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The New University of London.

THE title of this article is not intended to imply any disrespect for the 'old' University of London in any of its previous incarnations. In accordance with the new statutes under the University of London Act of 1926, sealed by the Privy Council on Mar. 21, the University is going through a process to which the now familiar word 'rejuvenescence' would perhaps be more appropriate than 're-birth'; for the University, established in 1836, is not old as such institutions go, and shows few of the stigmata of senility. But all institutions of the kind live a rhythmical life, and require periodic adjustment to changing conditions. This is the third time that the University of London has received special attention from the Government of the day, and we may question whether the proverbial attribute of the 'third time' will be confirmed in this case.

The original charter incorporated persons of eminence in arts and science for the purpose of awarding degrees to students of University College and King's College and other colleges which might become affiliated. In 1858, a new charter created Convocation and granted to the graduates important privileges in relation to the government of the University. At the same time, the system of affiliating colleges was virtually abandoned, being replaced by the policy of the 'open door.' In 1900, after a spate of argument, new statutes, based on the Act of 1898, erected the loosely jointed framework of a teaching University; and now, after another spate of argument, the attempt has been made to quicken the life of the University, without altering its essential character.

What is the essential character of the University of London? Like its medieval prototypes, it is a self-governing guild of teachers, graduates, and students. Let us not forget that the medieval university was a research as well as a teaching institution. The fellowship system originated in a desire to promote study, and not to promote teaching; indeed, the founder of Queen's College, Oxford, expressly declared that he intended his benefaction to relieve his fellows from the necessity of teaching. At Oxford and Cambridge the collegiate system was a later development, an afterthought, due to domestic rather than to educational considerations, and those universities have outgrown the misconception of a university as a federation of colleges, a misconception which impeded their progress for some centuries. The present is surely an inopportune moment to force forward, as some influential members of that University are doing, an alien conception of the University as a "federation of autonomous institutions." It is true that, under the new statutes, the link between the University and its colleges has been strengthened; but the University exists apart from its colleges, and must be free to live its own life, to do its peculiar work for the extension of higher education and research, whether directly or through existing agencies or through new agencies. This obligation is emphasised rather than weakened by the new arrangements to be made by the Government and by the London County Council for the allocation by the University of public grants for university education within the London area. If the University is to be merely a clearing-house for autonomous colleges, it can never hope to gain the public esteem to which the university of the metropolis of the Empire should be entitled.

Readers of NATURE are specially interested in the promotion of scientific research, and an application of our thesis is ready to hand. One of the current controversies in the University relates to the promotion of scientific research: Should it be concentrated in the colleges in close touch with undergraduate teaching or stimulated and developed by the creation of a series of research institutes, as at Cambridge? The best way to deal with a dilemma is often to adopt both alternatives. For our part, while recognising that every encouragement must be given to the prosecution of scientific research in the colleges, we are not satisfied that the University will make its due contribution to scientific discovery if it restricts its research work in this way.

That we are not discussing the question *in vacuo* is indicated by a report of the Site and Buildings Committee received by the Senate of the University on Jan. 23 on the utilisation of the Bloomsbury site of about eleven acres. It is proposed to allocate a large part of the area to residential purposes; but the Committee "do not at present propose that the University should build laboratories." There is no evidence that the professors wish to live next-door to one another on one of the most valuable sites in the world. It is not a London characteristic. But if the reference in the sentence quoted from the Committee's report is to laboratories for scientific research, we would urge the new Senate to announce at the earliest moment an intention on the part of the University to build on the Bloomsbury site a great Temple of Science, to use Lord Rosebery's phrase, dedicated to the silent pursuit of scientific truth, a noble counterpart of St. Paul's Cathedral. As Mr. H. G. Wells has well said, the University of London has "to supply facilities for research upon an altogether unprecedented scale; it has to maintain itself as the intellectual centre of the entire Empire."

The question of the promotion of scientific research will be one of the most important facing the new Senate, now in process of election, and of the subordinate Faculty of Science and Boards of Students. Electors, whether teachers or graduates of the University—each category is to contribute seventeen members to the Senate, making together two-thirds of the membership—should recognise their serious responsibility in this matter. Men and women are required capable of rising above the jealousies and intrigues which have hindered the progress of the University in the past, capable of taking a synoptic view of the needs and problems of university education in London, of pressing steadily forward to a clearly defined conception of the university which London ought to possess.

There are many questions relating to the organisation of the new University of London which might be usefully discussed, such as the question of the University area, the work of the University in extending higher education—it is difficult to understand why the vast area of London 'across the bridges' is almost *terra incognita* as regards university education—the popularisation of knowledge, the cultivation of art, music, and the drama, the founding of a great school of law, the creation of a great international centre for the exchange of thought and practice, the provision of a great meeting-place for conferences of all kinds bearing on education, science, economics, government, national and Imperial development. We prefer, however, to stress the importance of the elections to the Senate as the dominating issue at the moment.

For the first time in its history the University of London, thanks to the Rockefeller Foundation and to the Government, has its own land on which it can build its buildings and discharge its purposes, not the least important of which is, to quote from the new statutes, "to promote research and the advancement of science and learning." May Henry VIII.'s wise words, addressed to the University of Oxford, prove true in the case of the University of London: "I tell you, sirs, that I judge no land in England better bestowed than that which is given to our Universities, for by their maintenance our Realm shall be well governed when we are dead and rotten."

Travellers' Tales.

(1) *The Book of the Marvels of India.* By Buzurg Ibn Shahriyar. From the Arabic by L. Marcel Devic. Translated into English by Peter Quennell. (The Golden Dragon Library.) Pp. vi + 164. (London: George Routledge and Sons, Ltd., 1928.) 6*s*. net.

(2) The Broadway Travellers' Series. *Hans Staden: the True History of his Captivity, 1557.* Translated and edited by Malcolm Letts, with an Introduction and Notes. Pp. xx + 191. 10*s*. 6*d*. net. *Thomas Gage, the English-American: a New Survey of the West Indies, 1648.* Edited with an Introduction by Dr. A. P. Newton. Pp. xxxii + 407 + 12 plates. 15*s*. net. *Travels in Persia, 1627–1629.* By Thomas Herbert. Abridged and edited by Sir William Foster, with an Introduction and Notes. Pp. xl + 352 + 13 plates. 15*s*. net. (London: George Routledge and Sons, Ltd., 1928.)

(3) *Adventures of an African Slaver: being a True Account of the Life of Captain Theodore Canot, Trader in Gold, Ivory, and Slaves on the Coast of Guinea; his Own Story as told in the Year 1854 to Brantz Mayer, and now edited with an Introduction by Malcolm Cowley.* Pp. xxii + 376 + 9 plates. (London: George Routledge and Sons, Ltd., 1928.) 15*s*. net.

WHY is it that nine out of ten modern books of travel are intensely dull and yet early travels never seem to fail in their appeal to the imagination or their hold on the attention of the reader? This is equally true whether they break what, in their author's time, was new ground, or follow a beaten track. In all these books under notice there is scarcely a dull page.

(1) "The Book of the Marvels of India" calls for no extended comment, though it is infinitely entertaining. It is a collection of stories current among Arab seafarers in medieval times, full of marvels described with a wealth of detail and here and there a sly touch of humour. It was obviously on some common stock that the authors of Sindbad in the "Arabian Nights," of Sir John Mandeville, the author of this collection, and other writers of similar tastes, drew for their accounts of the wonders of the East. The roc, the old man of the sea, the island of women, and other familiar marvels, will be found here, but in such a form as not entirely to preclude a remote foundation in reality.

(2) This, with the two volumes mentioned next in order, is issued in the excellent series of Broadway Travellers, for which we are indebted to the scholarship of Sir E. Denison Ross. In this series the travels selected for publication have been chosen with much discrimination, while in illustration, type, and form, the series as a whole is very pleasing.

Hans Staden's account of his captivity among the Indians of Brazil is a remarkable document. A Dutchman of the middle sixteenth century who served the Portuguese as a gunner, he visited Brazil twice, being captured on the second occasion. The Indians, whom he usually but not invariably calls Tupinambu, made a practice of eating their prisoners if they were Portuguese. Staden barely escaped that fate. He gives a unique account of the details of their method of procedure.

Thomas Gage, the author of the "English-American," was a man of very different type. Educated as a Jesuit in France and Spain, he became a Dominican and went to America, where he stayed for twelve years as a missionary. His book, written on his return to England, was the first authentic account of Spanish America and the West Indies to be written in English. It had a great vogue in the seventeenth century, dropped into oblivion, and had not since been reprinted. This was no doubt due to the fact that, the author having changed his religion, his theological polemic as well as his narrative were used by the Commonwealth as propaganda against Spain and caused the very real merits of part of his work to be forgotten. The editor has judiciously excised those parts of his book which make no appeal to the modern reader.

Gage was scarcely an admirable character—he acted as informer against his former co-religionists—and it is characteristic of the man that he expects much of what he has to say not to be believed.

Herbert, author of "Travels in Persia," accompanied Sir Dodmore Cotton on the embassy to Shah Abbas in 1627, and was thus the precursor of Tavernier, de Chardin, and other great travellers of the seventeenth century. He returned to England in 1629, and published his book in 1633. He afterwards issued several enlarged editions. The book is of considerable historical importance, as it is the only detailed account of the first English embassy to Persia. Herbert had a good opportunity of seeing something of the country, as not only was the embassy compelled to make a stay of some length, but also, owing to the absence of the Shah from his capital on their arrival, they had to follow him so far as Kasvin. Herbert was an acute, if not very profound, observer, and gives a very good account of the Persia of that day. His observations of the peoples seen at the ports at which they touched on the voyage around the Cape are also of considerable interest.

(3) "Adventures of an African Slaver" is noteworthy as a graphic account of conditions in the slave trade in the earliest part of the nineteenth century when it had been prohibited, transcribed from the oral narrative of the protagonist by an American journalist. It is absorbing, if rather horrifying, as a story and valuable as a historical document.

The Movements of Plants.

The Motor Mechanism of Plants. By Sir Jagadis Chunder Bose. Pp. xxv + 429. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 21*s.* net.

It is safe to assume that there are certain fundamental resemblances in the behaviour of all living cells in virtue of their possessing the same ground plan of protoplasmic structure, and among all aerobic cells in virtue of a similar oxidative mechanism, as the recent work of Keilin suggests. Among all animal contractile cells, again, there are general resemblances. When, therefore, we consider the observations of Sir Jagadis Bose on plant movements from the point of view of general physiology, we have to decide whether the resemblances he finds are merely common properties of living protoplasm as such, or of excitable protoplasm, or contractile protoplasm; and whether there are specific differences between the processes of animal and plant.

In the present work, as in all the work of Sir Jagadis Bose, the apparatus and methods used combine delicacy and simplicity in a delightful way. For example, nothing could be neater than the various types of tapping recorder described on pp. 16-28, for writing without friction on a smoked surface and in the same process making a time record. Another ingenious device is the 'quadrant' method for recording the change in electrical resistance of a leaf on exposure to light (p. 194). A circular leaf is connected up to a battery and galvanometer by four leads so that the leaf is divided into quadrants, each of which forms one arm of a Wheatstone's bridge. By adjusting the position of one contact the bridge resistances are balanced. Two opposite quadrants can be exposed to light while the others are kept in the dark by a screen cut to the correct shape. If the illuminated quadrants vary in resistance, the galvanometer deflection will be proportional to the product of the changes; so that a method of high sensitivity is obtained with a minimum of apparatus.

The use of this device illustrates the chief defect in this work; the lack of experimental controls. The galvanometer deflections are taken at their face value as measuring change of resistance without any inquiry as to whether the 'action current' of the excited tissue may not be a complicating factor. So far as the description goes, this method, and another one mentioned, may be simply rather roundabout ways of recording the action current. The great similarity of the curves in 'resistance' and of electrical change lends colour to this suspicion.

Some other points in the book where similar criticism is called for may as well be dealt with at once. Be it understood that criticism is directed solely against the case as presented in the volume under notice; Sir Jagadis must not blame the reader for ignoring other evidence which is not quoted. The first case is the use made of the very ingenious magnetic method for magnifying the movement of a lever. By this method a movement can be magnified ten million times (p. 346). At this magnification temperature control to 0·01° C. would seem to be called for; but no indication is given that a thermostat was used at all. Using this instrument, an oscillatory response was obtained in stems in which there was an active flow of sap. The oscillations might have been due to the natural period of the instrument. They were probably not, but no evidence is given on the matter. Again, if the oscillations are genuine their period should correspond with that of the electrical changes described previously, and changes in amplitude should be in the same direction in both cases; but no information of this sort is given, so that the results must be accepted with reserve.

In Chapter ix. experiments are described on excitation with constant current. Owing to the slow conduction of excitation, it is easy to see from which electrode the excitation process starts in any plant that makes an obvious movement. With currents near the threshold potential, excitation occurs at the cathode at the make of the current only; with rather stronger currents up to about twice the threshold value, excitation occurs also at the anode at the break. This is strictly according to the behaviour of animal tissues. With stronger currents, however, there is excitation also at the anode at the make; with stronger still at the cathode at the break. If these results were taken at their face value, as the author intends them to be, they would imply the existence of a new type of excitation process; but the data do not warrant such an extreme conclusion. When a current is passed through a tissue with cells arranged in series as well as in parallel, each cell in the region of the flow has a cathodal and anodal region. With weak currents a few cells only near each external electrode will be subjected to a potential approaching the threshold value, and the probability is that cells near the external cathode will experience the highest potential at their cathodal end and those near the anode at their anodal end, and will be excited accordingly. With potentials above that required to excite at the external anode at the break, some of the cells near the external anode may have local cathodes at which excitation occurs, and correspondingly near the external cathode. There is no reason to doubt the observations, but good reason to doubt the naïve conclusions drawn from them.

In several of the experiments described in Chapters xiii. and xiv., which deal with the electric response on stimulation, positive galvanometer deflections were found as well as negative. These positive deflections are interpreted as genuine action currents in the opposite direction to the usual action current. In every case, apparently, both electrodes were placed on functional tissue, but as one was in contact with a more obviously active region, it is assumed that all galvanometer deflections were due to changes in that region, and that no changes occurred elsewhere that could affect the other electrode. This seems a rash assumption, and it is a pity it was apparently not tested, as it easily could have been by placing the second electrode on killed tissue. It is true that several observers have claimed to find positive electrical changes in the heart when it is inhibited by stimulation of the vagus nerve, but the interpretation of the results is not clear and the case is a special one.

Turning now to the more grateful task of summarising the chief positive results : there is clearly a fundamental similarity between the processes of excitation and conduction in plant and animal, but certain interesting differences. The actual contractile process in the plant seems to be different. Two main types of movement have been investigated. The first is leaf movements, such as those of *Mimosa pudica*, which are compared with the response of skeletal muscle, and the rhythmical movements of *Desmodium gyrans*, which suggest those of heart muscle. The other type is the process of sap propulsion in the stem. As the same tissue is concerned in leaf movement and sap propulsion, it would seem natural to look for a connexion between the two processes ; this possibility the author does not, however, discuss.

The leaf movements of *Mimosa* can be studied either in the intact plant or in isolated preparations. The tissue is very sensitive to electrical stimulation by single induction shocks. Torsion of the stem and other mechanical stimuli are effective, as can be shown by the electrical response. Light can act as a stimulus to *Mimosa*, and the plant is more excitable when illuminated, so much so that a cloud passing across the sun will cause a diminished response to electrical stimulation. Subliminal stimuli become effective on repetition. The contraction occupies about one second after a latent period of one-tenth of a second. Relaxation takes several minutes. The tissue is refractory after stimulation. It is readily fatigued and shows a ‘ staircase ’ effect with a few successive stimuli.

The character of the phenomena, particularly the slow response, together with sensitivity to electric currents of short duration, does not suggest the behaviour of an isolated muscle or muscle-nerve preparation, but something more like a reflex, where the sensitivity and speed of reaction of the receptor mechanism need not resemble that of the effector mechanism. Comparison with reflex processes in vertebrates cannot be ruled out, but a closer analogy is probably to be found in such a reflex, if it can be so called, as the retraction of the syphons of the clam (*Mya arenaria*) on exposure to light or other stimuli (cf. Hecht, *Jour. Gen. Physiol.*, vols. 1 and 2).

The movement in question consists of contraction of certain cortical cells of the leaf joint. There is a large body of active cells on the lower side the contraction of which generally masks the feebler action of the cells on the upper side ; consequently, the normal movement on stimulation is a fall of the leaf, but under suitable conditions an active erection can be demonstrated. The contraction, unlike the animal contractile process, consists of a diminution of volume, whereby sap is squeezed out of the cells. This accounts for the slowness of the relaxation, which is governed by the uptake of sap. With excessive turgor the movement is diminished or even abolished, though the electric response remains (p. 168). In the dark the leaf preparation or plant becomes excessively turgid—‘ subtonic,’ the author calls the condition. In this state the first stimulus applied elicits only a small erectile response ; with successive stimuli the opposite and normal response gradually reasserts itself. The phenomena appear to be sufficiently accounted for if we consider that turgor merely masks the response of the cells, makes them contract isometrically, and affects the cells of the lower side more than those of the upper, as is indicated by a greater erection than usual. With repeated stimulation the turgor is gradually worked off.

Sir Jagadis, however, considers (pp. 48-56 and 233-237) that the energy of the stimulus has not merely a trigger action but may also contribute to the available potential energy of the tissue ; that the ‘ subtonic ’ condition is one of lowered potential energy ; and that an erectile response involves an increase of potential energy (what if the plant be turned upside down?). Let it suffice to say that the theory, if the reviewer has not misunderstood it, would imply that the mechanism of plant movement is utterly unlike anything found in the animal kingdom.

Experiments are described showing that the effect of many drugs on muscle and on plant response are similar, but the work is of less importance than it might have been had the drugs been more judiciously selected. It is not specially interesting to be told that general protoplasmic poisons such as ether or sulphuretted hydrogen depress activity, because one could have predicted as much. With such nonspecific agents, quantitative comparison of the susceptibility of different cells would be of interest, but not a merely qualitative comparison. Of much greater interest are the few experiments quoted on the action of specific drugs, such as those showing a similar action of muscarine, pilocarpine, and atropine on frog's heart and the movements of *Desmodium* (p. 269).

As the contractile process is essentially a reduction in volume of the active cells, the diameter of a leaf stalk or a stem will be slightly diminished on stimulation. This change has been measured by means of a high magnification lever system (Chapters xi. and xii.). In the leaf stalk of *Mimosa* all the cortical cells appear to be active, consequently the contraction of a single cell can be calculated. With maximal stimulation the change in diameter of the cell is 13 per cent, which implies a volume change of about 35 per cent if contraction is uniform in all directions. The method of measuring the change in diameter on stimulation enables the activity of many plants which make no obvious movements to be investigated. A contractile process can be demonstrated in many common plants, such as the bean and *Impatiens*. The recorded movements are small and slow, and the latent period is long, but the difference between ‘ active ’ and ‘ inactive ’ plants is clearly a matter of degree. The inactive plant contains fewer or less developed contractile cells, but some active cells have been shown to be present in many herbaceous plants and shrubs. This is not surprising if we accept the author's further contention that sap propulsion is due to a contractile mechanism in the cortex. If the excitation process spreads along a stem, the effect of successive contraction of cortical cells is bound to be a forward movement of sap ; if a considerable number of cells in one region can be excited simultaneously and they are predominantly on one side of the structure, the effect will be a movement of the structure as a whole.

Sir Jagadis Bose argues convincingly against the view that the ascent of sap is due solely to the action of the roots and leaves, while the rest of the plant is passive and is only a system of tubes. By several different experimental methods he shows that there is a flow of sap in isolated stems and an active process in the cortex (Chapters xxii.-xxix.). It is possible to object to his use of the term ‘ peristalsis ’ for the sap-pumping process, as the analogy has not been demonstrated except in a vague way, but the objection is of no great moment. Propulsion of sap is found to be a normal response to stimulation. The direction of flow is always from an excited region to an unexcited region, but the pressure produced by propagation of the excited state in the normal direction is about four times as great as that produced in the opposite direction. The active tissue is identified as cortical by exploring with a needle electrode until the place of maximum electric response is found.

Something ought to be said of the performance of *Desmodium gyrans*, the telegraph plant (Chapter xix.). Under normal stimulation by light, the leaflets keep up a rhythmic movement with a period of two minutes or so. In the dark these ‘ spontaneous ’ movements cease after a time, but the plant can be excited electrically or by a light. With a weak stimulus it will give a single response, with stronger stimulation a series. Apparently other plants will give several responses with moderately strong stimuli, but *Desmodium* is more excitable, less readily fatigued, and shows this phenomenon of ‘ after discharge ’ in a far more striking manner. It is remarkable to find still another character of the motor response of plants suggestive of reflex movement in animals.

For the investigation of processes of excitation and conduction, and of some peculiar types of contractile process, the vegetable kingdom evidently offers very great scope. All those interested in these aspects of general physiology will be grateful to Sir Jagadis Bose for his pioneer work, and for the extraordinarily ingenious methods he has devised.

A. D. Ritchie.

Kinetic Theory and Electric Conduction through Gases.

Conduction of Electricity through Gases. By Sir J. J. Thomson and Prof. G. P. Thomson. Third edition. Vol. I.: *General Properties of Ions; Ionization by Heat and Light.* Pp. vi + 491. (Cambridge: At the University Press, 1928.) 25*s.* net.

THE Geissler tubes and Crookes tubes that were in almost every physical laboratory at the end of the last century enabled any student to observe with ease the fascinating phenomena of electric discharges in gases at low pressures. These and the newly familiar phenomena of radioactivity and X-rays made the theory of electric conduction through gases appear to be of bewildering complexity.

One of the most remarkable chapters in scientific history is that of the development of our knowledge of these phenomena. Perhaps the greatest single factor responsible for the rapidity of the progress was the publication in 1903 and 1906 of the first and second editions of Sir J. J. Thomson's book. The world-wide interest thus aroused by these discoveries, which had originated so largely in the Cavendish Laboratory, has had a profound effect on almost every branch of modern physics.

The great influence of the book was due, not so much to the importance of the discoveries which it described, as to the fact that it was in itself a new scientific contribution. The results of previously published investigations were discussed in a most critical, but constructive, manner; frequently new points of view were developed and new or improved methods of experimental investigation were suggested. For example, on p. 222 of the second edition, in proposing a method for determining e/m, differential equations were derived which were applicable to the potential distribution in a pure electron discharge in high vacuum. When in 1912 the experimental conditions for obtaining pure electron discharges limited by space charge were found, it was only necessary to perform one more integration of Thomson's equation and introduce the boundary condition $dv/dx = 0$ at the cathode to derive an equation for the relation between current and voltage in devices having discharges of this character.

The spirit in which the book was written is best illustrated by the first and third paragraphs of the preface to the first edition:

"I have endeavoured in this work to develop the view that the conduction of electricity through gases is due to the presence in the gas of small particles charged with electricity, called ions, which under the influence of electric forces move from one part of the gas to another. My object has been to show how the various phenomena exhibited when electricity passes through gases can be co-ordinated by this conception rather than to attempt to give a complete account of the very numerous investigations which have been made on the electrical properties of gases. I have, therefore, confined myself for the most part to those phenomena which furnish results sufficiently precise to serve as a test of the truth of this theory. . . .

"With the discovery and study of Cathode rays, Röntgen rays, and Radio-activity, a new era has begun in physics, in which the electrical properties of gases have played and will play a most important part; the bearing of these discoveries on the problems of the Constitution of Matter and the Nature of Electricity is in most intimate connection with the view we take of the processes which go on when electricity passes through a gas."

The methods of analysis which were used in the book are essentially a development of the classical methods that Maxwell employed in his development of the kinetic theory.

In the twenty-two years that have elapsed since the publication of the second edition, our knowledge in this field has been increasing at an ever-accelerating pace. Furthermore, industrial applications of the utmost importance, especially in telephony and radio communication, have been built upon the foundations laid by Thomson. New and even more important applications are almost within sight.

The advent of the third edition of this book must thus arouse extreme interest. It is not surprising that there are now to be two volumes. The preface by Sir J. J. Thomson says: "The preparation of this Edition was commenced some fifteen years ago and some of it was in type when the War broke out. . . . The publication of this Edition is due to my having had the co-operation of my son, Professor G. P. Thomson, who has done most of the work required for its preparation."

