slave Lake, which he considers to be rightly regarded as a distinct race of the species, although it probably once intergraded with the typical bison of the plains. Mr. F. Russell, who hunted these animals in 1894, informed the author that the herd at that time comprised only a few hundred head. "They cannot be hunted in summer," he writes, "as the country which they inhabit is an impenetrable mosquito-infested wooded swamp at that season. . . . They can only be killed by stalking in mid-winter, when their pelage is at its best." This is so far satisfactory, and affords some hope for the survival of the herd, which the Canadian Government is endeavouring to protect. Additional notes on both the reindeer and the bison of the North-western Territories and neighbouring districts are communicated by Mr. A. J. Stone in his report of a collecting trip.

PALÆONTOLOGISTS will find much matter for study in two articles communicated to the aforesaid *Bulletin* by Mr. R. P. Whitfield, the one dealing with certain Arctic fossils collected by the Peary expedition, and the other with the type-specimens of the marine cretaceous lizard described by Cope as *Mosasaurus maximus*. It is inferred that this monster could not have been less than eighty feet in length; portions of the jaws are figured for the first time. Monmouth county, New Jersey, is their place of origin. The Arctic fossils are of Silurian age, and differ in some cases specifically from their representatives in the New York district. In regard to some of the corals, the author writes as follows:—"The specimens are from calcareous clay and are finely weathered, indicating a locality where fine collections of fossils might be obtained with little trouble. The specimens have been collected from the surface and are mostly of small size and imperfect, so much so that those representing undescribed forms are too poor for description and illustration, though sufficient to determine the geological position.

ACCORDING to its Report for the past year, the Zoological Society of Philadelphia has started a new departure in regard to membership which may be commended to the attention of similar bodies at home. This is the admission of junior members, who pay an annual subscription of one pound (five dollars) up to the age of eighteen, when they are eligible for the full membership. In reporting the construction of a new aviary in the gardens, the directors call attention to the reduction which has been found advisable in the size of the cages. This reduction "has resulted from the long experience of the Society in the effort to adjust the needs of animal life to the economical limitations which are forced upon most zoological collections formed upon a large scale. In many groups, as in parrots among birds, and in reptiles of sluggish habit, it has not been found that cages relatively extravagant, both in space and cost, have added observably to health or longevity; in fact, with parrots the best results have been reached in cages too small to induce the attempt to fly." It is added that the public are gainers by the new plan.

WE have received a copy of the *British Central Africa Gazette*, with a supplement containing a full reprint of meteorological observations taken thrice daily at Zomba, during February, 1901. The organisation under which these observations are made is under the direction of Mr. J. McClounie, head of the Scientific Department, and its inauguration has been largely due to the efforts of the British Association Committee on the climate of tropical Africa.

IN the April number of the *Zeitschrift für physikalische Chemie* is a paper by G. Bredig and K. Ikeda, continuing the work commenced by G. Bredig and M. v. Berneck on the "inorganic ferments." It was shown in the first paper that there is a remarkable analogy between the behaviour of a solution of colloidal platinum and the organic enzymes, especially those present in blood. The platinum solution, on account of its perfectly definite composition, lends itself readily to quantitative study, and the results of a very numerous set of determinations of its catalytic power in decomposing solutions of hydrogen peroxide are given. The most remarkable analogy worked out in the second paper is that just as minute traces of certain substances inhibit the catalytic action of the enzymes of the blood, so traces of the same or similar substances act as "poisons" to the colloidal platinum, the quantities necessary in some cases being extraordinarily small. Thus the strongest blood poison is hydrocyanic acid, and this is also the strongest "poison" for colloidal platinum; thus the presence of only 0·0014 milligram of prussic acid per litre was sufficient to reduce the activity of a certain platinum to one-half its original value. Other blood poisons, such as iodide of cyanogen, mercuric chloride, phosphorus and carbon monoxide, behave similarly towards the platinum solutions. There is no doubt that this

work will lead to more quantitative studies of the catalytic action of the enzymes proper, the importance of which in both animal and plant physiology is becoming every day more manifest.

SOME of the papers published in the reports and other volumes of the Smithsonian Institution are printed separately for sale or exchange. A classified list of the papers at present available has been issued, and students of all branches of science will find in it many publications of value.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. W. W. Baker; a Red-flanked Duiker (*Cephalophus rufilatus*, ♂) from West Africa, presented by Mr. Th. Leportier; two Crested Curassows (*Crax alector*) from Guiana, presented by Mr. Robert Thom; two Vulturine Eagles (*Aquila verreauxi*) from the Gwatyn District, Cape Colony, presented by Mrs. Joplin; a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Mr. W. Champion; a Blue and Yellow Macaw (*Ara ararauna*), a Brazilian Tortoise (*Testudo tabulata*) from South America, a Red-masked Conure (*Conurus rubrolarvatus*) from Ecuador, a Starred Tortoise (*Testudo elegans*) from India, two American Glass Snakes (*Ophiosaurus ventralis*) from Mexico, seven Stink-pot Mud Terrapins (*Cinosternum odoratum*), twelve Pennsylvanian Mud Terrapins (*Cinosternum pennsylvanicum*) from North America, deposited; three Mandarin Ducks (*Æx galericulata*) from China, purchased; a Thar (*Hemitragus jemlaica*, ♂), a White Stork (*Ciconia alba*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RECENT TOTAL ECLIPSE OF THE SUN.—From the *Comptes rendus* we learn that a French expedition under M. Binot made successful observations at the island of Réunion, near Mauritius, so that very valuable comparisons may be hoped for between these and the photographs obtained at the Royal Alfred Observatory further east.

A telegram from Pulkowa states that during the eclipse at Padang, six photographs were obtained through cirrus clouds, the form of the corona corresponding to that of minimum solar activity.

SNOW ON THE MOON'S SURFACE.—Several accounts have appeared in the daily Press stating that observers from the Harvard College Observatory working in Jamaica have obtained photographs of the moon which afford evidence of the existence of some variable substance, probably snow, on many of the mountain peaks. The astronomer, presumably Prof. W. H. Pickering, has taken photographs of the lunar disc under as varied conditions of lighting as possible during several nights, and the inference now drawn depends on the interpretation of the changes in appearance of the highest tips of the lunar craters. Up to the time of writing no direct confirmation of these observations has been received in this country.

OXFORD UNIVERSITY OBSERVATORY.—The twenty-sixth annual report of the Savilian professor of astronomy to the board of visitors contains an account of the work of the observatory from 1900 May 1 to 1901 April 30. Prof. Turner states that the staple work during the year has been the measurement and reduction of the plates for the Astrographic Catalogue. This has been partly hindered by the building of the new dome and the arrangements for observing the minor planet Eros during its recent opposition, and also the Nova Persei. However, seventy-eight plates have been completed during the year, making a total of 783 in five years, out of the 1180 required. For the Eros determinations 114 plates were obtained, involving 757 different exposures, about half of these having been measured.

The instruments used in India (1898) and Algiers (1900) were taken to Sumatra by Mr. Newall, who will endeavour to make similar determinations with them of the brightness and polarisation of the corona, so that data on a uniform scale from all three coronas may be available for measurement.

All the instruments are in fairly good working order; the new dome by Messrs. Cooke and Sons gives every satisfaction.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last the Astronomer Royal presented his report for the past year to the Board of Visitors of the Royal Observatory. The weather was not all that could be desired on such an occasion, but the rain, which fell later in the afternoon was not sufficiently heavy to mar the proceedings.

Among the numerous guests were M. and Madame Lœwy from Paris.

Below will be found a brief *résumé* of the report:—

Transit Circle.

The sun, moon, planets and fundamental stars have been regularly observed on the meridian as in previous years. The number of transits, the separate limbs being counted as one observation, amounts to 10,938.

The number of stars observed in 1900 is 4787.

The apparent correction for discordance between the nadir observations and stars observed by reflexion for 1900 was found to be $-0''.39$. The results of recent years are as follows:—

	Mean.	Range in Yearly Means.
	"	
1880–1885	−0·34	From −0·29 to −0·45
1886–1891	+0·03	,, −0·12 to +0·09
1892–1900	−0·30	,, −0·25 to −0·41

The New Altazimuth.

This instrument is in good working order, and the new chronograph has worked satisfactorily. Some inconvenience has, however, been caused by breakages in the system of spider lines, which has a larger span than is really necessary.

