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Science and Religion.

DOES a description of the world afford any evidence of the existence of God? This is the subject of a symposium in the April issue of the *Hibbert Journal*, and the discussion has particular interest for biologists. A description of the world is not merely a statement of those conceptions that we call natural laws, but it is also an interpretation of what Prof. Whitehead calls the "passage of Nature"—the evolutionary career. In this passage the various points of view taken by the writers are these: there is an increasing enrichment of what we may call the content of Nature; there is progress; and there is an effort or striving against something.

The first interpretation is made by Dr. J. S. Haldane in an argument of sustained power. The world of our experience may be known to us through the mathematical sciences, through physics, and through biology. The conception attained through pure mathematics is *bare*; it need not include objects, and it deals typically with the space and time relationships between objects. These relations, or differential equations, need not have physical meanings. The world, from this point of view, has form but no content. To construct it out of pure extension, that is, to give all natural laws geometrical meanings, is the tendency of the later relativists; thus the world is deprived of substance, or at least, the nature of this substance is ignored. Next come the physical sciences, enriching this conception by inserting objects into the world but ignoring the plain fact that its natural laws are only working hypotheses which have limited practical meanings. They are statements of the ways in which we can *act* on our physical environment. They are descriptions of our increased power over Nature.

Then come organisms—which add something new to the world. This conclusion depends on Dr. Haldane's difference from the majority of the biologists of the last generation. "Weighed in the balance of accurate quantitative investigation the mechanistic theory of life has been found wanting." What the Victorian materialism has envisaged in the organism has been "a vista of mechanisms," one inside the other, so to speak; postulated rather than really observed; incapable of explaining organic functioning, to say nothing of reproduction and behaviour. The conception is even inadequate as a means of investigation, and it is being replaced by other methods—for example, Dr. E. S. Russell's psycho-biology. Thus mechanism fails and in this failure we recognise a further enrichment of Nature. Biology becomes a science with its own fundamental conception of life.

Lastly, there is the self-conscious human personality.

This we may consider, first, as having immediate self-interest. On the strictly mechanistic outlook, it must regard all other organisms and conscious persons merely as moving objects similar to those other objects called inorganic. But even a purely physical description of the organism is not to be obtained, and by no process called scientific can the self-conscious person explain his *own* consciousness in terms of mathematics and physics. Further, he sees other organisms that are not self-conscious, and so the mere biological life-conception fails to explain consciousness in other organisms than himself. So he is bound to make yet another fundamental conception, that of the conscious, self-interested organism; but even that is not all. Almost every action that he performs—as a member of a human community—means that he recognises *other* conscious, self-interested persons like himself: otherwise he would not seek to convince them, nor would he praise, or blame, or pity, or like, or hate them. On the purely mechanistic outlook, the things that he does, every conscious minute of his life, are meaningless.

Then, even the purely physical thing is not a unit. Anything that is known to us is known only when it changes. When it changes it does so only because other things in the physical system to which it belongs also change. In the long run, the only isolated physical system that we know is the whole universe, and it is only by convention that we arbitrarily isolate a thing from all the rest of Nature. So also the functioning and behaviour of an organism means that it is acting on, or reacting with, or adapting itself to the environment—which is the whole universe. The self-conscious person (which is also a physical thing and an organism) is only such because it reacts with other self-conscious persons. Add to this the literally true conception that all organisms, conscious or unconscious, are materially and strictly continuous in the time dimension, then the whole world is one, and personality is everywhere in it.

Thus, to the physical categories of substance, necessity, relation, modality, quantity, etc., we must add those of life, consciousness, and personality. The personality is universal in time and space and is God.

Next we have Mr. Julian Huxley's interpretation of the passage of Nature as a progress. But evolution, he sees quite well, is not necessarily a passage from the "simple to the complex." It is quite as easy to look upon the "lower" organism as more complex than the "higher" one—just because it is undifferentiated. It is plain that the morphological, evolutionary series of changes is *irreversible*, and that the goal towards which all organic races tend, as they specialise, is extinction. How, then, to define "progress"? There is a series of changes that have led up to the human race; let us attach a series of "values" to these changes, thus making a one-to-one correspondence, value to morphological change. What are the values? Those conditions judged by the human mind to have value *are* values. Progress then is the series of evolutionary changes that have *human* value, and it is, somehow, a tendency towards good. It is an obscure feeling "clarified and put on a firm intellectual footing by biology." It is true that the problems of evil, of pain, of strife, of death, of insufficiency and of imperfection remain to perplex us, but nevertheless progress is an element "essential to an externally grounded conception of God," to be incorporated into the common theology of the future.

Finally, there is Sir Oliver Lodge's interpretation of evolution as an effort: a conception which is more fundamental than any other that is touched in this discussion. Why, in the physical sense, have changes, or reactions, or events occurred at all? The answer is clear. If, by any change, a system can lose free energy or dissipate its energy, or increase its entropy-value (roughly equivalent statements), then that change will occur *of itself*. When the free energy has become minimal, or the entropy maximal, changes in the system will cease altogether. Now the only system which, in strict logic, we can consider is the whole universe. When entropy has attained its maximum value, or when all energy has become universally dissipated, all changes in the universe, all events, or phenomena (from our human point of view) will have ceased.

The world-paradox is that the universe is still the locus of change. Given an unbounded past, complete and final dissipation, with cessation of change, ought *already* to have been attained. The passage of Nature is thus towards materiality, or inertia, or passivity, but the passage is not accomplished—though it ought to have been accomplished. The world can only be the locus of activity and change because something resists, has arrested, or at least has retarded the passage towards materiality. There is an effort against inertia and this is life—the only physical conception of life that appears to be possible. There is a spiritual as well as a material passage.

Now why are there separate personalities at all? On Sir Oliver Lodge's general line of argument it may be reasoned (by analogy) that personality itself ought to exhibit a passage, or ought to be dissipated or absorbed into the universal personality, which is God. Why are they not so absorbed? Something, then, resists the ultimate dissipation of personality, just as life resists universal energy-dissipation. This something is the "invaluable but rather terrible and fearfully responsible grant" of Free Will, against which even Deity itself strives.

J. J.

Sanderson of Oundle School.

Sanderson of Oundle. Pp. vii+366+16 plates. (London: Chatto and Windus, 1923.) 12*s.* 6*d.* net.

FEW schools have passed through a more interesting development in modern times than Oundle. It is an old foundation and it has had periods of distinction in its long history, but its real rise to importance began in 1892 when Frederick William Sanderson went there from Dulwich to take charge. It was no light undertaking. There had been an unsuccessful period: the numbers of boys had gone down, and what was worse, the standard of work was low. Sanderson put all his tremendous energy and enthusiasm into the task and never paused till he had raised the school to its present high position. Then came his tragic death last June with the sudden break of all his plans for future development.

Some of Sanderson's colleagues welcomed the happy idea of writing down while still fresh in their minds what they knew of his methods and ideals, and these impressions have been brought together and interpreted in this book under the simple and sufficient title of "Sanderson of Oundle." The purpose was not so much to praise and honour Sanderson; it was the much more important one of saving all that could be saved of him for the world.

The task has been well done, and no man could wish for a nobler memorial. We see Sanderson entering Oundle as a young man of thirty-five—a very downright, uncompromising, and resolute personality—with perfectly definite ideas of what he wished to do and a perfectly definite intention of doing it. The development of the boy was his purpose, not the fostering of pure scholarship: if the classical method would not serve some other means must be found. To him no boy was in the first instance stupid or beyond training, though he might be made so by a wooden educational system or a stupid teacher: every boy, even the reputedly dullest, had in him a desire to make or do something—some creative instinct—and if only this could be reached the boy could be trained. So Sanderson sought to discover each boy's bent; for the ordinary boy it was used as a means of developing his mental powers; for the really clever boys full opportunities were provided for the study of their special subjects. He set up shops for wood and iron work, where real things were made (he always disliked instructional futilities), engineering, chemical and physical laboratories, biological departments, an experimental farm and an art room; he developed music. He had always the latest big thing in science on show or at work; a motor-car engine and chassis which the boys could dismantle and reassemble, an aeroplane engine for the same purpose, a big wireless set with which they could transmit their concerts, and a score of other things to awaken the boys' interest and enthusiasm.

To the purist in education it all seemed very upsetting—the multiplicity of forms, the rapid changes in books and subjects, the refined and delicate apparatus entrusted to only partly trained schoolboys. But there was method in it all. Sanderson looked on all his subjects—shops, laboratories, and sides—as so many resonators by which to test each individual boy. If he had enough resonators he could find the one to which each boy responded; and so he never hesitated to start some new side or to drop it when it no longer served a useful end. Once he found a way in to the real boy the training became easy.

But Sanderson was more than a trainer of the mind. He loved life and he wished that all might have more of it. Many of his boys were to become captains of industry in the large industrial towns. It was not enough for him that they should understand and be interested in their future work: he saw that the surest way to the enriching of their lives was to uplift it all. To him the meanest tasks of daily life had in them something divine so long as they were honourable and ministered to some need of the community, and he set himself to find this. He therefore made his workshops and laboratories serve a higher purpose than the awakening of strivings for knowledge. "I want not so much to teach engineering," he once said to me, "as to find the divineness of it." So he would never recognise the supposed conflict between science and religion or the limitations usually imposed on scripture lessons. The Bible was to him a handbook for daily life, not merely an exercise for Sundays, and he always regretted that people knew so little of it; his scripture lessons covered the whole range of human activities. He was always on the look-out for copy for them. One might be telling him of some recent development in science and he would listen with deep interest; suddenly his eyes would twinkle and he would pull out an envelope and jot down on the back some note for his next scripture lesson. He would go up to a boy working in a workshop or laboratory and ask him his views on some new thing—his own views, for all Sanderson's efforts in library, laboratory, and study were directed to the development of the boy's powers of thinking for himself. It might be relativity, the possibilities of "wireless," or something else; he would listen and encourage the boy to talk. He would then give some wider turn—probably sociological—to the conversation; for it was always his aim to train leaders of men rather than mere scholars, and he knew that no one can lead if he lacks wide sympathies.

Of late years the social or community interest became uppermost with him and he believed that the schools could do much to repair the wreckage of the War; he emphasised always the need for co-operation and pulling one's weight, for choosing the high path, for steadfast devotion to duties and leaving rights to take care of themselves.

The last evening of Sanderson's life was spent with the present writer. He had attended the Rothamsted annual function and had obviously enjoyed it. After the visitors had gone we sat talking and, as always, he soon came to his plans for the future. He was delighted that his long-desired Chapel was to be built. It was to be the centre of the school life and as beautiful and dignified as he could make it; not only with the beauty of stone: it was to be also in a wonderful garden—a miniature Kew, as he said. In the windows were to be the great calls to a high and noble life. Most of all he was delighted with Lady Scott's statue of the bright-eyed, eager-hearted, expectant boy—"Here am I, send me"—the type he wanted to send out to remake a broken world. It was the man himself speaking of his hopes and ideals, as few would care to do to another man—ideals of fulness and richness of life based on beauty and nobleness of living. For these we wished our boys to strive and so we had entrusted them to him.

Sanderson had thoroughly enjoyed life. He early found what most men desire—a great cause on which to spend himself, and to which he could give once and give all. As the years passed they had but mellowed him, bringing out his kindliness and his rich rare gift of keeping touch with youth. When the news of his death was told to the school there fell a great silence. It had been the homage given him in life when he rose to speak; it was given him now. But their abiding feeling was one of thankfulness for the life which had so truly moulded theirs, and of certainty that this was not the end. The triumphant song "Let joy and praise to Heaven rise" can rarely have been more wonderfully sung than by the boys of Oundle when he was carried from their midst.

E. J. RUSSELL.

Civil Engineering Geology.

Elements of Engineering Geology. By Prof. H. Ries and Prof. T. L. Watson. Pp. v+365. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 22*s*. net.

THE call for a smaller engineering geology than the large work issued by Prof. Ries and Prof. Watson in 1914, has led those authors to prepare an abridgment entitled "The Elements of Engineering Geology." The volume includes an account of the general principles of geology and petrology, apparently with the intention that the book should suffice for the geological needs of engineering students. It, however, includes no sections on stratigraphy or palæontology, some acquaintance with which is generally regarded as essential to a geological course in engineering. Knowledge of these subjects would be necessary to the student who would benefit by the long chapter on ore deposits.

The book may be highly recommended to British students of civil engineering owing to its clear treatment of many important problems and its instructive series of maps and illustrations, though its value to them is inevitably lessened by the fact that most of its illustrations are taken from American example and literature. The nomenclature is also American in such cases, such as "gumbo," and the use of "diabase" instead of "dolerite." The attribution of all China clay to weathering is a conclusion which is emphatically rejected in Europe. The statement on p. 90 that an oil shale to be of value should yield from 30 to 60 gallons of oil per ton in addition to ammonia, is not in accordance with experience in Scotland, where shales containing 20 gallons or even less have been profitably worked. Melting snow is said rarely to affect large streams; this is certainly not true of some large rivers in Europe and Asia, where the spring floods are due to this cause.