The spirit and plan of the new edition are essentially the same as those of the earlier ones; even the numbering of the paragraphs is the same. The preface says:

"We have adopted a decimal notation for numbering the paragraphs, those that were in the Second Edition are denoted by integers, and those dealing with subjects cognate to the original paragraph by this integer followed by a decimal. Most, though not all, of the original paragraphs have been retained, a few in shortened form. Otherwise little alteration has been made in them beyond replacing the values of the fundamental constants by the more accurate ones obtained since the publication of the earlier editions."

The nomenclature has been changed to accord with modern practice, using 'electron' in place of 'corpuscle' or 'negative ion,' and 'X-rays' instead of 'Röntgen rays.'

The new volume, in 482 pages, covers the ground of the first ten chapters of the second edition, which there required 290 pages. The material of about 240 pages out of these 290 is used in the new edition with only minor changes. Thus about one-half of the new volume is wholly new material. It has naturally been possible to cover adequately the work of the last twenty-two years only by restricting the subject matter rather closely to the title "Conduction of Electricity through Gases" instead of dealing with the broader field of electric discharges in gases.

In Chapter i., dealing with the conductivity of gases in a normal state, five pages are added covering recent research on the penetrating radiation "coming from the sky." In speaking of the uncertain origin of these radiations it is stated (p. 12): "It would be one of the romances of science if these obscure and prosaic minute leakages of electricity from well-insulated bodies should be the means by which the most fundamental problems in the evolution of the cosmos had to be investigated."

The subject of the mobility of ions, which occupied 38 pages, or about half of Chapter ii. in the second edition, is now treated in a separate chapter of 108 pages. Eleven methods, including the recent ones of Tyndall and Grindley, and of Laporte, are discussed at length, and there follows an excellent treatment of the theory of mobility and its dependence on pressure, temperature, impurities, and the sizes and masses of the ions.

Ten pages are devoted in Chapter vi. to an account of Thomson's early work on positive ray analysis, followed by 14 pages on Aston's further development of the mass spectrograph and a discussion of isotopes. In Chapters vii. and viii., ten pages are given to Millikan's determination of e and five pages to C. T. R. Wilson's cloud tracks of ions.

Chapter ix., on ionisation by incandescent solids, has been increased from 40 to 61 pages, much less than might seem warranted by the great development in this field. After dealing with the effect of space charge on pure electron currents in high vacuum, there follows on p. 374 a discussion of the effects to be attributed to the initial velocities of the electrons from the cathode. This is treated as a problem of the diffusion of the electrons. It seems to the reviewer that the concept of diffusion of electrons in high vacuum (such as that for which the 3/2 power law applies) is not appropriate in this case, and that the only proper treatment is one of the type that has been given by Epstein, Laue, Fry, and the reviewer in various publications on this subject.

As the plan of the book is an application of the classical kinetic theory to the phenomena of gaseous conduction, it is natural that no attempt is made to treat the collisions of electrons with atoms or ions from the point of view of the quantum theory. Critical potentials are mentioned practically only on p. 472 in a comparison of Townsend's data on ionising potentials with those obtained by the Frank and Hertz method. Quanta are mentioned only in connexion with photoelectric effects involving the Einstein equation. On pp. 57-59, a theory is derived for the energy which an electron loses in colliding with a molecule, based upon the classical assumption that an electron in the molecule has a definite period of vibration, so that the impinging electron transfers a variable amount of energy to the vibrating electron.

The present value of the classical methods is, however, in general amply demonstrated by this book, and by the numerous cases where the more rigorous methods of the new mechanics have not yet been or cannot yet be applied to the solution of practical problems. The book is to be thoroughly recommended not only to those interested in the historical development and the present status of the subject matter, but also to those who still desire to have 'physical pictures' to aid them in understanding phenomena.

IRVING LANGMUIR.

Our Bookshelf.

An Introduction to Organic Chemistry. By Prof. Alexander Lowy and Dr. Benjamin Harrow. Second edition. Pp. xiv+407. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 15*s*. net.

THE second edition preserves the general character of the original. Although not sufficiently didactic for use as a vade-mecum for junior students of organic chemistry, it should be of value as a supplement to lecture courses and experimental work. Some of the numerous tables and summaries are possibly overburdened with detail, while in other instances the treatment is unduly laconic. For example, the isomerism of maleic and fumaric acids is indicated by means of two formulæ with a footnote: "It is suggested that the instructor show this type of isomerism with the Kekulé [*sic*] models." An exposition of spatial isomerism, even with the aid of an instructor and Kekulé models, leaves something to be desired.

Although the carbohydrate chapter has been revised and enlarged, there is no reference to the δ-oxide formula for glucose; moreover, the representation of lactose with a formal aldehyde group is somewhat misleading. The book contains a number of useful indications of the connexion between organic chemistry and medicine, pharmacy, dentistry, agriculture, and the biological sciences. There is adequate mention of up-to-date methods of preparing various organic substances in common use; but it is surprising to find, in a modern text-book, the terms 'diatomic,' 'triatomic,' and 'polyatomic' applied to alcohols. The type and paper are of excellent quality; the portraits of eminent organic chemists, however, are not well reproduced. J. R.

Laboratory Methods of Inorganic Chemistry. By Heinrich Biltz and Wilhelm Biltz. Authorised translation by William T. Hall and Arthur A. Blanchard. Second edition. Pp. xv+261. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 12*s.* 6*d.* net.

The first edition of Biltz was very favourably received, and the present edition is an improvement on the previous one. New preparations have been added and the older ones revised. The short theoretical sections are also very good, especially that on the periodic system, in which atomic structure is included. In most undergraduate courses the amount of practical inorganic chemistry, apart from qualitative analysis, is usually much too small in comparison with the practical organic chemistry, and there is sometimes a danger that the course will lack balance and become one-sided. Any idea that inorganic preparations do not offer so much scope for manipulative skill as those in organic chemistry will quickly be dispelled by looking through the present volume, in which a number of more difficult preparations are included. These are in many cases suitable for students who have completed an ordinary course and wish to do more advanced work without actually embarking on research.

The book will also be found most useful by students beginning research in inorganic chemistry, and by teachers who wish to introduce inorganic preparations into the more advanced courses. It may be recommended to all these as the only work of its standard in existence. When the large amount of material presented is taken into consideration, the price is very reasonable indeed.

Che cos' è l' elettricità? Per Giovanni Giorgi. (Collezione Omnia, 8.) Pp. 136. (Roma: Paolo Cremonese, 1928.) 6·50 lire.

The latest developments of physical theories point not only to the possibility of a complete change in our conception of the nature of matter, but also in our views of causality and natural law. They are no longer purely mathematical and experimental. Speculations are being made in regions formerly regarded as metaphysical and outside the limitations of human knowledge. No one can say where these speculations will lead us. Recent theories, however, are becoming more acceptable to the average physicist. Electrons and protons appearing as energy centres in so-called material waves remind us of the vortex rings which were much studied fifty years ago.

G. Giorgi, in this interesting little book, gives us a clear résumé of the opinions held as to the nature of the phenomena of electricity, beginning with Du Fay in 1733, and ending with de Broglie, Schrödinger, Dirac, and Heisenberg. Practically no knowledge of mathematics is assumed, so this book will be appreciated by the layman as well as by the scientific worker. No one can claim to have a general knowledge of science who is ignorant of these theories. If they are as important as many physicists believe them to be, then the sooner they come up before the general tribunal of mankind the better.

Leaf-Mining Insects. By James G. Needham, Stuart W. Frost, and Beatrice H. Tothill. Pp. viii+351+5 plates. (London: Baillière, Tindall and Cox, 1928.) 27*s.* net.

The authors mention that the object of this book is to provide a non-technical introduction to leaf-mining insects, an account of their biology and lists of miners, together with their host-plants. Four orders of insects, namely, Coleoptera, Lepidoptera, Hymenoptera, and Diptera, include species which have developed leaf-mining habits in their larval stages. This type of behaviour attains its greatest development in Lepidoptera, and about one-half of the volume is consequently devoted to these insects. The various grades of mining habits are discussed, and the correlation between structure and function clearly stressed in different types of larvæ. Although the subject is a specialised one, the knowledge brought together by the authors shows that the study of leaf-miners offers many features of interest to the ecologist and to the student of adaptation. At the same time, the field naturalist and economic entomologist will find the book of material help in the identification of the species found, more especially in North America. The subject matter is well arranged, the illustrations are for the most part adequate, and there is a useful bibliography provided at the end. We can recommend the book as a useful introductory manual.

The Cellulose Lacquers: a Practical Handbook on their Manufacture. By Dr. Stanley Smith. Pp. ix+145. (London: Sir Isaac Pitman and Sons, Ltd., 1928.) 7*s.* 6*d.* net.

The cellulose lacquer industry is one of great importance, and the manufacture and applications of these materials are advancing at a rapid rate. The present manual is written from the practical point of view. The style is often rather discursive, and although the author remarks that he will avoid technical terms so far as possible, this is no reason why he should not spell correctly those which he uses; 'phthallate' occurs several times. The account covers the whole subject, including raw materials, formulæ, plant, pigments, methods of application, and the industrial applications. The book is well printed and illustrated, and it will be found useful to those actually engaged in the industry.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Proposed Modification of Einstein's Field-Theory.

IN previous issues of NATURE [1] mention has been made of Einstein's recent field-theory, intended to combine in a compact geometrical model the mathematical representation both of gravitation and of electromagnetism.

The original essay of Einstein is based upon a special covariant derivation and absolute parallelism (already introduced by Prof. Weitzenböck and, independently, by Prof. Vitali), and leads to the construction of two sets of relations, one of which corresponds exactly to Maxwell's theory, whilst the other reproduces the celebrated Einstein's gravitational equations, though only to a first approximation.

I have remarked that Einstein's model may be more completely and satisfactorily attained without abandoning the usual lines of absolute calculus, and, above all, rigorously accounting for both Einstein's and Maxwell's equations. A full exposition of this method with correlated mathematical developments is now in print in the Berliner *Sitzungsberichte* (by the kind transmission of Prof. Einstein). I take the liberty of resuming here my improvement, Einstein's procedure itself having been outlined some weeks ago in the article by Prof. Eddington already quoted.

The support of the model is still the space-time V_4, that is, a Riemannian four-dimensional manifold which embodies space and time; but something is to be added to the topological attributes of this fourfold continuum, and to the expression of its metrics

(1) $$ds^2 = g_{\mu\nu}dx^\mu dx^\nu$$

in general co-ordinates x^0, x^1, x^2, x^3.

To obtain a convenient filling we first recall some fundamental notions of differential geometry. A direction function of the point (x^0, x^1, x^2, x^3) may be defined by means of the corresponding parameters $\lambda^\nu (\nu = 0, 1, 2, 3)$, that is, four numbers which are proportional to the increments dx^ν of the x^ν in the given direction, the factor of proportionality being fixed (if we exclude the directions of zero-interval along which $g_{\mu\nu}dx^\mu dx^\nu = 0$) by the quadratic condition

(2) $$g_{\mu\nu}\lambda^\mu\lambda^\nu = 1.$$ [2]

The differential equations

$$\frac{dx^0}{\lambda^0} = \frac{dx^1}{\lambda^1} = \frac{dx^2}{\lambda^2} = \frac{dx^3}{\lambda^3}$$

define a family of lines, called congruence, such that a line of the family passes through every point of the V_4 in the direction.

Now we may provide our V_4 with a fourfold diagram, *world-lattice*, by introducing not only one only, but also a set of four congruences which intersect each other at right angles. If their parameters are denoted by $\lambda_i{}^\nu$ (i order-suffix, ranging from 0 to 3), we must have, combining (2) with the condition of perpendicularity,

(3) $$g_{\mu\nu}\lambda_i{}^\mu\lambda_k{}^\nu = \delta_{ik} \qquad (i, k = 0, 1, 2, 3),$$

where δ_{ik} has the usual meaning (0 if $i \neq k$, and 1 if $i = k$).

When the $g_{\mu\nu}$ are given, equations (3) represent $4 \cdot 5/2 = 10$ conditions to be satisfied by the 16 parameters $\lambda_i{}^\nu$. But, as the $g_{\mu\nu}$ are exactly as many as the equations (3), we may also regard (3) as the definition of the $g_{\mu\nu}$, that is, of the metrics of V_4, the 16 quantities $\lambda_i{}^\nu$ being taken at will, with the only restriction that the determinant $\|\lambda_i{}^\nu\|$ does not vanish. It is, moreover, very easy to solve explicitly the (linear) equations (3) with respect to the $g_{\mu\nu}$. Denoting by $\lambda_{i/\nu}$ the reciprocal element of $\lambda_i{}^\nu$ in the determinant $\|\lambda_i{}^\nu\|$ (that is, the algebraic complement, or minor, of $\lambda_i{}^\nu$, divided by the determinant itself), we have

(3′) $$g_{\mu\nu} = \sum_0^3{}_i \lambda_{i/\mu}\lambda_{i/\nu}.$$

Our task is to show that the 16 quantities $\lambda_i{}^\nu$ (and, with them, all the features of world-lattice) may be determined by means of the field-equations. From a mere formal point of view such a requirement is quite allowable. Indeed, the gravitational equations are in number *ten* (as many as the $g_{\mu\nu}$). On the other hand, Maxwell's system involves (besides the $g_{\mu\nu}$) the six elements $F_{\mu\nu}$ of an anti-symmetrical tensor, which define simultaneously the electric and the magnetic force. The system is formed by eight equations, bounded, however, by two differential identities, so that only *six* are independent; and effectively they are able, as is well known, to determine the $F_{\mu\nu}$ uniquely from their initial values. As $10 + 6 = 16$, we have exactly as many equations as there are $\lambda_i{}^\nu$. But in what sense and manner do these equations contain our $\lambda_i{}^\nu$ (and no other unknown quantity)?

The answer is obvious, or even forced, in regard to the gravitational equations, for they are essentially partial differential equations of the second order in the $g_{\mu\nu}$; hence, by (3′), we may regard them as well as 10 differential equations for the $\lambda_i{}^\nu$; which contain, moreover, like the Maxwellian equations, the six components $F_{\mu\nu}$. In order to get relations involving only the geometrical quantities $\lambda_i{}^\nu$, we must connect in some way the F's with the λ. From an abstract point of view this may be done arbitrarily, with the only condition that the six new equations, thus arising from the Maxwellian ones, are independent one of another, and, together, of the ten former, which implies, among other things, that the $F_{\mu\nu}$ cannot be combinations of the $g_{\mu\nu}$ alone.

I propose to put:

(P) $$F_{\mu\nu}\lambda_i{}^\mu\lambda_k{}^\nu = \nu\sum_0^3{}_l \frac{d\gamma_{ikl}}{ds_l},$$

where ν denotes a constant, $\frac{d}{ds_l}$ the operator $\sum_0^3{}_\nu \lambda_l{}^\nu \frac{\partial}{\partial x^\nu}$, and the γ_{ikl} are the *Ricci's coefficients of rotation* of the set of congruences to be determined. Their explicit expressions are well known; at any rate it may be remembered that they follow immediately from the equations

(4) $$\gamma_{lik} - \gamma_{lki} = \sum_0^3{}_\nu \lambda_{l/\nu}\left(\frac{d\lambda_k{}^\nu}{ds_i} - \frac{d\lambda_i{}^\nu}{ds_k}\right),$$

(5) $$\gamma_{ikl} + \gamma_{kil} = 0 \qquad (i, k, l = 0, 1, 2, 3).$$

I shall not enter into details concerning the features of the position (P) itself, or of its consequences as transformer of the Maxwellian equations in pure geometrical ones. I content myself with a hint to the limiting case of empty space.

It has been a starting-point in the original discovery of Einstein's gravitational equations (and was after-

[1] Compare especially the brief but striking account by Prof. Eddington in NATURE of Feb. 23, pp. 280-281, and the letter from Messrs. Wiener and Vallarta in the issue of Mar. 2, p. 317.

[2] Since the ds^2 of general relativity is indefinite, the condition (2) may very well introduce imaginary λ's. We allow them here for brevity; but in my paper it is shown how any appearance of imaginaries may be avoided in the very appropriate manner systematically worked out by Prof. Eisenhart in his "Riemannian Geometry" (Princeton University Press, 1926).

wards mathematically proved by Serini) that, if the energy-tensor is zero throughout all space, and singularities are excluded, this is necessarily Euclidean. Now what will be the set of congruences in such an empty space, that is, a space where not only material masses, but also electromagnetic forces are absent ?

Our position (*P*), for $F_{\mu\nu}=0$, leads almost immediately to the conclusion that, *in empty space, the world-lattice is Cartesian.* Any intervention of material or electric phenomena carries, on the contrary, some distortion of world-lattice with it.

T. LEVI-CIVITA.

University of Rome,
Mar. 18.

The Primary Process in the Formation of the Latent Photographic Image.[1]

IN two brief notes to NATURE (**120**, 441; 1927: **121**, 865 ; 1928), it was shown by one of us that the mechanism taking place during the formation of the latent photographic image in silver bromide emulsions must be closely connected with that causing the photo-conductivity effect (that is, the decrease of resistance on illumination) in silver bromide prepared free from gelatin and other substances present in commercial emulsions.

The complete building up of the latent image is now generally considered as divisible into two stages : (1) The absorption of light by silver bromide and the immediate resulting mechanism, and (2) complicated chemical reactions between the product of the light action and the other substances, such as gelatin, present in the emulsion. The first of these stages consists in the decomposition of silver bromide into silver and bromine and is known as the *primary process*, whilst the latter or *secondary process* is supposed to be concerned with the removal of the bromine (thus leaving metallic silver) due to its taking part in the chemical reactions which follow the primary process. The problems arising in this secondary process appear only to be open to attack by chemical methods, but the first is susceptible to physical methods of attack.

In the light of modern knowledge, the function of the light in decomposing silver bromide is to transfer the valency electron back from the bromine to the silver ; *during its passage it is momentarily a free electron.*

If, when light shines on silver bromide, there is no escape for the bromine set free (this condition holds when silver bromide is fused between quartz plates), then no permanent change in the substance can take place, and whatever exposure the salt may be given it will be in precisely the same state after the exposure as it was before. But even if there is no actual decomposition, the mechanism of transfer of valency electrons still takes place when the silver bromide is exposed, only in this case there is an equilibrium existing between the rate of their liberation from the bromine ions and the rate at which they go back again. It is these liberated valency electrons which cause the photo-conductivity effect.

Thus the photo-conductivity effect in layers of silver bromide made under conditions such that the bromine cannot escape is simply an expression of the primary photographic process, isolated completely from all secondary chemical processes. Since the primary process is the part chiefly concerned with the absorption of light, this explains completely why the spectral sensitivity of the photo-conductivity effect in silver bromide is so similar to that of the finished silver bromide emulsion, as the previous communication showed.

If these photo-currents are simply due to the liberation of valency electrons, as in the photographic process, then, since we know that the latter can occur in an extremely short time, it is to be expected that these currents will start to flow almost instantaneously with the illumination of the silver bromide.

If a melt of fused silver bromide containing electrodes connected in circuit with a source of E.M.F. and a current-measuring instrument be illuminated, very complicated effects will in general be observed ; indeed, sometimes a strong *negative* effect (*i.e.* decrease of current on illumination) is the result. The causes of these complications cannot be discussed here, but one of the chief difficulties, now overcome, has been to isolate the almost instantaneous electron liberation from all complications, such, for example,

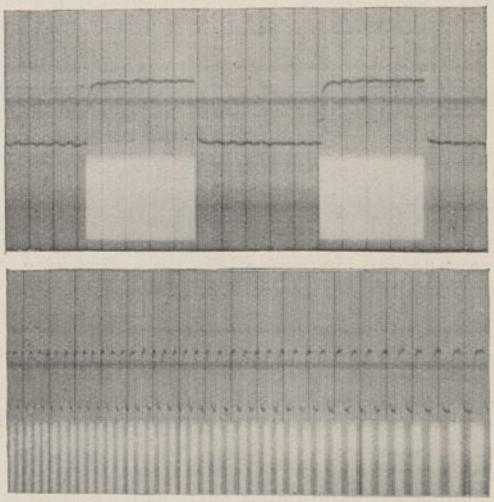

FIG. 1.—A: Two exposures, one of 0·46 sec. and the other of 0·45 sec. B: A succession of exposures from 0·02 sec. on the left to 0·06 sec. on the right; the dark vertical lines are 0·1 sec. apart and the fine lines 0·01 sec. apart.

as those which occur at the electrodes. The latter may be eliminated by using silver electrodes and shielding them from the light.

A word of explanation is necessary in connexion with the accompanying photographs (Fig. 1), the object of which is to show how nearly instantaneous is the photo-current, due to liberated valency electrons, when isolated from all other effects. A source of light was arranged so that a beam passed through a thin layer of silver bromide fused in between quartz plates and then fell on one half of a slit, behind which was a moving kinematograph film. Electrodes in the solidified layer of bromide were connected to a valve amplifier which magnified the photo-current about one hundred thousand times, and was connected to an Einthoven string galvanometer. The image of the string was focused on the other half of the moving film, along which timing marks were produced at intervals of 0·01 second. Thus the moment of illumination of the silver bromide was registered by the photographic impression on one half of the film (the lower half in the figures), whilst the time of appearance of the photo-current as given by the galvanometer deflection could be read off from the other half.

The film shows that the photo-current starts within about 0·001 second of the illumination and is completely established within 0·03 second. Since this is approximately the lag of the galvanometer in the

[1] Communication No. 72 from the British Photographic Research Association Laboratories.

valve circuit used, the probability is that the effect reaches its final value very much quicker than this, and there seems no reason to doubt that it *starts* instantaneously with the illumination as in the true photoelectric effect.

Incidentally, the film is an illustration of a single beam of light producing *only* the primary part of the photographic process in one layer of silver bromide and the *whole* photographic process (primary + secondary, giving latent image) in another layer, *i.e.* in the emulsion on the film.

We have further observed these photo-currents with an intensity of ultra-violet light which was so small that it only just produced a developable effect on a plate of H. and D. speed 550 in 1/25 second, *i.e.* the effect is observable in the region of normal photographic intensities.

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Electron Reflection from Cobalt, and Electron Waves.

Measurements by a number of observers of the velocity distribution of the electrons leaving the surface of a metal under bombardment by a beam of electrons of known velocity, have shown that a part of the secondary electrons have the primary velocity, the rest having, in general, a lower velocity. No attempt appears to have been made to resolve the secondary emission into its two components when the secondary emission is studied as a function of the velocity of the primary electrons. This is a preliminary account of the results of such an experiment. Previous work (Davis, *Proc. Nat. Acad. Am.*, **14**, p. 460; 1928) has shown that the total secondary emission from cobalt, when plotted against the primary velocity, exhibits a number of sharp maxima and minima extending over an unusually large range of voltages. This fact made it seem an ideal subject for the present type of investigation.

The procedure was to measure the total secondary emission (including both groups of secondaries) and then to apply such a retarding potential that only those electrons having within a few volts of the energy of the primary electrons could reach the collector. The difference between the two values so obtained for each primary velocity should give the magnitude of the group having the lower range of velocities. The results of the experiment are shown in Fig. 1. Here the ratio of secondary to primary currents as ordinates is plotted against the observed accelerating potentials. Curve *A* shows the total secondary emission. Curve *B* represents the 'reflected' electrons (those electrons leaving the target with velocities within two equivalent volts of the primary velocity), and curve *C*, the difference between corresponding ordinates of *A* and *B*, shows the behaviour of the low velocity group. It appears that, for cobalt at least, the important maxima of the total secondary emission curve may be attributed to the 'reflected' electrons.