The instrument has been used during the year mainly as a reversible transit-circle in the meridian in four positions for the better investigation of systematic errors, and for observation of the Eros reference stars and fundamental stars.

Throughout the year 6937 observations have been made, including those for the determination of the chief instrumental errors.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars.

With the 26-inch Thompson equatorial, the most important work has been the photographing of the planet Eros during the recent opposition for determination of the solar parallax. 255 photographs have been obtained, 197 of which show the planet satisfactorily.

Astrographic Equatorial.

Up to May 10, 682 plates have been taken on 167 nights; 72 of these, for various reasons, have, however, been rejected. In addition to the plates for the chart, 7 photographs were secured for the adjustment of the instrument, two of standard areas, 294 of Eros, 139 of Nova Persei, and 3 of Comet *b* 1900.

The report states that 144 chart plates have been copied on glass, and during the year 81,000 measures of pairs of images (6m. and 3m.), as well as of the diameters of the 6m. images, have been made. The number of plates measured in the twelve months in two positions of the plates is 137.

The measurement of the plates is now completed for 1412 square degrees out of 2087 (which is the area of the Greenwich zone), so that two-thirds of the whole work of measurement has now been done.

Spectroscopic and Heliographic Observations.

With the Thompson equatorial and the photographic spectroscope mounted on it, 22 photographs of the spectra of Capella, Regulus, Arcturus, Spica, α and μ Ursæ Majoris with comparison spectra have been obtained, and some preliminary measures of these give satisfactory results. The spectroscope is now in good adjustment.

For the year 1900, Greenwich photographs have been selected for measurement on 146 days, and photographs from India and Mauritius (filling up gaps in the series) on 214 days, making a total of 360 days out of 365 on which photographs are at present available. The decline in the number of spots noticed in the last report has been continued, and the minimum may be considered as reached, no Greenwich photograph showing a spot since March 7.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents, have been registered photographically, and accompanying eye observations of absolute

declination, horizontal force and dip have been made as in former years.

The regular determinations of magnetic declination, horizontal force and dip have been made with the new declinometer, the Gibson deflexion instrument, and the Airy dip circle mounted in the new Magnetic Pavilion.

The principal results for the magnetic elements for 1900 are as follow :—

Mean declination	16° 29′·0 West.
Mean horizontal force	4·0014 (in British units). 1·8450 (in Metric units).
Mean dip (with 3-inch needles) ...	67° 8′ 27″.

These results depend on observations made in the new Magnetic Pavilion, and are free from any disturbing effect of iron.

The magnetic disturbances in 1900 have been few in number. There were no days of great magnetic disturbance and eight of lesser disturbance.

The question of the possible effect of disturbances from electric railways on the magnetic work carried on at the Royal Observatory has required very careful consideration in regard to the conditions under which electric traction may be used without injuriously affecting the magnetic registers.

It may be remarked that the French magnetic observatory at St. Maur is in much the same position as Greenwich in respect to electric tramways, and recently M. Moureaux, in charge of that observatory, has found that copper "dampers" (such as have been in use at Greenwich for sixty years, but had not previously been applied to the magnets at St. Maur) reduce the vibratory disturbances from electric tramways to about one-tenth of their amount. This has recently been verified at Greenwich by the converse process of removing the copper "dampers" which are in regular use with the declination and horizontal force magnets, when it was found that the disturbances from existing electric railways were increased to about ten times their amount. It is proposed to apply a "damper" to the vertical force magnet, the need for which has not hitherto been felt, and it is possible that the "dampers" for the other two magnets may be improved by the use of copper of much higher conductivity than was obtainable when they were made sixty years ago.

It is hoped, however, that, in the event of future proposed electric tramways, regulations will be laid down by the Board of Trade to secure adequate protection for the magnetic work at Greenwich, which has now been carried on continuously on the same general system for a period of sixty years, and which could not be transferred to another site.

Meteorological Observations.

The meteorological instruments are all in good order. The registration of atmospheric pressure, temperature of the air, and of evaporation, pressure and velocity of the wind, rainfall, sunshine and atmospheric electricity has been continuously maintained.

The mean temperature for the year 1900 was 50°·5, being 1°·0 above the average for the fifty years 1841–90. During the twelve months ending 1901 April 30, the highest temperature in the shade (recorded on the open stand in the Magnetic Pavilion enclosure) was 94°·0 on July 16. The highest temperature recorded in the Stevenson screen in the enclosure was 91°·8, and in that in the Observatory Grounds 93°·4 on the same day. This is the highest shade temperature recorded in July since 1881. It has been twice exceeded in July in the sixty years 1841–1900, viz., on 1881 July 15, when the temperature reached 97°·1, and on 1868 July 22, when it was 96°·6. A reading of 94°·0 was also recorded on 1876 July 17. The monthly mean temperature for July was 66°·6; it has been exceeded only four times in the preceding sixty years, viz., in 1852, 67°·0; 1859, 68°·9; 1868, 68°·1; and 1876, 66°·7. The month of December was also exceptionally warm, the mean temperature for the month being 45°·7, which is 6°·0 in excess of the fifty years' average. This value has been exceeded three times in the preceding sixty years, viz., in 1852, 47°·6; in 1868, 46°·1; and in 1898, 45°·8. The lowest temperature of the air recorded in the year was 20°·4, on February 14. There were forty-seven days during the winter on which the temperature fell below 32°, a number slightly below the average.

The mean daily horizontal movement of the air in the twelve months ending 1901 April 30 was 298 miles, which is 17 miles above the average for the preceding thirty-three years. The greatest recorded daily movement was 973 miles on January 27, and the least 72 miles on December 23. The greatest recorded pressure of the wind was 34·4 lbs. on the square foot, and the greatest hourly velocity 54 miles, both on January 27.

The number of hours of bright sunshine recorded during the twelve months ending 1901 April 30, by the Campbell-Stokes instrument, was 1513 out of the 4457 hours during which the sun was above the horizon.

The rainfall for the year ending 1901 April 30 was 20·22 inches, being 4·32 inches less than the average of fifty years. The number of rainy days was 151. The rainfall has been less than the average in each year since 1894.

The remaining portion of the report deals with the work done in the remaining departments—namely, chronometer, time-signal, &c. It may be here remarked that arrangements have been made for a re-determination of the Greenwich-Paris longitude in conjunction with observers from the Paris Observatory, two of the four portable transit instruments used in former longitude work being available for the French observers, and the other two for the English.

It has been arranged with M. Lœwy that the first part of the longitude observations shall be made in October next, and the second part in the spring of 1902.

The eclipse of May 28, 1900, was observed by the Astronomer Royal with Mr. Dyson and Mr. Davidson in Portugal, while this year Mr. Dyson, with the assistance of Mr. Atkinson, went to Sumatra, and Mr. Maunder to Mauritius, for the recent eclipse of May 18.

In his general remarks the Astronomer Royal points out the great pressure of work that has fallen on all members of the staff during the past year. Two eclipse expeditions have been prepared and sent out, the revision of Groombridge's Catalogue for 1810, in connection with the Greenwich Second Ten-Year Catalogue (1890), the transfer of books and records to the New Observatory, and the rearrangement of the library and record rooms, all have added considerably to the ordinary work of the Observatory. Finally, he points out that within the last five months one-third of the whole staff of computers have left the Observatory for other posts and have had to be replaced by boys new to their work. Such an extensive change in the temporary staff has, to a certain extent, disorganised the work and has thrown a great strain on the assistants, who are charged with carrying it on under such difficult conditions. Considering the training and experience required in the varied work which, at Greenwich, has to be done by computers, a greater degree of permanence in the staff appears to be necessary for the continued efficiency of the Observatory.

THE MECHANICAL FORCES OF NATURE AND THEIR EXPLOITATION.

THE question of the probable end of the world's coal supply, in the not far distant future, is one which has in recent years been the cause of much discussion. In connection with this subject a pamphlet published by the Urania Gesellschaft of Berlin, on "Die mechanischen Naturkräfte und deren Verwertung," by F. Reuleaux, is of interest. In a clear and popular manner the author traces and explains the gradual utilisation by mankind of the various natural forces, from the ancient Assyrian water wheel to the installations of Niagara, and the Parsons steam turbine. It has been calculated that the supply of coal in England can only last at the most 200 years more; and though the coal-fields of the other European countries have not been used to the extent that the English ones have, still their eventual exhaustion can already be anticipated. The total consumption is now about 600 million tons per year, or, measured as a volume, about 500 million cubic yards. Assuming a yearly increase of 5 per cent. (it is at the present moment greater than this) this would mean that during the present century 6½ billion cubic yards of coal will be taken from the earth's coal mines. A cube of this volume would have a side over ten miles long.