The authors use the unlucky term "corrasion" for mechanical excavation by rivers and "corrosion" for solution. The American use of distinct terms for the basal and lateral wear of the streams had much to commend it; but "corrasion" as in the line "wealth corraded by corruption" means to "scrape together," and corrasion was first used in the sense of corrosion apparently by a misprint. In regard to nomenclature it is also to be regretted that the authors in a book on economic geology use the term "mineral" in the sense of "mineral species" or "simple mineral" and thus exclude coal, slate, most ores, oil shale and mineral oil from the category of minerals.

The chapter devoted to the coastal topography of the United States is particularly interesting and well illustrated; the difference of the problems from those which have to be dealt with by the British coastal engineer is shown by the absence in the book of any reference to groynes. In spite, however, of the book being mainly adapted for American colleges it may be warmly recommended to British civil engineering students.

J. W. G.

Physico-Chemical Themes.

(1) *Catalysis with special reference to Newer Theories of Chemical Action: A General Discussion held by the Faraday Society.* (Reprinted from the Transactions of the Faraday Society, Vol. 17, Part 3, May.) Pp. 545-675. (London: The Faraday Society, 1922.) 9*s.* net.

(2) *Some Physico-Chemical Themes.* By Prof. A. W. Stewart. Pp. xii+419. (London: Longmans, Green and Co., 1922.) 21*s.* net.

(3) *The Theory of Allotropy.* By Prof. A. Smits. Translated from the German with the Author's sanction, by Dr. J. Smeath Thomas. (Text-books of Physical Chemistry.) Pp. xiii+397. (London: Longmans, Green and Co., 1922.) 21*s.* net.

(4) *Colloid Chemistry of the Proteins.* By Prof. Dr. W. Pauli. Translated by P. C. L. Thorne. Part I. Pp. xi+140. (London: J. and A. Churchill, 1922.) 8*s.* 6*d.* net.

(5) *Laboratory Manual of Colloid Chemistry.* By Prof. H. N. Holmes. Pp. xii+127. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 10*s.* net.

(6) *Atomic Form: with Special Reference to the Configuration of the Carbon Atom.* By E. E. Price. Pp. iv+140+viii. (London: Longmans, Green and Co., 1922.) 5*s.* net.

(1) THE Faraday Society's general discussion on "Catalysis with Special Reference to Newer Theories of Chemical Action" was apparently arranged in view of the simultaneous presence in England of Prof. Perrin, Dr. Irving Langmuir, and Prof. Arrhenius. The first session of the discussion dealt with the radiation theory of chemical action and the second session with heterogeneous reactions, and these form Parts I. and II. of the report. The discussion on the radiation theory (which postulates that chemical action is due to radiation and that its velocity is proportional to the prevailing radiation-density) was characterised by two dramatic incidents. Prof. Lindemann pointed out that, if the original form of the radiation theory were correct, the inversion of cane sugar must be determined by the density of radiation of wave-length 1·05 μ; on this basis, the inversion should proceed 50 billion (5×10^{13} times more rapidly in sunlight than in the dark), whereas actually the acceleration is almost negligible. Following up this criticism, Dr. Langmuir said that the radiation theory "has all the characteristics of the typical unsuccessful hypothesis," since it has been made progressively more complicated, as successive attempts at verification have failed. Probably no theory has ever been put forward in which discrepancies of such magnitude have appeared, and it is at least a sign of courageous optimism that the authors should still hope to bring it into line with facts.

The discussion on heterogeneous reactions was opened by a paper in which Dr. Langmuir discussed the function of the solid surface, with special reference to the occlusion of oxygen on the surface of a tungsten filament. This takes place at a temperature of 1500° K. or more, even when the pressure is so low as 10^{-6} atmospheres, or when hydrogen, ammonia, or methane is present, as well as oxygen, showing that the film of occluded oxygen is extremely tenacious. It was suggested that the stable film is of monomolecular thickness, and that the film can only be dissipated in the form of the oxide WO_3. In the same way the tenacity with which a trace of carbon monoxide will cling to the surface of platinum, acting as a powerful poison as regards its catalytic activity towards hydrogen and oxygen, is attributed to the formation of a monomolecular film of carbonic oxide united chemically with the molecules of platinum. Carbon dioxide does not behave in this way, and does not act as a poison to the catalyst. On the other hand, the normal action of the catalyst in the presence of oxygen is attributed to the formation of a film of chemically bound oxygen of higher activity than the free gas.

Experimental work on the catalytic action of platinum in the oxidation of carbon monoxide and of hydrogen formed the subject of the second paper; and the discussion which followed is reported in full, together with a number of written communications on the same subject.

(2) Prof. Stewart has added another to the series of books, in which he has summarised, mainly perhaps for the benefit of the candidate for a degree in honours, some of the results of recent chemical research. The method of handling the material in such a volume is fairly familiar, and criticism may be limited to the question as to whether the work has been well done. On the whole, the answer may be given in the affirmative, but in more than one instance the reader who is familiar with current research will feel disappointed, because some of the sections appear to have been written so long ago that they are out of sympathy with current thought, even although later work may be included either in the same or some other part of the volume. Thus to many it would appear futile to discuss the theory of the colloidal state without including any reference to the work of McBain on colloidal electrolytes, which has now been going on for something like ten years; again it is merely tedious to read through a discussion as to whether hydrogen should be placed in Group 1 or Group 8 of Mendeléeff's classification, when modern theory makes it quite

clear that this element stands in a class by itself, and need not be forced into association either with the alkali metals or with the halogens. The final chapter, on atomic structure, is remarkable in that it begins with a recapitulation of some of the fantastic ideas of atomic structure that preceded the discovery of the electron, while it concludes by dismissing Bohr's atom as "considerably overrated," and setting up in its place "Stewart's atom" as possessing merits which are not possessed by the atoms of other workers.

The various chapters of the book do, however, provide useful summaries of work which must otherwise be studied either in separate monographs or in original literature, and to those who prefer this method of assimilating knowledge the book may be commended.

(3) Prof. Smits, whose monograph on allotropy has been translated from the German, deals with a very interesting subject, namely, the application of the phase rule to those cases in which at least one of the components is capable of existing in more than one form, so that the familiar phenomena of phase-equilibrium are complicated by the occurrence of a reversible isomeric or polymeric change in this component. When the change is sufficiently rapid, the component in question counts as one molecular species; but when the change is slow, each separate form must be treated as a separate species.

There can be little doubt that if the editor of these text-books had entrusted to Prof. Findlay the work of expounding the application of the phase rule to these fascinating cases, he would have been able to tell the story in simple language, and in such a way as to interest and attract the type of student for whom these monographs are written. It is, however, certain that, while a translation of the monograph into English is a real advantage as eliminating one of the most formidable difficulties of the student, who usually finds German not an easy language to read, even the translation gives the impression that the author has deliberately made the subject as difficult as possible. One must assume that in his own teaching the author discusses these phenomena at the close of a rigorous course of training, and that those who have followed his lectures may perhaps find in the theory of allotropy a puzzle worthy of their highly developed skill; but to the student who has not gone through this training, no mercy whatever is shown, and he might well be excused for forming the opinion that Prof. Smits, like one of the old alchemists, was trying to disguise his knowledge, instead of to diffuse it, by using a bewildering system of symbols and diagrams. Almost any one of these might "hold up" the reader for many minutes, if not indeed for hours, while he was trying to discover what meaning he must attach to symbols decorated with a positive cascade of super-script and subscript signs, and thus to find out the inner meaning of the diagram. By way of further punishment, the author omits to write down the chemical formulæ of the organic compounds with which he deals, so that the student must refer to the original literature if he wishes to know what formulæ have been assigned to the two forms of benzoylcamphor, or to the various modifications of milk sugar. In this case it would appear that the author is so concerned with the mathematical dissection of these compounds in their various phases that he has no interest whatever in their chemical composition; and this view is supported by the attitude which he adopts in similar cases throughout the volume.

In conclusion, it may be said that if a keen student wishes to test his abilities by means of a volume which might well bear the sub-title, "The Phase Rule made Difficult," the book might perhaps be commended. On the other hand, the average student will probably prefer to wait for an interpreter before he attempts to study the work of an author whose desire for complexity leads him to postulate the existence of half a dozen molecular species in the simple and orderly space-lattice of a metal.

(4) Prof. Pauli's monograph on the colloid chemistry of the proteins possesses nearly all the merits that are lacking in Prof. Smits' book. Although dealing with a much more difficult subject, it has the merit of being not only brief, but also as simple as any treatise on colloids that has yet appeared. Not only those who are specially interested in colloid chemistry, but also chemical students generally, would find both pleasure and profit in reading the book, and on these grounds it can be heartily commended. It is, indeed, a particularly easy task to review a book on which none but favourable comments are possible.

(5) Prof. Holmes, at the request of the Colloid Committee of the National Research Council, has written a "Laboratory Manual of Colloid Chemistry." The total number of experiments described in the book is 186, and most of these have been tested in the laboratory over a period of six years. It is an indication of the importance that now attaches to the study of colloids that a book dealing with laboratory experiments only should be called for, and Prof. Holmes has produced a volume which every teacher of physical chemistry will find it necessary to possess. It will also be welcomed by many other workers who are not responsible for the organisation of laboratory classes in physical chemistry.

(6) Mr. Price has invented a tetrahedral model of the carbon atom which has an equilateral triangle

as section on two of its planes of symmetry, while its faces are isosceles triangles. He claims that this figure lends itself better than the regular tetrahedron to the construction of models representing the structure of organic compounds. The close packing of polyhedral figures is an important factor in crystallographic research, but, when it is not correlated in any way with crystallographic data, it cannot be regarded as of any value in the investigation of molecular structure. The author proceeds as if the carbon atoms were actually tetrahedral in shape, with real poles at the corners, whereas in fact, the tetrahedron merely serves as a convenient means of showing the directions in which the valencies radiate. It is, however, interesting to notice that the figure which Lewis obtained by concentrating four duplets on the centres of four *edges* of a cube is actually a tetrahedron of the shape described by the author, although obviously the duplets in marsh gas must occupy the alternate *corners* of a cube, since all the evidence points to the fact that methane has the full symmetry of a regular tetrahedron.

The Trend of Evolution.

The Evolution of Man: a Series of Lectures delivered before the Yale Chapter of the Sigma Xi during the Academic Year 1921–1922, by Richard Swann Lull, Harry Burr Ferris, George Howard Parker, James Rowland Angell, Albert Galloway Keller, Edwin Grant Conklin. Edited by George Alfred Baitsell. Pp. x+202. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 15*s*. net.

IN the chapter entitled "The Natural History of Man" Prof. Ferris gives a very lucid summary of the most elementary facts of embryology and anatomy, which suggests to the uninitiated reviewer that the Society of the Sigma Xi, for whom the lectures in this book were prepared, is a lay body unfamiliar with biological teaching. As a means of interesting such an audience in some of the manifold aspects of biology and sociology these lectures no doubt served a useful purpose, but why call the volume "The Evolution of Man"? One would imagine that in a series of six lectures with such a title some one would have discussed seriously the problems of man's pedigree, and have attempted to explain how and why the human family acquired those distinctive attributes of brain and mind which conferred the rank of mankind upon it. But there nothing of the kind is to be found in the book.

Prof. Parker gives an excellent account of his investigations on the nervous system of sponges and other animals, but the title "The Evolution of the Nervous System of Man" raises hopes that are not fulfilled; and the same remark applies to the address by the president of Yale on "The Evolution of Intelligence," as well as to Prof. Keller's "Societal Evolution." The criticism one is impelled to make of all these addresses is that, while they are interesting and illuminating, both their own titles as well as that of the book are irrelevant.

In Prof. Conklin's essay, the title of which the reviewer has adopted as the label for this notice, is a sane discussion of the trends of civilised mankind under post-War conditions and an earnest plea for education, and better education, as the remedy for the ills of society and the means of averting the downfall of the best types of mankind.

Our Bookshelf.

Department of Agriculture and Technical Instruction for Ireland. Memoirs of the Geological Survey of Ireland. Mineral Resources. Memoir and Map of Localities of Minerals of Economic Importance and Metalliferous Mines in Ireland. By Prof. G. A. J. Cole. Pp. 155. (Dublin: Stationery Office, 1922). 7*s*. 6*d*. net.

IT is much to be regretted that this volume must be looked upon as the swan-song of the old regime in Ireland rather than as the first effort of the new authorities. Information as to the mineral resources of Ireland has never before been collected into any authoritative memoir, but had to be sought for piecemeal among a number of miscellaneous geological and mining publications, for, as the author of the present work correctly observes, Sir Robert Kane's book on the industrial resources of Ireland is now far too old to be of any real value under the economic conditions of the present day.

Prof. Cole has done his work extremely well; he has arranged the various minerals that Ireland produces in alphabetical order, commencing with antimony and ending with zinc. It is perhaps characteristic of an Irish publication that the most important of all mineral products, namely coal, is not even mentioned. The author states specifically that he excludes sands, clay, and marble, and devotes his attention to "minerals of economic importance"; surely coal should be included under this head. The other minerals of economic importance are very fully and clearly dealt with; the list of localities is very complete and carefully drawn up, and all the more important occurrences are briefly described. If it does nothing else, the present work will serve to dispel some of the wild statements that are occasionally heard as to the immense mineral resources of Ireland, which have been neglected or, it is even sometimes hinted, deliberately concealed, by jealous Englishmen. Among the more persistent of such legends is that of the immense resources of iron ore in the Arigna valley; the present work shows that two persevering attempts were made to found an iron industry there, at the end of the eighteenth and again in the first half of the nineteenth century, and that both ended in failure; at what appears to have been the last attempt, only 300 tons of iron were produced in seven years at a cost of 50,000*l*. A study of the entire book shows that at the moment barytes is practically the only mineral of serious economic importance that Ireland is capable of producing. Apart, however, from the strictly commercial aspect of the subject, Prof. Cole's work is of great value to the student of mineral deposits, inasmuch as it supplies authentic information concerning the mineral resources of the country.