The critical dependence of the number of 'reflected' electrons upon the primary velocity provokes speculation as to the nature of the phenomenon. A number of unsuccessful attempts to connect the maxima in secondary emission curves with atomic characteristics having been made in the past, it seems possible that a more fruitful line of reasoning might be one analogous to that used so successfully by Davisson and Germer (*Phys. Rev.*, **30**, 705; 1928) in explaining the reflection of electrons at the face of a single crystal of nickel. The observations being reported on were made with a polycrystalline cobalt target rather than a single crystal. Hence electrons might be expected to suffer diffraction at its surface in a manner similar to the diffraction of X-rays in the so-called 'powder' method. In this case the Bragg formula

$$n\lambda = 2d \cos \theta$$

should be satisfied, where n is the order of the diffraction beam, λ the de Broglie wave-length

$$\left[\lambda = \frac{h}{mv} = \left(\frac{150}{V}\right)^{\frac{1}{2}}\right]$$

of the electrons, d the spacing of the diffracting planes, 2θ the angle between incident and diffracted beam, and V the velocity of the incident electrons in equivalent volts.

The longest wave-length which can be diffracted by a set of planes with a spacing d will be $\lambda_{\max.} = 2d$. From the geometry of the apparatus it follows that,

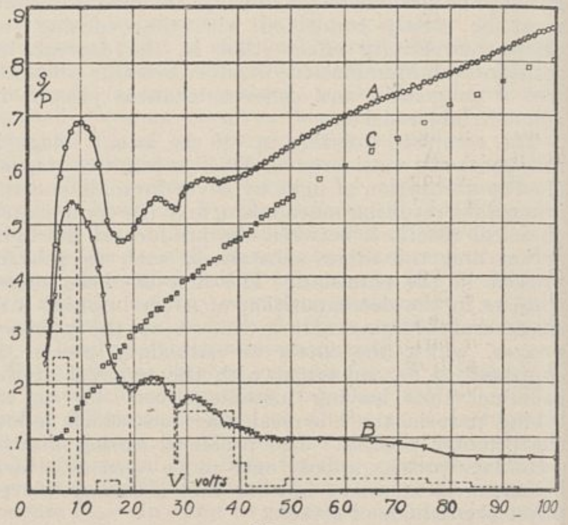

Fig. 1.

in order to reach the receiver, secondary electrons must leave the target at an angle with the normal not greater than 60°. Applying the Bragg formula within this angular range to the most important sets of planes known for cobalt in the hexagonal close-packed form, it is possible to compute ranges of electron velocities, or bands on the wave-length scale, which should be sent back into the receiving cylinder by constructive reflection. These bands are shown in the figure, their relative intensity having been taken as the known relative intensities of the corresponding X-ray reflections.

It will be seen that by this simple and obviously only approximate procedure, a fair correspondence is obtained between three groups of bands and the most prominent maxima of the secondary-electron curve. The degree of correspondence shown was obtained by shifting the observed curve to the right by a matter of 4 to 5 volts, which is just about the observed thermionic work function of cobalt. It should be pointed out that such a small shift is not in agreement with Davisson and Germer's adjustment of their own observations, they having found that an assumed surface potential of about 18 volts was the most satisfactory.

Bethe has derived approximately the same large value from theoretical considerations. In spite of this difference, it seems worth while directing attention to what can be done in the way of accounting for secondary electron maxima of cobalt on the basis of electron waves. Attempts to correlate, in a similar way, the maxima observed with other metals are now being made. MYRL N. DAVIS.

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Temperatures of Positive Ions in a Uniformly Ionised Gas.

A GAS through which a current is passing may be considered as a mixture of three gases—neutral molecules, electrons, and positive ions. In regions of relatively small field and space charge, each of these gases will show an approximate Maxwellian distribution of energies among the particles, that is, will be in temperature equilibrium within itself, but each gas will have a different temperature. Even at gas pressures so high as a millimetre of mercury, and in an almost field-free space, the temperature of the positive ions will be very much higher than the temperature of the neutral molecules with which they are continually colliding. The only available source of energy of random motion appears to be the electron gas, which is at a still higher temperature. L. H. Thomas (*Proc. Royal Soc.*, A, **121**, 464; 1928) derives formulæ for the interchange of energy between particles interacting according to the inverse square law and uses them to explain the rapidity with which a Maxwellian distribution of velocities is set up within an electron gas. They may also be used to calculate the temperature of the positive ions from the temperature of electrons and the pressure of the gas in a field-free space.

For comparison with the calculations, data of mine on the width of lines emitted from the negative glow of the helium arc will be used (*Phys. Rev.*, **32**, 918; 1928). The following assumptions form the basis of the calculations:

1. The positive ions acquire energy solely from the energy of random motion of the electrons.
2. They lose energy by collision with the molecules of neutral helium at a rate which may be calculated from kinetic theory.

The rate at which the positive ions acquire energy from the electrons is calculated from formulæ (4·22) and (4·23) of Thomas's paper, assuming all the electrons to have the most probable velocity and neglecting the velocity of the positive ions. In calculating the loss of energy to the neutral molecules, the latter are taken as stationary and the radius of the ion is taken from the Bohr theory of the helium ion. Equating the rate of gain to the rate of loss gives the calculated temperature. As the pressures were very roughly measured and the ion temperatures are subject to considerable uncertainty, the data do not warrant making a more exact calculation. The comparison is given in Table I.

TABLE I.

Electron Temp. (Volts).	Electron Density (Electrons/c.c.).	Gas Pressure (mm. of Mercury).	Ion Temp. Calc. (Volts).	Ion Temp. Obs. (Volts).
0·66	$3{\cdot}2 \times 10^{12}$	1·1	0·12	0·07
0·52	$7{\cdot}5 \times 10^{11}$	0·5	0·11	0·10
1·2	$2{\cdot}1 \times 10^{12}$	0·4	0·14	0·14
0·87	$3{\cdot}4 \times 10^{12}$	0·4	0·22	0·10
0·86	$1{\cdot}8 \times 10^{12}$	0·25	0·20	0·14

That the calculated values are consistently high may be due to neglecting the shielding effect of the gas on the interaction of the charged particles or to taking too small a radius for the helium ion. The agreement is within the error of calculation and measurement. It is interesting that even the order of magnitude is correct, as all direct measurements of interaction between positive ions and gas molecules give values which differ from those calculated from the kinetic theory. Harnwell (*Phys. Rev.*, **31**, 634; 1928), for example, found that the loss of energy of alkali ions of high velocities passing through helium was only a few per cent of that expected. Ramsauer and Beeck (*Ann. der Physik*, **87**, 1; 1928) made measurements on the same ions which extended to velocities so low as one volt, and found that the effective radii of interaction were always larger than the predicted radii and increased rapidly as the velocity decreased. The radius of the helium ion is so small compared to the radius of the helium atom that doubling or tripling it would have only a small effect on the calculated temperatures of Table I. Interesting results of the calculation are that the ion temperature should increase with decreasing electron temperature and increase with increasing electron concentration. The range of variation of electron density and temperature in these experiments is too small to test these conclusions.

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(National Research Fellow).

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Princeton University,
Princeton, N.J., April 5.

Selenium and Cathode Rays.

IN the course of some experiments upon the light-sensitive properties of selenium, evidence has been obtained by me of what appears to be a direct action of cathode rays upon the grey crystalline form of that substance.

The cell was prepared by condensing vapour of heated selenium upon a gold grid. It was placed in a glass tube which could be exhausted and so arranged that a pencil of cathode rays fell upon the crystals after passing through the openings in an earth-connected metal gauze tube which completely surrounded the cell. The cell itself was also connected to earth.

Precautions were taken to absorb all mercury vapour that might otherwise have diffused from the pump into the exhausted vessel and provision was also made for the elimination of moisture.

A simple plan was devised to detect the effect, if any, of the slight luminosity due to fluorescence that appeared when the discharge occurred, and a series of control experiments were made with all conditions similar except that a plain gold grid *without selenium* was placed within the earthed gauze screen.

The anode was sealed into a side tube behind the cathode and at a distance of about one inch from it.

It was found that, although the selenium cell used was markedly sensitive to light, no appreciable effect whatever was produced by the slight luminosity of the tube due to fluorescence either of the walls or of the glass strip upon which the selenium was deposited.

When the cell was exposed to cathode rays, however, a rapid diminution of resistance occurred which could be widely varied by deviating the rays with a magnet.

The cell exhibited many of the effects observed when light was shone upon it but the lag was less. Its resistance somewhat increased at first, due to the bombardment, so that the 'dark current' was reduced. This effect was not permanent, but frequently resulted in an unusual rise of the 'dark current' value after the discharge had ceased.

It is improbable that the marked action of the cathode rays can be attributable to the production of X-rays in the selenium, because in that case the decrease of resistance and recovery would have been far less and taken place much more slowly.

Experiments made by enclosing the cell in an earth-connected brass tube provided with an aluminium window 3/1000 inch thick looking towards the cathode, but through which the cathode rays could not penetrate, produced a very slight and gradual decrease of resistance; this and the slow increase on cessation of the discharge are typical of the action of X-rays upon selenium. In this case the X-rays were generated at the aluminium window.

Under these conditions, and with a P.D. of 60 volts across the cell, the reading of the microammeter rose slowly 10 microamperes, whereas on replacing the aluminium window by one of metal gauze the deflection suddenly increased to 250 microamperes and fell rapidly, with a slight lag, before returning to the 'dark current' value, when the cathode rays were momentarily allowed to impinge upon the selenium. The alternate spark gap at the induction coil was two inches, and the only luminosity appearing in the tube was that due to fluorescence.

C. E. S. Phillips.

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Shooter's Hill, S.E.18,
April 22.

Deposition and Surface Tension.

The publication of a lengthy study of related phenomena by L. K. Luce (*Ann. de Phys.*, February 1929, pp. 167-257) prompted this preliminary report of similar results found by the same as well as other methods during the last two years, under the direction of Prof. Gerlach, in Tübingen.

Iodine deposits resulting from directional molecular rays, as in the Dunoyer experiments (*C.R.*, **152**, 592-594; 1911), showed that those of a homogeneous nature are only possible on smooth, clean, perfectly annealed surfaces. On a surface, which was etched, rubbed, or scratched in any particular portion, crystal nuclei started growing immediately. A long series of experiments on glass and silver surfaces of various convex and concave curvatures, showed that deposition and chemical attack are a function of the curvature, cold working; or, in short, a function of the surface tension of the underlying surface. Reboul's early work (*C.R.*, **155**, p. 1227; 1912, and **156**, p. 1376; 1913) on the chemical attack of silver rods of different curvatures, as well as Luce's later work, give functional curves which are not unlike those obtained in Tübingen.

That the factors of adsorption and diffusion play a part in these experiments, as Luce remarks in his work, we find very probable. Adsorption experiments on glass surfaces of known curvature carried out on a long series of glass tubing, and on plane glass of different varieties, show similar functional relations to the results for deposition and reaction. Such thin layers can be weighed with a microbalance. For plane and slightly curved surfaces the sorption layer does not exceed monomolecular thickness, which agrees with the theory of Langmuir (*Zt. f. Elektrochemie*, **26**, p. 197; 1920), but with increasing curvature the adsorbed layer increases. In capillaries 0·8 mm. in diameter and less, the adsorbed layer is of the order of seven molecules in thickness. Where chemical attack plays the primary rôle, diffusion is of greater importance. Experiments on single crystals of silver are being carried on, and it is hoped that they will throw light on the nature of diffusion.

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Invisible Oxide Films on Metals.

In his letter in Nature of April 13, page 569, Dr. F. H. Constable adduces interesting evidence bearing upon the formation of invisible oxide films on copper at room temperatures. In fairness to Dr. W. H. J. Vernon, whose researches in this field are not mentioned by Dr. Constable, it should be stated that, working in my laboratories under the auspices of the British Non-Ferrous Metals Research Association, he demonstrated the formation of invisible oxide films on copper, and studied their inhibiting effect on tarnishing.

Dr. Vernon's results were communicated to the Atmospheric Corrosion Research Committee in 1923 though they were not published until three years later (*Journal of the Chemical Society*, p. 2273; 1926). Invisible protective films were obtained by exposure to air at room temperatures, while at higher temperatures (from 50° C. upwards) certain quantitative relationships were established. A critical thickness of film was recognised, *within the invisible range*, below which protection was no longer afforded; it was concluded that this corresponded with the unit lattice of cuprous oxide. Later (*Transactions of the Faraday Society*, **23**, 113; 1927) it was shown by the same worker that under favourable conditions, invisible protective oxide films are also produced at room temperatures upon lead and iron.

It is interesting to note that some of Dr. Vernon's earlier conclusions are confirmed by the spectrophotometric methods employed by Dr. Constable. Moreover, it is satisfactory that there is now general agreement as to the part played by the direct oxidation of metals at ordinary temperatures, about which only a few years ago differences of opinion existed.

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Skull Thickness.

With reference to Mr. Wilfred Trotter's paper, published in Nature of April 6, the following quotations from Herodotus (Isaac Taylor's translation) may be of interest:

"A remarkable Fact was pointed out to me by the People who live on the Spot where this Battle took Place. The bones of the slain being heaped apart—the Persians lying by themselves as they fell in their Ranks, and the Egyptians separately also;—the skulls of the Persians are so weak, that you may, if you please, break them in, by throwing a Pebble; while those of the Egyptians are so strong, that you scarcely produce a Fracture by dashing a stone at them."—"I observed also a similar appearance on the Field at Papremis, where lay those slain by Inarus, the Lybian, under Achaemenes, son of Darius."

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The Volta Temple at Como.

IN the year 1899 the centenary of the discovery of the voltaic pile was celebrated in Como, Volta's native city, by a joint International Electrical Exhibition and a National Exhibition of Silk Products. On the morning of July 8, fire broke out in the Exhibition, and the buildings and their contents, including the precious collection of Volta relics, were almost entirely destroyed within the short space of forty minutes.

Of the instruments constructed and used by Volta in his epoch-making experiments, only a few damaged fragments were recovered. By a fortunate chance, Volta's documents were not being exhibited, as the Royal Institute of Lombardy had refused to allow them to be sent to Como. The rebuilding of the Exhibition was commenced immediately, and was prosecuted with such vigour that the reopening ceremony took place on Sept. 1, less than two months after the fire.

A few years later the more difficult problem of the restoration of the Volta relics was attacked energetically and, in view of the apparent futility of the attempt, secretly, by one of Como's citizens, Francesco Somaini, with the help of a small band of earnest coadjutors, and in due course was successfully accomplished. No pains were spared and no document or drawing bearing on the subject was left unstudied, so that the resemblance of the reproductions to the original instruments is as close as it is humanly possible to make it. Besides having this work done and bearing the cost thereof, Somaini has, also at his own expense, erected the sumptuous Volta Temple, in which the whole of the relics, including Volta's records, the national edition of Volta's works, etc., are now housed.

This temple was designed by Frigerio, and is situated close to the shore of the lake. It is of incombustible material throughout, and is in the neoclassic style, consisting essentially of a circular court or hall of ceremonies, surmounted by a hemispherical cupola which admits a soft light to the interior. On the roof of the building, at each of the four corners, is a pedestal light faced by a griffin. The main floor of the temple is approached by two wide lateral staircases, and the doorway has, on either side, recessed statues representing Faith and Science.

Within, the recesses between the central court and the outer walls of the building contain glazed cases in which are arranged both the fragmentary remains of the instruments rescued from the fire and the reproductions of the originals. The court contains a bust of Volta on a tall column and an ornamental bronze tripod presented by the University of Pavia, where Volta served for several decades as professor and rector.

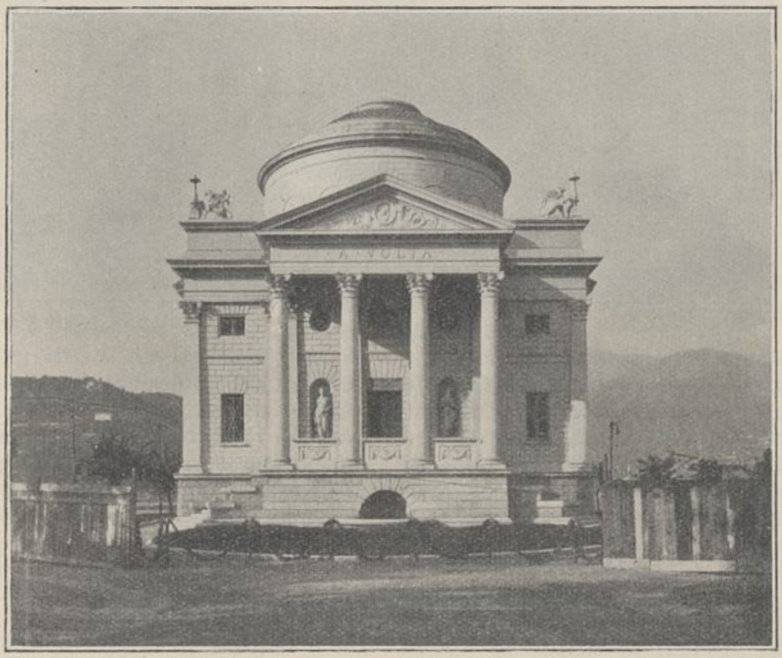
Photo.] FIG. 1.—The Volta Temple, Como. [A. C. Gatti, Milan.

A marble staircase, to the left of the entrance, leads to a gallery which surrounds the central hall and contains the library, manuscripts (including some which Somaini was fortunate enough to discover at Vienna), medals, minor records, etc. The cupola is supported by four decorated angular pilasters and eight marble columns. On the front of the parapet of the gallery are sixteen plaques giving the most significant dates in Volta's life, and four bas-reliefs representing him teaching at the University of Pavia, demonstrating his pile to Bonaparte at Paris, receiving the Emperor Napoleon in Pavia, and prophesying, as he leaves the church at Lazzate, telephonic communication. The mosaic paving of the circular hall and of the surrounding recesses is ornamented with marble, onyx, and alabaster, and the framework of the glazed cases in which the exhibits are arranged is of iron or bronze coated with green patina so as to resemble ancient bronzes.

The skeleton of the building, including the foundations, is of reinforced concrete, the external ornamentation being chiefly of Aurisina stone and the internal of Musso marble, Viggiù stone, and stucco. The structure measures about 20 metres wide by 25 deep, and the height to the apex of the cupola is more than 21 metres. The building was commenced in November 1925 and was completed by May 1927.

First among the instruments invented by Volta comes the electrophorus (1775), which followed as a natural consequence of the views expressed in his dissertation: "De vi attractiva ignis electrici ac phenomenis independentibus," published in 1769. In the three years subsequent to the appearance of the electrophorus, Volta studied, both theoretically and experimentally, the influence of the form on the electrical capacity of a conductor and elaborated the conception of tension or electrical potential. These considerations formed the starting-point of a thorough investigation into the action of atmospheric electricity, this leading to the invention of the condenser, which is also numbered among the exhibits. While developing his ideas concerning electric meteorology and the origin of atmospheric electricity, Volta devised the very sensitive straw micro-electrometers and the electrostatic balance, reproductions of these being among the apparatus shown. The various forms of voltaic pile assembled by the inventor from such ordinary household articles as spoons, and water-vessels from bird-cages, are also included.

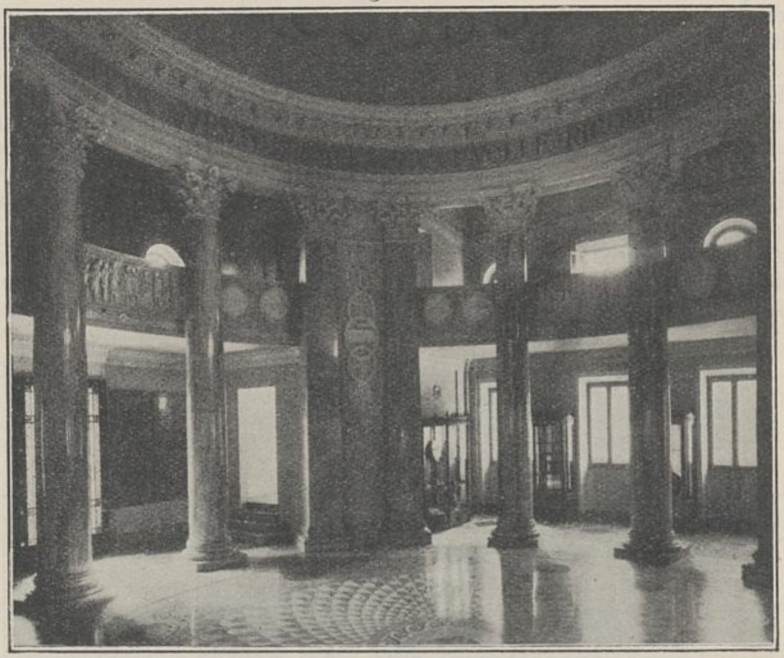

Photo.] [A. C. Gatti, Milan.

Fig. 2.—Interior of the Volta Temple.

The temple has been placed in the charge of Prof. Felice Scolari, in conjunction with the Royal Lombardy Institute, and has been generously provided, also by Somaini, with an endowment fund of 500,000 lire, the income from which is to furnish annual prizes of 5000 lire each, to be awarded to distinguished students of Como or of the canton of Ticino desirous of prosecuting studies in electrical subjects.

Physics in Relation to Oil Finding.[1]

By Prof. A. O. Rankine.

Evidence has accumulated during recent years that physical methods can be used under suitable conditions to facilitate the detection and location of minerals buried under the ground. This is a fact of considerable economic importance, having regard to the very great and wasteful expense of indiscriminate boring. Even the most careful geological survey often fails to fix with sufficient accuracy the points at which drilling is likely to be successful. Here, properly applied, physics may make its contribution to enhance the probability of success.

We are not now concerned with the divining rod and similar devices—similar, at any rate, in the respect that they can only be operated by persons specially endowed with certain obscure faculties. Sometimes the devices are dressed up to have the appearance of physical apparatus, and the methods are called geophysical; but all have this in common—that they are not capable of being independently checked, and for that reason may safely be ruled out of serious consideration. We are dealing with genuine physical methods which depend on the differences of physical properties of underground materials, and produce above the surface reliable indications, the measurement of which may provide valuable information regarding sub-surface structure.

It is important to emphasise at the outset that there is no question of physics being employed to the exclusion of geology. At the best the problems to be solved are extremely difficult, and the closest possible co-operation between the two sciences is essential. This alliance is implied in the term 'geophysics,' and for the successful development of this as a practical subject, geophysicists adequately trained both in physics and geology are the ideal personnel. Physics alone cannot solve problems of underground structure, whatever may be the efficiency of the method employed, for the unknown factors are far too numerous for a unique solution to be possible. The geologist must first indicate the kind of underground structure which is sought, and all the probable conditions under the region to be surveyed, before the physicist can even decide whether any available physical method

[1] Substance of two lectures delivered at the Royal Institution on Feb. 21 and 28.

has a reasonable chance of being applied with success. Often, owing either to the absence of surface indications of a geological character, or to such indications being misleading because of 'non-conformability' of superincumbent strata, the geologist is unable to locate with precision the structures he is seeking. It is in such circumstances that physics has been able to join forces and help to define underground conditions more exactly.

With particular reference to the occurrence of mineral oil, geology provides the information that it is usually associated with salt-domes or anticlines, buried more or less deeply below the earth's surface. A typical salt dome, of which there are numerous examples in Texas, is a sort of underground plateau of rock salt, sometimes with a relatively thin covering of anhydrite, called cap-rock, the whole being below an overburden of sands and clays. The superficial area of the roughly circular top of the dome may be several square miles, and its depth may vary from a few hundred to several thousand feet. Oil may be located sometimes at the top of the dome, and sometimes at various levels down its flanks. The earth's surface above and around the dome is usually very flat, and there is little in the way of reliable geological indications to determine their positions.

On the other hand, limestone anticlines, such as occur in south-west Persia, are blunt limestone ridges, perhaps several miles in length and relatively narrow, covered, too, with a thin layer of cap-rock, underlying a mixture of alluvium, sand-stones, marls, gypsum, and salt. In the upper part of the anticline, just below the cap-rock, natural gas may be found; farther down the flanks occurs the crude oil with much gas in solution, and still farther down the flanks salt water. Unlike the conditions relating to salt-domes, however, surface evidence of folding structure is abundant, the general direction of the strike being unmistakable. But, unfortunately, owing apparently to the plasticity of the overburden, these geological indications leave in considerable uncertainty the positions of the summits of the anticlines.

Here, then, is the problem of oil finding from the point of view of physics. It is to locate, within regions already roughly delimited by geological considerations, the position and extent of salt domes and limestone anticlines. Thus the search is not for the oil itself, but for the structures with which it is commonly associated. It is true that some claims have been made of locating oil as such by a method depending on its electrical conductivity, but this is very doubtful, and on theoretical grounds the method is distinctly unpromising. To find the oil itself is not asked of the geophysicist; if he can locate the salt dome or the anticline with enough precision, it will always be worth while to drill.