It may be urged that this is not a matter of immediate importance; still, in considering the future industrial state of the world one must admit that great changes must take place, and that countries which have been indebted for their growth to their natural resources of power in the form of coal must give way to those countries where power is supplied in another form. On examining the natural sources of power, one sees that really

the only other available source of power besides coal, which, it may be said, can be regarded as the accumulated energy of the sun, stored up through countless ages, is water power. This, unlike coal, is a source of energy which is always with us. The sun piles the waters of the ocean upon the mountain side, and following the force of gravity it flows down again in a never ending cycle, watering, fertilising and, under the careful direction of mankind, rendering the land fruitful and inhabitable and providing for the wants of the human race a source of power immeasurably greater than any power to be derived from the combustion of coal, and what is more, a source of power which will never cease, or be exhausted, while the world lasts. To form a computation of the total energy of the atmospheric depositions is very difficult. It has been calculated to reach the value of 100,000 million horse-power. The realisation of the one-thousandth part of this would be enough to replace the whole of the coal consumption for an incalculable time to come.

An example of how a water power can be used to its fullest extent is furnished by the Upper Hartz. There nearly every drop of water available is utilised, and, although boasting no streams of any size, the respectable total of 3300 horse-power is generated and used in the mining operations carried on there. It is, however, with the advent of electricity that the full realisation of water power has become possible. By means of the facilities offered us by this agent we arrive back at the original motive power of mankind, and will be enabled to tap energies incalculable in comparison with our present ones. This greatest and farthest-reaching application of electricity is but now in its infancy. In 1891, only ten years ago, the first long distance power transmission plant was erected at Lauffen on the Neckar. The power, amounting to 100 horse-power, was transmitted to the electro-technical exhibition at Frankfort on the Maine, a distance of 110 miles, at a voltage of 8000 volts, using a three-phase current. In the short space of time since then immense progress has been made. Now whole towns and large tracts of country are supplied with power and light from distant waterfalls, and new industries have sprung into existence which were formerly impossible. The future developments of this branch of science will be as great, comparatively, as the mighty forces of nature they are designed to employ, and in endeavouring to imagine them the scientific mind merges into the poetic, with which it is, after all, very closely related.

THE COLOUR AND POLARISATION OF BLUE SKY LIGHT.[1]

THE theory of the colour of the sky has been of slow growth. One of the first explanations that we find in scientific literature—almost barbarous in its crudity and unsupported by fact or theory—is the speculation of Leonardo da Vinci that the blue of the sky is due to the mixing of the white sunlight, reflected from the upper layers of the air, with the intense blackness of space. This corresponds to the speculative stage of science, the age of the philosophers. In the next step analogy comes into play; this is a most valuable and effective tool for the man of science endowed with a vivid scientific imagination and with a keen, clear insight into nature, but for others a most dangerous weapon. In this case it is wielded by no less an intellect than that of Sir Isaac Newton. In his optical investigations, about 1675, he had been led to a study of the colours produced when light is reflected from thin films of transparent substances; these he found to depend upon the thickness of the film. When it is very thin it appears black; as the thickness gradually increases it becomes blue, then white, yellow, red, &c. This blue which first appears, and which may be seen surrounding the black spot on soap bubbles, Newton termed the "blue of the first order," and he thought it was of the same tint as the blue of the sky. Analogy now steps in and suggests that the colour of the sky is due to the reflection of sunlight from transparent bodies of such a size that the reflected light is the blue of the first order. This was Newton's belief, and he thought that the reflecting particles were small drops of water.

This is the first theory worthy of serious consideration, and was for a time generally accepted as correct. But no theory based on pure analogy can be regarded as final; it must first be subjected to the most severe analytical and experimental criticism of which we are capable. If it stands the test, well and good; if not, it must be rejected. In 1847 Clausius subjected Newton's theory to a strict mathematical analysis, and proved that, if the blue of the sky is the blue of the first order, resulting from the reflection of light from transparent bodies, these bodies must be in the form of thin plates or thin-walled, hollow spheres. They cannot be solid drops or spheres, for then astronomical objects would never be sharply defined; a star would appear as large as the sun, and the sun immensely larger; all celestial objects would appear as large discs of light, brightest at the centre and fading out gradually toward the edges. For this reason Clausius, believing the blue to be that of the first order, held the opinion that the reflecting bodies were hollow spheres, or vesicles of water. The belief in the existence of so-called "vesicular vapour" did not originate with Clausius, but was a relic which had persisted from the speculative age to this time in spite of its *a priori* improbability, and the natural opposition so caused. As the theory of vesicular vapour has now been completely discarded we need say no more about it; the real value of the work of Clausius lies in the proof that the light from the sky cannot be due to the regular reflection of sunlight from small drops of water.

The experimental test was applied by Brücke, who pointed out that the blue of the sky is radically different from the blue of the first order. Thus, the era of analogy began to give way to that of experimentation and analysis, which must go hand in hand.

Brücke (1853) proved that the light scattered from a turbid medium is blue, and Tyndall (1869) performed his beautiful experiments on this subject, in which he showed that when the particles causing the turbidity are exceedingly fine (too small to be seen with a microscope) the scattered light is not only a magnificent blue but is polarised in the plane of scattering, the amount of polarisation is a maximum at an angle of 90° with the incident light, and the definition of objects seen through it is unimpaired by the turbidity. Here, for the first time, all the essential features of sky light were reproduced in the physical laboratory. This experiment of Tyndall's was at once recognised as giving the key to the problem. Lord Rayleigh (1871–1899) undertook the analytical treatment of the subject and proved that when white light is transmitted through a cloud of particles, small in comparison with the cube of the shortest wave-length present in the incident light, the light scattered laterally is polarised in the plane of scattering, the maximum of polarisation is at 90° to the incident light, and the intensities of the components of the scattered light vary inversely as the fourth powers of their wave-lengths; no account is taken of the light which has undergone more than a single scattering. All these facts have been shown to agree with the phenomena observed in the laboratory when light is passed through turbid media. Recently (1899) Lord Rayleigh has shown that in this way about one-third of the total intensity of the light from the sky may be accounted for by the scattering produced by the molecules of oxygen and nitrogen in the air, entirely independent of the presence of dust, aqueous vapour, or other foreign matter.

We cannot do better than to stop here for a few moments to consider Lord Rayleigh's physical explanation of the scattering produced by small particles. On this theory, light is propagated as transverse vibrations of the atoms or corpuscles of a medium that acts like an elastic solid; it is something like the waves that go along a rope when one end is shaken, only in the case of light we are dealing with no rope but with an infinite medium. When we speak of a beam of light being polarised we mean that all the vibrations in this beam take place in the same plane, and the plane of polarisation may be defined as the plane passing through the direction of propagation of the light but perpendicularly to the direction of the vibrations, and therefore perpendicular to the plane of vibration. Now, imagine a beam of parallel light advancing through a homogeneous medium, say the free ether, in a vertical direction; there will be no light propagated except in this direction; there will be no scattered light. If, however, there exist in it particles optically denser than the ether, but small as compared with the wave-length of light, then light will be scattered laterally by these. Indeed, the effect of these particles is to locally increase the effective inertia of the ether, whereas the rigidity remains unaltered; therefore, when a wave advancing through the medium reaches one of these particles, the displacement of the medium at this point is less than it would be were the particle absent. If we should apply to each

[1] Abridged from an article by Dr. N. E. Dorsey, in the U.S. *Monthly Weather Review*, September 1900.

particle a suitable force (which of course must be in the direction of the displacement and proportional to the difference of the densities of the particle and of the ether) we could restore the amplitude to the value it would have were the particle absent; under these conditions everything would go on as though there were no particle in the ether, and consequently there would be no scattered light, *i.e.*, we should have neutralised the effect of the particle by the application of this force. Hence, on the other hand, we would have the same scattered light if the particle were absent, and we should apply to this portion of the ether this force reversed in direction, that is to say, each particle acts as a centre of a certain harmonic force acting upon the surrounding ether. Such a force will send out a plane polarised wave, whose intensity is symmetrical about the direction of the force as axis; it is zero in the direction of the force, and a maximum in the plane perpendicular to this direction.