Overzicht van de theorie en de toepassingen van gassen, waarin de onderlinge botsingen der moleculen kunnen verwaarloosd worden. Door Dr. Jos. ter Heerdt. Pp. vii+324. (Utrecht and Nijmegen: N. V. Dekker & Van de Vegt en J. W. van Leeuwen, 1923.) 6.50 florins.

SINCE the classic researches of Maxwell on the internal friction of gases and those of Crookes on radiometer theory, no investigations have been so important in connexion with the kinetic theory of gases as the work of Martin Knudsen on the properties of highly rarefied gases, in which the mutual collisions of the molecules may be neglected. Dr. Jos. ter Heerdt has produced a very clear monograph in which the work of Knudsen and that of some other investigators, Soddy and Berry, Gaede, Langmuir, Weber, etc. (scattered in many periodicals), is brought together and critically discussed.

After a short historical introduction and some general considerations regarding the kinetic theory of gases, (Chap. I.), the author deals in the following chapters with molecular flow through narrow capillaries and small holes in plates, with molecular flow through tubes with a temperature gradient (pressure equilibrium between two reservoirs at different temperatures, connected by a capillary tube), with the molecular conduction of heat and the coefficient of accommodation. The treatment of the problem of accommodation, as given in Chap. VI., is new and throws a new light on the question. Nevertheless no general solution is given of this very complicated problem. Chap. V. deals with the radiometer force and with the formula which Knudsen has deduced for it. In Chap. VII. a full and detailed description is given of modern high vacuum pumps, based on the principles of the kinetic theory of rarefied gases (Gaede, Langmuir) and of different kinds of high vacuum manometers. The book ends with a very complete bibliography.

The volume forms a readable and clearly written monograph on a subject not covered by any existing work and may be highly recommended to all who are interested in this subject. It is to be hoped that the book, which is published in Dutch, will be translated into English, French or German in order that it may reach a wider circle of readers. C. A. CROMMELIN.

Hawaiki: the Original Home of the Maori. With a Sketch of Polynesian History. By S. Percy Smith. Fourth edition. Pp. 288+20 plates. (Auckland, Melbourne and London: Whitcombe and Tombs, Ltd., 1921.) 12*s*. 6*d*.

IT is most fortunate that Mr. Percy Smith was able to publish the fourth and authoritative edition of this book before his death, as it contains a considerable amount of new material and of revised conclusions. It represents the gleaning of a long life spent in amassing new data, and laboriously sifting and collating existing information. All students of oceanic ethnology owe a great debt to this painstaking, kindly, and learned pioneer. Mr. Smith entirely justifies his reliance on the general accuracy of tradition, and he has been able to give approximate dates to events in unwritten history, and also to trace three main migrations into the Pacific from Indonesia, and numerous migrations within the Polynesian area. Constructive work of this kind on imperfect material is necessarily open to criticism, but Mr. Smith courageously attempts to interpret hints and obscure words, and by imagination, controlled by intimate knowledge of Polynesian ethnology, he has made a plausible connected story, which, in his concluding words, "will in the meantime serve the purpose of a summary of the history of the people, on which others may build."

The Indian dates on p. 85 require revision. The Sâka entered the Panjab about 75 B.C., not 950 B.C.; the great colonisations of Java from India are also placed much too early; according to Havell they were due to the final collapse of the Sâka power at the beginning of the fifth century. It is important to have correct dates for events in India, as Mr. Smith uses them in the development of his thesis. The view that the Polynesians may have been in part a branch of the "ancient Gangetic race" has much to recommend it, but by terming them "Proto-Aryan" he raises very grave difficulties, but, perhaps, Pre-Aryan is what he meant to express.

This little book is invaluable to all those who take an interest in the history of the most intrepid explorers of the Pacific. A. C. HADDON.

Expressionism in Art: Its Psychological and Biological Basis. By Dr. Oskar Pfister. Authorised translation by Barbara Low and Dr. M. A. Mugge. Pp. viii+272. (London: Kegan Paul and Co., Ltd., 1922.) 6*s*. 6*d*. net.

DR. PFISTER'S work is a study by psycho-analytic methods of a French artist suffering from depression, who came to the author for psychological treatment. In addition to the analysis of his dreams, the artist was asked to draw whatever he liked, and these drawings, usually of an extremely unconventional character, were treated in the same way as the dreams. The results are very interesting, both from the insight obtained into the personality of the artist and also from the light thrown on that type of art generally known as expressionism.

The first part of the book is a study from a psychological point of view of the artist; the second part discusses the psychological and biological background of expressionism. The author shows how excellent for diagnostic purposes were the pictures which invariably represented the artist's psychical state. From a study of the pictures of other expressionists, he concludes that all expressionists carry into their work a number of infantile characteristics. Instead of attempting to understand the external world, they turn away and represent their own internal conflicts in phantasy form, their pictures thus being in reality self-portraits. If pushed to its logical extremes, expressionism would result in an absolute rejection of the empirical world, and hence in many it tends to become pathological. The relationship between the various neurotic types and expressionists is discussed.

It is a very interesting study, both of a particular man and of an art movement; but the method of writing is discursive, and the book might with advantage be considerably condensed.

The Races of England and Wales: a Survey of Recent Research. By Prof. H. J. Fleure. Pp. 118. (London: Benn Bros., Ltd., 1923.) 5*s*. net.

PROF. FLEURE'S modest claim to have given in this work a survey of recent research is an understatement which may give a misleading idea of its very real importance as a contribution to the ethnology of England and Wales—an idea which the brevity of the book does nothing to remove. It summarises in a fair and judicial spirit the results of the observations of anthropologists on the physical characters of the peoples of England and Wales, both in prehistoric and in recent times, to which Prof. Fleure himself has contributed in no small degree; but it does far more than this. It reviews these results in the light of certain general conclusions on the question of the development of racial type at which Prof. Fleure has arrived. The inferences which he has drawn in consequence cannot fail to have a profound influence on the future discussion of British ethnology as well as to stimulate observation in certain directions in the future in support or refutation of his views. Of these, perhaps the most important is that the intermediate type, which forms a common element in the population of Britain, and is usually taken to be a combination of Nordic and Mediterranean, represents in reality an independent "descent with modification" within this country from a palæolithic type.

Cryptography. By André Langie. Translated from the French by J. C. H. Macbeth. Pp. viii+192. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 9*s*. net.

As there is no manual of cryptography in English, this book, which is translated from the French, will be welcomed by all who wish to make a serious study of the subject, either for practical purposes or as an intellectual exercise. The author deals with his subject under three heads. Under the first he gives a brief history of the methods of conveying information secretly, beginning with the Greeks, Egyptians, and Romans; under the second he gives examples of cryptographical writings of which he himself has found the solution, for the most part, during the War; and under the third he gives lists and tables of frequency of single letters, bigrams, and other combinations in English and other languages. This section will naturally be one of the most frequently consulted in the book, as a knowledge of the relative frequency of occurrence of the different letters and combinations is essential in all decipherment. The translator adds a supplementary chapter dealing with methods of conveying information secretly, such as the use of sympathetic inks, tramps' signs, the marking of cards by cardsharpers, and the like, and describes the Playfair cipher, a substitution system extensively used for military purposes, Commander W. W. Smith, United States Navy, adding a note on its solution.

Botulism and Food Preservation (The Loch Maree Tragedy). By Dr. Gerald Leighton. Pp. xiii+237. (London: W. Collins, Sons and Co., Ltd., 1923.) 10*s*. net.

DR. LEIGHTON'S report on the outbreak of botulism at Loch Maree in 1922 has been already noticed in NATURE (March 24, p. 415) and some account has also been given of the comprehensive researches of Prof. K. F. Meyer, of the University of California, into the distribution and biology of the responsible microbe (January 20, p. 95). In the present volume Dr. Leighton has collected into a convenient form most of the available information about the disease as it occurs in man and animals. Originally most frequently associated with sausages and especially common in Würtemberg, most of the recent cases have been identified in America and more commonly with canned vegetables than meat products. "Limberneck" in poultry appears to be botulism, and "grass sickness" of horses is either this or a closely allied condition. Prevention is a question of the adequate sterilisation of preserved foods. The second part of the book recounts the details of the tragedy of the potted duck sandwiches and concludes with an ample bibliography.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1922. Edited by Dr. M. Epstein. Pp. xii+316+199. (London: Longmans, Green and Co., 1923.) 30*s*. net.

A WORK of reference that has reached its hundred and sixty-fourth volume requires no commendation. This annual review of the year has an established place among indispensable works of reference. English history, which appears to include Irish history, and foreign and colonial history occupy about two-thirds of the book, in a summary which is conspicuous for its impartiality and lucidity. A chronicle of events is less well-balanced but extremely useful. The year's obituary gives biographical sketches of about 300 eminent men and women of all countries. Literature of the year is dealt with in a forty-page summary, which is a comprehensive and, to a large extent, critical survey of the year's books. Science has to be content with a twelve-page summary, which, however, ranges over so wide a field that little, if anything, of notable value is omitted. A full index enhances the value of the book.

A Text-Book of Machine Construction and Drawing. By H. E. Merritt and M. Platt. Pp. x+197. (London: G. Bell and Sons, Ltd., 1922.) 7*s*. 6*d*. net.

TEACHERS of classes dealing with machine construction and drawing are frequently put to a great deal of trouble in seeking for modern examples to put before their students. Text-books on the subject go out-of-date, and on account of the great strides which have been made in recent years in the manufacture of engineering materials, and in their treatment in the machine shop, and consequently in design, details have shown an increasing tendency to become obsolete. The volume before us contains a large number of designs suitable for students, and all of these examples are up-to-date. The authors make use of the American system of projection, and there is sufficient practical geometry included for the purposes of the draughtsman.

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.*]

Dr. Kammerer's Alytes.

THOSE who have followed the discussion of Dr. Kammerer's claims will be aware that special interest has centred on the question whether he could produce for examination males of Alytes showing the modification alleged to occur in consequence of his treatment. Some of the circumstances which aroused scepticism are related in my letter to NATURE, July 3, 1919, p. 344. We were originally told (*Arch. Entwm.*, 1909) that nuptial callosities or *Brunftschwielen* appeared on the thumbs of males of the treated strain, and that in the 5th treated generation (Kammerer's F_4) *all* the males had these structures. They are a conspicuous feature in most Batrachia, and Alytes is one of the few forms in which they are not known to occur. Since normal Alytes mate on land and the treated animals were made to pair in the water, we were asked (1909, pp. 516-7) to see in these *Schwielen* a true functional adaptation. The rugosities were developed to give the males a better grip of the slimy females.

Dr. Kammerer remarks that any one who has compared the feel of a dry toad with that of a wet one will not question that rugosities on those parts of the limb which come into contact with the body of the female are a very necessary equipment for an aquatic embrace (p. 516). This theme was developed at considerable length. In *Arch. Entwm.*, 1919, the same argument reappears, and, various other hypotheses being discussed and set aside, it is argued that the most probable cause of the development of rugosities was to be found in the change of mating habits. The process of mating in the water takes twice or thrice as long and is far more laborious. If his interpretation is right, Dr. Kammerer continues, the development is to be regarded as a "*funktionelle Anpassung*: ihre nachweisliche Erblichkeit würde hierdurch an theoretischer Tragweite gewinnen" (p. 339).

Up to 1919 nothing but vague diagrams (1909, Figs. 26 and 26*a*) had been offered us to show what these new organs looked like, and no detailed description had appeared. Dr. Kammerer in that year published the long paper mentioned above, making some new statements which I will consider presently. In illustration a photograph of the whole animal (F_5 in 1913) was given. This picture was rather like those handed about a few years ago as "spirit-photographs," and for demonstrational purposes was worthless. There were also several drawings, and a photograph, representing sections through the skin of a supposed *Schwiele*. At about that time Dr. Przibram was good enough to send me a slide with six similar sections labelled "F_3," which I have shown to numerous colleagues. As regards the sections and representations of sections, I do not question that they may have been taken through real incipient rugosities, but the development is slight and ambiguous.

The description of 1919 amplifies that of ten years before. The rugosities were originally described as in the proper place, namely, on the upper (sc. dorsal) and radial surface of the thumb; and as more males of F_4 and F_5 came into breeding condition, rugosities appeared not simply on the bases of the thumbs but extended in various degrees and with individual differences up the inside of the forearm. Inasmuch as various Batrachians have rugosities in that region (showing also individual differences and asymmetries), and since in the embrace of Alytes the parts named are in contact with the female, the new account raised no fresh improbability—rather the contrary. Many modified males are said to have been under Dr. Kammerer's observation during three years after he had (1910) been challenged to produce one, but a photograph of a single specimen—and that absolutely non-committal—was all that had been published to show the structures in position. We are told that the 1913-hatched brood failed to breed, and the last male (F_6) died in 1914 (1919, p. 328).