The physicist thus has to consider what properties of these structures are likely to provide surface indications capable of physical measurement and interpretation. Caution is necessary in this respect, having regard to the unfortunate tendency to generalise geophysical methods. These have been enumerated in Prof. Eve's interesting article in NATURE last year.[2] Although various claims have been made, there exists no convincing evidence that magnetic and electrical surveys have assisted materially in the location of the structures under discussion. Moreover, the magnetic susceptibilities and electrical conductivities of salt and limestone differ insufficiently from those of the surrounding materials to give on theoretical grounds any real expectation of successful application. The only physical properties which have hitherto without doubt provided means of discrimination are the differences of density and elasticity as between the salt or limestone on one hand, and the superincumbent material on the other.

Remarkable success has been achieved by measuring local variations of gravity which depend directly on the differences of density of sub-surface materials. The approximate relative densities of salt and clay, for example, are 2·1 and 2·4, and of the cap-rock over a salt dome 2·9. Small though these differences are, the elegant and amazingly sensitive Eötvös torsion balance has been proved capable of measuring the corresponding gravitational effects in the neighbourhood of numerous salt domes in Texas and elsewhere, thereby locating and defining the limits of such domes, some of them deeply buried below the surface. For a lucid account of this beautiful instrument the reader may be referred to papers by Capt. Shaw and Mr. Lancaster Jones.[3]

The main purpose of this article is to give an account of a relatively new and less well-known successful method of locating structures likely to be oil-bearing, known as the seismic method. This method can be applied even in rough country, like that in the Persian oil-fields, where gravity measurements are too much distorted by surface effects to give reliable indications of underground conditions. It depends not only on the relative densities but also on the relative elasticities of the rocks encountered, or, what amounts to the same thing, the speeds of propagation of longitudinal mechanical disturbances in these media. In the salt dome structures of Texas, these velocities differ considerably, being about 5300 metres per second for the salt, and about 2000 metres per second for the clay and sand overlying the dome. For the limestone structures of Persia the difference is not so marked, the approximate figures being 4700 metres per second in the limestone and 3700 metres per second in the overburden.

One may perhaps digress for a moment to consider the possibility of using direct reflection from a clay-salt interface as a means of determining its depth. If a device similar to the remarkable depth-sounding machine[4] which has been so successful at sea could be used, the great advantage would accrue that the measurement of the time taken for the sound to go down to the interface and return by normal reflection would enable the local depth to be estimated. But the method is not

[2] "Geophysical Prospecting." By Prof. A. S. Eve, NATURE, Mar. 10, 1928, vol. 121, p. 359.
[3] *Proc. Phys. Soc.*, vol. 35, p. 151 and p. 204.
[4] "The Acoustic Method of Depth Sounding for Navigational Purposes," by the Staff of the Director of Scientific Research, Admiralty, NATURE, Mar. 29, 1924, vol. 113, p. 463.

successful in practice, not because of the failure of the interface to reflect, the reflecting power being reasonably great, but because of the enormous damping of vibrations of audible frequency in the upper layers of the earth. Trials with an Admiralty echo-sounding machine have actually been made in Persia, but the sounds from the hammer proved much too feeble to be heard through the ground on the microphone at any useful distance. It is significant also of the poor transmitting power of the ground that the explosion of several hundred pounds of gelignite at half a mile distance was not audible through it as a medium, although it could be heard, of course, very loudly through the air.

We are thus faced with the position that great disturbances of the earth's surface, conveniently in the nature of explosions, are necessary effectively to penetrate to the depths at which oil-bearing structures are frequently found. Also that a seismograph, which will record vibrations of low inaudible frequency, is preferable to the microphone on account of the smaller damping of such vibrations. This at once rules out the direct determination of depth, previously suggested, for a sensitive seismograph obviously cannot be operated in the same position as a large explosion which excites the initial disturbance. The recording must be done at a 'safe' distance and the depths of the interface at points other than those immediately below the explosion become involved, thus complicating the problem by the change from one to two dimensions.

The necessity for using an explosion involves a new difficulty on account of the appreciable time the consequent disturbance of the earth lasts. In all cases the reflected disturbance reaches the seismograph *later* than that travelling direct near the surface, since its path is longer. Moreover, it is usually small in comparison with the direct waves, and the effects of the latter upon the seismograph at practicable distances last considerably longer than the difference of times of transmission. Consequently the reflected effect becomes so much obscured by the larger direct effect as to be unrecognisable. The solution to this difficulty lies in the existence in practice of another disturbance associated with the lower (higher velocity) medium, but distinct from the reflected disturbance, which may, at a sufficient distance from the explosion, reach the seismograph *first*. Although small, its time of arrival can be readily recognised, since it makes its record on the seismograph *before* the latter becomes violently disturbed by the direct waves. That is the essence of the success of the seismic method of revealing underground structure.

The phenomenon with which we are dealing is the same as that which has recently been recognised as operative in natural earthquakes. Even in near earthquakes, where the curvature of the earth plays no important part, the records of seismographs show preliminary displacements which apparently correspond to 'rays' from the earthquake source which pass from an upper stratum (of low propagation velocity) at the critical angle into a lower stratum (of higher propagation velocity), run parallel to the interface and eventually emerge again at the critical angle to reach the seismograph on the surface. This is, of course, an 'optical path' of an extreme character according to the ordinary laws of refraction, but since the initial incidence is at the critical angle, total reflection would occur according to the same laws, and no energy at all would be associated with the path in question. Dr. Jeffreys [5] has, however, shown that if the problem be treated as one of diffraction instead of simple refraction, the rather curious result emerges that a finite fraction of the initial energy may be expected to reach the seismograph (as is in fact found in practice) at a time which is the same as that obtained by considering the extreme optical path above described. This applies to longitudinal disturbances. There are in solids, of course, transverse disturbances as well, but these travel more slowly, and need not concern us here, since, as has been already stressed, the question is one of *first* arrivals.

Prof. Mintrop was the first to recognise the applicability of this phenomenon to the smaller scale problem of the relatively shallow formations in the earth, using artificial explosions instead of natural earthquakes. As a result he has initiated a practical system which has been widely and successfully used to determine the depths of such formations. To make the method clear, we may take the simple case of two superposed horizontal strata (Fig. 1) in which the velocities of com-

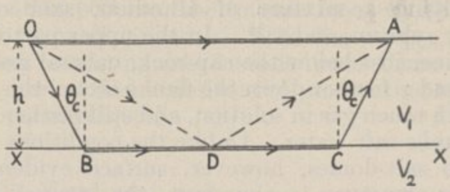

FIG. 1.—Explosion at O, seismograph at A, both on the earth's surface. XX is interface between two media of velocities V_1 and V_2, with $V_2 > V_1$.

pressional waves are V_1 and V_2, the latter corresponding to the lower medium and being (necessarily) greater than V_1. If an explosion is caused at O and a recording seismograph is located at A, three distinct disturbances reach the seismograph. One goes direct from O to A. (We are neglecting here the small curvatures which may arise from gradual variation of velocity with depth.) Another is reflected at D and arrives at A necessarily later than the former, its path being longer. The remaining disturbance arrives at A at a time corresponding to the equivalent path $OBCA$, OB and AC each making the critical angle $\theta_c = \sin^{-1} V_1/V_2$ with the normal. In the part BC the speed is the higher velocity V_2, and it is evident that if OA is great enough the total time occupied in transmission may be equal to or even less than that for the direct path OA, which is wholly in the lower velocity medium. If so, its small effect will be recognisable on the seismogram in spite of the large disturbance which follows afterwards.

(*To be continued.*)

[5] "On Compressional Waves in Two Superposed Layers." By Dr. H. Jeffreys, *Proc. Camb. Phil. Soc.*, vol. 23, p. 472; 1926.

Centenary of the Zoological Society of London.

THE annual gathering of the Zoological Society of London to receive the Council's report was held on Monday last, April 29, at the meeting room in the Gardens at Regent's Park. The occasion signalised the centenary of establishment of the Society by Royal Charter in 1829. Following this compliance with precedent and duty, a centenary celebration, extended and exceptional in character, took place in the Great Hall of University College, the Duke of Bedford, the Society's president, occupying the chair. In the evening a private complimentary dinner was held elsewhere, at which foreign and official guests were present, including the Prince of Wales.

The Zoological Society itself, as an organised body carrying diverse and onerous responsibilities, has deserved well in endeavour during its centenarian existence; its gardens, moreover, as a prime and essential feature of the original scheme, have long constituted a household word inseparable from national thought and concern. But the story of initiation of effort is somewhat older than the century implied by the charter date, 1829, and is comparable, we think, with the early beginnings of other scientific societies which sprang up at the threshold of the Victorian era. There were influences tending towards corporate association, such as British exploratory activity, the arrival of natural history specimens, and new views attaching to zoological studies. The Linnean Society, instituted in 1788, could not, as time went on, fully satisfy the requirements of zoology. In such circumstances, a group of members of that body conceived the idea, in 1822, of establishing a Zoological Club, the object of which should be "the study of zoology and comparative anatomy in all their branches, and more especially as they relate to the animals indigenous to Great Britain and Ireland." The meetings were held in Soho Square, at the former residence of Sir Joseph Banks (who had died in 1820) and home of the Linnean Society.

The Club accomplished much important work before its dissolution in 1829. Engaged in the advancement and recognition of zoology, the members were mutually cognisant of the outstanding achievements of Sir Stamford Raffles, the distinguished British colonial governor in Eastern lands, and of the unique and extensive zoological collections he had brought together. On returning permanently to England in 1824, Sir Stamford suggested to Sir Humphry Davy, the president of the Royal Society, a plan for the formation of a zoological society which should combine with the pursuit of science the introduction and domestication of such quadrupeds, birds, and fishes as might be most likely to prove useful for agricultural and domestic purposes.

Early in 1825 a circular announcement was made of a proposal to establish a society the object of which would be to attempt the introduction of new races of quadrupeds, birds, or fishes, applicable to purposes of utility, either "in our farm yards, gardens, woods, waters, lakes, or rivers; and to connect with this object a general zoological collection of prepared specimens." The name of Sir Stamford Raffles occurs in this circular, as well as, it is interesting to note, that of the Duke of Bedford. Writing round about this date to his cousin, Sir Stamford says: "I am much interested at present in establishing a grand zoological collection in the metropolis. . . . Sir Humphry Davy and myself are the projectors, and while he looks more to the practical and immediate utility to the country gentlemen, my attention is more directed to the scientific department; . . . it is further expected we may go far beyond the Jardin des Plantes at Paris." Here, adverting again to the members of the Zoological Club, it was afterwards (1829) put on record that it was in the impulse originally given by their exertions to the propagation of science, more particularly by laying the foundation of the Zoological Society, that their agency could be traced in principles and objects.

The scheme outlined briefly above, wide in its interests, and to be regulated by laws drawn up with the concurrence of the members, met with a cordial reception, and by this time (1826) Sir Stamford Raffles was an active, and in all probability dominant, personality in the difficult procedure of inauguration. Wisely, the decision was taken to draft a report on the present state and progress of natural history, especially zoology, with an account of the institutions which supplied encouragement on the Continent, and showing the necessity of some similar establishment in Great Britain. Next, application was made to the Commissioners of Woods and Forests for a grant of land from the Crown. Looking back, we may perhaps picture some perturbation of the official mind respecting so novel a proposition. However, all went well, and finally space was allotted in the great demesne of Regent's Park.

The first general meeting of the Society was held on April 29, 1826, when Sir Stamford Raffles was unanimously elected president. He read an introductory address reviewing the position of zoological studies; detailing also the objects and plans of the embryo institution. Soon after, there occurred, on July 5, the death from apoplexy, at the early age of forty-five, of this notable president and man of affairs. Sir Humphry Davy, in offering tribute, said of him that "having lost one splendid collection by fire he instantly commenced the formation of another; and having brought this to Europe, he made it not private, but public property, and placed it entirely at the disposal of a new association for the promotion of zoology, of which he had been chosen president by acclamation." The following year the Marquess of Lansdowne was elected to the presidential chair, retiring in 1831. The fellowship roll comprised then 2000 names. In 1829 the crowning of effort came in the grant of a charter by King George IV.

Through limitations of space we must leave at this point reference to the activities of the immediately succeeding years as regards both the Gardens and the Society. Some idea, however, of the achievements which had marked the close of the nineteenth century can be formed by a perusal of Mr. H. Sherren's interesting volume on the Zoological Society.

The establishment enjoyed special advantages during the secretaryship of Dr. P. L. Sclater, covering forty-three years. Since then the zealous and enterprising work of Dr. P. Chalmers Mitchell has brought the Society to its present distinctive and high position among the zoological societies of the world. As regards staff, it is significant that two women now hold office, respectively, as curator of reptiles and curator of insects. Recently, the Society has acquired Whipsnade Park, on the borders of the Chilterns, a derelict estate, destined for conversion into a zoological park, open to visitors.

News and Views.

British chemical manufacture since 1913 has not only made rapid strides which have brought it into a position of commercial eminence and have kept it abreast of world-wide development, but it has also, at least so far as its leaders are concerned, taken care to consolidate the ground gained and to prepare for further progress by the establishment and endowment of research work. At a public meeting arranged by the British Science Guild at the Mansion House on April 24, an account of which appears elsewhere in this issue, Lord Melchett, Sir Frederick Keeble, Mr. A. B. Shearer, and Mr. F. H. Carr showed something of the immensity of the contribution which chemical manufacture is making, especially in Great Britain, to the welfare and prosperity of the people. The attention of the recipients is of course distracted at the moment by discussions and political promises of employment, industrial prosperity, peace, and social service. Perhaps it was fortuitous, but more probably inevitable, that the very same phrases were used, not of ideals, but of solid accomplishments, by the speakers. The artificial silk industry has already, directly or indirectly, given employment to hundreds of thousands of workers; creating its own demand, it has often brought a touch of colour and beauty where there was little that was not drab and formless, and it has probably not been without influence where of late years a notable increase in self-respect and self-confidence has been apparent. The nitrogen industry, in time of war a sharp sword for which the British Empire reached too late, has since been beaten into a ploughshare, which is already firmly harnessed to man's ever-increasing material needs, so that the fear of nitrogen-hunger has been completely dissolved. The drug industry has already been enabled in a multitude of homes to give health where but the spark of life remained, to free the mind from the assaults of the body, and to raise barriers between whole communities and the menace of disease.

All this has been made possible by basing commercial acumen and technical skill on a firm foundation of fundamental research. The chemical industry is a structure which must be designed elastically, in order that it may rest securely and continue to grow on a base which is not only continually extending, but also may at times be found deceptive in its appearance, as researchers probe more and more deeply into the origin and meaning of things. It is to the credit of British industry and to that of the State that provision has been made for such investigations to be carried on both in the industrial and in more purely academic laboratories. Scientific research of many kinds is even more than a base; it is a frame whereby existing industries are kept virile and progressive, and around which may be built a new industry. We cannot enter into a discussion regarding the precise relation of our chemical industries to the various articles of political faith, but we can at least point out three ways in which individual or political action can help to maintain our industry and pave the way for further successful advances. We hope that our fellow-citizens will never permit themselves to forget the vital position which modern chemical manufacture occupies, not only in determining the prosperity of nations, but also in alleviating human suffering and in increasing the comforts of life. Further, we hope that they will use their influence, in whatever way seems to them proper and effective, to secure that those industries shall be nurtured in their infancy, fed with men and women of sound training, and encouraged in their growth. Finally, although we should not contemplate with equanimity an entire Cabinet of chemists, we hope that the experience and advice of our pioneers in science and the scientific foundation of industry may be given yet greater weight in the counsels of the nation.

A large and representative assembly attended the centenary celebration of the Zoological Society, held on Monday last in the Great Hall of University College, London. The Duke of Bedford, president of the Society, occupied the chair, supported by members of Council and those who were designated to convey congratulations on behalf of British and foreign countries. In his introductory remarks the president extended grateful thanks to the delegates who had come from many parts of the world to offer good wishes in person, and express their appreciation of the Society's long continuity of effort. Dr. P. Chalmers Mitchell, secretary, gave an epitome of the scientific work which had engaged the attention of the Society. He emphasised that the institution was founded by scientific men, and that their aim was not to be merely exhibitors of animals and entertainers of the public. The Society has an obligation to advance zoological studies and is fully mindful of it. In parasitology much has been done of practical importance to men and animals. An interesting summary was given by Dr. Mitchell of the work of the prosector's department. Through the publications of the Society a great body of original research is carried on and encouraged; and he recalled that one of the obligations is the maintenance of a standard library. In physiology, the relations of animals to their environment, or response to different physiological conditions, is receiving attention in the light of modern studies in that field.

Sir Charles Sherrington offered felicitations on behalf of the Royal Society; M. Charles Gravier, for the Paris Academy of Sciences, Zoological Society of France, and the Paris Museum of Natural History; Herr H. H. Dieckhoff (representing the German Ambassador), speaking in excellently phrased English, claimed that Germany has always been happy to assist in the Society's pioneer work, which has brought rich compensations to knowledge. Dr. Casey Wood, speaking for the Smithsonian Institution, Washington, referred to a message just to hand from its secretary, Dr. C. G. Abbott, who, he thought, represented the natural history institutions of his country. The message ran: "It is my desire to extend to you the greetings and best wishes of our organisation overseas. The Smithsonian Institution has had close and pleasant affiliation with the Zoological Society of London. It is my sincere wish that your Society may grow and prosper equally in the coming hundred years as it has in the century that has elapsed." Dr. Jordan, Royal Academy of Sciences, Amsterdam, expressed "deep and proud respect." Prof. Cossar Ewart and Prof. A. F. Dixon, representing respectively Scottish and Irish institutions, offered congratulations. The proceedings, which were worthy of the great Society, closed with a vote of thanks to the Duke of Bedford, proposed by Sir John Bland-Sutton.

An instructive discussion took place in the House of Lords on April 25 on the proposed large power station in Battersea. The principal objection to this station is the probable large emission of sulphurous fumes from the proposed chimneys, which will be 255 feet high. It appears that approximately one-third of the station will replace three existing generating stations, and to this extent only has authorisation to proceed been given at present. The displaced stations are antiquated, and it has been calculated that the completion of this part of the scheme will reduce the present output of sulphurous acid by about 30 per cent. We understand that the matter is being carefully considered by the Ministry of Health. Unless the Ministry, the Government Chemist and the Department of Scientific and Industrial Research, say that no danger accrues from this cause, the full scheme is not to be completed. Special methods are being tried for cleaning coal so as to reduce its sulphur content. Washing the chimney gases with forced sprays of water is also being tried. For large scale research, one of the large London power stations might be employed. Lord Birkenhead pointed out that little had been done in the past to develop the cheap supply of electric power, on which our future commercial prosperity largely depends. He said that the arguments brought forward by the opponents of the scheme should have been brought forward two years ago, and that the erection of the new power station would, from the commercial point of view, be a great boon to the residents in Battersea. In our opinion, intensive scientific study should be devoted to the elimination of sulphurous acid from the chimney gases, and electrical engineers would do well to enlist the aid of chemical experts.

Sir Harold Hartley, who delivered the Theodore William Richards memorial lecture before the Chemical Society on April 25, gave an intimate and inspiring account of the social and scientific life of that great Harvard chemist, former president of the American Chemical Society, Davy and Faraday medallist, and Nobel prizeman, who died on April 2, 1928. He said that in Richards chemistry has lost a great experimenter, the founder of a famous school of research, and one whose methods and example have exerted a profound influence on chemical investigations in every country. His earliest investigation, suggested by Prof. Josiah Parsons Cooke of Harvard, under whom he commenced his research career at eighteen years of age, consisted of a re-determination of the atomic ratio hydrogen: oxygen, and involved the weighing of globes of hydrogen, the passage of the gas over cupric oxide, and the weighing of the resulting water. The excellence of the work was recognised by the award of a fellowship which enabled Richards to spend a semester at Göttingen, and to visit most of the important laboratories of Germany, Switzerland, France, and England. He always advocated this plan of spending half a year abroad in intensive work in one institution, followed by half a year of peripatetic study, as generally offering the greatest advantage in the time available. In 1901 he received an unusual compliment in the form of a call to a chair at Göttingen, but his services were retained at Harvard, where he remained for the rest of his life. The investigation of atomic weights occupied the greater part of Richards's life, their fundamental nature appealing especially to his intense desire to know something more definite about the material and energetic structure of the universe; his first choice was copper, the study of which occupied several years, and was carried out with his typical thoroughness.

Richards was responsible for devising the nephelometer as a means of overcoming certain difficulties in atomic weight work which arise from the slight solubility of the silver halides. A second visit to Germany in 1895 gave him a new outlook, and he returned an enthusiastic, if critical, disciple of van 't Hoff and Ostwald. All of Richards's early work had been performed under most trying conditions in Boylston Hall, but in 1912 the Wolcott Gibbs memorial laboratory, which in equipment, convenience, freedom from fumes and dirt and from rapid temperature changes probably excels any other research laboratory in the world, was erected. A constant stream of researches on atomic weights came from Harvard, but the solution of the problem of their relationships seemed no nearer. Richards expressed his conviction that the periodic system represents only in a very crude fashion relationships which are highly complex and subtle. The answer to the riddle was, however, provided in 1912 by Russell, Fajans, and Soddy in their conception, independently, of isotopy. Richards's interests were not confined to atomic weights, and his activities included investigations on electro-chemistry, thermo-chemistry, and ionic equilibria. Four papers, entitled "The Significance of Changing Atomic Volume," published in 1901–4, outlined the fields of physical chemistry with which he was most closely to be associated for the next twenty-five years. Many compressibilities up to 500 atm. were measured from 1904 onwards, and fresh possibilities were opened in 1922 by Bridgman's researches on compressibility up to 12,000 atm.; during the last year of Richards's life, much of his time was devoted to the analysis of Bridgman's results and his own earlier work, and the relative magnitudes of the internal pressures are found to correspond satisfactorily with the physical properties of the elements examined. A long series of researches in thermo-chemistry originated in his interest in the energy changes and changes in heat capacity accompanying chemical action, and their relation to his theory of compressible atoms. He was, in fact, the pioneer of modern precision calorimetry, and his electro-chemical work is a most valuable contribution to our knowledge of amalgams. His work, indeed, constitutes a coherent attack on the constants of Nature.

The Annual Report for 1927–28 of the Agricultural Research Council of the Ministry of Agriculture consists of short summaries of the work in progress at the research stations and institutions in Great Britain in receipt of grants. It is a lengthy document, full of interest both scientific and practical. A perusal of this document would cause no little surprise to those who are loud in their complaints that the Government does little or nothing to benefit the agricultural industry, and would be enlightening to others who do not realise the extent to which research into the sciences associated with agriculture is assisted by government funds. Scientific research, however, is not always popular even among those who will ultimately benefit from it, and unless it can be proved that the results of such work are of immediate service to the farmer, he, at any rate, is apt to be sceptical of its value. Criticism of this kind, however, is apt to neglect two important aspects of the problem which become of increasing importance in a country like Great Britain. Under the various conditions of soil and climate, transport and markets, the agricultural industry is not really one, but consists of a large number of concerns differing largely in their needs, and in the character of the problems that beset them, so that results of research of vital importance to one section of farmers may be of little or no interest to others. As time goes on and an ever greater call is made upon the products of the soil, and farming departs more and more from traditional and accepted methods, which were in the main designed to limit risk, and ensure economic stability, so will the industry depend to an increasing extent upon the results of scientific research. It is in these two directions that the contents of this volume are of special interest, dealing as it does with almost all aspects of plants and animals in relation to the soil and to the means of their production.