The exact effect of such a force has been investigated analytically by Stokes and also by Lord Rayleigh. The displacement in the wave sent out by it is

$$\xi = \frac{F \sin \alpha}{4\pi b^2 D r} \cos \frac{2\pi}{\lambda} (bt - r)$$

if the force is $F \cos \frac{2\pi bt}{\lambda}$; where r is the distance from the centre of force to the point where the displacement is measured; α is the angle between the direction of the force and the line joining the point considered to the centre of force or the mean position of the disturbing particle; b is the velocity of light; D the density of the ether; λ the wave-length of the light sent out by the force; and π is the ratio 3.1416.

If the displacement in the incident wave is $A \cos \frac{2\pi bt}{\lambda}$, the force we must apply to the particle to restore the displacement to its natural value is

$$T(D' - D) A \left(\frac{2\pi b}{\lambda}\right)^2 \cos \frac{2\pi bt}{\lambda},$$

where D' is the optical density of the particle and T is its volume; therefore,

$$\xi = A \frac{D' - D}{D} \frac{\pi T}{r\lambda^2} \sin \alpha \cos \frac{2\pi}{\lambda} (bt - r),$$

and the intensity of the scattered light is for each particle

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 T^2}{r^2 \lambda^4} \sin^2 \alpha.$$

Since the particles are in motion the light scattered from different particles will have no definite phase relation; hence, to get the effect of a cloud of such particles we must add the intensities of the light sent out by each separate particle.

If the incident light is plane polarised, α will be a constant for any given direction from the incident beam, and the total intensity of the light scattered in this direction will be

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 \sin^2 \alpha}{\lambda^4} \Sigma \frac{T^2}{r^2}.$$

If the incident light is unpolarised, the intensity of the light scattered at an angle β with the direction of the incident beam will be

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 (1 + \cos^2 \beta)}{\lambda^4} \Sigma \frac{T^2}{r^2},$$

where $\Sigma \frac{T^2}{r^2}$ denotes the sum of $\frac{T^2}{r^2}$ for all the scattering particles in the line of vision. In none of this have we taken account of the light that has undergone more than a single scattering. If we denote the mean of the square of $\frac{T}{r}$ by $\frac{T_1^2}{r_1^2}$ and let N denote the number of particles in the line of vision, we can write the expression for the intensity of scattered light in the form

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 (1 + \cos^2 \beta)}{\lambda^4} \frac{N T_1^2}{r_1^2}.$$

What are the assumptions we have made in this treatment? They are:

(1) Every scattering particle is so small that when a wave of length λ passes through the medium containing it the force is the same at every point of the particle, *i.e.*, each particle is small as compared with the cube of the shortest wave-length of the incident light.

(2) The particles are so far apart that their effect upon the velocity of light through the medium is negligible; *i.e.* the particles are far apart as compared with the longest wave-length with which we are dealing.

In his discussion of Lord Rayleigh's equations, Crova claims there is a third assumption, viz., that the number of particles in unit of volume must be sensibly the same for all sizes of particles. He says: "La formule $\frac{1}{\lambda^4}$ est basée sur l'hypothèse que le nombre N de corpuscules contenus dans l'unité de volume d'air est sensiblement le même pour toutes les dimensions de ceux-ci." Mascart is of the same opinion. This is evidently wrong. The expression

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 T^2 \sin^2 \alpha}{r^2 \lambda^4}$$

applies to particles of *all* sizes, provided they are small in comparison with the cube of the shortest wave-length. The light from a cloud of such particles is merely the sum of the light from the individual particles; the relative number of particles of various sizes does not enter into the consideration at all; indeed, the composition of the light is entirely independent of all consideration of the number and size of the particles other than as specified in the two assumptions we have named. Particles of a size intermediate between these small ones and those larger ones that reflect light regularly produce effects as yet unknown, and are not amenable to this analysis.

From Lord Rayleigh's expression for the intensity of the scattered light we may conclude, if the manifold or multiply scattered light may be neglected:

(1) The scattered light is polarised in the plane of scattering and the amount of its polarisation is $\frac{1}{1 + \cos^2 \beta}$, being a maximum (completely polarised) when the direction of scattering is perpendicular to the direction of propagation of the incident light.

(2) The intensity of the scattered light varies $\frac{1}{\lambda^4}$ times the intensity of the incident light. Its colour or wave-length is independent of the direction of scattering.

(3) The maximum intensity of the scattered light is in a direction almost coincident with that of the incident light and in the opposite direction, and the minimum is in the plane perpendicular to this.

(4) The larger the particles (provided the assumptions above are fulfilled), the more intense is the scattered light.

As stated above, we know little, if anything, about the action of particles that are just too large for this treatment to apply, but in another of his papers Lord Rayleigh has solved to the next approximation (on the electro-magnetic theory) the special case of spherical particles, and finds that the light scattered should vary as the inverse eighth power of the wave-length. In the air there are surely some particles approximately fulfilling these conditions, and hence the sky should appear bluer than indicated by the simple theory we have just considered. But we have not yet bridged the gap between "very small" particles and those large enough to give regular reflection.

We have thus far neglected the multiply scattered light, but this increases in intensity as the square and higher powers of the number of particles per unit volume, while the once-scattered light increases as the first power only. Hence, for a cloud of particles the multiply scattered light may easily become appreciable. This again increases the proportion of the blue.

For all these reasons the colour of the light from the sky should be expressed by the sum of a series of terms of powers of the reciprocal of the wave-length; not by a single term, as is ordinarily attempted. Crova, endeavouring to express the intensity by a single term of the form $\frac{k}{\lambda^n}$, found values of n varying from 2 to 6 under different conditions, the average being about 4, as Lord Rayleigh and Captain Abney had found. But in no case could n be determined so as to give more than a fair agreement. As we have seen, values of n higher than 4 are to be expected; the lower ones are to be accounted for by the lateral scattering caused by the particles between the

observer and the source of the scattered light which reaches him, by the absorption of the short waves by interposed water vapour and by the admixture of white light reflected from the larger particles.

The scattering to which we have been referring is evidently different from what we ordinarily mean by reflection; the latter assumes that the reflecting surfaces have an area large as compared with λ^2; whereas scattering assumes that the volume of the particle must be small as compared with λ^3.

Such is in outline the theory and the main facts in regard to the cause of blue sky light; but there are several secondary features which must be now considered. The sky is bluer in the zenith than elsewhere, evidently because the path traversed by the scattered light is here the shortest, so that it suffers less admixture with white light and less absorption of blue light. Conversely it should be less blue near the horizon, and when the sun is low may take on a red or orange tint, as we know is the case. The light from the zenith is most intense when the sun is nearest it, as at true noon, and its blue is least pure at the hottest part of the day, on account of the maximum amount of large particles of dust and vapour constituting the haze existing at this time.

Arago discovered that there is a point, about 15° above the point diametrically opposite the sun (the antisolar point), where the polarisation is zero; between this and the horizon the polarisation is horizontal. Babinet discovered a similar point above the sun, and Brewster found one below it. Between the neutral points discovered by Babinet and by Brewster the polarisation is horizontal; below Brewster's point and above Babinet's it is vertical. For a little way on each side of the neutral points the plane of polarisation is inclined at about 45° to the vertical. This seemed to indicate that superposed upon the polarisation resulting from the scattering of direct sunlight is a horizontal polarisation due to some secondary cause. It was soon suggested that the horizontal polarisation is due to a secondary scattering of the light coming from the lower layers of the atmosphere, and this has generally, but not universally, been accepted as the most probable explanation. Other neutral points have been observed under rare conditions.

The positions of the neutral points, the amount of polarisation, the position of the point of maximum polarisation, as well as the colour of the sky, are intimately connected with other meteorological phenomena, but as yet the observations have been so meagre, made under such dissimilar conditions and by such various forms of apparatus, that it is nearly impossible to tell what is the true connection.