But one specimen (presumably that photographed) was known to be preserved in Vienna. It had been examined by visitors to the Versuchsanstalt, who reported verbally and variously as to what they had seen. A few weeks ago the announcement was made that this Alytes would be shown in Cambridge, and I received an invitation to attend a meeting at which it would be exhibited. Knowing that Dr. Kammerer had abstained from appearing at the Congress of geneticists which met at Vienna in September last, I inferred that he had no new evidence to produce, and I therefore excused myself from attendance, not wishing to enter deliberately into what was likely to prove a profitless altercation. When, however, an exhibition before the Linnean Society was arranged, I naturally attended as a fellow of the Society to see what I could. I expected to see a dark mark on the thumb or other fingers extending perhaps more or less over the wrist or up the forearm ; and whether this was to be interpreted as a nuptial rugosity or not, would, I imagined, be more or less a matter of opinion.

What I did see was something altogether different. The animal was fastened with its back against an opaque plate in a cylindrical museum glass, with the ventral surface exposed. The right hand showed nothing special, but *across the palm* of the left hand was a broad dark mark. It looked like a piece of thickened, blackish-brown skin. Examining it with a good lens I could see no papillary or thorny structure, though considering the minuteness of the alleged spines, I scarcely expected to make them out very distinctly. But the appearance was quite unlike that of any natural *Brunftschwielen*. In them, even in *Rana agilis* which has them developed very slightly, one sees with a lens characteristic grey specks, not a dark uniform surface as in the creature exhibited. I do not mean that there was no break in the pad as a whole, about which my memory is doubtful, but that the surface was uniform and the colour continuous in tone, without the dotting or stippling so obvious in true *Brunftschwielen*. That there was no development on the right hand was explained. The skin had been snipped off during life to furnish sections.

A photograph of the palm of a hand was thrown on the screen. This palm was pointed to as showing rugosities, but I saw none. In the specimen exhibited, the backs of the digits were not visible, nor were we shown any photograph of them.

I direct attention first to the fact that the structure shown did not look like a real *Brunftschwiele*. Next I lay stress on its extraordinary position *It was in the wrong place*. Commenting on the evidence, I pointed this out. In the embrace of Batrachians the palms of the hands of the male are not in contact with the female. Those who looked at the specimen naturally concluded that they must be. One speaker confidently told me in the discussion that I was wrong, and that in the common toad the rugosities *are* on the palmar surface! To show how the hands are placed I send a photograph (Fig. 1) of a pair of *Rana agilis* killed and preserved while coupled. The lower digits of the male's hands are the thumbs.

Clearly the rugosities, to be effective, must be on the backs and radial sides of the digits, round the base of the thumb, as in our common frog, on the inner sides of the forearms, or in certain other positions, but not on the palms of the hands. There are, of course, minor variations, in correspondence with which the positions of the rugosities differ. The clasp of Alytes, for example, is first inguinal and afterwards round the base of the head (Boulenger). Minute thorns may be formed on the back of Bombinator and perhaps in other places on the skins of Batrachians, where they cannot serve as *Brunftschwielen*; but on the palm of Alytes they would be as unexpected as a growth of hair on the palm of a man.

FIG. 1.

Dr. Kammerer's own reply was on different lines from that of the speaker I have mentioned, but curious and, as I thought, significant. He asked us to note that in his lecture he had refrained from using the word "Adaptation"—a defence sound perhaps, though surely disquieting to his disciples.

The discoveries claimed by Dr. Kammerer are many and extensive. To geneticists that regarding heredity and segregation in Alytes (*Verh. naturf. Ver.* Brünn, 1911) which I called in question at the Linnean meeting is the most astounding. But what I then heard and saw strengthens me in the opinion expressed in 1913, that until his alleged observations of *Brunftschwielen* in Alytes have been clearly demonstrated and confirmed, we are absolved from basing broad conclusions on his testimony.

W. BATESON.

May 16.

The Light Elements and the Whole Number Rule.

I HAVE recently developed a method of generating anode rays of high velocity which is much more suitable to mass-spectrum analysis than the hot anode method previously applied. By means of this device it is possible to obtain the mass-lines of the metals of the lithium and beryllium groups at the same time as those of such elements as carbon and chlorine, the masses of which are known.

The masses of Li^6, Li^7, Be^9, Na^{23}, Mg^{24}, K^{39}, K^{41}, Ca^{40} have all been determined, and the divergence from whole numbers is in no case so great as one-tenth per cent. of the mass measured. The masses of the isotopes of lithium are most probably about 0·005 of a unit high, but naturally this figure does not have much significance with the present apparatus.

The effects with magnesium and calcium are too weak to show their fainter components, but the integral relations between these and the principal lines have already been demonstrated by Dempster. (Phys. Rev. xviii, xx.)

This work completes the determinations of the masses of the more important isotopes of all the first twenty elements on the mass-spectrograph, and, with the obvious exception of hydrogen, each obeys the whole number rule to the accuracy of experiment, one part in a thousand.

It is of particular interest that no difference in mass is detectable between the isobaric atoms Ca^{40} and A^{40}, for general considerations might lead one to expect a radical difference in their nuclear structure owing to the presence of the two additional nuclear electrons in the latter.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, May 17.

Microphonic Flames.

[A FEW weeks ago it was reported in the daily Press that Dr. Lee de Forest had used a flame for the direct production of telephonic currents by sound waves. In response to a request for details of his device, Dr de Forest writes as follows.—ED. NATURE.]

I have as yet prepared no paper on the subject of the "microphonic flame." For a long time I had puzzled over the problem of turning sound waves *directly* into electric telephonic currents. I recognised that sound waves passed through flames in the air; also that a flame was, to a certain degree, conducting electrically. Hence, I reasoned that if one passed a current through a flame, its conductivity *must* vary, more or less, with the alternate waves of compression and rarefaction, which constitute sound.

Setting out to verify my deductions, I succeeded almost at once. I employed first a "bat-wing" gas-flame, enriched this with potassium salts, used two platinum wire electrodes across a dry cell battery of 100 to 200 volts, in series with a high-resistance (radio) telephone receiver. By carefully adjusting the electrodes in the flame (especially the *cathode*—the position of the anode is not important; it can even be located a short distance *outside* the flame) I obtained in the telephone receiver a faint but *very perfect* reproduction of the music of a gramophone played 3 ft. from the flame. The adjustment of the gas pressure, using this type of flame, is critical. If too strong, the flame roars in the telephone receiver. If too low, the conductivity and sensitiveness of the flame falls off.

I next employed a type of Welsbach burner and mantle, using as electrodes platinum gauze "imbedded" in the mantle and directly inside the mantle. Also, an oxy-acetylene flame, employing for electrodes platinum wire *encased* in quartz, which, of course, becomes conducting in this flame. This arrangement gives an exceedingly perfect reproduction of the sound—voice or music—far better than any carbon microphone.

A small alcohol burner and flame can be employed. In this case I recommend as cathode a Nernst glower as supplying the necessary electrons. Or enrich the blue flame by potassium or sodium salts fed up through the wick, with the alcohol.

Audion amplifiers must, of course, be employed if one wishes to use the "flame microphone" for broadcasting, radio-phone, or "phonofilm" purposes.

The sensitiveness increases in general with the impressed P.D. across the electrodes—up to a limit.

Care must be taken to guard against: (1) hissing due to too high voltage discharge; (2) flame noises; (3) air fluctuations; (4) depositing of carbon upon the electrodes.

I have not had time yet to make a careful scientific study of this phenomenon, but am persuaded it is chiefly a *pressure* effect, controlling ionisation and the ionised conductivity of the flame.

LEE DE FOREST.

Molecular and Crystal Symmetry.

MR. T. V. BARKER has discussed in NATURE of May 12 the theory advanced by Fedorov and Shearer with reference to the relations between molecular and crystal symmetry. According to this hypothesis the symmetry of the crystal includes the symmetry of the molecule with such additional symmetry as is afforded by the arrangement of the molecules, if there be more than one, in the unit parallelepipedon or cell of the structure.

At the reading of Mr. Shearer's paper I mentioned some considerations which required to be taken into account in applying this principle (Proc. Phys. Soc., vol. 35, p. 99, 1923), and I propose to restate them here in somewhat more detail.

In many cases there is reason to believe that molecules have no existence in the structure of a crystal. In others they appear to maintain their identity. It does not, however, follow that they retain the full symmetry they possess when in the free state in a fluid; for the whole or a part of the symmetry may be destroyed by close packing in the crystal structure. Nor is it probable that the symmetry actually possessed by the unit cell formed of one or more molecules is always identical with that of the structure of which it forms part.

In the first place, a number of primary cells with different but similar orientation (including in this expression a symmetrical relation between enantiomorphic forms) may be combined by what may be termed cell-twinning to form a greater cell with higher symmetry. These greater cells may of course be regarded for crystallographical purposes as unit or elementary cells; but it is improbable that they would always be recognised as such by means of the X-rays, which would in many cases not permit of discrimination between the differently orientated primary cells. The same crystallographic characters would also result from ultra-microscopic twinning on a larger scale, involving groups of differently orientated cells instead of individual cells. Repeated ultra-microscopic twinning of this character is believed to take place with the triclinic mineral microcline, so as to give rise to the monoclinic mineral orthoclase.

Apart, however, from regular twinning, one would expect cells of low symmetry to build up in many instances structures of higher symmetry, but usually belonging to the same system. Perfect identity in cells is not necessary in the building up of a structure. A plagioclase crystal is formed of cells both of albite and of anorthite, with quite distinct atomic composition, and even to a limited extent of orthoclase which differs both in system and in molecular volume. Where, therefore, the outward forms of cells of the same substance in different orientations (in the wide sense employed above) closely resemble each other but do not show absolute identity, it may be expected that the crystal structure will be built up indiscriminately of cells with similar but not identical orientation. The result will be that the special features characteristic of a lower symmetry will be eliminated and only the highest symmetry of the system will remain. This is probably the reason why crystals possessing the symmetry of one of the lower classes of a system are comparatively rare, and in some instances are not known to occur.

These principles are well illustrated by the facts disclosed in a paper on the "Relation between the Crystal Structure and the Constitution of Carbon Compounds, Part I., Compounds of the Type CX_4" (Journ. Chem. Soc., vol. 123, pp. 71-79, 1923), by Miss Knaggs, of the Imperial and Bedford Colleges. She shows that in substances of the CX_4 type, where X is an element, the crystal usually belongs to the cubic system. Those of the type CX_3Y, where X and Y are elements, are as a rule trigonal or hexagonal, unless X is hydrogen, the atoms of which appear to be too small to determine a trigonal symmetry. Those of the form $C(CX_3)_4$ are usually cubic, as the trigonal character of the CX_3 group enables all four trigonal axes of the cubic system to be preserved. Finally, substances of the form $C(CX_2Y)_4$ are in general tetragonal. In every case in which the symmetry of the crystal shows it to belong to the same system as that of the molecule, it must be referred to a higher class, usually that with the highest symmetry in the system. For example, the molecules CX_4 and $C(CX_3)_4$, which are cubic, have no axial planes of symmetry, but wherever there is any definite crystalline form, the crystals possess such axial planes. In some cases, however, the cubic system is only recognised by the isotropic character of the crystals. Again it can be easily shown that the molecule $C(CH_2Y)_4$ belongs to a class of the tetragonal system with only a contra-directional or inverse tetragonal axis, but the crystals have all a co-directional or simple tetragonal axis, such as is found in the higher classes of the tetragonal system.

In many cases, on the other hand, there are isomorphic forms with lower symmetry, formed usually at lower temperatures. In these the atoms are apparently more tightly packed, and the molecules have either been distorted or have lost their identity altogether.

JOHN W. EVANS.
Imperial College of Science and Technology,
South Kensington, S.W.7,
May 15.

IN a recent letter to NATURE (May 12, p. 632) Mr. T. V. Barker takes exception to statements made by the writers in respect to the relation between the symmetry of a crystal and that of its components (G. Shearer, Proc. Phys. Soc., 1923, vol. 35, p. 81, and W. T. Astbury, Proc. Royal Soc., 1923, vol. 102, p. 506). It appears to us that his criticisms are based on certain misapprehensions.

Fedorov tried to prove (*Zeits. Kryst.*, 1912, Vol. 52, p. 22) that if n is the symmetry number of the structural unit of the crystal, or, briefly, the crystal unit, or, in other words, is the number of identical or enantiomorphously related asymmetric parts into which it is subdivisible, if m is the number of molecules it contains and p the symmetry number of each molecule, then $n = mp$. Mr. Barker believes that Fedorov failed to prove his case, that the first paper referred to above contains an unconscious repetition of Fedorov's argument, which, though new evidence is brought forward, is still unconvincing, and that the suggested structure for tartaric acid is against the principle and not, as we have said, in its favour.