It is perhaps invidious to single out the work of any single institution from this interesting account, but the Rothamsted work on the inoculation of lucerne, and that at East Malling on the manuring of apple trees, will appeal with great force to those interested in either of those problems. In view of the economic pressure in the farming industry and the reversion of arable land to grass, and the attempts that are being made in the direction of intensive grassland production, the work at Cambridge, Aberystwyth, and Aberdeen will make a wide appeal. It is now beginning to be realised that the problems connected with the management of a mixed herbage such as natural and artificial grassland are more difficult of solution than those of a single crop. The work of these centres has made it clear that, given suitable soil and climate, it is possible to produce in grass all types of food for live stock, from that which is little better than straw to that which is more similar in character and composition to linseed cake. It is surely a triumph for scientific work that this should have been possible, and should be a sufficient answer to those, ever decreasing in numbers, who doubt the value of expenditure on research.

A committee has recently been formed, with Lord Cottesloe as chairman, with the object of placing a memorial in the Tower of London to the memory of the Rev. Alexander John Forsyth, the inventor of the percussion lock and primer for firearms. Forsyth was born in 1769 at Belhelvie, Aberdeenshire, and died there on June 11, 1843. A graduate of King's College, Aberdeen, he succeeded his father as minister at Belhelvie. He was interested in the scientific discoveries of his time, and was a chemist and a practical mechanic; following up experiments made many years before in France, he succeeded in constructing a percussion lock which, with the use of detonating compounds, eventually superseded the old flint lock that had been in use for two hundred years. Forsyth's invention was made in 1803, and in 1806 he carried out experiments in the Tower of London. It was not until 1834, however, that the percussion lock was adopted for the British army. Interest in his work has been renewed by the presentation to the Tower Armouries of examples of early English firearms by Prof. Reid, of Aberdeen, one of the few surviving relatives of Forsyth. The movement has the support of the Gunmakers' Company and the Gunmakers' Association, and particulars of the proposal for a memorial can be obtained from the Curator of the Armouries, Tower of London.

On April 24 Mr. Dendy Marshall read a paper to the Newcomen Society on "The Rainhill Locomotive Trials of 1829." These famous trials actually took place in October 1829, the four competing engines being the 'Rocket,' 'Novelty,' 'Sans Pareil,' and 'Perseverance.' At that time the Liverpool and Manchester Railway was nearing completion, but though some fifty locomotives had been constructed in England and many of these were in daily use at various mines and on the Stockton and Darlington line, the directors of the Liverpool line were still in doubt as to whether to use stationary engines with rope haulage or locomotives. It was on the advice of the well-known engineers Rastrick and James Walker that a prize of £500 was offered for a locomotive which should be "a decided improvement on those now in use, as respects the consumption of smoke, increased speed, adequate power and moderate weight." Of the four engines entered, only the 'Rocket' fulfilled all the conditions and went through the trials satisfactorily, a performance which did much to establish the locomotive in an unrivalled position as the motive power of the future. The design was due to the collaboration of George and Robert Stephenson and Henry Booth, and the engine was the first locomotive containing the present features of a roomy fire-box combined with a tubular boiler. The 'Rocket' was employed on the Liverpool and Manchester Railway until 1836, when it was sold for £300. It then worked on the Midgeholm Colliery until 1844, and in 1862 was secured by Bennet Woodcroft for the Patent Office Museum, from which it passed to the Science Museum, where it is one of the most attractive of many historic relics of the past. Simultaneously with the meeting of the Newcomen Society in Caxton Hall, the American members of the Society held a meeting in New York, at which Mr. Dendy Marshall's paper was also read. An abridgment of the paper appeared in the *Engineer* for April 26.

THE atmosphere of incredulity surrounding the subject of the 'sea-serpent' tends to obscure the fact that several varieties of true sea-snake are frequently met with in the Indian Ocean and other tropical waters. Little, however, is known of their habits, a deficiency which adds interest to a recent report from the steam trawler *Humphrey*, Capt. John MacDonald. On Dec. 22, 1928, while steaming eastward from Torres Strait, a commotion was observed in the water about four miles from Double Island, and on closing it a large fish was seen to be struggling in the coils of a sea-snake, which was engaged in rapidly striking the fish's head with its own. On the ship's approach, the snake sank slowly with its prey, which it had apparently succeeded in stunning. The snake is described as being striped with bright yellow and dull brown, in rings, a coloration which points to its having been a *Platurus fasciatus*. Later in the same day, several similar snakes were seen, ranging from three to nine feet in length. According to the *Humphrey*, they are not uncommon in these waters, and craft at anchor are accustomed to plug their hawse-pipes in order to prevent the snakes, whose bite is reputed to be poisonous, from coming on board by climbing the anchor-cables.

AT a meeting of the Linnean Society of London on April 18, Sir Sidney Harmer read extracts from correspondence relating to the habits and probable end of "Pelorus Jack," probably a specimen of Risso's dolphin, which for many years accompanied ships through Pelorus Sound, at the northern extremity of South Island, New Zealand. "Pelorus Jack" was shot at several times, but after 1904 was protected by successive Orders in Council of the Government of New Zealand. The animal used to escort steamers appearing in the Sound for about 5 miles, leaping and gambolling under their bows. It is thought that it was killed about April 1912, possibly by a twin-screw steamer which took the place of a single-screw vessel formerly plying on a route passing through Pelorus Sound. In the discussion which followed, Dr. G. P. Bidder referred to an experience of his own off Plymouth in a 3-ton cutter. Five or six porpoises played close alongside, one within reach from the steersman's seat, but none touched the boat. Mr. H. N. Ridley stated that off the Dindings, on the coast of the Malayan Peninsula, his launch had been repeatedly escorted by dolphins, which rubbed against the boat and played so close to it that they could be slapped. The general opinion was that dolphins do not rub against vessels to clear themselves of barnacles, as has often been suggested. Dr. Bidder stated that the size and character of the dolphin's brain are such that it is capable of delighting in exhibiting skill and may be attracted to a ship by its noises. The classical stories of the friendliness of dolphins towards mankind may not be quite so incredible as we have supposed.

THIS year the State of Western Australia celebrates its centenary. An article in the *Nineteenth Century* for April by Mr. J. W. Kirwan recounts some of the remarkable developments in that part of Australia during the last hundred years. Although known to the Portuguese and Dutch at least from the seventeenth century, no notice was taken of Western Australia until early in the nineteenth century. It was only in May 1829 that formal possession was taken by Great Britain of the west coast of New Holland and a settlement was founded on Swan River. At the end of that year the new colony contained only 850 settlers. The struggle that faced them was severe. Knowledge of conditions had to be learnt slowly, and the aborigines were none too friendly. After five or six years the colony had made little progress. Then the introduction of penal labour improved matters, and most of the new settlers turned into good colonists. But it was the gold rush in the eighties and nineties of last century that set the colony on its feet and raised it from poverty and stagnation to prosperity and progress. The gold rush brought men of ability and enterprise as well as others of little value. Public works were undertaken, the agricultural wealth of the State was realised, and steady and continuous development begun. The population is now above 400,000 and there is ample space for many more.

ON April 24 a Fairey monoplane, piloted by Squadron-Leader A. G. Jones-Williams and Flight-Lieutenant N. H. Jenkins, left Cranwell Aerodrome, Lincolnshire, with the intention of making a non-stop flight to Bangalore, India. According to the Karachi correspondent of the *Times*, they passed over that city on the afternoon of April 26, and shortly afterwards returned and descended owing to lack of petrol. They had flown a distance of approximately 4130 miles in 50 hours 48 minutes; Karachi was reached in a little more than 48 hours. The monoplane was specially designed for the journey, and was fitted with a Napier Lion engine giving 530 h.p. at full throttle. Its weight when fully loaded was about 16,000 lb., and it is estimated that a further 1000 lb. of fuel could have been carried had a suitable runway been available for the start. The average speed for the first 2000 miles was 96 miles an hour, but along the Persian Gulf the average dropped to 70 miles an hour, the airmen travelling at a height of about 10,000 feet, being unaware of a favourable wind up to about 6000 feet.

Recent additions to the Department of Entomology of the British Museum (Natural History) include a further batch of insects presented by Mr. R. E. Turner, which, with the consignment announced last autumn, makes a total of 13,946 insects of various orders collected by him in South and South-west Africa during 1928. Upwards of 6000 of these specimens are Hymenoptera, upon which Mr. Turner is a well-known authority, while some 4000 are Coleoptera (beetles). But all orders of insects are represented in this donation, which, when fully worked out, will form a most valuable contribution to the knowledge of the insect fauna of the southern extremity of the African continent, especially since many of the specimens were obtained in localities where little if any collecting has hitherto been done. Prof. V. M. Goldschmidt, of Oslo, has presented to the Mineral Department of the Museum both rough and faceted specimens of olivine of gem quality recently discovered in western Norway. Mr. G. Tandy, of the Department of Botany, who has recently spent five months with the Great Barrier Reef Expedition, has brought back a large number of specimens illustrating the marine flora of the Reef and adjacent areas, which are being added to the botanical collections.

It is announced that the first Congress of the International Society for Microbiology, which was fixed to take place in Paris in October 1929, has been definitely postponed to June 25, 1930. The programme, which has already been published in various scientific journals, will stand.

After fifty years in the service of the Royal Institution, Mr. Henry Young is about to retire from his post as assistant secretary and keeper of the library. He was engaged as an assistant in the library in 1879, when Tyndall was the resident professor, and was promoted ten years later to the position which he now occupies. He has been a devoted servant to the Institution and a familiar friend to a large number of the members. The Royal Institution is full, as is well known, of interesting and honourable traditions, and Mr. Young has been and still is one of the chief agents of their preservation. In his place Mr. Thomas Martin, at present secretary to the Institute of Physics, has been appointed as general secretary; Mr. Ralph Cory, assistant in the library, becomes librarian.

Applications are invited for the following appointments, on or before the dates mentioned:—A first assistant in the Clinical Laboratory of the Manchester Royal Infirmary—The General Superintendent and Secretary, Royal Infirmary, Manchester (May 8). A public analyst for the City of Salford—The Medical Officer of Health, 143 Regent Road, Salford (May 11). A ballistic research officer under the Ordnance Committee—The Secretary, Ordnance Committee, Royal Arsenal, Woolwich, S.E.18 (May 11). A lecturer in pharmacy at the Belfast Municipal College of Technology—The Principal, Municipal College of Technology, Belfast (May 14). An assistant morbid anatomist and curator of the museum of the Royal Free Hospital and London School of Medicine for Women—The Secretary, Royal Free Hospital, Gray's Inn Road, W.C.1; or The Warden and Secretary, London (R.F.H.) School of Medicine for Women, Hunter Street, W.C.1 (May 15). A lecturer in biology at the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth (May 25). A technical officer and a junior technical officer at the Royal Aircraft Establishment, for work relating to the development of instruments and allied equipment for aircraft use—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 25). An assistant lecturer in physics in the University of Manchester—The Registrar, The University, Manchester (May 25). An assistant lecturer in zoology in the University of Bristol—The Secretary, The University, Bristol (June 1). An assistant lecturer in economics at the University College of North Wales, Bangor—The Registrar, University College of North Wales, Bangor (June 8). An assistant in natural history at University College, Galway—The Secretary, University College, Galway (June 8). An assistant in the Mechanical Engineering Section of the Engineering Department of the Halifax Municipal Technical College—The Principal, Municipal Technical College, Halifax. A master for building subjects in the Southall Junior Technical School—The Principal, Junior Technical School, Southall, Middlesex. A resident lecturer in science, biology and botany, elementary chemistry and physics, at St. Gabriel's Training College for Women—The Principal, St. Gabriel's Training College for Women, Camberwell. A lecturer on physics and chemistry at the Maria Grey Training College—The Principal, Maria Grey Training College, Salusbury Road, N.W.6. A technical assistant in the Department of Entomology of the Museum of Zoology, Cambridge—C. Forster Cooper, Superintendent, The Museum of Zoology, Cambridge. An experienced shorthand-typist-secretary for library work, indexing and correspondence, at the Research Station, East Malling—The Imperial Bureau of Fruit Production, Research Station, East Malling, Kent.

Erratum.—In the article on "High-Voltage Alternators for the Grid" in Nature of April 13, p. 586, "25 kilowatts" on line 33, and "10 kilowatts" on line 34, of the second column, should read "25,000 kilowatts" and "10,000 kilowatts" respectively.

Research Items.

A Remarkable Object from beneath the Red Crag.—In *Man* for April, Mr. J. Reid Moir describes a remarkable object obtained from beneath the Red Crag at a pit on the north bank of the River Gipping at Bramford, near Ipswich. It was obtained from the detritus-bed lying below loamy sand, which in turn was below glacial gravel. The bed lies at about 100 O.D. upon the surface of the London Clay. It is made up of typical sub-crag detrital material and does not exhibit any signs of glacial disturbance. The object was discovered in 1926, but beyond being labelled, was not specially noted until attention was directed to its remarkable character by the Abbé Breuil, who, on examining it, pronounced it shaped by the hand of man. In shape it is like an elongated egg with one end slightly blunter than the other. At each end is a small depression or punctuation, and similar marks are visible on other parts—in places four or five being grouped together as a rhomboid or as straight lines. It is possible that these may be due to decomposition of crystalline grains. The whole surface has been scraped with a flint, so that it is covered with a series of facets running fairly regularly from end to end. From each one is made up a number of longitudinal striations of unequal depth; a number of fine concentric incisions are visible at one of the poles. The specimen is of a greyish-brown colour, weighs approximately $\frac{1}{2}$ ounce, and measures at its greatest length $1\frac{6}{16}$ in., and at its greatest depth $\frac{14}{16}$ in. The exact nature of its material is in doubt. The Abbé Breuil compares it with the steatite sling stones of New Caledonia.

Tlingit Emblems.—In the *Museum Journal* (Philadelphia) for December last, Mr. Louis Shotridge describes a number of ancient clan emblems of the Tlingit of Alaska; these formed part of a collection of ancient objects representative of the traditional art of this people which he was able to collect solely in virtue of the fact that he himself was a Tlingit of noble birth. These objects, it is stated, had not seen the light since the introduction of the white man's religion and law. The emblems are in the form of ceremonial head-dresses, each of a once generally recognised grade in rank and importance. The Tlingit were divided into two nations, each of which was subdivided into clans. Each clan had its ceremonial head-dress, but its possession was often the subject of dispute and the cause of internecine war. On the side of the Tlhigh-naedi nation, first in importance was the raven hat, which signified culture; next in order the whale hat, an emblem of greatness and the cult object of the greatest clan. The frog hat signified persistence and was the emblem of the Kiks-adi clan. On the side of the Shungookaedi nation were the eagle, the grizzly bear, the emblem of power, and the wolf, signifying courage. The hats are for the most part woven of roots of the spruce, with highly conventionalised representations of the head or other part of the animal simulated carved in wood and ornamented with locks of human hair. On most there was a 'top-stock' of spruce roots, woven to resemble a number of interlocking cylindrical boxes superimposed which could be made to expand or contract. The number of these boxes or divisions represents the number of ceremonies in which each hat was used.

Lessons from the Human Foot.—In the third lecture in memory of Hugh Owen Thomas, delivered before the Medical Institution at Liverpool on May 11, 1928, Sir Arthur Keith discussed some of the problems of the human foot (*Jour. Bone and Joint Surgery*, January 1929). He looked upon the sequence of postural functions as a more promising line of investigation than anatomical details, and took it as proved that the human foot had been evolved from a prehensile foot, the nearest representative of the primitive form being that of the chimpanzee. The chief changes which transformed the prehensile into plantigrade were due to growth—a recession of growth of the external or planar limb of the prehensile foot with a progressive growth in the hallucial limb. Three stages of this growth-development can be followed: the pronograde prehensile foot, the small orthograde foot (hylobatian), the massive orthograde foot (troglodytian) leading to the human plantigrade. The mass of the body has been the most important factor in bringing about the later changes, and it is inferred that it was the weight of the body which compelled man's anthropoid ancestors to assume terrestrial habits of life, and that man is the descendant not of a pigmy anthropoid but of one of massive body.

Rural Population of New York State.—In a study of the movements of population in New York State from 1855 to 1925 (Cornell University Agricultural Experiment Station, *Memoir* 116) Mr. B. L. Melvin brings to light a number of interesting facts especially with regard to recent years. While the population of New York State increased 7·5 per cent from 1920 to 1925, the total city population, including New York City, grew less than did other classes, and the larger cities gained less than the smaller ones. Suburbanisation was the most marked phenomenon in the shifting of population in that period. As a result, rural population increased, especially in those counties where urban influences were most dominant. That this increase was due to urban influences, provided no doubt by improved transport, seems to be clear from the fact that farm population increased only in suburban counties but decreased in all others. Cities seem to maintain the farm population near them rather than to cause its decline. In such a study, of course, the use of terms is somewhat arbitrary. Mr. Melvin classes as rural population all persons living outside places of population 2500 and above. The pamphlet is well illustrated with distributional maps.

Migrations of the Arctic Tern.—A *Daily Science News Bulletin*, issued by Science Service, Washington, D.C., announces that an Arctic tern, ringed as a fledgling at Turnevik Bay, Labrador, on July 28, 1928, was found dead on the beach at Margate, fifteen miles south-west of Port Shepstone, Natal, South Africa, on Nov. 14, 1928. This is a remarkable record, not only for the distance covered, but also for the fact that the bird could have been only about three months old at the time of the flight. It suggests the possibility that the birds, which are rarely or never seen on the south Atlantic coast of the United States, may cross the ocean to Europe and then proceed south. The extensive migrations of the Arctic tern are well known, and owing to its habit of breeding in the northern portion of the northern hemisphere and of wintering in the far south, it enjoys more hours of sunlight than any other living creature. In the northern part of its breeding range and during its stay in the Antarctic regions, it lives practically in continuous daylight.

Genitalia and Genital Ducts of Insects.—C. J. George (*Quart. Jour. Micr. Sci.*, vol. 72, part 3) has examined the development and morphology of the genitalia of Homoptera, as represented by the frog-hopper, *Philœnus*, and of Zygoptera as represented by *Agrion* (one of the demoiselle flies) and sets down the homologies of the parts. As the result of studies on the development of the genital ducts, he concludes that the vaginal opening in Orthoptera, Hymenoptera, Homoptera, Diptera, and Lepidoptera is homologous, and that the vaginal opening in Coleoptera is homologous with the oviducal opening of Lepidoptera and with the opening of the accessory gland of Homoptera, Hymenoptera, Diptera, and Isoptera. The common oviduct, being formed differently in the different groups, is not homologous, and the accessory organs, for example, spermatheca, are not homologous. The author discusses the probable lines of evolution of the female ducts in Insecta, and points out that the Ephemeroptera with their double female openings on the seventh abdominal segment exhibit an ancient condition, and that many higher insects pass through this condition during their larval and nymphal stages. The existence of an ectodermal invagination behind the seventh abdominal segment in Homoptera and Orthoptera shows that the acquisition of a single gonopore was the next step. The later ontogenetic history shows that there has been a tendency to shift the gonopore to the terminal abdominal segments. The conclusion is that the Orthoptera, Homoptera, Lepidoptera, and Diptera are closely allied, but the Coleoptera have had a different line of evolution.

Chromosome Linkage in *Œnothera* Hybrids.—Prof. R. R. Gates and F. M. L. Sheffield, in *Phil. Trans. Royal Soc.*, B, vol. 217, 367 (1929), have published an account of important cytological researches on reciprocal hybrids obtained from *Œnothera ammophila* and *Œ.* (*biennis* × *rubricalyx*). The reciprocal F_1 hybrids are very different and are patroclinous. The chromosome linkages were found to be unlike in the reciprocal hybrids. In *Œ. ammophila* × (*biennis* × *rubricalyx*) the spireme segments in diakinesis into three free pairs of chromosomes and a ring of eight. In the reciprocal cross there are, on the contrary, seven chromosome ring pairs. That the latter has all its chromosomes paired makes it clear that complete pairing is not necessarily a sign of the homozygous condition. The conclusion is reached that since the same two haploid sets of chromosomes are present in the reciprocal hybrids, the cytoplasm plays a part in determining what pairing shall take place ; it influences the attractions between the chromosomes and the distribution of chromosomes in the reduction division. This leads in itself to a departure from usual Mendelian behaviour. The production in F_1 of true breeding hybrid types is to be explained through the occurrence of chromosome linkage, which prevents free assortment of the chromosome pairs, and hence of the differential characters. Linkage differences in *Œnothera* occur in wild species as in mutations arising in controlled experiments. It seems, therefore, that evolution can occur through germinal changes (mutations) of various kinds arising in a succession of species which are of natural hybrid origin, but, in the main, breed true because of their persistent chromosome linkages in meiosis. In this probable sequence we have suggested a new evolutionary phenomenon which may be of much significance for the student of the origin of species.

A New 'Deep' in the Pacific.—A *Daily Science News Bulletin*, issued by Science Service, Washington, D.C., announces that the non-magnetic ship *Carnegie*, now cruising in the Pacific Ocean, has discovered a new deep some fifty miles west of Tahiti. The greatest depth was 5400 metres, and its area does not seem to be extensive. The observations were made with the sonic depth-finder. Captain Ault named the depression the Bauer deep, after the director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. A further discovery was that of a submarine ridge in approximately lat. 23° S. and long. 80° W. This seems to be a northward extension of the ridge on which the San Felix Islands lie. It was named the Merriam ridge. Other oceanographical discoveries were made, but details are not yet given.

Ice in the Arctic Sea.—The Danish Meteorological Institute has published in the *Nautisk-Meteorologisk Aarbog*, 1928, its usual report on the state of the ice in Arctic Seas during the year. Most of the observations are naturally for the summer months, but off south-west Greenland, western Spitsbergen, and in the North Atlantic it is possible to give reports for all months. In the Barents and Kara Seas there was less ice than usual in the summer. Franz Josef Land could be reached in August, while in September there was even water between some of the islands of the archipelago. In Spitsbergen waters conditions were favourable except for unusually late streams of pack-ice on the south-west coast. In August and September Spitsbergen could be circumnavigated without difficulty. The east coast of Greenland had rather more ice than usual, and this state of affairs was found also in the east of Spitsbergen. On the other hand, there seems to be no evidence of an increased outflow of pack-ice by the other outlets of the Arctic Sea. Davis Strait and Baffin Bay had rather less ice than usual. Reports from the Bering Sea are few and vague. Iceland coasts were practically free throughout the year. On the Newfoundland Banks pack-ice was below the normal in every month, but icebergs were much above the normal in April, May, and June. The report is illustrated with the usual charts for the spring and summer months.

Raman Effect and the Spectrum of Hydrogen.—In Nature, Jan. 26, p. 127, Prof. H. S. Allen suggested the view that many of the faint lines in the secondary spectrum of hydrogen may result from the bombardment of hydrogen molecules by light quanta of frequencies corresponding to the Balmer lines. A table was given for the first five Balmer lines showing a number of possible Raman lines having frequency differences with respect to the exciting line which were integral multiples of a particular wave number. Dr. D. B. Deodhar, Physics Department, University of Lucknow, in a letter to the Editor, states that he has made a further search in this direction, using the recently published wave-length tables of Finkelnburg, and for ten members of the Balmer series has found a large number of lines, both of lower as well as of higher frequencies, which approximately occupy the positions of Raman lines. Finkelnburg's experimental tube was energised with 2000 volts, giving a discharge current of 600 ma., while the current in Gale, Monk, and Lee's tube was only 20 ma. Finkelnburg discovered about 2000 lines which were previously unknown in the spectrum of hydrogen. The intensity of the Balmer lines in his experiments was considerably greater than in those of Gale, Monk, and Lee. It is interesting to note that a majority of the Raman lines of *increased* frequency belong to the newly discovered lines, and that they are of very low intensity. Dr. Deodhar expresses the opinion that his results strongly corroborate the view put forward by Prof. Allen ; but, in consideration of the high accuracy of recent measurements of wave-lengths in the hydrogen spectrum, it may be well to scrutinise such results very carefully.

Molecular Rays.—Some experiments performed with beams of molecules by Prof. O. Stern and F. Knauer (*Zeitschrift für Physik*, Mar. 7) furnish good qualitative evidence that particles of atomic dimensions, as well as electrons, behave as waves in certain circumstances. The de Broglie waves of a hydrogen molecule at room temperatures gave an average wave-length of about 1 A., and should therefore be reflected specularly from a well-polished mirror if they are incident upon it at an angle of the order of a thousandth of a radian, as are X-rays of corresponding wave-length. This has been shown to be the case; the efficiency of reflection is greater the less the glancing angle, and the angle at which reflection first becomes marked is about that which would be expected from the size of the irregularities on the polished surface, whilst the amount of reflection increases as the temperature of the beam of molecular rays is lowered, that is, as the equivalent wave-length of the particles is increased. Prof. Stern was unable to obtain any positive results in an attempt to diffract molecules from a ruled grating, but his results with a crystal surface, although not quite definite, are compatible with the idea that diffraction takes place in this case.