Cornu says—in words of which the following is a translation—"In a general way, the amount of polarised sky light is connected in so direct a manner with the condition of the atmosphere that I have been led to think that it is characteristic of the state of the atmosphere. The greatest clearness of the sky corresponds to the greatest amount of polarisation; cirrus and fog decrease the amount, and even completely destroy the polarisation when the sky is overcast. . . . What is particularly interesting is that the least change in the state of the atmosphere is plainly shown by the polarimeter several hours before other precursory phenomena (barometric variation, halos and various other optical phenomena) have begun to indicate a change.

"Under these conditions it would be useful to carry out these observations in a methodical manner, and to compare the polarimetric variations with other elements characteristic of the atmospheric condition. . . . The amount of polarisation increases as the sun sinks below the horizon until it reaches a certain maximum, after which the polarisation rapidly disappears. The law of this increase of polarisation with the time is very important, for it appears to me to give the vertical distribution of fog in the atmosphere; indeed, if the increase is rapid the lower layers are foggy and the upper ones transparent; if the increase is slow, the atmosphere is more homogeneous."

In short, the more fog or cloud there is present the less the amount of polarisation and the less pure is the blue of the sky.

The most extensive series of observations are those of Rubenson and of Brewster on the polarisation, and of Crova and Abney on the colour of the light from the sky. The first limited himself to observations made in fairly clear weather, and the second directed his attention principally to the determination of the positions of the various neutral points. Rubenson and most other observers have laid special stress upon the intensity of the polarisation at its maximum point in the vertical circle through the sun. This is undoubtedly the point where observations can be most easily taken, and those so obtained must be of great meteorological value; but the interpretation of them is rendered difficult by the variation in the length of the path of the scattered light at different times of the day. At sunrise and sunset the point observed is the zenith, and the path is a minimum; while at noon, if the observer be in the tropics, the point observed may be on the horizon, and the length of the path a maximum. For other positions on the surface of the earth the variation in length of path is less than this.

On the other hand, unless we observe a point of maximum polarisation the observations will be vitiated by every error in determining the position, with respect to the sun, of the point observed. Though other objections may be urged, it has occurred to me that for meteorological prediction the most valuable data would be obtained from continuous observations of the amount of the polarisation of the light from points of the sky on the horizon and 90° distant from the sun. These are points of maximum polarisation; these observations will give a kind of integration of the atmospheric conditions over a large area, and the length of path being the same at all times the observations should all be comparable, except for the varying angle of illumination of the surface of the earth, which, unless the nature of the surface differs greatly in different directions, I think would hardly affect the results appreciably, except, perhaps, when the sun is near the horizon. No one, to my knowledge, has carried out such a series of observations, hence the suggestion is advanced with great hesitation.

Since the colour of the sky is independent of the angular distance of the point observed from the sun, being a function of only the state of the atmosphere and the thickness of the stratum observed, there is but little choice in the altitude of the point where we make the colour observations. But since the blue is a maximum in the zenith this is rather to be preferred, for a slight error in the position of the point observed will here produce the least effect.

Whatever point or points are observed, the fact remains that careful observations on the colour and the polarisation of the light from the sky will give us data determining the amount and size of the particles floating in the air, be they dust or water, and, as any change in the state of the atmosphere will affect these quantities, such observations should be of ever-increasing importance to meteorology. First, however, we must have a long series of observations taken at different places and under all conditions, with exact meteorological data obtained at the same time and place, together with a description of the nature of the surrounding country. When these have been obtained it should be not very difficult to find means of using future observations with great success.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Senate of the University of Dublin has decided to confer the honorary degree of D.Sc. upon Prof. W. Burnside, F.R.S., and Mr. W. E. Wilson, F.R.S.

ON Tuesday, June 18, Lord Avebury will open an exhibition of students' practical work, executed in connection with the technological examinations of the City and Guilds of London Institute, at the hall of the University of London.

THE Report of the Council of the City and Guilds of London Institute upon the work of the Institute during last year refers to a number of noteworthy matters. The Institute has been incorporated by Royal Charter, but the general constitution remains unchanged. The Central Technical College has become a School in the Faculty of Engineering of the University of London. The Departmental Committee appointed to consider "the best means for coordinating the technological work of the Board of Education with that at present carried on by other educational organisations" has had several meetings, and it is hoped that arrangements may be made for the more intimate association of the work of the Institute's Technological Examinations Department with that of the Board, by which the overlapping of examinations may be avoided and the instruction provided by county councils and technical schools may be brought into closer relationship with the Board of Education and the Institute. Referring to the extrance examination and the teaching of science in secondary schools, the Council remarks: "The Central Technical College is the only college of

the University in London which imposes such an entrance test for engineering, and unless and until the University is prepared to adapt its matriculation to suit the requirements of particular classes of students, which it is empowered to do under the new Statutes, and especially to engineering students, no very general or substantial improvement can be expected." Appended to the Report is an address given by Prof. Armstrong upon his retirement from the office of Dean of the College, his term having expired, and an address delivered by Sir Alexander R. Binnie at the opening of the current session. Both at the Central Technical College and at the Finsbury Technical College there was an increase in the number of students in the electrical departments, owing possibly to the development of electric traction in this country.

THE president of the Massachusetts Institute of Technology, in his annual report, records that there were in the Institute at the end of last year no less than 1277 students—the largest number yet reached. Of this number 193 were fourth-year students. The average age on entrance is eighteen years and ten months, which is a few months more than the average age at which students enter the Central Technical College, London. An increasing number of students remain for a fifth year or enter the Institute for post-graduate courses. There are thirteen courses extending over four years, and including such subjects as chemical engineering, sanitary engineering and electrochemistry. In looking through the "Annual Catalogue" containing the outlines of the work done in these courses, we are reminded of the statement made in connection with the recent dismissals at the Royal Engineering College, Coopers Hill, that Indian engineers only need to know chemistry "to the extent required to enable the engineer to interpret results given by professional chemists." This is not the way in which engineers are trained at the best technical colleges in the United States, and if Lord George Hamilton and the Board of Visitors of Coopers Hill had seen the programmes of the engineering studies at the Massachusetts Institute they might have decided upon a more liberal action with regard to the subjects to be taught and the provision for teaching in a college where engineers are trained for the public service. The Faculty of the Massachusetts Institute has decided to discontinue the announcement of the degree of Doctor of Science, and to make the requirements for the degree of Doctor of Philosophy include "high attainments of a grade which qualifies the recipient as a scientific investigator and teacher." During 1900 the Institute received 100,000 dollars (less succession tax) under the will of the late Mr. R. C. Billings. The gift of 50,000 dollars by the late Mr. A. Lowell to constitute "The Teachers' Fund" has been increased to 100,000 by the executors, in conformity with his wishes. Other gifts received during the year amount to about 45,000 dollars. The total amount of the Institute property, both real and personal, was increased during the year by a net amount of 219,853 dollars, after deducting the sum of 8593 dollars, which is the excess of expenses over income.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2,6H_2O$—Salts in which M is Magnesium." By A. E. Tutton, B.Sc., F.R.S.

This memoir on the magnesium group of double selenates, in which R is represented by potassium, rubidium and cæsium, is analogous to that which was presented to the Society in March 1900 concerning the zinc group.

The conclusions derived from the study of the morphological and physical properties of the crystals of the three salts are generally similar to those arrived at from the study of the zinc group. There is observed an uniform progression with regard to every property in accordance with the order of progression of the atomic weights of the three alkali metals present. That is to say, the constants of the rubidium salt are generally intermediate between those of the potassium and cæsium salts.

The magnesium group has, however, proved particularly interesting, inasmuch as the progressive diminution of double refraction, according to the rule which has now been established for this series of double sulphates and selenates, leads in the case of cæsium magnesium selenate to such close approximation of the three refractive indices that the crystals of this salt exhibit exceptional optical phenomena. This includes dispersion of the optic axes in crossed axial planes at the ordinary temperature, the uniaxial figure being produced for wave-length 466 in the blue; and the formation of the uniaxial figure for every wave-length of light in turn as the temperature is raised, the attainment of uniaxiality for red lithium light occurring at the temperature of 94°. As the life-history of the salt terminates at 100°, owing to the presence of water of crystallisation, this substance exhibits the property of simulating uniaxial properties at some temperature within its own life-range for every wave-length of light, while still retaining the general characters of monoclinic symmetry, including slight dispersion of the median lines. In this respect it resembles to a truly remarkable extent the analogous sulphate, which the author has shown to possess like peculiarities, but it is even more striking than the sulphate, as the dispersion is much larger. It is interesting to observe that these optical properties of cæsium magnesium selenate could have been predicted, given the constants of the potassium salt and the rules of progression established for the double sulphate and for the zinc group of double selenates. For the double selenates resemble the double sulphates so closely that in general it may be said that their properties are precisely parallel, the constants and curves being merely moved on to a slight extent by the replacement of sulphur by selenium without disturbing their relationships.