In the first place, Fedorov's statement was surely unexceptionable in the form in which he made it. If one of the molecules, or groups of molecules into which the unit is divided, possesses a plane of symmetry, this can mean only that it has similar relations with its neighbours on either side of the plane and through them with the rest of the crystal. That is to say, the plane of symmetry of the molecule is also a plane of symmetry of the crystal. On the other hand, we must be ready to allow, as Sir William Bragg has pointed out, that a molecule as built into a crystal may not have the same form as the freer molecule of a liquid or a gas. Such a difference seems to occur in the case of tartaric acid, on which account the crystal and its solution differ in their optical properties. The molecule may have a plane of symmetry in one case and not in the other. It is a task of the future to correlate the forms and the symmetries of the molecule in its different conditions. It is by no means improbable that the differences are small (Journ. Chem. Soc., 1922, vol. 121, p. 2766). Fedorov was quite aware of this possibility himself. If Fedorov's statement is taken to refer to the molecule as built into the crystal, it seems to require no further defence.

In the next place, the rules or principles set out in the first of the two papers referred to do contain Fedorov's statement, no doubt. If the author had been aware of the paper he would have referred to it. But the essence of the statement which is criticised is not an enunciation of a law of crystal symmetry which could not have been and was not overlooked by the searching examination of the crystallographers. It was an attempt to codify certain results of X-ray analysis. Fedorov could say, rightly as we think, that a crystal of the monoclinic prismatic class could be formed of four groups, A, B, C, and D: of which B was obtained from A by reflection across a plane, C by digonal rotation about an axis, and D by inversion through a centre of symmetry. He had no direct evidence to carry him further. The X-rays do go further: they show that in the crystal unit of benzoic acid, for example, there really are four groups so related to one another, and they give their relative positions. Moreover, they show that each of these groups is, in substance at least, the chemical molecule. This is new knowledge, which could not be proved by Fedorov. If it had been in his power to do so, the crystallographic tables would have contained the dimensions of the unit cell of each crystal; and not merely, as they do now, the topical ratios.

We may point out that Mr. Barker is in error also in supposing that nothing can be said about the symmetry of the molecule until the position of every atom in it is accurately determined. The X-rays show that the molecules of benzoic acid, for example, are divisible into two groups, which present exactly the same aspect when viewed along the axis of the crystal and different aspects when viewed in any other direction. This is in agreement with the hypothesis that the two are the reflections of each other across the plane of symmetry, and that each is by itself asymmetric with respect to that plane.

Lastly, Mr. Barker refers to the structure of tartaric acid, described in the second of the two papers, as an infringement of the principles set out in the first, because, as he says, it has an "unobtrusive dyad axis," which does not coincide with the axis of the crystal. The only answer is that it has not, as may be seen from Figs. 8, 12, 14, 15 of the paper, or more easily from the model itself. There is no such axis, and, therefore, no infringement.

G. SHEARER.
W. T. ASTBURY.

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The Mechanism of the Cochlea.

IN Mr. Wilkinson's letter in NATURE of May 12, p. 636, three points are raised upon which I wish to comment.

For the sake of simplicity I described the mechanical conditions occurring when sound waves reach the cochlea in the normal manner by the chain of ossicles. In the case of bone conduction the mechanism of analysis ought to be the same as under other conditions. Bone conduction is the response to a continuous series of uniform waves from a tuning-fork which would produce a corresponding series of vibrations in a resonating system. I cannot agree that the movement "originates *at the basilar membrane*," because the movement depends on the whole resonating mechanism, including the inertia and friction of the fluids.

Damping is the decrease in amplitude due to resistance, and I believe that by using that term Mr. Wilkinson intends to deny any influence due to liquid friction in affecting the note to which the system resonates. In White's "Handbook of Physics" (Methuen and Co., first edition, p. 305), I find "partly closing the mouth [of a resonator] lowers the note." This is an example of friction in a gas affecting the frequency of resonance, which is also seen in the well-known method of tuning organ-pipes. If such an effect is shown with a gas, surely it must be much greater with a liquid in such narrow tubes as those of the cochlea.

With reference to the spiral ligament, I think that the point is unimportant. I merely pointed out the danger of deducing from the size of the ligament the tension on the membrane at rest. To make the point clearer I would suggest the analogy of the size of a pair of hooks supporting a cable. The size of the hooks may not be designed with reference to the tautness of the cable. The cable may be slack, so that the only pull may be that due to its weight; but large hooks may be used, because the cable may have to sustain heavy weights from time to time. I am quite willing to believe that the fibres of the basilar membrane near the *fenestra ovalis* may be more tightly stretched than those near the apex of the cochlea, but that does not necessarily follow from the dimensions of the spiral ligament.

Finally, I wish to emphasise that this correspondence arose in relation to the dimensions of the cochlea and the possibility of such a small structure acting as a resonating mechanism. The point that I wished to bring out was that, on account of its small size, liquid friction will be very great and that this friction may be *one* of the factors in the analysis.

H. E. ROAF.

London Hospital Medical College,
Turner Street, Mile End, E.1,
May 15.

An Einstein Paradox.

THE following, with amplified details to help discussion, is, I trust, a fair statement of the problem in Einstein's "Relativity" (Methuen). K, K_1 are together, each provided with a clock. The clocks agree at noon when K_1 starts moving in a straight line with uniform speed v (*estimated in K's units*).

Some time later, a light signal is flashed from a point L on the line, ahead of K_1, and is seen by K, K_1 at times t, t' on their respective clocks; $KL = x$ of K's units of space and $K_1L = x'$ of K_1's. Then, according to Einstein,

$$(1) \ldots x' = (x - vt)/\sqrt{1 - v^2/c^2},$$

$$(2) \ldots t' = (t - vx/c^2)/\sqrt{1 - v^2/c^2},$$

where c = vel. of light *in vacuo*.

Since (1) does not contain t' we shall avoid the comparison of clocks by considering that equation only.

Now let us take the case of $x' = 0$; *i.e. let the light signal be made exactly when K_1 reaches L.*

Then by (1), $t = x/v$.

But x/v is the time on K's clock when K_1 reaches L; to this must be added the time for light to come from L.

Therefore true value of $t = x/v + x/c$.

Hence (1) appears to be fallacious.

In that case, also, $x^2 - c^2t^2$ is not equal to $x'^2 - c^2t'^2$.

It is remarkable that Einstein actually considered the case of $x' = 0$, but overlooked the interpretation of it.

It may be interesting, possibly instructive, to consider how a "Newtonian philosopher" would deal with the above problem as soon as he became aware that the velocity of light was not negligible. There are three cases.

1. As above—the signal *ahead of* K and K_1, then

$$t = \frac{x - x'}{v} + \frac{x}{c} = \frac{(c+v)x - cx'}{cv},$$

$$t' = \frac{x - x'}{v} + \frac{x'}{c+v} = \frac{(c+v)x - cx'}{v(c+v)};$$

whence

$$t' = \frac{c}{c+v}t \quad \text{and} \quad x' = (1 + v/c)x.$$

2. The signal *from behind* K, K_1, so that x, x' are negative:

$$t = \frac{x - x'}{v} + \frac{(-x)}{c} = \frac{(c-v)x - cx'}{cv},$$

$$t' = \frac{x - x'}{v} + \frac{(-x')}{c-v} = \frac{(c-v)x - cx'}{v(c-v)},$$

equations which, as might be expected, are deducible from the previous pair by writing $(-c)$ for c.

3. The signal *from between* K, K_1; or x positive, x' negative:

$$t = \frac{x - x'}{v} + \frac{x}{c},$$

$$t' = \frac{x - x'}{v} + \frac{(-x')}{c-v},$$

whence no neat results.

It seems reasonable to conclude that *no single pair* of equations, such as the Lorenz transformation, can meet all the cases!

R. W. GENESE.

40 London Road,
Southborough, Kent.

Longevity in a Fern.

I WONDER what is known of the duration of life in common herbaceous plants, other than annuals and biennials? The following instance may serve as a contribution to the lore of the subject.

About the year 1872 I found on the Mendip Hills a mature specimen of that curious sport of the hart's-tongue known as *Scolopendrium vulgare* var. *peraferum-cornutum*, in which the mid-rib and the lamina part company at the apex of the frond, the mid-rib projecting as a horn, and the lamina forming a frilled pocket on the anterior surface. I transferred it to my father's garden in the same neighbourhood, where it has flourished ever since, retaining its peculiar character.

In 1917, as it was in danger of being choked by the growth of surrounding shrubs, I transplanted it. The stock had twice divided dichotomously, forming three crowns, of which one was dead. I placed the living ones where they had room to grow, and now they are as vigorous, and as young in appearance, as the original plant fifty years ago. As the plant was of unknown age when found, and looks no older after fifty years, its capacity for life seems indefinite.

F. J. ALLEN.

Cambridge, May 3.

The Recording Ultramicrometer.

THE recording ultramicrometer was first very briefly described before the Royal Dublin Society (Royal Dublin Society, xvi. p. 185, March 1921; *cf.* also NATURE, June 23, 1921, vol. 107, p. 523). Since its exhibition at the Edinburgh meeting of the British Association many short accounts of it have appeared in England and abroad. Many correspondents have requested further information, and, as some time may elapse before a full account of my investigations in this connexion are published, I take this opportunity of giving some practical hints to enable others to set up the apparatus.

In Fig. 1 the three-electrode valve is connected to

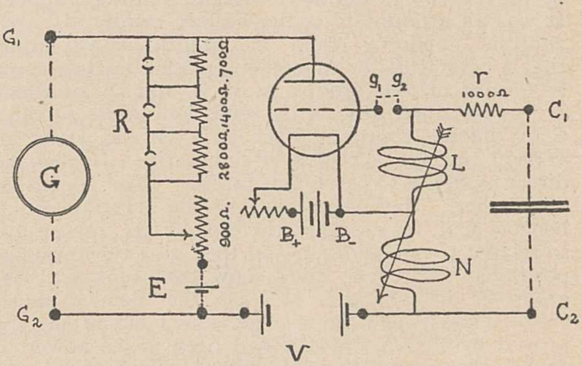

FIG. 1.—Diagram of connexions: B, 4 to 6 volts; V, 30 to 100; E, 1.5 to 6. L, N, about 10 cm., flat, 150 turns. G, aperiodic galvanometer, 10^{-8} amp. per div.

an oscillation circuit of the "Hartley" type, and in the anode circuit a sensitive galvanometer is introduced, its terminals being shunted by the "zero-shunt" E, R. The condenser C_1 C_2 of the oscillation circuit is formed by two parallel metal discs (say 5 cm. diameter). One of these may conveniently be adjustable by a fine micrometer screw, so that the capacity can be altered by turning the latter. As the plates are screwed together, increasing the capacity, it will generally be found that, from a certain point, the anode current increases, reaches a maximum, and finally rapidly recedes to its original value.

This sequence of changes takes place only when the circuit can oscillate. To follow the complete sequence it is necessary either to shunt the galvanometer heavily or to substitute for it a milliamperemeter.

A set of observations so obtained is given in Fig. 2, which represents the apparatus in the best adjustment for our purpose. To obtain this linear form of curve

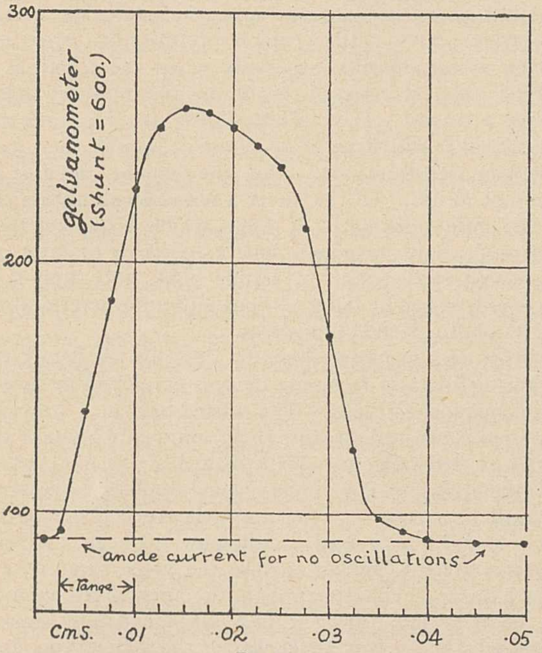

FIG. 2.

the relative positions (" coupling ") of the coils must be altered, and the most suitable plate voltages (V) ascertained by trial. With some valves it may be necessary to apply a negative potential to the grid between the points g_1 g_2, Fig. 1. I have used several common makes of " R Type," hard valves, and have never found any difficulty in obtaining the condition shown.

The function of the " zero-shunt " is to by-pass an amount E/R of the anode current j, so that, if R is large compared with the resistance of the galvanometer, the current through the latter is approximately $j - E/R$. When E and R are chosen so as to make this difference small, a sensitive galvanometer can be employed, unshunted, which will then give large deflexions, when the plates of the condenser suffer minute displacements. In view of the *linear* form of the curve (Fig. 2), it will be clear that the galvanometer reading is proportional to the plate displacement. Also, calibration is readily obtainable by shunting the galvanometer, say ten times, and then observing the deflexion obtained when the micrometer screw is turned through, say 1/1000 cm.

A resistance r up to 1000 ohms may be introduced into the oscillation circuit to reduce the sensitivity and widen the range of the plate movement. This resistance also renders it easier to obtain the linear adjustment. The large black dots in Fig. 1 represent the terminals on the case of the instrument; the batteries, galvanometer, and condenser plates are external and are connected to these terminals. The actual resistances, coils, etc., are mounted beneath the ebonite top of a small box, about one foot square and a few inches deep. Rigid connexions are employed to eliminate vibrational effects.