Load and Tariff in Electric Supply.—The standard method of distributing electrical energy in Great Britain is by means of three wires carrying alternating currents, the phases of the currents in each wire being different. The consumer's load can either be connected in mesh (like a triangle) or in star (the three wires being joined together at one point). When the load is balanced, the measurement of the power taken presents no difficulty. When, however, the power expended in each of the three arms is different, the problem becomes complex and the ordinary methods of measurement give no useful or sufficient indication of the nature of the load taken by a consumer. In addition to the values of the three currents in the arms, we have to take into account the phase differences between these currents and the electromotive forces driving them. This problem, which is almost purely mathematical, was discussed in a paper by E. W. Hill, read to the Institution of Electrical Engineers on April 5. The solution arrived at, however, whilst possibly better than some of the methods at present in use, appears to us not to classify consumer's loads in a truly equitable way. If the assumption is made that all the waves follow the harmonic law, the solution given by Russell, which is referred to in the paper, seems to be a satisfactory one. The general case, however, yet remains to be solved, although a very large number of papers have been written on the subject, especially in America. There are few industrial applications where mathematics can be more usefully employed than in electrical engineering.

Geographical Influences and Radio Waves.—In the *Revue Scientifique* for Mar. 23, R. Bureau, of the French meteorological office, gives data which show that ordinary meteorological and geographical causes exert a very appreciable influence on the propagation of radio waves. In the early days the hypothesis of a conducting layer in the upper atmosphere was a great help in enabling us to picture how part of the radio energy flowed round the earth. With waves the frequency of which exceeds 6000 kilocycles (wave-length less than 50 metres) it gives a fairly satisfactory explanation of the 'zones of silence' observed in practice. It is now accepted, however, that the height of this layer is a quantity varying at different times of the day and that there are possibly several conducting layers at different heights. Apart, however, from what happens in the upper atmosphere, important effects are produced in the troposphere, which is about six miles in height, and in the lower layers of the stratosphere. Contrary to expectation, direct experiment has shown that the surface which separates the stratosphere from the troposphere has little, if any, effect on the propagation of the waves. It is found that short waves, whether entering or leaving France, have very different properties, which depend on their direction of propagation. Waves coming from the Caribbean Sea, Panama, and the Gulf of Mexico suffer little attenuation. On the other hand it is, if not impossible, at least very difficult to get signals from the north-east of the United States and from Newfoundland. Signals given by a 200-watt emitter on the Atlantic coast of Morocco seem never to reach central or eastern Europe, although they can be heard in other directions for thousands of miles. The radio waves seem to have difficulty in passing through the surface of separation between a mass of cold air and a mass of warm air. The lines which separate the audible zones from the zones of silence often coincide very closely with the meteorological lines separating masses of cold and warm air.

Crystal Structure of β-thallium.—At the ordinary temperatures, α-thallium has a hexagonal close-packed lattice. Drs. Nishikawa and Asahara have shown by X-ray methods that it has an inversion point at about 230° C. The change in crystal form consequent upon this has been investigated by Mr. Sinkiti Sekito, of the Research Institute for Iron, Steel, and other Metals, Sendai, Japan, who has sent us a short communication on the subject. The metal was retained in the form stable above the inversion temperature by quenching it in iced water. Photograms were then prepared, using a chromium anticathode and taking the wave-length as $CrK_\alpha = 2{\cdot}287$, $CrK_\beta = 2{\cdot}080$. It appears from these that β-thallium has a face-centred cubic lattice ($a = 4{\cdot}841$). Calculating the specific gravity from this value, the figure 11·86 is obtained, which agrees well with the results obtained by other methods. A similar face-centred cubic structure was obtained with thallium alloys containing bismuth, lead, antimony, or tin in solid solution. Mr. Sekito concludes, therefore, that the face-centredness of thallium above 230° C. has been definitely established.

Hydrates of Cadmium Sulphate.—The hydration of cadmium sulphate was for long the subject of controversy, until Hauer and also Rammelsberg showed that, at ordinary temperatures and pressures, this salt crystallises from its solutions as the monoclinic hydrate, $CdSO_4$, 2·67 H_2O. This result was confirmed by later investigators and, as a consequence of vapour pressure measurements by Carpenter and Jette in 1923, the temperature of transformation into the monohydrate was given as 41·5°. A systematic study of the dehydration of this salt, carried out by Prof. Luca Coniglio, is recorded in the *Rendiconti* of the Academy of Physical and Mathematical Sciences of Naples for January–April 1928. The experimental data show that at 74°, $CdSO_4$, $\frac{8}{3}H_2O$ loses $\frac{5}{3}H_2O$, giving the monohydrate, which is stable until the temperature reaches about 120°, when further expulsion of water occurs, with formation of $3CdSO_4$, $2H_2O$. The latter hydrate is stable at temperatures below about 138°, when another molecule of water is lost, giving $3CdSO_4$, H_2O, which is converted, but only comparatively slowly, into the anhydrous salt at 150°. It seems probable that the water of crystallisation of the original salt is combined, not with a single molecule, but with three molecules, of the cadmium sulphate, the formula being $3CdSO_4$, $8H_2O$.

Developments of British Chemical Manufactures.

AT the instance of the British Science Guild, a public meeting was held at the Mansion House, London, on April 24, when an account was given of certain phases in the development of British chemical industry. Lord Melchett, who presided, referred briefly to the origin and the present status of the nitrogen industry, remarking that although the synthetic ammonia industry has grown up in the last few years, the problem of the supply of artificial fertilisers is by no means new. Nevertheless, older sources of combined nitrogen were inadequate, and had the new industry not been created the fields of the world would soon have starved for one of the most elemental necessities. The new textile also, originally a British conception, has proved applicable in numerous directions, whilst the drug industry is proceeding in the direction of the synthesis of highly complex substances. Other manufactures are equally dependent on the prosecution of scientific research, and the value of such research should be more fully realised.

Sir Frederick Keeble then addressed the meeting on "Fertilisers from the Air," saying that, like the legendary discovery by Prometheus of fire, fertilisers have been brought down from heaven by modern chemists. Without sufficient nitrogen in the form of salts of ammonia or nitrates, the green plant is unable to manufacture sugars and proteins at its maximum capacity; lack of available nitrogen has always limited life on this planet. Natural processes are too slow for the modern world, and before the year 1913 a general nitrogen-hunger had become apparent. Now, however, the nitrogen of the air is being made into fertilisers at the rate of more than one million tons a year, drawing on a supply so vast that, at the present rate of use, it will last for four thousand million years. Farmers are now acquiring the habit of using larger quantities of nitrogenous and other fertilisers; Holland leads the way, followed by Belgium, Germany, Japan, Egypt, Great Britain, and France, whilst the use of nitrogenous fertilisers in the United States of America is well below that of Western European countries. The material is now one of our cheapest commodities, and thus provides the farmer with the best means of reducing costs and of obtaining improved economic results from his farm. Sir Frederick then outlined the origin and development of the great factory at Billingham, where attention is now being directed to the manufacture of fertilisers containing other plant foods in addition to nitrogen.

The 'rayon' (artificial silk) industry was described by Mr. A. B. Shearer, who insisted that the use of the expression 'artificial silk' only keeps alive an erroneous impression of inferiority, since the new textile is no more artificial than is steel or many other manufactured products, and since it possesses none of the chemical, and few of the physical, characteristics of silk. The four principal processes involved, in order of their industrial development, are those known as the nitrocellulose, cuprammonium, viscose, and cellulose acetate processes. Nitrocellulose was first used in 1883 to produce a continuous cellulose thread by Sir Joseph Swan, who in 1885 exhibited fabrics made from his yarns, whilst a year later Count Hilaire de Chardonnet became the first producer of rayon for textile purposes. After briefly indicating the nature of the processes employed in the production of these textile fibres, Mr. Shearer emphasised the debt which the new industry owes to scientific discovery, and showed how the new fabrics successfully minister to the needs created by changes in the habits and outlook of civilised peoples. The difficulties of establishing a new industry are seldom realised, but it must be placed to the credit of British organisation, business foresight, engineering skill, textile technology, and salesmanship, that Great Britain has been able to take and maintain the lead in this great industry. Moreover, the use of rayon has had a marked effect on the general condition of the textile industries, its special requirements leading to generally applicable improved methods of manufacture and treatment, in the application of which the worker has benefited.

Mr. F. H. Carr spoke of developments in the study and manufacture, particularly in Great Britain, of synthetic drugs. The great success of salvarsan provided a strong incentive for the search for other synthetic drugs which exert an antagonistic effect on disease organisms without injuring the infected person; for example, various organic compounds of arsenic and antimony are now employed, especially in the treatment of certain tropical diseases. In its normal chemical processes the body is continually producing active principles, chemical substances, which control and regulate its action. A study of these substances has led to the possibility of their replacement, in cases of deficiency, by synthetic, or at least externally prepared, substances. Insulin has not yet been made synthetically, but adrenaline, secreted by the suprarenal gland, has been synthesised, and, moreover, nearly related compounds with other valuable medicinal properties have been prepared. Mr. Carr also referred to the synthesis of ephedrine, an alkaloid which occurs in the Chinese plant Ma-huang; this substance powerfully relieves the distressing effects of asthma. Vitamin-D is now made by the action of ultra-violet light on ergosterol, a substance derived from yeast.

Mr. Carr sketched the progress of the medicinal chemical industry in Great Britain, and remarked that to-day there are important manufacturing firms which, between them, are making most of the synthetic drugs. The fact that there are some exceptions, chiefly substances derived from intermediates employed in the manufacture of dyes, shows that the organisation of chemical industry in Great Britain, although it has made rapid strides, has not yet been completed. The changes which have occurred in chemical industry of late years are in large measure the result of the mutual approach and understanding which have already taken place between the business, the scientific, and the practical men in the industry. Future progress lies in extending the use of science in the industry, in the first place by promoting research in industrial laboratories in the closest possible relationship with that carried out in academic institutions and under the ægis of the Medical Research Council, and, secondly, by finding employment for greater numbers of scientifically trained staffs and workers to whom is given responsibility and a living interest in the work they are performing.

Sir Richard Gregory, who proposed a vote of thanks to the chairman, said that the fact that scientific research leads not only to new outlets for employment but also to the creation of entirely new industries is too often overlooked by politicians. British scientific capacity is at least as great as that of any other people in the world, and he hoped that it would be yet more fully employed in such development and creation.

Radium Requirements of Great Britain.

ON July 7, 1928, the chairman of the Committee of Civil Research appointed a sub-committee, with the Right Hon. Lord Rayleigh as chairman, to examine the radium requirements of Great Britain in relation to the present sources of supply and to submit recommendations. The Report of the Radium Sub-Committee (dated Mar. 7, 1929) has now been published (London: H.M. Stationery Office. 6*d*.). The document is of absorbing interest, for it not only discusses the importance of radium in medical treatment and the amount required for such purposes in Great Britain, but it also presents a valuable survey of the sources of radium production, with special reference to deposits in the British Empire. Among the conclusions reached are the following:

The amount of radium belonging to the Government which is available for medical purposes in England, Scotland, and Wales is 2·2 grams, and the estimated amount believed to be the property of hospitals and private medical practitioners, or likely to be so in (say) three months' time, is approximately 22·7 grams, making a total of 24·9 (or say 25) grams.

The amount required to meet existing needs in Great Britain is probably approximately 49 or 50 grams, that is, an immediate addition of about 24 grams to the existing national stock is required.

Owing to the lack of trained personnel and to the inadequacy of the available hospital accommodation, it is probable that not more than 20 additional grams of radium could be effectively absorbed for medical purposes by the end of 1930.

There exists a pressing need for the establishment of a central stock of radium and the organisation of some systematic method for its distribution.

Until sources of supply at present unproved or unknown are discovered in the Empire or elsewhere, the only source from which additional supplies of radium for medical purposes are obtainable in any quantity is the Belgian Congo.

The following are the chief recommendations submitted:

Steps should be taken at once to ensure the acquisition by instalments of 20 additional grams of radium element for medical purposes.

A body of trustees should be appointed entitled the National Radium Trustees, whose duty it should be to hold the funds provided by Parliament or otherwise, and to purchase therewith and hold radium for use by the Radium Commission referred to below.

The National Radium Trustees should appoint a body to be called "The Radium Commission," who should have the following powers and duties:

Generally to deal with the custody, distribution, and use of all radium held by the trustees, having regard to the advancement of knowledge, the treatment of the sick, and economy of use; and, in particular, to consider and approve plans submitted to them for the use of radium for the purposes of medical treatment and research, and to make the necessary arrangements for the supply of radium for such uses.

As was announced in our issue of April 27, p. 649, the Government has accepted the financial recommendation of the Sub-Committee, and will contribute £1 for every £1 of private subscription up to £100,000 for the purchase of radium. This leaves a sum of £150,000 to be raised by private subscription if the quantity of radium required is to be purchased. A double appeal has now been issued. An anonymous donor has given £100,000 to King Edward's Hospital Fund for London, to form the nucleus of a thank-offering fund for the recovery of His Majesty the King, and the *Times* has undertaken to raise the £150,000 required for the National Radium Fund. The two movements are in close co-operation and have the same treasurer and office organisation. The King has signified his approval of the scheme by sending a cheque for £1000, to be divided equally between the two appeals, and other members of the Royal family have contributed. The eagerness of the public to express its thankfulness for the King's restoration to health has been marked by its swift response to the appeals, nearly £60,000 being subscribed to the National Radium Fund on the day it was opened. Further subscriptions, for either fund, should be addressed "The Treasurer, Thank-offering Fund, 103 Kingsway, W.C.2.

Annual Meeting of the International Council for the Exploration of the Sea.

THE annual meeting of the International Council for the Exploration of the Sea was held in London on April 8–15. The meetings of the area and other committees took place at the House of Lords, and the rooms of the Zoological Society were placed at the disposal of the Council for the scientific meetings held on April 12 and 13. About sixty delegates and experts attended the meetings.

The main work of the Council is organised on a regional basis, and the investigations carried out in each geographical area are reviewed by the area committees, which also lay down the programmes for the ensuing year. Hydrography, plankton, statistics, and the study of salmon and trout are dealt with by special non-area committees.

At the Hydrographical Committee, the main points under discussion were the preparation of mean surface salinity charts for the North Sea, plans for combined work on submarine waves in the Kattegat, and the hydrography of the Faroe-Shetland Channel; regular observations of the surface waters on two additional lines in the North Sea were arranged. Prof. W. Mielck presented a report to the Plankton Committee on the work he has carried out in testing the comparative catching-power of various types of plankton nets, and Prof. H. H. Gran initiated a discussion on quantitative methods used in the investigation of phytoplankton. In the Atlantic Slope Committee, under the chairmanship of Dr. E. D. le Danois, Prof. A. Ramalho gave an account of the Portuguese hydrographical work in the area, including the Straits of Gibraltar and the adjacent Portuguese, Spanish, and Moroccan coasts, and Dr. Fernando de Buen demonstrated an inverse correlation between the catches of sardines and sprats, as shown by both English and Portuguese statistics. Dr. R. S. Clark gave a detailed account to the Northern North Sea Committee, of the distribution of the young herrings of the northern waters of Great Britain, and Dr. A. Molander contributed notes on the witch fishery of the area. Dr. A. Bowman, the chairman, read a paper on the age determination of the lemon sole by means of scales. In the meetings of the Southern North Sea and Combined North Sea Committees the advisability of continuing the practice of issuing advance proofs of the tables from the *Bulletin Hydro-*

graphique to people concerned, was discussed. It was decided that this procedure was very helpful and should continue.

Prof. A. C. Hardy showed a new model of his continuous plankton recorder, which it is hoped will be of great service in enabling plankton collections to be made from commercial vessels. A question which is becoming of great practical importance, namely, the design of fishing gear which will avoid the wasteful destruction of small fish, was discussed by a special Committee on Savings Gear, in the light of experiments carried out in several countries during the past year.

Special interest attaches to the recommendations of the Whaling Committee, in view of the recent great expansion of the industry, especially in the Antarctic. The Committee expressed the view that, while investigations are not sufficiently advanced to enable definitive and adequate regulations to be framed for the conservation of the stock of whales, there are certain practical steps, for example, for the protection of young and immature whales, which might be taken at once by international agreement, and it asked the Council to impress this point of view upon the governments concerned. It proposed also the organisation of adequate statistics of the catch of whales in all parts of the world.

At last year's meeting the innovation was made of devoting two days to the discussion of subjects of general scientific interest affecting the Council's work, and the same useful plan was adopted at the present meeting. The subjects chosen for discussion on this occasion were "Fluctuations in the Age Classes of Fishes," and "Current Measurements, Direct and Indirect." No fewer than twenty communications were read on the former subject, and as there was no time for discussion it was arranged that the papers should be published and debated at the next meeting of the Council. The same procedure was adopted for the papers read on current measurements.

On Tuesday and Wednesday, April 16 and 17, a joint meeting of the International Council and the Challenger Society was held at the Laboratory of the Marine Biological Association at Plymouth. Scientific exhibits were arranged by the staff of the Laboratory on the Tuesday, and on the following morning a discussion took place on the subjects considered at the special scientific meetings of last year, namely, "The Estimation of Phosphates and Nitrogenous Compounds in Sea Water" and "Racial Investigations of Fish" (see *Rapports et Procès Verbaux*, vols. 53 and 54; 1929). Prof. H. H. Gran described the results of his work on diatom frequency in relation to phosphates and nitrates. He finds that while these salts decrease in proportion with increased frequency of diatoms, there are indications of some other unknown factor also at work. Dr. W. R. G. Atkins remarked on the necessity for observing the greatest caution in estimating phosphates, as the slightest trace of impurities renders the samples useless.

The discussion on races in fish was then opened by Prof. E. Ehrenbaum. In the discussion which followed, the majority of the speakers inclined to the view that the counting of variable characters such as vertebræ, etc., is more likely to show up the effect of local conditions than to demonstrate the existence of distinct races. Prof. J. Hjort proposed that the meeting should send a message to Prof. F. Heincke as a mark of respect for the great work he originated, many years ago, on the races of herring.

Meteorology in India.

WE have received the first three volumes of a new series of meteorological publications that is being issued by the India Meteorological Department, entitled "Scientific Notes." We suppose that this publication will correspond with the "Professional Notes" of the Meteorological Office, London, and if this be the case it will be valuable in that it will place on permanent record contributions to meteorology which, though not always of the first rank in importance, afford collectively a useful body of information, the reliability of which is to some extent vouched for by the issuing authority—in the case of the series under review, presumably the Director-General of Observatories in India. The only serious drawback of publications of this kind, as compared with similar papers read before a scientific society, appears to be that no discussion of the validity of the conclusions is published with them and the general reader can form little idea, in those cases where novel views are brought forward, as to whether or no a definite advance has been made.

The first 'note' is by Mohammad Ishaque. It is entitled "A Comparison of Upper and Gradient Winds at Agra and Bangalore." Here no novel opinions are put forward, but an unfortunate mistake in the statement of the motion of winds under balanced forces has been made in the introduction—a mistake that would immediately have been pointed out had the paper been read before a scientific audience—namely, that the ordinary 'gradient wind' equation does not hold at the equator, and therefore that the fairly good agreement found in temperate latitudes between the gradient wind and the actual wind at a height of 500 metres can scarcely be expected to hold in such a low latitude as that of Agra (27° N.) or at Bangalore (13° N.). This is no mere verbal slip; the author did not mean 'geostrophic' wind instead of 'gradient' wind, for he states that in determining his theoretical 'balanced' wind the curvature of the isobars was taken into account.

Mr. Ishaque's results show an astonishingly poor agreement between the computed and observed winds: at Agra the correlation coefficient is only 0·34 for a height of 500 metres, and 0·39 for 1000 metres. Sir Napier Shaw in his "Manual of Meteorology" quotes coefficients of about 0·7 and 0·8 for observations made in England. To an uncritical reader, noting these contradictory results and observing that the Indian meteorologist was careful to deal only with days on which the pressure gradient was apparently determinable, an important fact would appear to have been established, but when it is pointed out that in England, where the difficulties in the way of obtaining a close network of reliable observations of barometric pressure must be less than in India, determination of the pressure gradient, and from it the 'gradient-wind,' is impossible to do accurately, one is tempted to wonder whether the relative magnitude of the correlation coefficients in the two countries are not a measure simply of the point to which accuracy of measurement of barometric pressure has been carried in each case.

The second and third 'notes' are useful contributions of a straightforward kind, dealing respectively with the hourly rainfall of Madras over a long series of years and with an interesting type of thunderstorm—the 'nor'wester' of South Bengal. The nor'wester appears to be a thunderstorm of the line-squall type which yields hailstones of a size fortunately seldom encountered in Europe, but the maximum wind-speeds are more comparable with those of the European line-squall and rarely exceed 50 miles an hour. The storms are most frequent in April and May.

University and Educational Intelligence.

Cambridge.—The Adams Prize for 1927–28 has been awarded to Prof. Sydney Chapman, professor of mathematics in the Imperial College of Science and Technology, London. The value of the prize is about £246. The subject set was "The Variations in the Earth's Magnetic Field in Relation to Electric Phenomena in the Upper Atmosphere and on the Earth."

Dr. R. P. Raup, professor of the philosophy of education in Teachers College, Columbia University, New York City, will deliver a lecture on May 8 at 6 P.M., on "The Psychological Basis of the 'Project Method,'" in the Library of the Central Hall, Westminster, S.W.1. Tickets (price 1*s.*) can be obtained from the secretary, New Education Fellowship, 11 Tavistock Square, W.C.1.

A summer tour to Norway, leaving Newcastle on July 27, is being arranged by the Educational Travel Association. Shore excursions under competent guidance will be made for studies in the fiord region, and an extension overland will be made to the sub-arctic area of the tableland, and to Oslo for the ethnological exhibits of Eskimo life collected by Amundsen, and the geological, botanical, and archæological collections there. Particulars may be obtained by sending a 2*d.* stamp to the honorary secretary, E.T.A., c/o the Cheshire Training College, Crewe.

A summer school of biology, under the direction of Prof. F. A. E. Crew, is being organised by the Education Committee for the County Borough of Brighton, to be held at the Municipal Training College on Aug. 2–16. Courses will be given on biology and the school curriculum (Prof. A. D. Peacock, University of St. Andrews, and Mr. G. B. Walsh, High School for Boys, Scarborough), on the theory of the cell, the gene, and organic inheritance in man (Prof. F. A. E. Crew), and there will be single lectures on special topics. Practical and field work is being arranged. Particulars can be obtained from the secretary to the Brighton Education Committee, Mr. F. H. Toyne, 54 Old Steine, Brighton.

Particulars of vacation courses to be held in Great Britain in 1929 are given in a pamphlet recently issued by the Board of Education. There will be courses in science subjects in England and Wales as follows: arranged by the Board for teachers only—in physics at Cambridge and Harrow, in chemistry at Oxford, in biology at Cambridge, in engineering at Oxford, and in gas technology at Leeds; arranged by local education authorities—in chemistry at Nantwich, in biology at Brighton, Nantwich, and Bingley, in rural science at Barry (South Wales), in mining and engineering at Swansea, and in regional survey at Folkestone; organised by university bodies—in biology at Cambridge, Great Ayton (Yorks), and at or near Birmingham, in psychology at Cambridge, Oxford, Bristol, Rocester (Staffs), Chester, Bangor, and Harlech; organised by other bodies—in mine survey and economic geology at Camborne, in regional survey at Stratford-on-Avon, and in psychology of handwork at Chester. A novel course in mothercraft, organised by the Board for teachers in elementary schools, will be held in London on July 22–Aug. 2. Only three courses for foreigners are announced, to be held at Cambridge, London, and at Exeter. The Board has this year, for the first time, included in the pamphlet particulars of vacation courses in Scotland, namely, courses for teachers arranged by the National Committee for the Training of Teachers, and courses, planned to be completed in two summers, of the ordinary university degree standard, to be held at Edinburgh in mathematics, physics, geography, and biology.