Physical Society, May 31.—Prof. S. P. Thompson, president, in the chair.—A paper on the resistance of dielectrics and the effect of an alternating electromotive force on the insulating properties of india-rubber, by A. W. Ashton, was read by Prof. Fleming. The author has obtained from his experiments formulæ for the charging and discharging currents of a condenser with rubber dielectric. The currents are exponential functions of the time. Curves for various potential differences have been plotted and were exhibited. These curves show that the insulating properties of rubber are increased by the application of high alternating electromotive forces.—Prof. Fleming then read a note by Mr. Ashton on the electrification of dielectrics by mechanical means. A sheet of pure Para rubber was placed in a condenser, the plates of which were connected to a quadrant electrometer. A two-pound weight was then dropped upon the condenser from a height of 3 inches. The electrometer received two impulses of opposite sign, one quickly following the other. The rubber was then stretched while in position and a potential difference of seven volts was shown between the plates, the top plate being negative. The condenser and electrometer were then discharged, the sheet reversed and the experiment repeated. The same effect was produced, the top plate again being negative. It appears, therefore, that polarisation of a dielectric being thus produced by mechanical energy, some part of the mechanical energy expended on the india-rubber during manufacture would remain in the dielectric as electric energy.—A model which imitates the behaviour of dielectrics, by Prof. Fleming and Mr. Ashton, was exhibited by Prof. Fleming. The behaviour of dielectrics with regard to their residual charge is analogous to that of wires subjected to mechanical stress. A simple twisted wire is not, however, able to imitate all dielectric effects, and the present paper describes a model which represents things more completely. Six pistons, separated by springs, are placed inside a vertical cylinder. The bottom piston fits fairly tightly in the cylinder. The second piston fits slacker than the first. The third piston has a small hole in it, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with machine oil and vaseline. To the top piston is attached a rod by means of which pressures can be exerted on the pistons for any length of time. This represents the charging of the condenser. The motion of the rod after releasing the weights represents the discharge of the condenser. This is registered graphically by a revolving drum, and the curves obtained are very similar to those from condensers with dielectrics. Prof. Ayrton said he would like to know in what respect the model shown was superior to a strained wire. He had noticed, about ten years ago, that alternating E.M.F.'s appeared to improve condensers. He was then working with comparatively small voltages, and he was interested to know that Mr. Ashton, working with high voltages, had established the improvement. The deflection obtained by stretching the india-rubber sheet might be due to changes in temperature, the dielectric having a high

thermoelectric power. Mr. Price was glad that the question as to what actually might be called the resistance of a dielectric had been raised. There are two theories of residual charge, one due to Maxwell and the other to Heaviside. The model exhibited represents Maxwell's theory. He considered that the electrometer experiment with the rubber dielectric favoured Heaviside's theory—that is, that the dielectric is composed of small charged bodies similar to the small magnets conceived to constitute a magnet. He expressed his interest in the fact that the top plate of the condenser was always negative. Mr. Blakesley suggested putting a small hole in the bottom piston of the model so that it might represent a condenser passing a small steady current. With regard to the stretched rubber experiment, he said it would be interesting to make observations with the plates of the condenser vertical. Mr. Campbell said he had made experiments and found that the change in capacity of the rubber condenser affects the voltage sufficiently to mask the real effect. Mr. Appleyard said it was important to have perfect contact between the dielectric and the metal plates. It was pointed out by a visitor engaged in the cable industry that manufacturers are aware that pressure affects the insulating properties of guttapercha. Rubber is a mixture, and different rubbers behave differently under the action of alternating potential differences. The chairman said that if the quantity of electricity taken in on charging was equal to the quantity given out on discharge, then there could be no dielectric hysteresis.

Royal Microscopical Society, May 15.—Dr. R. Braithwaite, vice-president, in the chair.—A paper by Mr. Fortescue W. Millett, being part xi. of his report on the recent Foraminifera of the Malay Archipelago, was taken as read.—Notice was given that on June 19 there would be a special meeting of the fellows for the purpose of making certain alterations in the by-laws.—The secretary announced that at the next meeting of the Society there would be a paper on the aperture theory of the microscope by Mr. J. W. Gordon. Mr. Beck asked any fellows who possessed Abbe's diffraction apparatus to lend them for use in illustrating the subject of Mr. Gordon's paper. Mr. Gordon would endeavour to show that the effects described by Prof. Abbe, and relied upon by him to prove his diffraction theory, were produced, not by the object on the stage, but by the diaphragm over the object glass; to demonstrate this satisfactorily Mr. Gordon would require the use of several sets of diffraction apparatus besides those at his present disposal.—The chairman drew attention to a large number of objects illustrating pond life which were exhibited (under about 35 microscopes) by members of the Quekett Microscopical Club and fellows of the Society.

Zoological Society, May 21.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Mr. Oldfield Thomas read a paper on the more notable mammals lately obtained by Sir Harry Johnston in the Uganda Protectorate. The following species were described as new:—*Colobus ruwenzorii*, allied to *C. palliatus*, but with longer hair and less white on the tail-tip; *Genetta victoriae*, a genet nearly as large as a civet, strongly banded, and without a dorsal crest; *Procavia marmota*, like *P. dorsalis*, but much smaller; and *Cephalophus johnstoni*, like *C. weynsi*, but darker throughout.—A communication was read from Mr. R. C. Punnett containing an account of the Nemerteans collected by Prof. D'Arcy W. Thompson and others in Behring Straits, Davis Strait and North Greenland. Of the seven species enumerated in the paper two had been previously named, whilst the remaining five were new to science and were described as *Amphiporus arcticus*, *A. paulinus*, *A. thompsoni*, *Drepanophorus borealis*, and *Cerebratulus greenlandicus*.—A communication was read from Dr. W. B. Benham containing an account of the viscera of a whale of the genus Cogia. He pointed out that in this whale there is but a single blowhole asymmetrically placed like that of Physeter, but crescentic in outline, with the concavity directed backwards. The alimentary canal contained a dark-coloured substance, which the author considered to be the "ink" from the cuttle-fishes upon which this whale undoubtedly feeds, as was evidenced by the beaks of these molluscs in the stomach. The stomach was constructed upon the plan of that of the large sperm-whale (Physeter), and the author agreed with others in regarding the first division of it as a paunch belonging really to the œsophagus, and comparable with that of the Ruminants.—Mr. G. A. Boulenger, F.R.S., described two new species of chameleon, obtained by Sir Harry Johnston, K.C.B., on Mount Ruwenzori, under the names *Chamaeleon xenorhinus* and *C. johnstoni*.—A paper was read, prepared by the late Dr. John Anderson, F.R.S., shortly before his death. It contained an account of the reptiles and batrachians obtained by Mr. A. Blaney Percival in Southern Arabia. Twenty-five species of reptiles and three species of batrachians, of which specimens were contained in the collection, were enumerated; two of the former were described as new under the names *Bunopus spatalura* and *Agamodon arabicum*.—Mr. Boulenger described a new fish under the name *Gobius percivali*, specimens of which had been obtained by Mr. A. Blayney Percival in Southern Arabia.