In the use of the apparatus for recording small displacements, movements, etc., one of the condenser plates is caused to partake of the movement to be measured by direct attachment, if possible, to the moving member. The other plate may be mounted, as already described, on a micrometer screw device to facilitate calibration. For steady working, at all times great care must be taken to employ batteries that are in perfect condition, and have an adequate current capacity. It is advisable to use cells of the same type for E as for V. Temperature changes must naturally be avoided in view of expansion and other effects. For " super " sensitivities (above 10^{-7} cm.) screening and other precautions become necessary.

JOHN J. DOWLING.

University College, Dublin, May 7.

A Permanent Image on Clear Glass.

THE interesting observation described by Mr. Eric Robinson in NATURE of April 28, p. 569, and commented upon in the same issue by Dr. J. W. French, is an excellent example of the ease with which the surface of glass may suffer modification and retain it over a long period of time. The present writer has studied a number of phenomena connected with " breath figures," and an account of the work will be found in the *Philosophical Magazine* for October last.

If the tip of a small blowpipe-flame is drawn rapidly across a sheet of glass it can be shown in various ways that the surface of the glass along the flame-track has been considerably modified. Flames of coal-gas, carbon monoxide, and hydrogen produce identical results. When moisture from breath condenses on the glass it is in the form of a misty deposit of minute hemispherical droplets, except along the flame-track, where it collects as a continuous transparent film. The contrast between the two types of condensation is most marked and constitutes a " breath figure." These flame-tracks are revealed when silver is chemically deposited upon the glass and they can also be traced by the greatly increased friction which manifests itself when a chemically cleaned watch-glass, which is being dragged across the plate, encounters one of the tracks. The insulation of the glass surface is also less along a flame-track than it is on those parts which have not been exposed to the action of the flame.

It is not possible in the space available to give the evidence in favour of the conclusion reached by me that at least two causes operate in producing the modification of the glass surface which leads to a " breath figure." One of these is that the flame removes the extremely thin film of contamination which certainly covers all glass which has not been subjected to a rigorous chemical cleansing process, and the other is probably a physical change in the surface of the glass itself. The latter is very persistent and can be detected for many months after the passage of the flame across the glass. I am inclined to attribute Mr. Robinson's effect to a physical change in the glass surface. Is it not possible that the gelatin of a photographic print which has been squeegeed upon glass may, when dry, exercise a considerable force on the surface in contact with it and that this force may have different local values depending upon the density of the photographic image? Such local differences in tension may impress upon the glass corresponding differences in surface structure which would then be capable of detection as a " breath figure " or by deposition of silver.

T. J. BAKER.

King Edward's School, Birmingham, May 7.

The Transmission of Speech by Light.[1]

By Prof. A. O. RANKINE.

IN 1880 Graham Bell devised a system of using light for transmitting sounds, including speech, and called his instrument the "photophone." This system afterwards experienced a chequered career, having attracted only occasionally the attention of other investigators, with the result that, although considerable improvements have been made, it has until quite recently remained a novelty. It is beginning, however, to enter upon the phase of practical use, more particularly in connexion with some of its applications in which the distance over which the light acts as the vehicle plays no essential part. In these circumstances it is, perhaps, desirable to introduce some modification of nomenclature. There is little doubt that Graham Bell's original idea was to transmit speech by means of a beam of light which travelled over as great a distance as possible. It is true that the maximum range he records having attained is 700 feet. The modesty of this achievement perhaps prevented him from introducing the notion of distance into the name he gave to the apparatus. Now, however, the name "photo-telephony" would appear to be appropriate for the improved system which, with its increased efficiency, and with the aid of modern amplifying devices, has a range of transmission of several miles and the immediate prospect of such extension that the earth's curvature will prove in practice to be the limiting factor. The adoption of this name for telephony by light would have the additional advantage that it would leave us free to retain the equally appropriate term "photophone" for those special modifications, already mentioned, in which distance is an unimportant consideration.

If we wish to use light for the transmission of sounds it is clear that we must impose on the light features which are characteristic of the sounds in question. The plan generally adopted is to modulate the intensity of the light in accordance with the vibrations constituting the sounds. How this is done will be considered later. For the moment the question is by what means these fluctuations of intensity can be made to reproduce audibly the original vibrations. This reproduction is possible because we have at our disposal certain substances, of which suitably prepared selenium is the best-known example, capable of acting as electric valves operated by variations of illumination. Selenium is not ideal for the purpose. Indeed, having regard to its many defects, it is surprising that it functions so well as it does. Shelford Bidwell, in a Friday evening discourse at the Royal Institution in 1881, spoke of the "capricious behaviour" of selenium, and it has to be admitted that this is still a fair description, even though many improvements of design and efficiency have been introduced by various makers of so-called selenium cells. There are, for example, obscure changes of conductivity, occurring slowly, which have defeated all attempts to use the electrical conduction of selenium as a basis in photometry.

Fortunately, these relatively slow changes are not of appreciable importance in connexion with the photophone, for in that case the fluctuations of light intensity are very rapid, corresponding, as they do, to audible frequencies. A more objectionable feature is that there is displayed a considerable lag in the electrical valve action, which prevents its operation being at all efficient, especially when the selenium is called upon to respond, as in the photophone, many times a second. If a suitable substitute free from this inertia-like effect could be found it would very soon displace selenium cells and the similar devices at present in use. Of the latter a notable example is the "thalofide" cell of T. W. Case, which is quicker than selenium in its response, but is sensitive to infra-red radiation rather than to visible light, and cannot be exposed to bright light without suffering deterioration in its photo-electric properties.

It is not proposed here to describe in detail the transmitting and receiving devices employed in speech transmission by light. The writer has, in a previous issue of NATURE,[2] already given some indication of the lines of development. With regard to the modulation of the light by speech two general plans have been adopted, namely (1) to cause the speech vibrations to control the actual candle-power of an artificial source of light, and (2) to use the voice to actuate a mechanism which interrupts in the appropriate manner a beam of light after it has left a constant source. Graham Bell's transmitter was of the latter type, and, although until recently the tendency, particularly on the continent, has been to employ the former plan by superimposing on the current in an electric arc or suitable filament lamp the microphonic currents arising from speech sounds, it is now fairly generally recognised that greater efficiency can be attained by improved forms of the interruption method. This method has also the advantage that it can be applied to any source of light, and thus brings into our service sunlight, which is the brightest of all.

The simplest form of the receiving device is a circuit consisting of a selenium cell, an electric battery, and a telephone receiver. On exposure of the selenium to constant illumination, a constant, or, at any rate, a very slowly varying current passes. If, however, the illumination is of a fluctuating character—if, in particular, the variations are those due to modulation by speech vibrations—the selenium is able, in spite of its lag, to control the current in a closely corresponding manner, so that the diaphragm in the telephone receiver, through which this current flows, is set in vibration, and emits sounds resembling with a remarkable degree of accuracy the original sounds used in modulating the light. The speech currents in this simple circuit can be transformed into other circuits if desired, and they can be amplified in the usual way by means of thermionic valves. It only has to be borne in mind that selenium cells are usually of very high resistance, and that, therefore, methods of transformation appropriate to such cases should be employed.

It is easy to arrange the optical system of the transmitter so that the light projected is confined to a very narrow angle and directed upon any small chosen

[1] From two lectures delivered at the Royal Institution on April 12 and 19.

[2] NATURE, vol. 104, p. 604 (1920).

area in the distance. The amount of light received by the selenium, placed, as it is, near the focus of a lens or mirror of definite aperture, diminishes, of course, as the distance is increased. Several factors determine the range of efficient transmission—the intrinsic brilliancy of the light source, the dimensions of the optical parts, the sensitivity of the selenium, and the number of stages of amplification which are used. No very conclusive tests of the maximum range of the photo-telephone have yet been carried out; it may, nevertheless, be asserted with some confidence that, given sunlight and modern amplifying devices, it is probably the earth's curvature which would impose a limit on the range of an instrument of quite reasonably small dimensions.

It is of interest to compare the photo-telephone with the system of wireless telephony now so commonly used in broadcasting. In both, waves in the ether constitute the fundamental basis; the medium is the same and the speed of propagation is the same. In both, speech vibrations modulate the intensity of the energy transmitted, and in both the results are made audible by changes of current in the receiving apparatus. The details are, of course, dissimilar. The radio-frequency waves are produced artificially, and are under control as regards wave-length; the luminous waves are taken as we find them emitted from the source. The detectors—the valve or crystal on one hand, and the selenium cell on the other—are not strictly comparable. But the only really important difference lies in the lengths of the waves. Roughly, the radio-frequency waves commonly employed are one thousand million times as long as those operative in photo-telephony. This difference is of great importance in relation to the mode of propagation. Wireless waves at present in use are so long that they turn readily round corners, so that not only does the earth's curvature impose no serious limitation of range, but broadcasting in all directions is possible and, indeed, inevitable. Light waves, on the other hand, are for practical purposes propagated rectilinearly; consequently photo-telephony can never be expected to attain a very great range. It has, however, the compensating feature that by its directiveness it implies not only secrecy of communication but non-interference by simultaneous transmissions, without the necessity of tuning as in radio-telephony. It is true that selenium is more sensitive to red light than to other colours, and is therefore somewhat selective as regards frequency, but the suppression of the other colours is not called for, and would, in fact, be a disadvantage.

The photophone, as distinct from the photo-telephone, has several other applications. Two may be briefly indicated. The modulated light from the transmitter can be focussed into a narrow line upon a uniformly moving kinematograph film upon which, after development, there appears a band of varying opacity corresponding to the light fluctuations, and, therefore, to the speech or other sounds used for modulating purposes. The same film, on being run at the same speed between a source of light and a selenium cell with a suitable optical arrangement, gives a reasonably good reproduction of the original sounds. With sufficient amplification the results can be heard proceeding from a loud-speaking telephone. The application of this form of gramophone to the problem of synchronised pictures and sounds is obvious, and has been described in an earlier article.[3] Many workers in various countries are now concentrating their attention upon perfecting a system of this kind, and there is no reason to suppose that realisation will be long delayed.

The speech currents controlled by selenium under the action of the modulated light from a photophone transmitter compare favourably in accuracy of form with those obtained by means of a carbon microphone. The photophone as a whole—*i.e.* the transmitter and receiver together regarded as one unit—can thus be used as a substitute for the microphone in cases where stricter accuracy in electrical sound transmission is desired. This necessity has arisen in acute form in connexion with radio-telephony, in which the radio-frequency oscillations have to be modulated in the transmitting valve as nearly as possible in accordance with the sounds it is desired to transmit. A photophone has been used successfully at the Manchester broadcasting station for this purpose, and for some months those who listen to this station have been receiving the results of what can quite fairly be described as a remarkable sequence of occurrences. A singer sings, and the aerial vibrations thus created fall upon a diaphragm. This is forced also into vibration and imparts its motion to a small mirror, which in turn deflects a beam of light so that more or less of it reaches a selenium cell. By its photo-electric property the cell controls an electric current so feeble that it has to be amplified by thermionic valves in several successive stages before it is intense enough to modulate efficiently the radio-frequency oscillations in the transmitting valve. Thence the modulated wave travels through the ether to the receiving aerial; here, perhaps, it undergoes one or more high-frequency magnifications, and then the modulations are detected by a crystal or valve. Then there may be several low-frequency amplifications before, eventually, the fluctuating current actuates a telephone diaphragm causing it to re-create those aerial vibrations which we hear. When we bear all this in mind our attitude is not that of criticism of the defects of reproduction, but rather that of amazement that it so closely resembles the original.

[3] Nature, vol. 108, p. 276 (1921).

Recent Experiments in Aerial Surveying by Vertical Photographs.[1]

By Prof. B. Melvill Jones and Major J. C. Griffiths.

II.

Compilation of the Mosaics.

The compilation of the mosaics presents considerable difficulties unless approached in a systematic manner, for, although individual prints fit well together, there are always some slight errors which tend to accumulate, unless special precautions are taken to prevent this occurring.

We begin the compilation by laying out each strip of photographic prints separately, paying special attention to the joins between successive prints. Slight

[1] Continued from p. 709.

changes of height, either in the aeroplane or the ground, will cause slight changes in scale between successive strips, and slight persistent tilts, either in the camera or the ground, will cause the strips, as fitted in the first place, to show fictitious curvatures due to differences being represented to a larger scale on one side of the strip than on the other.

To make a good fit between successive strips, these fictitious curvatures and differences of scale must, so far as possible, be eliminated by distributing errors between all the joins of the individual prints. We do this by securing to the back of the strips lengths of stretched elastic, fixed to each print in one spot by dabs of seccotine, and, when all the strips have been so treated, we lay them side by side upon a table and stretch and bend them systematically, until we have got the best general fit that can be obtained, without detail handling of the separate prints.

Provided that the strips were originally taken in fairly straight lines, this process of systematic adjustment appears to eliminate the fictitious curvature almost entirely and to adjust the relative positions, even of points that are far apart, with remarkable accuracy. A final adjustment is then made, in which attention is given to each print separately, but no print is moved far from the position that it has taken up in the systematic adjustment. Fig. 1 shows a mosaic laid out in this way. Notice the straightness of the strips due to the gyroscopic control, which was used in this case.