Calendar of Patent Records.

May 6, 1845.—The introduction of the electric telegraph and its rapid progress were mainly due to the united efforts of Sir Charles Wheatstone and Sir William Fothergill Cooke, who, approaching the subject one from the scientific and the other from the business point of view, were brought together at a time when many attempts were being made to devise a practical system. Their first patent was taken out in 1837. But complete success was not achieved until they produced the single needle telegraph, which was patented by them on May 6, 1845. A special Act of Parliament was passed to permit the formation of a company of more than twelve persons (the maximum number allowed under the various grants) to work this and all the earlier patents of the two inventors.

May 7, 1794.—The first real gas engine was the invention of Robert Street, who patented it on May 7, 1794, under the title "A new invented method to produce an inflammable vapour-force by means of liquid, air, fire, and flame, for communicating motion to engines and machinery." In Street's engine, a few drops of spirit of turpentine are introduced into the cylinder, the bottom of which is kept heated so that the spirit is instantly converted into vapour. The piston is at the same time moved upwards, and a quantity of air thereby sucked into the cylinder, which mixes with the vapour and forms an explosive mixture which is ignited by a flame applied to a touch-hole.

May 7, 1802.—The corkscrew now in common use in which the prong is fixed to the end of a right-handed screw which works in a hollow quick left-handed screw working in a hollow cylinder shaped to fit over the bottle mouth, so that the cork is pierced and extracted by one continuous right-handed turning of the handle, was patented by Sir Edward Thomason of Birmingham on May 7, 1802. During the term of the patent more than 130,000 corkscrews of this type were made at prices ranging from one guinea to four shillings.

May 9, 1807.—Sir William Cubitt's invention for automatically varying the area of sail in a windmill according to the strength of the wind was patented on May 9, 1807. Cubitt substituted movable shutters for the sail fabric, and geared the shutters to a rod running through the centre of the wind-shaft, so that the opening and closing movements of the shutters were communicated to the rod. A hanging weight attached to the end of the rod was adjusted to keep the shutters at the most suitable angle, but allowed them to open to present less effective surface to the wind when this became stronger than normal. This mechanism and the earlier invention of Andrew Meikle for automatically keeping the sails into the wind were extensively adopted and are still in use in England, but were not taken up on the Continent.

May 9, 1865.—The first application of hydraulic power for the operation of tools was Ralph Hart Tweddell's invention for fixing or tightening the ends of boiler tubes by means of expanding dies operated by hydraulic or other fluid pressure, which was patented on May 9, 1865. The invention was immediately successful and resulted in a reduction of more than one-fourth in the cost of riveting.

May 10, 1837.—The manufacture of galvanised iron is due to two Frenchmen, Ledru and Sorel, of Paris, who were granted a French patent for their invention on May 10, 1837, and followed this with twenty-three patents of improvement between that date and 1846. The English patent was sealed in the name of Craufurd in April 1837.

Societies and Academies.

LONDON.

Royal Meteorological Society, April 17.—The late **W. H. Dines** and **L. H. G. Dines**: Monthly mean values of radiation from various parts of the sky at Benson, Oxfordshire. Records for the five years 1922–1926 are given. The radiation is dealt with under two heads: (1) Luminous rays; (2) dark heat rays of wave-length exceeding about 2 μ; each is measured under conditions of (1) clear skies, (2) completely overcast skies.—**L. H. G. Dines**: An analysis of the changes of temperature with height in the stratosphere over the British Isles. The average temperature distribution in the stratosphere over the British Isles consists of a pronounced inversion of 3° C. at the bottom, followed by a lapse of about 0·5° C. per km. from $(H_c + 3)$ km. upwards to at least $(H_c + 8)$. There is no significant connexion between the magnitude of the inversion and either the lapse rate just below it, or the temperature in the troposphere in the layer 3½ to 7½ km. Such evidence as is available is against the existence of a diurnal variation of temperature in the stratosphere.—**H. A. Hunt**: A basis for seasonal forecasting in Australia. A fairly definite four-year cycle is indicated, consisting of two dry years followed by two wet years, and requiring two years to be allotted to the drying and heating phase and two to the wetting and cooling. The four-year period in the rainfall is also fairly well marked in the percentage of the continental area over which the rainfall is above the average each year.

PARIS.

Academy of Sciences, Mar. 25.—**P. Villard**: Associations and forms of clouds. Discussion of the relations between the forms of clouds and production of rain.—**F. E. Fournier**: A means of extending French trade.—**Alex. Véronnet**: There are three distinct spaces and three only: Euclid, Riemann, and Cartan.—**R. Chambaud**: The deformation of arches.—**J. H. Coblyn**: Diagrams and monograms.—**H. Weiss** and **E. Vellinger**: The measurement of the interfacial tension between mineral oils and aqueous solutions. The influence of time and of the hydrogen ion concentration. The interfacial tension of a system mineral oil–aqueous solution of electrolyte depends not only on the hydrogen ion concentration of the aqueous phase but also on the nature of the electrolytes utilised. But the variations due to the nature of the electrolytes are negligible as a first approximation compared with those brought about by the variations of the hydrogen ion concentration.—**F. Prevet**: The influence of boric acid on the phosphorescence of zinc sulphides prepared by the explosion method. The phosphorescent zinc sulphide prepared with boric acid is unaffected by air and moisture. There is a marked increase in the luminosity of the product.—**Pierre Leroux**: Study of the absorption of a specimen of blue rock salt. A study of the variation of the absorption of blue rock salt as a function of the wave-length and of the temperature.—**Jean Cabannes** and **Pierre Salvaire**: The enlargement and displacement of the lines of the spectrum by molecular diffusion.—**M. Ponte**: Electronic analysis: lattice of the oxides of magnesium, zinc, and cadmium. The experimental results given permit of the conclusion being drawn that for the velocities of electrons utilised, electronic analysis is at least as accurate as analysis by X-rays, and may be used with confidence.—**E. Sevin**: The photoelectric effect and the continuous X-spectrum.—**André Michel** and **Pierre Benazet**: The reheating of austenitic steels.—**Léon Lortie**: The combinations of the salts of tetravalent cerium and of thorium with sodium carbonate (sodium cericarbonate and thoricarbonate). The ceric salt $Na_6Ce(CO_3)_5 + 12H_2O$ has been isolated in crystals. A thorium salt of analogous composition has also been isolated.—**L. Jacqué**: The fusibility of the ferro-calcium alloys.—**R. Cornubert** and **Ch. Borrel**: Anomalies of condensation and of cyclisation. Studies on the condensation products of α-methyl-α′-cyclopentanone and benzaldehyde in the presence of hydrochloric acid.—**J. Bougault** and **Mlle. Bl. Leroy**: Phenyloxymaleic anhydride. This substance gives crystallised compounds with amines, insoluble in ether, useful for the characterisation of the amines.—**A. Demay**: The antestephanian tectonic of the central French plateau to the east of the Loire.—**René Bréon**: Observations on beach deposits. In the bay of Authie pebbles and fragments of rocks are found which appear to have been transported at least 250-300 kilometres from the coast of the south of England. It is impossible for these to have been carried in suspension like sand, and the question as to the means of transportation is difficult of solution. One single specimen of rock had attached to it remains of *Fucus saccharinus*, and the author suggests that seaweed attached to the rocks may have been the cause of the flotation.—**A. Vincent**: The electrification of winds charged with snow. Winds charged with frozen snow caused the development of high potentials in an aerial capable of giving sparks up to 5 mm. in length.—**Joseph Devaux**: The measurement of the absorption factor of the surface of some Pyrenees glaciers for the solar radiations. If the surface of the glaciers consisted of pure ice limited by a plane surface, about 98 per cent would be absorbed. The absorption factors found were between 0·4 and 0·77, the lower value being undoubtedly due to the extensive alterations in the surface of the glaciers.—**I. D. Streinikov**: The ecological conditions of existence of the fauna of the Kara Sea.—**C. Chabrolin**: The decay of the inflorescence of the date palm (Khamedj). The author confirms the conclusions of Cavara that this disease is due to the parasite *Manginiella Scœttœ*. The most practical treatment appears to be dusting the terminal bud with a mixture of powdered copper sulphate and slaked lime.—**Jules Amar**: Sex and nutrition.—**Serge Yourievitch**: The principal characters of the ocular movements. A summary of the results of a kinematographic study of more than 20,000 movements of the eye.—**Jacques Pellegrin**: The Cichlidæ of Madagascar.—**E. Voisenet**: New researches on the nature of the substance which produces the bitter taste in the disease of bitter wines. A description of the isolation of a very bitter substance, a derivative of acrolein, from 40 litres of wine attacked by the disease.—**H. Colin** and **Marc Simonet**: The viscous fermentation of the frozen beet. The viscous material is produced by a coccus at the expense of the sugar. The coccus has been isolated and cultivated. The viscous material appears to be identical with the dextrane previously isolated by various authors from sugar refinery juice contaminated with *Leuconostoc mesenteroides*.—**Ducloux, Rinjard,** and **Mlle. Cordier**: The symbiosis *in vivo* of the virus of Borrel's pustule in sheep and the virus of foot-and-mouth disease.

April 2.—**A. Lacroix**: A meteorite which fell at Beyrout (Syria) on Dec. 31, 1921.—**L. Léger** and **O. Duboscq**: *Harpella melusinœ*, an eccriniform entophyte parasite of the larvæ of *Simulium*.—**J. A. Schouten**: The geometrical significance of the semi-symmetrical property of an integral connexion which leaves the fundamental tensor invariant.—**C. Bonnier**: The determination of the temperatures in explosion motors.—**Georges Mignonac** and **René Vanier de Saint-Aunay**: The polymerisation of acetylene by the silent discharge. The synthesis of dipropargyl and of its isomers. The complicated mixture produced by the action of the silent discharge on acetylene consists partly of a primary condensation product due to the discharge alone and partly of the secondary polymerisation of this by heat. By carrying out the reaction at $-60°$ C. the hydrocarbons dipropargyl, methylpentadiine and a hexadiene were isolated.—**Pierre Bedos** and **Adrien Ruyer**: The dehydration of the oxide of cyclohexene and the passage from the C_6 ring to the C_5 ring. Cyclohexene oxide can be dehydrated by phthalic anhydride giving 1.3-cyclohexadiene, and this is generally accompanied with isomerisation of the oxide to cyclopentane aldehyde.—**Paul Lemoine**: The superposition of a Tertiary anticline on a Cretaceous syncline.

BRUSSELS.

Royal Academy of Belgium, June 2.—**G. Cesaro**: The points of equal inertia of the rhombohedron.—**Victor Willem**: The polarity of the locomotor apparatus of the actinians.—**Th. De Donder**: The photonic field.—**Ad. Mineur**: Left projective cubics.—**L. Van den Berghe**: Researches on deglutition in the teleostean fishes.—**Frans Halet**: The discovery of an eruptive mass in the subsoil of Grammont.—**L. Godeaux**: The congruences formed by the Wilczynski lines of a surface.—**L. Godeaux**: The surfaces having the same quadrics of Lie.—**G. Van Lenberghe**: The calculation of the fugacities of a solution.—**R. H. J. Germay**: The formula of Lagrange and its generalisation by M. T. J. Stieltjes.

Aug. 4.—**A. de Hemptinne**: The ionisation and chemical combination of gases.—**Lucien Godeaux**: The congruences of Goursat and surfaces having the same Lie quadrics.—**J. Jaumotte, E. Lahay**, and **J. F. Cox**: An apparatus for the measurement of the magnetic inclination intended to be utilised by an aviator to determine his latitude. The measurement is based on the electromotive force developed by a rotating coil, a null method being adopted in which the galvanometer, unsuitable for an aeroplane, is replaced by a telephone. An accuracy of 10′ is indicated as possible, fixing the position in latitude within about 20 kilometres.—**P. Teilhard de Chardin**: Complementary note on the mammalian fauna of the lower Tertiary of Orsmael.—**M. D. V. Jonesco**: A theorem of Lord Kelvin.

CRACOW.

Academy of Science and Letters, Jan. 7.—**T. Banachiewicz**: Auxiliary tables for the calculation of the selenographic co-ordinates.—**T. Banachiewicz**: New methods for the correction of orbits.—**W. Lesnianski**: A method for the synthesis of acridone derivatives. The use of phosphorus oxychloride as the condensing agent in the transformation of arylamine carboxylic acids into derivatives of acridone is advantageous, good yields being obtained.—**Mlle. E. Majdecka-Zdziarska**: *Galinsoga parviflora* and *Galinsoga hispida*. A discussion of the geographical distribution of these American species in Europe and in Poland, and of the question whether these should be considered as varieties or distinct species.—**Mlle. C. de Kleist**: Phyto-sociological researches on the peat bogs of the region of the dunes of the right bank of the Vistula in the neighbourhood of Warsaw.—**S. Macko**: Researches on the geographical distribution and the biology of *Azalea pontica* in Poland.—**W. Szafer**: The element peculiar to the mountains in the flora of the Polish plain. The geographical distribution of mountain plants in the plain leads to conclusions relating to the history of the migration of the plants during the diluvial period.—**M. Thomaschewski**: Pollen analysis of the peat bogs of Kalmuzy and Pomerania.—**Z. Woycicki**: The crystalloids in the nucleus and in the formations known as oleoplasts in *Ornithogalum caudatum*.—**R. J. Wojtusiak**: Comparative studies of the larvæ of the genus *Mamestra*.—**S. Karasinski**: Researches on the action of the antirachitic vitamin. Rickets should be considered as a trouble of development, due to a complicated avitaminosis which can only be partly suppressed by the antirachitic factor.

Feb. 4.—**E. Zylinski**: A theorem of the theory of algebraic numbers.—**L. Marchlewski** and **O. Wyrobek**: The absorption of the ultra-violet radiations by certain organic substances.—**L. Marchlewski** and **A. Szymanski**: Researches on chlorophyll.—**P. Mazák** and **J. Susko**: Researches on the oxosulphonic acids.—**K. Dziewonski** and **A. Wulffsohn**: Researches on β-methylnaphthaline.—**B. Hryniewiecki**: The geographical distribution of *Trapa* in Poland and contribution to the study of the varieties of this species.—**T. Wisniewski**: Associations of Bryophyta of Poland and especially of those of the virgin forest of Bialowieza.—**R. Kobendza**: The flora of the fallen ground in thè massif of Ste. Croix.—**B. F. Petschenko**: New and little known forms in the development of *Bacillus megatherium* and their cytology.—**St. Smreczynski**.—Experimental researches on gastrulation in the batrachians.—**R. J. Wojtusiak**: The orientation in space of the caterpillars of *Pieris*.—**W. Heinrich**: The function of the capillaries and the fixation of the attention.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 24, 1928).—**S. Borovik** and **Afanasjeva**: Influence of a vacuum on the radium clock. Some improvements in the Strutt radium clock are offered, and a method of making exact measurements with it of the pressure in relative vacua.—**A. Lukašuk**: Helium in some thorium minerals of Russia. The quantity of helium found in four minerals examined was as follows: chevkinite 0·109 c.c., eshinite 0·648 c.c., ortite 0·0638 c.c., monatsit 0·287 c.c. in one gram of the mineral.—**P. Svetlov**: Osmotic pressure and the permeability of membranes of trout eggs. External membrane is permeable to electrolytes, organic molecules, and colloid particles. Osmotic pressure in the yolk of the eggs is constant throughout the period of development, so that some unknown mechanism for the regulation of the pressure must be present.—**B. Stegmann**: A preliminary communication on an ornithological expedition in the upper and middle course of the Amur and in the western part of the Stanovoi ridge. Notes on distribution, nesting habits, etc., of a number of local bird species.—**C. Flerov**: Preliminary note on the diagnostic characters in the genus *Moschus* Linn. (Mammalia, Cervidæ). A brief review of musk-deers, containing diagnoses of five subspecies of *Moschus moschiferus* (including two new ones, namely, *arcticus*, from north-east Siberia, and *sachalinensis*, from Sakhalin Island), two subspecies of *M. chrysogaster*, and of a new species, *M. berezovskii*, from the Sze-chuan province of China.

(*Comptes rendus*, No. 25, 1928.)—**B. Schtylko**: Fossil remains of a pike from the Akmolinsk province. The remains are those of a *dentale*, and their study showed no differences from the *Esox lucius*; and it may be suggested that the latter species existed already in the Pleistocene.—**A. Mordvilko**: *Geoica* Hart and its anolocyclic forms. Plant-lice of the genus *Pemphigetum* Mordv., forming galls on *Pistachia* trees, proved to be able to migrate to roots of grasses, where they have been long known under the name

Geoica. The *Geoica* root-form occurs in the areas where there are no *Pistachia* at present (North America), but it is possible to state definitely that the trees grew there in previous geological ages; with their disappearance only the grass-root form of the aphid remained.—**G. Lindberg**: Southern elements in the fish fauna of the Bay of Peter the Great (Sea of Japan). The fauna differs strikingly from that of the Okhotsk and the Bering Seas in its subtropical character, while including a number of typical Arctic forms, many of which, however, penetrate as far south as the Korean coasts. At the same time, a number of southern forms are in their turn met with as far north as Vladivostok and Olga Bay.

Melbourne.

Royal Society of Victoria, Dec. 13.—**Edwin S. Hills**: The geology and palæontology of the Cathedral Range and the Blue Hills, in North-Western Gippsland. This range is a double razorback composed of two beds of hard sandstone separated by softer shales and sandstones. Although formerly believed to be Upper Palæozoic in age, they are overlain with a strong unconformity by Upper Devonian rhyolites, basalts, tuffs, and sediments outcropping to the east, and are apparently conformable with Upper Silurian sediments which outcrop to the west. The Cathedral Beds have as yet yielded no fossils, but in the Upper Devonian rocks a new fish fauna was discovered.—**F. Chapman**: (1) On a fine example of the flanged cowrie, *Cypræa gastroplax* McCoy. The subgenus *Palliocypræa*, to which the species was referred by M. Cossmann, is here given generic rank. The shell structure is discussed.—(2) On some trilobites and brachiopods from the Mount Isa District, North-West Queensland. For many years these beds were referred to as schists of unknown age. The rock in which the fossils are preserved is a cherty shale, horizontally bedded and found twelve miles west of Mount Isa at the head of the Templeton River. The assemblage of fossils indicates a middle to upper Cambrian horizon.—(3) On a new species of *Capulus* found attached to a *Pterygotus* carapace. Some attached univalves, *Capulus melbournensis*, adherent to the counterpart of the Silurian *Pterygotus* somite which was described by McCoy in 1899. This palæozoic *Capulus* shows, in its habit and form, a close resemblance to the related tertiary genus *Hipponix*.

Vienna.

Academy of Sciences, Jan. 31.—**E. Haschek**: On Talbot's Law.—**M. Eisler** and **L. Portheim**: Further researches on the nicotine poisoning of fruits and seeds. In *Nicotiana* and *Avena*, the alkaloid penetrates unhindered through the husk, in *Fagopyrum* with difficulty, in *Helianthus* scarcely at all. The embryos are unequally resistant to nicotine. Calcium and potassium chlorides influence the degree of poisoning.—**L. Mirskaja**: Regenerative processes in growing points of *Tradescantia guianensis*.—**M. Holly**: Some new African fish forms. Species of *Barbus* from rivers.

Feb. 8.—**R. Wegscheider**: Reactions in light and in the dark with counter and following effects.—**L. Moser** and **A. Brukl**: Determination and separation of rare metals from other metals (15). The quantitative analysis of gallium. For separation of little gallium from much iron, sodium thiosulphate was used; this reduces ferric to ferrous and precipitates gallium.—**F. Staudinger**: Heteromorphoses in stigmata and other organs of *Carausius morosus*.—**H. Burchardt**: Regeneration and symmetry of limbs stuck through the bodies of newts.—**C. Zawisch-Ossenitz**: The promotion of bone-growth by injection of bone extract.

Feb. 14.—**A. Kailan** and **G. Brunner**: Velocity of esterification of alcohols in formic acid.—**O. Gugenberger**: The Brachiopoda of the Cardita strata at Launsdorf in Middle Carinthia.—**O. Gugenberger**: Upper Triassic Cephalopoda and Brachiopoda from Plakles on the Hohe Wand.—**R. E. Mark**: Researches on the influence of various altitudes on the action of the thyroid gland in the dog.—**K. Federhofer**: Graphical kinematics of a crank-loop oscillating in space.

Official Publications Received.

British.

Royal Photographic Society of Great Britain. List of Honorary Fellows, Honorary Members, Fellows, Associates and Members, 1929. Pp. 31. (London.) 1*s*.

Philosophical Transactions of the Royal Society of London. Series B, Vol. 217, No. 446: Chromosome Linkage in certain Oenothera Hybrids. By Prof. R. Ruggles Gates and F. M. L. Sheffield. Pp. 367-394+plates 89-90. (London: Harrison and Sons, Ltd.)

Proceedings of the Royal Society of Queensland. Vol. 40, No. 1: Presidential Address. By Prof. E. J. Goddard. Pp. 12. (Brisbane: Anthony James Cumming.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 17, No. 1: Non-dehiscence of Anthers in Punjab American Cottons. By Trevor Trought. Pp. 5+2 plates. (Calcutta: Government of India Central Publication Branch.) 4 annas; 5*d*.

Memoirs of the Commonwealth Solar Observatory, Mount Stromlo, Canberra, Australia. Memoir No. 1: The Luminosity of the Night Sky, observed with a Rayleigh Photometer at the Commonwealth Solar Observatory during the Years 1926 and 1927, by the Director and Staff, Pp. 29. (Melbourne: H. J. Green.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 16: The Integration of Light by Photo-electrolysis. By Dr. W. R. G. Atkins and Dr. H. H. Poole. Pp. 159-164. 6*d*. Vol. 19 (N.S.), No. 18: The Photo-electric Measurement of the Illumination in Buildings. By Dr. W. R. G. Atkins and Dr. H. H. Poole. Pp. 173-188. 1*s*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1205 (Ae. 366): Full Sca e Tests of Bristol Fighter Aeroplane with R.A.F. 30 Wings, fitted with "Pilot Planes" at the Wing Tips. (T. 2666.) Pp. 4+2 plates. 4*d*. net. No. 1173 (Ae. 337): Full Scale Determination of the Effect of High Tip Speeds on the Performance of an Airscrew. By W. G. Jennings. (T. 2655.) Pp. 10+8 plates. 9*d*. net. (London: H.M. Stationery Office.)

Commission of Inquiry into the Holborn Explosions and Fires. Report of the Commissioners appointed by the Home Secretary to inquire into the Circumstances of the Series of Explosions and Fires which occurred on the 20th and 21st December 1928 in the neighbourhood of New Oxford Street. (Cmd. 3306.) Pp. 54+4 plates. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Third Report of the Committee appointed by Viscount Peel to consider the Establishment of Bird Sanctuaries in the Royal Parks in Scotland. Pp. 6. (Edinburgh and London: H.M. Stationery Office.) 6*d*. net.

Nyasaland Protectorate: Geological Survey. Water Supply Paper No. 3: Weirs, Dams and Reservoirs for Estate Purposes. By Dr. F. Dixey. Pp. 12. Annual Report of the Geological Survey Department for the Year 1928. Pp. 22. (Zomba.)

Union of South Africa: Department of Agriculture. Division of Chemistry Series, No. 92: Manuring of Wattles, by C. O. Williams; and Fertilizer Trials with Wattles, by J. B. Osborn. Pp. 10. (Pretoria: Government Printing Office.)

Colony and Protectorate of Kenya. Agricultural Census: Ninth Annual Report, 1928. Pp. 55. (Nairobi: Department of Agriculture.)

Trinidad and Tobago: Department of Agriculture. Administration Report of the Director of Agriculture for the Year 1927. Pp. 42. (Trinidad, B.W.I.: Government Printing Office, Port-of-Spain.) 1*s*. 6*d*.

Journal of the Royal Microscopical Society. Series 3, Vol. 49, Part 1, March. Pp. xvi+90. (London.) 10*s*. net.

Imperial Chemical Industries, Ltd. Annual Report for the Year 1928. Pp. 18. (London.)

Royal Astronomical Society. List of Fellows and Associates, March 1929. Pp. 54. (London.)