Geological Society, May 22.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On the skull of a chiru-like antelope from the ossiferous deposits of Hundes (Tibet), by Richard Lydekker. Twenty years ago the author proposed the provisional name of *Pantholops hundesiensis* for an extinct species of antelope typified by an imperfect skull figured in Royle's "Botany &c. of the Himalaya Mountains," pl. iii. fig. 1. The specimen is in the Museum of the Geological Society, and an examination has confirmed the original determination.—On the occurrence of silurian (?) rocks in Forfarshire and Kincardineshire along the eastern border of the Highlands, by George Barrow (Communicated by permission of the Director of H.M. Geological Survey). These rocks occur in three lenticular strips between the schistose rocks of the Highlands and the boundary-fault next the Old Red Sandstone. The largest is about twenty miles long, and extends almost from Cortachy to beyond the Clattering Bridge; it is about three-quarters of a mile wide at its widest. The rocks are divided into two groups, the Jasper and Green-Rock Series below and the younger Margie Series above. A section along the North Esk River is described in detail, and other sections referred to it. The lower division consists of fine-grained sandstones (bearing microcline), grey slaty shales, jaspers (sometimes containing circular bodies resembling radiolaria), and a variable series of basic igneous rocks ("green rock") of coarse texture and probably intrusive origin. The upper division consists of conglomerates, pebbly grits, dark and white shales, pebbly limestone and grey shale. The age of the series cannot be definitely ascertained, but the lower division is compared with the Arenig cherts, &c., of the Southern Uplands, while the Margie Series is newer than this, but older than the Old Red Sandstone.—On the crush-conglomerates of Argyllshire, by J. B. Hill, R.N. (Communicated by permission of the Director of H.M. Geological Survey.) While the sedimentary origin of the Highland Boulder-bed is proved by the foreign boulders contained in it, there occur in the Loch Awe region certain conglomerates, often along definite horizons, which may have been confused with it, but which the author is able to prove have originated by crushing. The sedimentary rocks of the area include all the members of the Loch Awe series, consisting of grits, slates and limestones, the latter being mostly gritty in character. Associated with these is an enormous amount of igneous material of Dalradian age, ranging from intermediate to basic in composition, together with porphyrite-dykes probably of Old Red Sandstone age, and a plexus of Tertiary dykes.

Linnean Society, May 2.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. Charles Stewart, F.R.S., exhibited and made remarks on the egg and oviducal gland of *Scyllium catulus*, and on the nature of the egg-shell of Sphenodon.—Mr. W. P. Pycraft read a paper on the palate of the Neognathæ, in which he traced the derivation of the Neognathine from the more primitive Struthious or Palæognathine palate.—Mr. George Massee communicated a second instalment of his redescriptions of Berkeley's types of fungi, and explained the circumstances in which such redescriptions under higher powers of the microscope had become desirable.

May 24.—Anniversary meeting.—Prof. S. H. Vines, F.R.S., president, in the chair.

Anthropological Institute, May 28.—Prof. A. C. Haddon, F.R.S., in the chair.—Dr. Chervin referred to the proposed bibliography of anthropology and to the exchange of abstracts of *Proceedings*; he further suggested the possibility of a more frequent interchange of visits, offering, on behalf of his Society, to act as cicerone if the Institute would undertake an anthropological excursion in France.—Mr. A. Henry exhibited (1) an ancestral tablet, (2) a MS. of the Lolos of Yunnan.—Mr. J Gray presented a communication on the measurements of crania from the Fly River, New Guinea.—Mr. C. G. Seligmann pre-

sented anthropometrical craniological notes on the Eastern Papuans.—Dr. A. C. Haddon discussed the present state of our knowledge of the ethnology of British New Guinea.

CAMBRIDGE.

Philosophical Society, May 20.—Prof. Macalister, president, in the chair.—On the rate of growth of certain corals, by Mr. J. Stanley Gardiner. The author put in a plea for more precise observations on the subject, showing in discussing his specimens the various conditions of life, which he considered necessary to record. It was suggested that the volumes of specimens should be calculated, and that if possible the thickness of each skeleton, imagined as a flat plate covering the same horizontal area as its living colony, should form the basis for comparison. By the latter method the specimens showed, in a growth of less than 1030 days from the larvæ, various thicknesses between 10 and 25 mm.—On the breeding habits of *Xenopus laevis Daud*, by Mr. E. J. Bles.—On the recovery of foliage leaves from surgical injuries, by Mr. F. F. Blackman and Miss G. L. C. Matthaei. It has been found that if definite areas of these leaves be killed by heat or by physical means, the remaining sound tissues divide actively and form an abscis-layer which surrounds the dead cells and cuts out the area so that it drops away from the leaf. Specimens were exhibited showing the stages of this process, which takes place with such precision that leaves may thus be shaped to any desired form.—On a new species of *Bothriocephalus*, by Mr. A. E. Shipley.—On a class of matrices of infinite order and on the existence of matricial functions on a Riemann surface, by Dr. A. C. Dixon.—On liquid motion from a single source, by the Rev. H. J. Sharpe.

EDINBURGH.

Royal Society, May 20.—Prof. Geikie in the chair.—Mr. Alfred Harker communicated a paper on ice-erosion in the Cuillin Hills, Skye, in which evidence was accumulated to show that this region had never been over-ridden by foreign ice, but had supported during the maximum glaciation a local ice-cap. The general radial outflow followed with few exceptions the principal valleys, but on reaching the lower ground was sharply diverted toward the west by the pressure of the great Scottish ice-sheet. The chief part of the paper was devoted to an analysis of the surface relief of the Cuillins, the more striking elements of which were the result of glacial erosion, as distinguished from aqueous erosion. Among these were the general absence of any relation between detailed topography and geological structure; the unbroken extent of the main ridge with its steep flanks and cuspate cross-section, and the tricuspate ground-plan of its principal peaks; the curiously asymmetric form in cross-section of the branch ridges, with the steeper face always toward the north; the straight steep-sided valleys with U-shaped cross-section and abruptly stepped longitudinal profile; and other well-marked characteristics. The drift accumulations were also discussed, stress being laid on the action of ice not merely in grinding down a rock-surface but in tearing away fragments, especially of well-jointed rocks. The maximum glaciation in central Skye was succeeded by a period of valley glaciers; and at the same time the withdrawal of the Scottish ice-sheet allowed an unimpeded out-flow of the ice-drainage from the Skye mountains. At this stage the exposed summit ridges of the Cuillins suffered greatly from frost-action, the detached blocks being in part carried away on the glaciers, in part accumulating in great taluses wherever the head of a valley had become vacated by the dwindling ice.

PARIS.

Academy of Sciences, May 28.—M. Fouqué in the chair.—On the parallax of the sun, by M. Bouquet de la Grye.—The addition of hydrogen to various hydrocarbons, by MM. Paul Sabatier and J. B. Senderens. It has been shown in a previous paper that benzene and toluene in contact with hydrogen and reduced nickel readily form the hexahydro-addition products. It is now shown that this reaction is a general one, similar addition compounds being obtained from a great number of aromatic hydrocarbons. In the case of substituted benzenes in which the side chain exceeds a certain length, a secondary decomposition takes place. Thus ethyl-benzene gives not only the ethyl-cyclohexane, but also methyl-cyclohexane and a small quantity of methane. Propyl-benzene in the same way gives a little methyl-cyclohexane and ethyl-cyclohexane. The yields of the various hydrocarbons are very good, and the physical constants of several of them now prepared for the first time are given.—Observations of the comet A(1901) made at the Observatory of Algiers with the 31·8 cm. equatorial, by MM. Rambaud and Sy. The comet appears in the form of a nebula with a nucleus of a lustre comparable with a star of the 8th magnitude.—On the spectrum of the solar corona photographed at Elche (Spain) during the total eclipse of the sun of May 28, 1900, by M. A. de la Baume-Pluvinel. Five photographs of the corona and its spectrum accompany the paper.—The wave-length of some iron rays, by MM. Fabry and Perot. By the application of the interference method described by the authors in previous papers the wave-lengths of fifteen of the chief iron lines have been determined with an accuracy of six significant figures.—On the density of alloys, by M. E. van Aubel. The aluminium-antimony alloy containing 81 per cent. of aluminium is produced with a large increase of volume, 7 c.c. of aluminium and 12 c.c. of antimony giving 23·7 c.c. of the alloy AlSb.—On a very sensitive balance which is capable of acting either as a galvanometer, electrodynamometer or an absolute electrometer, by M. V. Cremieu. Two small magnets are carried on a small torsion balance composed of two silk fibres. These wires are sucked into bobbins carrying a current, the arrangement forming a sensitive astatic and dead beat galvanometer.—On the reduction of silver chloride by hydrogen, by M. Jouniaux. The interaction of hydrogen and silver chloride at various temperatures above 500° C. is reversible. The experimental results are applied to calculate the difference between the heats of formation of hydrogen and silver chlorides.—Observations on the preceding note, by M. Berthelot.—The action of mercuric oxide upon aqueous solutions of metallic salts, by M. A. Mailhe.

NEW SOUTH WALES.