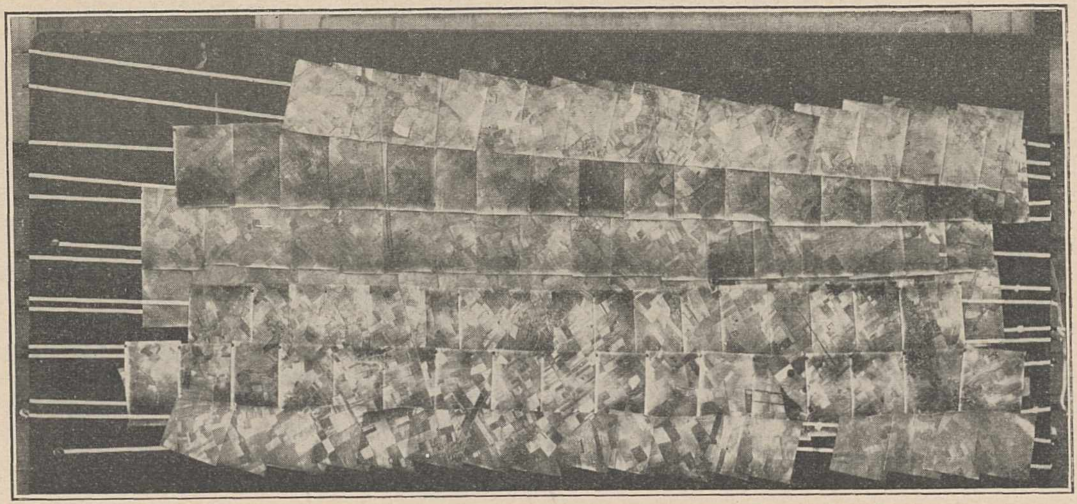

FIG. 1.—Photographic map of $7\frac{1}{2}$ by 15 miles, showing the elastic bands used in the compilation. In the finished map the prints would be properly trimmed and the elastic bands removed.

ACCURACY OF THE MAPS.

Two mosaics of $7\frac{1}{2}$ by 15 miles have been compiled in this way, without any reference whatever to existing maps. Some 40 points were selected on each of these, and their positions on the mosaic plotted on transparent paper. A plotting of these same points was then taken from the Ordnance map and enlarged until the best possible fit could be obtained with the points from the mosaic. The two plottings were then slid over each other until the best fit was obtained, and thus the remaining discrepancies give a measure of the distortion of the mosaics, without regard to scale.

The first of these mosaics was made without the gyro control on the rudder; it contains an area of 10 miles by 5 in which no point is displaced by more than 100 yards, but outside this area, towards the ends, there are points displaced by as much as 250 yards.

In the second mosaic, which is the one illustrated in Fig. 1, the gyro rudder control was used, and in this mosaic there is no distortion greater than 100 yards in any part. The increased accuracy is due, mainly, to the greater straightness of the runs, and to the pilot having been able to give more attention to maintaining height and speed constant.

The average scale of both mosaics came out to 1/19,800 as against 1/20,000 intended. The difference of 1 per cent. may be due either to the aeroplane having been about 100 feet too low, or to errors introduced during the systematic adjustment.

COMPILING TO CONTROL POINTS.

Our next experiment was to start again with new prints and to compile these two days' work together into a single 15-mile square. But this time, instead of fastening the ends of the elastics down to the table, we fastened them to laths on the edges of the table. (See Fig. 2.) The object of this was to enable us to apply systematic strains to the mosaic as a whole, after the first systematic adjustment, to cause it to fit control points.

We chose four control points, forming a rough 10-mile square, and, assuming their positions to be independently known (in this case from the Ordnance map), constructed a template to fit them, upon a scale that would most nearly fit the corresponding points upon the mosaic, after its first adjustment. We then applied this template to the mosaic and found that, owing to the distortion of the latter, displacements of about 150 yards were necessary at each control point to obtain an exact fit. These displacements were given to the mosaic by moving the laths as a whole, so that the adjustments were distributed over all the joins. The mosaic was then given a final adjustment in detail and the prints stuck down in place after removing all the elastics. When this work had been completed, some 40 points, distributed over the surface of the mosaic, were measured up and compared with the Ordnance map, and it was found that there were no errors of more than 60 yards, except on the extreme northern edge of the part of the mosaic that was made without gyro control on the rudder. In this region errors up to 130 yards were recorded.

The scale to which the template had to be constructed came out at 1/19,930. The difference between this scale and that of the separate mosaics compiled from the same photos was possibly introduced during the systematic adjustments.

a good measure of control between very widely spaced ground-surveyed points. If, for example, the photos in these flights be taken at exactly equal time intervals and the positions of the ends of the strips be known, the centre of each intermediate photo could be determined with considerable accuracy.

We have in hand experiments upon a scheme for using these indication strips, together with a few long strips at right angles, to control the positions of the 10-mile square units. We estimate, on good but not yet conclusive evidence, that, representing these preliminary strips by elastic bands and stretching the frame so formed to fit control points, we could so distribute the errors that the 100 square mile units mosaics could be located in position within $\frac{1}{4}$ to $\frac{1}{2}$ a mile, even when the

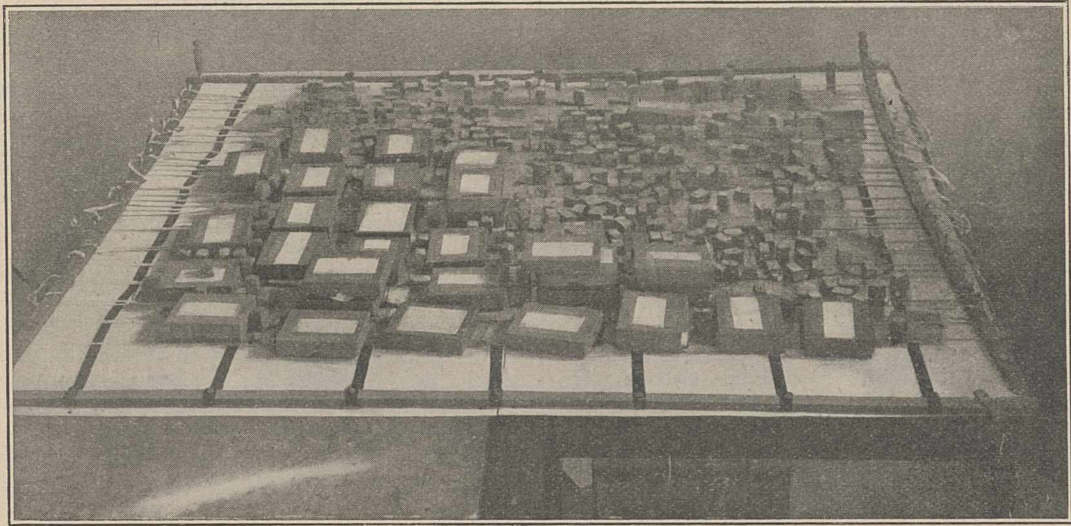

FIG. 2.—Showing method of compiling the 15-mile square photographic map to fit four control points. The prints are hidden by the weights used to hold them in place after their final adjustment, but the white elastic bands to which the prints are fastened are clearly shown. The black elastic bands were added to facilitate systematic straining at right angles to the direction of the strips.

control points are spaced as much as 50 miles apart. It will be noted that this method of locating position is unaffected by the presence of hills.

We do not recommend using control points so widely spaced as this, but we are concerned to show that the mosaics could be located with moderate accuracy even when the control points are so far apart.

The methods upon which experiments are in progress would not be limited to use with control points forming any particular pattern; they could be used with any form of triangulation. If, however, triangulation is impracticable, as it may be in flat wooded country, we are informed that astronomical methods, carried out on the ground, with the help of wireless time signals, can be used to locate position within 100 to 200 yards. If this method could be employed, therefore, in conjunction with aerial methods, it would be possible to push accurate mapping into unsurveyed country in which the ordinary ground-surveying methods, based on triangulation, are impracticable.

VARIATIONS OF HEIGHT.

The country of which this map was made contains local differences of level up to 300 feet in several places and on the extreme southern edge rises to 500 feet above the lowest part.

NAVIGATIONAL CONTROL.

In some types of country, control points even of 10-mile spacing may not be economically obtainable. The complete absence of control points would not, as we have seen, seriously affect the accuracy of the individual mosaics as regards distortion, but it may leave their average scale in some doubt. There may, therefore, be some difficulty, in these circumstances, in fitting the mosaics together and in controlling their relative positions. It will be remembered, however, that it was necessary, for the identification of the starting points of the mosaic strips, to begin a survey by laying down identification strips spaced 10 miles apart. The most economical way to do this, when mapping over large areas, would be to commence by laying down a series of long parallel strips 10 miles apart having a convenient length of, say, fifty miles. If care is taken to fly these indication strips very straight and at a constant speed, it may be possible to use them to give quite

TRAINING AND EQUIPMENT.

The methods that we have described require considerable skill and special training on the part of the pilot and observer. If they are not adequately trained the probabilities are that the strips of photographs that they produce will be badly curved and leave gaps between them, while the individual photos will be tilted up to about 6 degrees and taken from varying heights. In such circumstances accurate compilation is almost impossible unless a map already exists, and, even then, re-section and re-projection of individual photos will be necessary if anything but the roughest results are to be obtained. The gaps that have been left between strips will, moreover, have to be filled up; and, as this is not an easy operation, several additional flights may be necessary for a satisfactory completion of the mosaic.

We are, for these reasons, definitely of the opinion that to employ crews that are not specially practised in the work is to court certain failure; at least in the earlier stages, before experience has been gained.

Special equipment, such as gyro rudder controls, etc., is, in our opinion, necessary for continuous successful work at the rate we have indicated, namely 100 square miles a day. Should the gyros break down in the field, it would be possible to carry on for a time in the absence of any gyroscopical aid, but the strain on the pilot would be so greatly increased that his work would deteriorate seriously unless he confined himself to considerably less work than we have indicated for a single flight.

It is also important to use a stable aeroplane, having adequate accommodation for the observer and his camera and for the pilot's special instruments. We have ourselves used a tractor (D.H. 9a), but we consider that a pusher would be far more satisfactory on account of the better view downwards, sideways, and forwards.

Summary.

We have shown that it is possible to carry out aerial surveying by vertical photographs at the rate of 100 sq. miles to the day's flying. When working in moderately flat country the results so obtained can be worked up into 100 square mile mosaics which, when reduced to a suitable scale, will fit a true map within 100 yards at all points. If so desired these maps can be adjusted to fit any number of control points with very little extra labour. If these control points are spaced about 10 miles apart, the absolute error of any point on the mosaic should be less than 100 yards, but, if more closely spaced control points are available, the errors can be reduced, reaching a limit of something less than 20 yards, when the spacing is reduced to one mile.

If the available control points are spaced more widely than 10 miles apart, a measure of control can be provided from the air by navigational methods. We estimate that, even when the control points are spaced so far apart as 50 miles, we could in this way control the position of the 100 square mile units within ¼ to ½ mile. We are working on this problem at present.

The maps can be made throughout from contact prints off original negatives, no re-projection of individual photos being necessary.

Triangulated points, forming any convenient pattern, can be used as control points; *e.g.* previously existing primary, or secondary, triangulations could be used.

The methods are dependent on there being sufficient detail visible on the photos to allow them to be joined correctly; they would not be practicable on absolutely featureless deserts or prairies.

Specially trained, picked crews using suitable aeroplanes, specially equipped, are necessary for success.

Obituary.

Col. G. F. Pearson.

On April 25, Col. George Falconer Pearson died at Kington, Herefordshire, aged ninety-six years. He was one of the last, if not the very last, of devoted servants of the Crown who joined the Indian service some time before the Mutiny, and became a distinguished pioneer of systematic conservancy of the Indian forests.

Pearson commenced his service in the 33rd Regiment of the Madras Light Infantry in 1846, in which he became adjutant, and he also acted for some time as A.D.C. to Sir Herbert Maddock. He happened to be on leave at home when the Mutiny broke out, but returned at once to India and joined his regiment in the Central Provinces, where he was employed in the chase of Tipoo Sahib and other rebels. After the Mutiny he raised a force of military police, 600 strong, with which he put down general lawlessness in the province.

Having thus become well acquainted with the extensive forests and the various tribes living in and around them, Mr. Temple, the Chief Commissioner, appointed Pearson the first Conservator of Forests of the Central Provinces in 1860. Pearson, being endowed with an iron constitution and great energy, devoted the next eight years to the organisation and administration of the 20,000 square miles of Government forests in the province, selecting and demarcating reserves, introducing a system of regulated utilisation, starting a successful method of protecting the forests against the annually recurring forest fires, and regulating shifting cultivation; in other words, substituting a regular system of management for the method of reckless devastation of the past. His success brought him the special thanks of the Government of India for his valuable services.

In 1868 Pearson was transferred to the charge of the forests in the North-west Provinces, where he reorganised the department, estimated the yield capacity of the forests, and opened out the hill forests by the construction of roads, bridges, and timber slides, by which large quantities of timber were brought down to the plains for railway construction. In 1871 he was appointed to act for Dr. Brandis as Inspector-General of Forests, and in 1872 he left India to take up the appointment of director of studies to the British forest probationers at Nancy, a post which he held until 1884. On his final retirement he settled at Kington, where he lived for thirty-nine years, being a J.P. and the friend of all classes of the inhabitants.