Ministry of Health. General Circular on the Local Government Act, 1929. Pp. 14. (London: H.M. Stationery Office.) 3*d*. net.

Ministry of Health: Advisory Committee on Water. Report on Rural Water Supplies. Pp. 38. (London: H.M. Stationery Office.) 9*d*. net.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1165 (Ae. 329): Wind Tunnel Experiments on the Design of an Automatic Slot for R.A.F. 28 Section, and on Interconnection with Ailerons. By F. B. Bradfield and K. W. Clark. (T. 2625 a.b.c.) Pp. 20+13 plates. 1*s*. net. No. 1181 (Ae. 345): Instrumental Records of the Lateral Motions of a Stalled Bristol Fighter Aeroplane. By Prof. B. Melvill Jones and Flight-Lieut. C. E. Maitland. (T. 2657.) Pp. 11+22 plates. 1*s*. net. No. 1186 (Ae. 348): Wind Tunnel Tests of various Servo Rudder Systems. By K. V. Wright. (T. 2630.) Pp. 17+10 plates. 1*s*. net. No. 1192 (Ae. 354): Wind Tunnel Tests for Design of an Automatic Slot for Avro 504.N. By E. T. Jones and K. W. Clark. (T. 2633.) Pp. 11+5 plates. 9*d*. net. No. 1193 (Ae. 355): The Longitudinal Control of an Aeroplane beyond the Stall. By H. M. Garner and K. V. Wright. (T. 2727.) Pp. 6. 4*d*. net. No. 1198 (Ae. 359): Wind Tunnel Tests with High Tip Speed Airscrews. The Characteristics of a Conventional Airscrew Section, 0·082c Thick, and of R.A.F. 27 and R.A.F. 28. By Dr. G. P. Douglas and W. G. A. Perring. (T. 2631.) Pp. 4+5 plates. 1*s*. net. No. 1202 (Ae. 363): Determination of the Twist of a Wing of an Aeroplane in Flight. By W. G. Jennings. (T. 2665.) Pp. 5+1 plate. 6*d*. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Society. Series A, Vol. 123, No. A792, April 6. Pp. 373-736+plates 18-22. (London: Harrison and Sons, Ltd.) 12s.

The Proceedings of the Physical Society. Vol. 41, Part 3, No. 228, April 15. Pp. iv+181-230. (London.) 7s. net.

Judicial Statistics, England and Wales, 1927. Criminal Statistics: Statistics relating to Criminal Proceedings, Police, Coroners, Prisons and Criminal Lunatics for the Year 1927. (Cmd. 3301.) Pp. xxiii+13-229. (London: H.M. Stationery Office.) 4s. net.

Reports of the Council and Auditors of the Zoological Society of London for the Year 1928, prepared for the Annual General Meeting to be held at the Society's Offices in Regent's Park, on Monday, April 29th, 1929, at 4 p.m. Pp. 87. (London.)

Report of the Rugby School Natural History Society for the Year 1928. (Sixty-second Issue.) Pp. 40+2 plates. (Rugby.)

Brackenhill Open-Air Home School, Hartfield, near Tunbridge Wells. Annual Report, September 1927 to August 1928. Pp. 16. (Hartfield.)

FOREIGN.

Proceedings of the American Academy of Arts and Sciences. Vol. 63, No. 9: Thermo-electric Phenomena and Electrical Resistance in Single Metal Crystals. By P. W. Bridgman. Pp. 351-399. 90 cents. Vol. 63, No. 10: The Effect of Pressure on the Rigidity of Steel and several varieties of Glass. By P. W. Bridgman. Pp. 401-420. 45 cents Vol. 63, No. 11: Tables of Lagrangean Coefficients for Interpolating without Differences. By Edward V. Huntington. Pp. 421-437. 45 cents. (Boston, Mass.)

Proceedings of the United States National Museum. Vol. 73, Art. 15: Contribution to the Comparative Anatomy of the Eared and Earless Seals (Genera Zalophus and Phoca). By A. Brazier Howell. (No. 2736.) Pp. 142+1 plate. Vol. 74, Art. 14: New Fossil Mollusks from the Miocene of Virginia and North Carolina, with a Brief Outline of the Divisions of the Chesapeake Group. By Wendell C. Mansfield. (No. 2759.) Pp. 11+5 plates. Vol. 74, Art. 23: Mineralogy and Geology of Cerro Mercado, Durango, Mexico. By William F. Foshag. (No. 2768.) Pp. 27+4 plates. Vol. 74, Art. 26: The Gums of the Porpoise Phocœnoides Dalli (True). By Gerrit S. Miller, Jr. (No. 2771.) Pp. 4+4 plates. (Washington, D.C.: Government Printing Office.)

Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research, Vol. 2, No. 2, February. R.P. No. 38: A Technical Method of Using the Mercury Arc to obtain Data at Wave Length 560 mμ in the Spectrophotometric Analysis of Sugar Products, by H. H. Peters and F. P. Phelps; R.P. No. 39: Reflecting Power of Beryllium, Chromium, and several other Metals, by W. W. Coblentz and R. Stair; R.P. No. 40: Note on a Piezo-electric Generator for Audio-frequencies, by August Hund; R.P. No. 41: Heats of Combustion of Organic Compounds, by M. S. Kharasch; R.P. No. 42: Laboratory Corrosion Tests of Mild Steel, with special reference to Ship Plate, by Henry S. Rawdon; R.P. No. 43: Least Retinal Illumination by Spectral Light required to evoke the "Blue Arcs of the Retina," by Deane B. Judd; R.P. No. 44: The Service of Refractory Blocks in a small Experimental Glass Tank, by W. L. Pendergast and Herbert Insley. Pp. 335-465+10 plates. (Washington, D.C.: Government Printing Office.)

Académie Tchèque des Sciences (Česká Akademie Věd a Umění): Bulletin International. Résumés des travaux présentés, Classe des Sciences mathématiques, naturelles et de la médecine. 27e année (1926). Pp. v+628. (Prague.)

Sveriges Geologiska Undersökning. Ser. Aa, No. 121: Beskrivning till kartbladet Skövde. Av Henr. Munthe, A. H. Westergård och G. Lundquist. Pp. 182+2 tavlor. 4.00 kr. Ser. Aa, No. 158: Beskrivning till kartbladet Valdemarsvik. Av R. Sandegren och N. Sundius. Pp. 70+1 tavla 4.00 kr. Ser. Aa, No. 159: Beskrivning till kartbladet Gusum. Av Bror Asklund, Gunnar Ekström och Gunnar Assarsson Pp. 107+1 tavla. 4.00 kr. Ser. Aa, No. 165: Beskrivning till kartbladet Filipstad. Av Nils H. Magnusson och Erik Granlund. Pp. 119+1 tavla. 4.00 kr. Ser. Aa, No. 169: Beskrivning till kartbladet Slite. Av Henr. Munthe, J. Ernhold Hede och G. Lundquist. Pp. 130+1 tavla. 4.00 kr. (Stockholm.)

Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol 2, No. 3, March. R.P. 45: Apparatus and Methods for the Separation, Identification and Determination of the Chemical Constituents of Petroleum, by Edward Washburn, Johannes H. Bruun and Mildred M. Hicks; R.P. No. 46: Recombination Spectra of Ions and Electrons in Cæsium and Helium, by F. L. Mohler and C. Boeckner; R.P. No. 47: The Spectral Absorption of certain Monoazo Dyes, i. The Effect of Position Isomerism on the Spectral Absorption of Methyl Derivatives of Benzeneazophenol, by Wallace R. Brode; R.P. No. 48: Transmission of Sound through Wall and Floor Structures, by V. L. Chrisler and W. F. Snyder; R.P. No. 49: Discharge Coefficients of Square-edged Orifices for Measuring the Flow of Air, by H. S. Bean, E. Buckingham and P. S. Murphy. Pp. 467-658+8 plates. (Washington, D.C.: Government Printing Office.)

Bulletins of the Pacific Scientific Fishery Research Station. Vol. 2, Part 3: Some Observations on the Spawning of the Amour and Kamchatka Salmons. By I. I. Kusnetzow. Pp. 196. In Russian, with Summary in English. 3 rub. 75 kop. Vol. 2, Part 4: Materials of the Land Flora of the Shantar Islands. By I. K. Shishkin. Pp. 48. In Russian, with Summary in English. 75 kop. Vol. 2, Part 5: Mammals of the Shantar Islands. By Prof. S. I. Ognew. Pp. 43. In Russian, with Summary in English. 60 kop. (Vladivostock.)

Proceedings of the Imperial Academy. Vol. 5, No. 2, February. Pp. iii-iv+57-102. (Tokyo.)

Japanese Journal of Astronomy and Geophysics: Transactions and Abstracts. Vol. 6, No. 2. Pp. 71-142+4 plates. (Tokyo: National Research Council of Japan.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 18, No. 4: Marine Miocene and related Deposits of North Colombia. By Frank M. Anderson. Pp 73-213+plates 8-23. (San Francisco.)

Proceedings of the United States National Museum. Vol. 74, Art. 16: A Revision of the North American Ichneumon-Flies of the Genus Mesostenus and related Genera. By R. A. Cushman. (No. 2761.) Pp. 58. Vol. 75, Art. 7: A Revision of the American Two-winged Flies of the Psychodid Subfamily Bruchomyinae. By Charles P. Alexander. (No. 2778.) Pp. 9. (Washington, D.C.: Government Printing Office.)

List of Publications of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, 1928. Pp. 9. (Washington, D.C.: Carnegie Institution.)

Proceedings of the California Academy of Sciences. Fourth Series. Vol. 18, Nos. 5, 6, 7, 8. No. 5: A New Pecten from the San Diego Pliocene, by Leo George Hertlein; No. 6: A New Species of Land Snail from Kern County, California, by G. Dallas Hanna; No 7: A New Species of Land Snail from Coahuila, Mexico, by G. Dallas Hanna and Leo George Hertlein; No. 8: Some Notes on Oreohelix, by Junius Henderson. Pp. 215-227+plate 24. Vol. 18, No. 9: Notes on the Northern Elephant Seal. By M. E. McLellan Davidson. Pp. 229-243+plates 25-26. Vol. 18, No. 10: On a Small Collection of Birds from Torres Strait Islands, and from Guadalcanar Island, Solomon Group. By M. E. McLellan Davidson. Pp. 245-260. Vol. 18, No. 11: The Generic Relationships and Nomenclature of the California Sardine. By Carl L. Hubbs. Pp. 261-265. (San Francisco.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 23: Record of Current Educational Publications, comprising Publications received by the Bureau of Education, October-December 1927, with Index for the Year 1927. Pp. 116. (Washington, D.C.: Government Printing Office.) 20 cents.

CATALOGUES.

Getting the Most out of Radio. Pp. 184. (Liverpool: Claude Lyons, Ltd.)

Clarostat: a Brief Survey of their Applications in the Science of Radio. Third edition, revised and enlarged. Pp. 24. (Liverpool: Claude Lyons, Ltd.)

Concerning High Frequency Stabilisation by Piezo-Electric Oscillators. Pp. 12. (London: Adam Hilger, Ltd.)

Spectroscopy in Control of Purity in Food Stuffs. Pp. 7. (London: Adam Hilger, Ltd.)

Diary of Societies.

FRIDAY, MAY 3.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Announcement of the award of the Andrew Carnegie Research Scholarships for 1929-30.—Presentation of the Carnegie Gold Medal to Dr. A. Bramley.—The Hon. Sir Charles Parsons and H. M. Duncan: A New Method for the Production of Sound Steel. —Third Report on Heterogeneity of Steel Ingots, by a Committee of the Institute.—J. M. Robertson: The Microstructure of Rapidly Cooled Steel.—D. Lewis: The Transformation of Austenite into Martensite in a 0·8 per cent Carbon Steel.—A. L. Norbury: Constitutional Diagrams for Cast Irons and Quenched Steels.—At 2.30.—G. R. Bolsover: Brittleness in Mild Steel.—L. B. Pfeil: The Oxidation of Iron and Steel at High Temperatures.—E. G. Herbert and P. Whitaker: The Differential Method for Measuring the Thickness of Hard Cases without Sectioning them.—T. E. Rooney and G. Barr: A Method for the Estimation of Hydrogen in Steel.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—The Treatment of Chronic Deafness:—Dr. D. McKenzie: The Symptomatic Treatment of Deafness.—H. Kisch: Chronic Deafness; its Treatment and Prevention.—T. Neville: Chronic Deafness. —G. S. Hett and A. G. Wells: Ionisation as a Treatment for Middle-ear Suppuration.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Cloud Formation. C. J. P. Cave, Sir Gilbert Walker. Chairman, Sir Frank Dyson.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Annual General Meeting), at 5.—F. J. Cleminson: Treatment of Carcinoma of the Œsophagus by Radium.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Anniversary Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—G. D. Malcolm: Chairman's Address.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—H. Berry: London's Water.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. S. W. Wooldridge and A. J. Bull: The Arun Gap and Lower Greensand around Pulborough.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Institution of Production Engineers) (at Royal Society of Arts), at 7.45.—H. F. L. Orcutt: The Production and Application of Ground Gears (Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (Annual General Meeting), at 8.30.—Dr. H. Sington: Pre-medication by Paraldehyde in Children.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Daniel Hall: The Garden Tulip.

SATURDAY, MAY 4.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District) (at Red Lion Hotel, Cromer), at 1.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District) (at Aerodrome Hotel, Croydon), at 2.15.—G. A. Ballard: Town Planning and Municipal Airports.

MONDAY, MAY 6.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School), at 4.30.—A. H. K. Petrie: On the Ionic Equilibria of Plant Tissues.—R. G. Tomkins: Mould Growth and Atmospheric Humidity.—R. D. Whyte: The Cytological Basis of Partial Diœcism in Plants.—*Papers to be communicated by title only*:—C. Pellew: The Genetics of Unlike Reciprocal Hybrids.—A. F. Shull: Determination of Types of Individuals in Aphids, Rotifers, and Cladocera.—J. A. Bierens de Haan: Animal Language and its Relation to that of Man.—G. Koller: Internal Secretions in Invertebrate Animals.

ROYAL SOCIETY OF EDINBURGH, at 4.30—G. N. Hunter: Colour Sensitivity.—Dr. E. B. Ludlam and R. B. Mooney: The Influence of Air and Moisture on the Budde Effect in Bromine.—A. C. Stephen: Studies on the Scottish Marine Fauna: The Fauna of the Sandy and Muddy Areas of the Tidal Zone.—George Redington: Study of the Effect of Diurnal Periodicity upon Plant Growth.—Dr. Margery Knight: Studies in the Ectocarpaceæ: II. Life-History and Cytology of *Ectocarpus siliculosus* Dillw.—*To be read by title only*:—Miss Mary H. Latham: Jurassic and Kainozoic Corals from Somaliland.—Dr. S. Goldstein: On the Asymptotic Expansion of the Characteristic Numbers of the Mathieu Equation.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Canon A. Lukyn Williams: Early Anti-Judaica—the Books of Testimonies.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Dr. G. C. Simpson: The Importance of Climatic Stations in Polar Regions.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. R. B. Raup: Is there a Psychology for Modern Education?

RAILWAY CLUB (at 57 Fetter Lane), at 7.30.—D. D. Barrie: A Thirty Years' Survey.

ROYAL SOCIETY OF ARTS, at 8.—Sir E. Denison Ross: Nomadic Movements in Asia (Cantor Lectures) (IV.).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. T. Moran: Recent Advances in the Low-temperature Preservation of Foodstuffs.

SURVEYORS' INSTITUTION, at 8.—H. F. Bidder and W. V. Graham: Rights in Underground Water.

TUESDAY, MAY 7.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—Annual General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Major S. S. Flower: Exhibition of the Centenary Edition of the Vertebrate List. Vol. i., Mammals.—F. Martin Duncan: Exhibition of Cinematograph Films of North American Big Game presented to the Society by Mr. Prentiss N. Gray.—E. B. Worthington: New Species of Fish from the Albert Nyanza and Lake Kioga.—W. Rowan: A Hermaphrodite Spiny Dogfish (*Squalus sucklei*).

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—T. J. Evans: Life in the Deep Sea.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—W. J. Muller: Notes on the Lentz Standard Marine Engine as Fitted to Ships of the Koninklijke Paketvaart Maatschappy (Royal Packet Line), Amsterdam.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Sir Oliver Lodge: Some Ideas about Metals (Annual May Lecture).

TELEVISION SOCIETY (at Engineers' Club, Coventry Street), at 8.—Capt. R. Wilson and A. A. Waters: Some Practical Considerations in the Building of Television Apparatus.—Demonstrations:—Model Showing Mechanical Exploring as the Speed of the Disc Increases from Zero, R. R. Poole.—Model of "Talking-Film" Projector, H. S. Ryland.

WEDNESDAY, MAY 8.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology) (Annual General Meeting), at 4.45.—At 5.—Discussion on Fistula-in-ano.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—F. M. Trotter: The Glaciation of Eastern Edenside, the Alston Block, and the Carlisle Plain.—J. A. Douglas: A Marine Triassic Fauna from Eastern Persia.

ROYAL SOCIETY OF ARTS, at 8.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—Dr. H. C. Cocks: Some Possible Uses of Alternating Currents in Electrodeposition.

INSTITUTION OF CHEMICAL ENGINEERS (jointly with Institute of Fuel).—Discussion on The Scope of the Chemical Engineer in Relation to the Fuel Consuming Industries.

THURSDAY, MAY 9.

ROYAL SOCIETY, at 4.30.—R. H. Fowler and Dr. P. Kapitza: Magnetostriction and the Phenomena of the Curie Point.—Prof. C. G. Darwin: A Collision Problem in the Wave Mechanics.—J. A. Gaunt: The Relativistic Theory of an Atom with many Electrons.—R. de L. Kronig: The Quantum Theory of Dispersion in Metallic Conductors.—*Papers to be read by title only*:—F. J. Wilkins: The Kinetics of the Oxidation of Copper. Part I.—C. E. Eddy, Prof. T. H. Laby, and A. H. Turner: Analysis by X-Ray Spectroscopy.—M. C. Johnson: The Adsorption of Hydrogen on the Surface of an Electrodeless Discharge Tube.—A. Elliott: The Absorption Band Spectrum of Chlorine.—H. W. Thompson and C. N. Hinshelwood: The Influence of Nitrogen Peroxide on the Combination of Hydrogen and Oxygen.—H. J. Phelps and R. A. Peters: The Influence of Hydrogen Ion Concentration on the Absorption of Weak Electrolytes by Pure Charcoals.—Dr. H. T. Flint: The First and Second Order Equations of the Quantum Theory.—S. Bhagavantam: The Magnetic Anistropy of Naphthalene Crystals.—A. H. Wilson: Perturbation Theory in Quantum Mechanics. II.—C. G. Lyons and Dr. E. K. Rideal: On the Stability of Unimolecular Films. Parts I., II., and III.—P. A. M. Dirac: Quantum Mechanics of Many-Electron Systems.—Prof. O. W. Richardson and P. M. Davidson: The Spectrum of H_2. The Bands Analogous to the Parhelium Line Spectrum. Parts III. and IV.—H. E. Hurst: The Suspension of Sand in Water.—D. Brunt: The Transfer of Heat by Radiation and Turbulence in the Lower Atmosphere.—R. K. Asundi: The Third Positive Carbon and Associated Bands.—Prof. G. I. Taylor: The Criterion for Turbulence in Curved Pipes.—W. G. Bickley: Hydrodynamic Forces acting on a Cylinder in Motion, and the Idea of a 'Hydrodynamic Centre.'—M. L. E. Oliphant: The Action of Metastable Atoms of Helium on a Metal Surface.—J. Hargreaves: The Effect of a Nuclear Spin on the Optical Spectra.—Prof. M. N. Saha and Ramash Chandra: New Methods in Statistical Mechanics.—N. F. Mott: The Interpretation of the Wave Equation for Two Electrons.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Dr. E. D. Adrian: The Nervous Mechanism of Sensation and Movement.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—Discussion on A New Method for the Production of Sound Steel, by the Hon. Sir Charles Parsons and H. M. Duncan.—Third Report on Heterogeneity of Steel Ingots, by a Committee of the Institute.—First Report on Blast-Furnace Plant and Practice, by a Committee of the Institute.—Twenty Months' Results of Dry-Blast Operation, by E. H. Lewis.—The A.I.B. Sinter Plant at Messrs. Guest, Keen and Nettlefolds, Ltd., Cardiff Works, by W. E. Simons.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 30 Russell Square), at 7.—F. Fancutt: Painting as it Affects the Railways.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. H. Court and Dr. M. von Rohr: Contributions to the History of the Spectacle Makers' Company (Second Paper on the Court Collection).

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Annual General Meeting.

FRIDAY, MAY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. E. Hertzsprung: The Pleiades (George Darwin Lecture).—E. A. Kreiken: On the Dwarf Nature of Double Stars.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. W. E. Sumpner: Heaviside's Fractional Differentiator.—J. H. Awbery: A Simple Method of Fitting a Straight Line to a Series of Observations.—E. W. H. Selwyn: Arc Spectra in the Region λ1600–λ2100.—Dr. K. R. Rao: The Spectrum of Trebly-ionised Thallium.—G. A. Wedgwood: The Elastic Properties of Thick Cylindrical Shells under Internal Pressure.—A Demonstration relating to Standards of Length and Mass, by J. E. Sears.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Abbey Hotel, Kenilworth), at 5.30.—Discussion on Stare Bridge, D. H. Brown; Kenilworth: Castle and Town, S. Douglas.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 8.—Captain P. Johnston-Saint: An Outline of the History of Medicine in India (Sir George Birdwood Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. E. Boycott: The Twist of Snail Shells.

SATURDAY, MAY 11.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District) (at Council Chamber, Swansea), at 3.15.—Discussion on Some Road and Other Schemes at Swansea, R. Hudson; Swansea Main Drainage Scheme and Flood Relief Schemes, J. Hassall; Llansamlet Sewage Pumping Scheme, Swansea, M. E. Habershon.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Sections) (at Harrogate).

PUBLIC LECTURES.

FRIDAY, MAY 3.

UNIVERSITY COLLEGE, at 4.—Prof. A. J. Hall: Some of the Sequels of Epidemic Encephalitis (Lethargica).—At 5.30. (Succeeding Lecture on May 10.)—Prof. R. Robinson: Public Inaugural Lecture.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. F. O. Bower: The Origin of a Land Flora reviewed 21 Years after Publication (Huxley Memorial Lecture).

TUESDAY, MAY 7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY—ROYAL SCHOOL OF MINES, at 5.30.—Prof. E. de Margerie: Some Aspects of French Tectonics. (Succeeding Lectures on May 10 and 13.)

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Sir Oliver Lodge: Some Ideas about Metals (Annual May Lecture).

WEDNESDAY, MAY 8.

UNIVERSITY OF BIRMINGHAM, at 4.30.—Dr. C. Singer: Medicine and the Revival of Learning.

CONGRESSES.

MAY 6 TO 11.

INTERNATIONAL CONGRESS OF MILITARY MEDICINE AND PHARMACY (in London).—Subjects to be discussed:—The Evacuation of Sick and Wounded by Air and Water; Tropical Fevers of Short Duration; Injuries to Blood-vessels and their Sequelæ; Physical and Chemical Analysis of the Glass and Rubber Articles Employed by the Medical Services; The Standard of Dental and Physical Fitness in the Various Military Services.

MAY 15 TO MAY 20.

ROYAL INSTITUTE OF PUBLIC HEALTH CONGRESS (at Zurich).

Section I.—State Medicine and Municipal Social Hygiene.
Section II.—Industrial Hygiene and Industrial Diseases.
Section III.—Child Welfare, School Hygiene, and Women and Public Health.
Section IV.—Pathology, Bacteriology, and Biochemistry.
Section V.—Tuberculosis.
Section VI.—Climatology and Sports Hygiene.
Section VII.—Veterinary Medicine and Meat Hygiene.

MAY 15 TO MAY 23.

WORLD POWER CONFERENCE ON COMPLETE UTILISATION OF WATER POWER RESOURCES (at Barcelona).—Subjects to be dealt with:—General Hydrological Problems; Technical Problems of Water Power Utilisation; Economic and Financial Problems; Legal Problems; Protective Measures and Defence Works of Undertakings.