Linnean Society, March 27.—Mr. J. H. Maiden, president, in the chair.—Description of a new species of Acacia, by J. H. Maiden. The plant described is an erect shrub of several feet from the highest part of the Blue Mountains.—Note on the Subgenus salinator of Hedley, by Edgar A. Smith.—Studies on Australian mollusca, part iv., by C. Hedley. Geological notes on Kosciusko, by Prof. T. W. Edgworth David, F.R.S, Richard Helms and E. F. Pittman. This paper deals with the subject of recent discoveries by the authors in company with Mr. F. B. Guthrie, of ancient moraines, erratics, and extensive rock surfaces grooved by glacier ice on the Kosciusko plateau. Some of the best preserved evidences noticed were in the Lake Albina Valley and in the valley of Lake Merewether (Blue Lake). At the latter locality there is a magnificent and well preserved moraine 400 feet above the surface of the lake, and containing ice-scratched blocks in enormous numbers. A very fine ice-grooved pavement of granite was observed at a point about 300 yards west of the southern end of Lake Albina. There is certain evidence that the glaciers came down, in comparatively recent geological time, to 5800 feet above the sea and probably to 5500 feet at least, Mount Kosciusko proper being about 7328 feet high. It is also clear that the ice in some of these glaciers was at least 400 feet thick. It is quite possible that at a still earlier period the whole plateau down to a level of about 5000 feet was buried under an ice-sheet. The exact downward limit has not yet been ascertained. The comparatively recent nature of the glaciation is shown by the fact that since the ice disappeared a depth of only about 10 feet of loose moraine and a further depth of 10 feet of soft slate have been eroded in the beds of the creeks which form the sources of the Snowy River. The authors consider that this evidence, taken in conjunction with that recently adduced in South America, Kerguelen, New Zealand and Tasmania, suggests a synchronism of glaciations of the northern and southern hemispheres, due to some such cosmic cause as that suggested by Dr. Arrhenius, viz., a slight temporary diminution of carbon dioxide in the earth's atmosphere.

April 24.—Mr. J. H. Maiden, president, in the chair.—Notes from the Botanic Gardens, Part 7, by J. H. Maiden and E. Betche. A number of new species and varieties were described.—Notes on the caves of Fiji, with especial reference to Lau, by B. Sawyer and E. C. Andrews. During their travels in the Fijian Archipelago the authors observed two types of caves—the excavated and the enclosed. Magnificent examples of caves excavated by percolation and subterranean streams occur in Viti Levu. In the Lau group appear the enclosed caves—vacant spaces walled and roofed in by coral growth. In their early stages these are seen in the living reef

as precipitous chasms.—Observations on the eucalypts of New South Wales, Part 8, by Henry Deane and J. H. Maiden.—Bacteria and the disintegration of cement, by R. Greig Smith. Stutzer and Hartleb considered that the disintegration of the cement work of water reservoirs might be caused by the action of the nitrifying organisms. The author has investigated a case where the cement work of a water canal was disintegrating. Nitrifying organisms were found in the surface mud, but not deeper into the cement where disintegration was in active progress. The nitrifying bacteria appear when disintegration is complete. Other bacteria were separated by selective methods. One of these, *Bact. croceum*, can grow in bouillon with 5 per cent. sodium carbonate, but neither it nor the others separated had any action upon experimental cement blocks. Since the disintegrated cement contained alkali soluble in water equal to 1·4 per cent. lime, the disintegration is probably purely physical.—Notes on *Vibrio denitrificans*, Sewerin, by R. Greig Smith. This is not a vibrion, but an organism morphologically similar to *Rhizobium leguminosarum*. In media containing potassium phosphate, branching and irregular forms are found in young cultures. It appears to be a budding rod, and the variety of forms of the organism is caused by the mother and daughter cells being contained in a branching capsule.

CAPE TOWN.

South African Philosophical Society, April 24.—Mr. L. Péringuey, president, in the chair.—Mr. Garwood Alston showed three photographs of stones standing erect about six miles south of Port Nolloth, near which Mr. R. Colson found certain kitchen-middens, from which a skull and several native pots and grinding stones were obtained. The stones form enclosures of four feet by two, running north and south. Two of the enclosures were dug into, but yielded nothing. The underlying indurated sand seemed to be quite undisturbed. Mr. Alston emphasised the absence of evidence as to the meaning of the enclosures, and said that the small size was against the view that old burial places are indicated.—Prof. J. T. Morrison communicated a paper on some pressure and temperature results for the Great Plateau of South Africa, by Mr. J. R. Sutton. The author discusses the annual run of daily maximum and minimum temperatures, and of daily barometric pressures at Kimberley and Durban, as deduced from observations made during the ten years 1888–97, the pressures at Kimberley being, however, available only for 1890–97. The object was to discover the outstanding features of plateau meteorology. The results suggest to the author that "we might adopt the working theory (not forgetting how easy it is to theorise when facts are few), which, however, is rather a geometrical conception than a mechanical possibility, that there is a certain temperature factor—if we may so call it—travelling round the earth from west to east, while a pressure factor is going the opposite way."

DIARY OF SOCIETIES.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—On the Electric Response of Inorganic Substances, Preliminary Notice: Prof. J. C. Bose.—On Skin-Currents. Part I. The Frog's Skin: Dr. Waller, F.R.S.—Vibrations of Rifle Barrels: A. Mallock.—The Measurement of Magnetic Hysteresis: G. F. C. Searle and T. G. Bedford.—A Conjugating Yeast: B. T. P. Barker.—Papers to be read *in title only*: Thermal Adjustment and Respiratory Exchange in Monotremes and Marsupials: a Study in the Development of Homo-thermism: Prof. C. J. Martin.—On the Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load: L. N. G. Filon.—The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions: B. D. Steele.

ROYAL INSTITUTION, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—On the Necessity for a Provisional Nomenclature for those Forms of Life which cannot be at once arranged in a Natural System (Adjourned Discussion): H. M. Bernard.

CHEMICAL SOCIETY, at 8.—A Laboratory Method for the Preparation of Ethylene: G. S. Newth.—Oroxylin: W. A. H. Naylor and C. S. Dyer.—Some Relations between Physical Constants and Constitution in Benzenoid Amines, II.: P. Gordon and L. Limpach.—The Constitution of the Acids obtained from α-Dibromocamphor: A. Lapworth and W. H. Lenton.—The Decomposition of Chlorates. IV. The Supposed Mechanical Facilitation of the Decomposition of Potassium Chlorate: W. H. Sodeau.—Condensation of Phenols with Esters of the Acetylene Series. V. Homologues of Benzo-γ-pyrone: S. Ruhemann.—On the Action of Sodium Methoxide and its Homologues on Benzophenone Chloride and Benzal Chloride: J. E. Mackenzie.—Preliminary Note on Hydrides of Boron: W. Ramsay and H. S. Hatfield.—Gum Tragacanth: C. O'Sullivan.

RÖNTGEN SOCIETY, at 8.30.—X-Ray Diagnosis of Aneurism: Dr. Hugh Walsham.

FRIDAY, JUNE 7.

ROYAL INSTITUTION, at 9.—Mimetic Insects: Prof. Raphael Meldola, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Geysers of the Yellowstone: John Parkinson.

SATURDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Biological Characters of Epiphytic Plants: Prof. J. B. Farmer, F.R.S.

MONDAY, JUNE 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels in Search of Waves in 1900: Vaughan Cornish.

VICTORIA INSTITUTE, at 4.30.—Annual Meeting.—Address by Sir Robert Ball, F.R.S.

TUESDAY, JUNE 11.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Notes from Five Years' Work with X-Rays: W. Webster.

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: Prof. James Dewar, F.R.S.—The Nadir of Temperature and Allied Problems. (1) Physical Properties of Liquid and Solid Hydrogen: (2) Separation of Free Hydrogen and other Gases from Air; (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen; (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen; (5) Pyro-Electricity, Phosphorescence, &c.

MATHEMATICAL SOCIETY, at 5.30.—Remarks on the Quartic Curve $2\alpha^2\beta+m\beta^2\gamma+n\gamma^2\alpha=0$: A. B. Basset, F.R.S.—The Theory of Cauchy's Principal Values, II.: G. H. Hardy.—The Rational Solutions of the Equation $u^3+v^3+w^3+\rho^3=0$: Prof. Steggall.

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