Pearson, though not specially educated as a forester, energetically absorbed and utilised the leading principles of rational forest conservancy, and took a great part in the introduction of a system of rational forest management in India. He recorded his experiences and ideas in numerous reports, and he published a book on his "Reminiscences" of his activity in the Central Provinces. He was a great judge of character, and he succeeded in becoming the friend of those who served under him, while stimulating them to energetic action similar to his own. While at Nancy, he overcame in a short time the difficulties which had sprung up before his arrival, and his influence upon the students was highly beneficial; in return they loved and admired him. His younger son is a distinguished member of the Dehra Dun Research Institute.

CAPT. C. H. RYDER.

NEWS has come from Copenhagen of the death of Capt. Carl Hartvig Ryder, director of the Danish Meteorological Service, on May 3. He had been known to be suffering from rheumatism for some years and lately to find the cares of his official duty onerous; but, to us, the news of his death has come quite unexpectedly.

The Danish Meteorological Office is justly famous for the early production of Daily Weather Charts of the Atlantic Ocean, 1873 to 1876, by Capt. Hoffmeyer, sometime director, a work which was continued by the Danish Meteorological Office and Deutsche Seewarte jointly from 1881 until 1911, with the interval of August 1882 to August 1883, which was covered by the maps of the London Meteorological Office. In 1921 the International Committee expressed the desire for the charts to be brought up-to-date and Capt. Ryder had promised his aid. Further, with its relations to Greenland and Iceland, Denmark is one of the guardians of the farthest North, and for many years the Danish Meteorological Office has compiled all available information about ice in northern waters and published with great promptitude year by year reports thereupon.

Capt. Ryder, a naval officer, was appointed director in 1907 on the death of Paulsen. He became a member of the International Meteorological Committee in 1910 and was an indefatigable and most helpful member of that body, especially in regard to weather telegrams from Iceland. By nature he was disposed to work out meteorological progress on conservative lines: he realised that there was still much to be done in improving the data without which there are no adequate means of testing theories. His presence at future international meetings will be sadly missed by his colleagues.

NAPIER SHAW.

WE regret to announce the following deaths:

Dr. D. Duncan, formerly director of Public Instruction in India and principal of Presidency College, Madras, and biographer of Mr. Herbert Spencer, on May 18, aged eighty-three.

Dr. Hans Goldschmidt, the originator of the process for the preparation of chromium known by his name and of thermite, a mixture of aluminium and oxide of iron, used for welding iron and steel, and also in incendiary bombs, on May 20, aged sixty-two.

Prof. G. L. Goodale, professor of botany at Harvard University from 1878 until his retirement as emeritus professor in 1909, and president of the American Association in 1890, on April 12, aged eighty-three.

Prof. Immelmann, general secretary of the German Röntgen Society, in Berlin, on April 1, aged fifty-six.

Dr. A. Looss, formerly professor of parasitology in the School of Medicine, Cairo, a distinguished helminthologist, on May 4, aged sixty-two.

Mr. M. de C. S. Salter, superintendent of the British Rainfall Organisation, on May 21, aged forty-two.

Prof. A. G. Webster, professor of physics, Clark University, Worcester, Mass., known for his work on acoustics, aged fifty-nine.

Current Topics and Events.

WE learn from the Paris correspondent of the *Times* that the celebrations of the centenary of the birth of Pasteur commenced on May 24 with a reception by the French President at the Elysée. On the following day the principal ceremony was held at the Sorbonne, where a plaque was unveiled which bears an inscription recording the meeting between Pasteur and Lister in the Sorbonne on December 27, 1892. This tribute was arranged by the Association France–Grande Bretagne. A visit was paid by the President and the Minister of Education to Pasteur's birthplace at Dôle on May 26. M. and Mme. Vallery-Radot, descendants of Pasteur, have presented a bust of Pasteur, which was unveiled in the Galerie des Glaces at the Palace of Versailles on May 28, and the French President is to unveil the Pasteur monument at Strasbourg on May 31. A kinematograph film tracing the principal events in the life of Pasteur and giving a general idea of his scientific work was exhibited on May 24 to more than 3000 school-children in Paris, and considerable sums in aid of French laboratories have been collected by the sale of Pasteur badges in the streets. A new French 10-centimes postage stamp bearing the effigy of Pasteur engraved by Prud'homme has been issued to mark the occasion of the centenary. We hope to publish later an account of the celebrations by one of the British delegates.

As recorded in our columns, the late Arthur William Bacot, entomologist to the Lister Institute of Preventive Medicine, one of the most brilliant and original investigators in the field of medical entomology, lost his life a little more than a year ago in the course of an experimental inquiry into the rôle of the louse in the transmission of typhus. Several of Mr. Bacot's friends and colleagues have thought that some memorial of him ought to be established in the village where he resided and, before his appointment to the staff of the Lister Institute, carried out important medico-entomological researches. Mr. Bacot entered the ranks of specialist investigators from those of amateur naturalists and Nature students, and always attached the greatest importance to the teaching of Nature study in the elementary schools. His colleagues and friends believe that the form of recognition which would have been most congenial to his feelings would be the provision of assistance to the authorities of the Council schools in his home (Loughton) in furthering the study of natural history. With that object, a fund has been opened—the Bacot Memorial fund. It is proposed that the interest on any money received—to be invested in the name of trustees chosen by the subscribers—should be devoted to the purchase of such pieces of simple apparatus such as collecting boxes, specimen cabinets, etc., necessary for the development of Nature study in a school. It is well known that in the present state of public finances it is difficult to obtain grants for such purposes from educational authorities, and that the availability of even a very small income makes a great difference to an enthusiastic teacher. Should any of Mr. Bacot's friends or admirers of his work who feel in sympathy with the proposal care to subscribe to the fund, subscriptions will be gratefully acknowledged either by the hon. treasurer, Mr. Hubert Baines, Bryn Mawr, Church Hill, Loughton, Essex, or by Dr. Major Greenwood, National Institute of Medical Research, Hampstead, N.W.3.

The Jonas Laboratory for the mechanical testing of metals and the Edgar Allen Laboratory for magnetic investigations at the University of Sheffield were formally opened on May 3 by Sir Oliver Lodge. These laboratories have been equipped by means of two gifts of 5000*l*. each from the late Mr. Joseph Jonas and the late Mr. Edgar Allen respectively, accommodation being found in the existing buildings of the Applied Science Department of the University of Sheffield. The equipment of the Jonas Laboratory includes Armstrong-Whitworth machines of 85 and 50 tons capacity, with oil-pump and accumulator and a variety of extensometers, an Izod machine, and a new instrument for the detection of early slip in metals by electrical means. Special equipment for the study of fatigue has been provided, including a Haigh machine for alternating tension and compression, a modified Stromeyer machine for alternating torsion, and a modified Wöhler machine, the latter two having been designed and constructed in the department, and provided with optical devices for short-period tests. The instruments for the measurement of hardness include the ordinary Brinell machines, the small Brinell machine for tests with balls of small diameter, a scleroscope, sclerometers, and the Herbert pendulum instrument. There is also a series of instruments, optical and other, for determining the accuracy of standard gauges. The Edgar Allen Laboratory is specially equipped for investigations on the magnetic properties of steels and other alloys, and has been designed and arranged by Dr. T. F. Wall. Current of various voltages, direct and alternating, is supplied by cables to distributing boards around the room, and a special generating set has been installed for obtaining alternating currents of variable high frequencies. A powerful electro-magnet, capable of producing very intense fields, has been constructed in the department. The electrical instruments include a Duddell oscillograph, a variety of measuring instruments, vacuum thermo-junctions for small alternating currents, standard condensers and resistances, and magnetic instruments (Epstein square, fluxmeter, etc.). The equipment of this laboratory is exceptionally complete. On the occasion of the opening, a number of visitors inspected the laboratories, and Sir Oliver Lodge delivered an address on the value of research work in industry.

To commemorate the fiftieth anniversary of the foundation of the Institution of Electrical Engineers (under the name of the Society of Telegraph Engineers), the Council decided in 1921 to establish a Faraday medal in bronze to be awarded not more than once a year for "notable scientific or industrial achievement in Electrical Engineering, or for conspicuous services rendered to the advancement of Electrical Science, without restriction as regards nationality, country of residence, or membership of the Institution." The Council selected for the first award of the medal Mr. Oliver Heaviside, who, unfortunately, owing to ill-health, was unable to attend a meeting of the Institution to receive the medal, which was personally presented to him by the then president, Mr. J. S. Highfield, at Torquay on September 9, 1922. The second award of the medal was made by the Council to the Hon. Sir Charles Parsons, at the ordinary meeting of the Institution held on Thursday, May 10. Mr. Highfield, past-president, said that the name of Sir Charles Parsons stood first in the engineering world of to-day, and that there was, he thought, no one who did not know what a mighty work Sir Charles had done for the engineering of the last thirty or forty years. His name would be remembered in connexion with the design and development of that great engine for the production of power which we know to-day, the turbine. After Dr. S. Z. de Ferranti had also spoken of the work and of the great benefits that had come to the world as the result of Sir Charles Parsons's invention, the president, Mr. F. Gill, presented the Faraday medal to Sir Charles. In making the presentation, the president expressed the wish that Sir Charles would live many years in which to enjoy the very special position of regard and affection of all members of the Institution.

Summer time commenced in France on Saturday last, May 26, at 11 P.M.

Sir Arthur Keith will deliver the twelfth biennial Huxley lecture at the Charing Cross Hospital Medical School on Wednesday, June 27, at 3 o'clock. The subject will be "Recent Advances in Science and their bearing on Medicine and Surgery." No tickets of admission will be necessary.

Prof. W. D. Bancroft, professor of physical chemistry in Cornell University, New York, will deliver an address entitled "A Plea for Research" at the house of the Royal Photographic Society, 35 Russell Square, W.C.1, on June 5 at 8 o'clock.

By the will of Sir James Dewar, who died on March 27, the University of Cambridge is to receive all his scientific apparatus in the chemical laboratory of the

University, and, similarly, the Royal Institution will receive all his apparatus in the Institution and the laboratory attached to it.

ON Wednesday, June 6, the Anglo-Batavian Society will entertain Dr. H. A. Lorentz, professor of physics in the University of Leyden, at dinner at the Langham Hotel, London, W., when Sir Walter Townley, chairman of the council of the Society, will preside. Among the guests who have accepted invitations for the dinner are Lord Haldane, Sir Frank Dyson, and Sir William Bragg.

EXAMINATION of candidates for the Associateship of the Institute of Physics will be held in London at the latter end of September next. Applications for entry must be received before June 30. Forms of application and copies of the papers set in 1922 can be obtained from the secretary, 10 Essex Street, London, W.C.2.

IT is stated in the *Times* that a wireless station is to be erected on Novaya Zemlya Island by the Russian authorities. The station will be situated by Matochkin Strait and will be in communication with North Russian and Siberian stations. The personnel will include, in addition to the wireless experts and meteorologists, a geologist and a zoologist.

THE seventy-ninth general meeting of the Institution of Mining Engineers will be held at Glasgow on June 12-14, and among the papers to be presented are "Coal-dust as an Explosive Agent," by Mr. G. H. Rice, and "The Recent Search for Oil in Great Britain," by Mr. H. P. Giffard. A summary will be submitted of the research work carried out for the committee on the control of atmospheric conditions in hot and deep mines. Excursions to collieries and works in the neighbourhood of Glasgow have been arranged.

AT the April meeting of the Franklin Institute, Philadelphia, the Howard N. Potts gold medal was presented to Dr. Albert W. Hull of the Research Laboratory, General Electric Company, Schenectady, New York, for his paper on "The Crystal Structure of the Common Elements," and the Edward Longstreth medal was presented to a representative of the Société Genevoise d'Instruments de Physique of Geneva, Switzerland, for the universal measuring machine produced by the company.

THE Association of Economic Biologists will hold its annual field meeting at Cambridge on Friday, June 15. The programme includes visits to the School of Agriculture, where investigations on animal nutrition and physiology will be demonstrated; to the National Institute of Agricultural Botany, where will be shown the field trials of agricultural crops, and to the University Farm and Plant Breeding Institute to see the investigations in progress on cereal hybridisation.

THE trustees of the Ramsay Memorial Fellowships for Chemical Research are prepared to consider, at the end of June, application for not more than two fellowships, one restricted to candidates educated in Glasgow. The fellowships, which are each of the annual value of 250*l*., plus a grant of not more than 50*l*. yearly for expenses, are tenable normally for two years, but they may be extended to three years. Applications must be sent by, at latest, June 15, to Dr. W. W. Seton, University College, Gower Street, W.C.1.

AT the annual general meeting of the Linnean Society held on May 24, the following officers were elected: *President*: Dr. A. B. Rendle; *Treasurer*: Mr. H. W. Monckton; *Secretaries*: Dr. B. Daydon Jackson, Dr. W. T. Calman, and Capt. J. Ramsbottom; *Other Members of Council*: Dr. W. Bateson, Dr. G. P. Bidder, Mr. R. H. Burne, Prof. F. E. Fritch, Prof. E. S. Goodrich, Dame Helen Gwynne-Vaughan, Sir Sidney F. Harmer, Dr. A. W. Hill, Mr. L. V. Lester-Garland, Baron Rothschild, Dr. E. J. Salisbury, Mr. R. J. Tabor, Mr. T. A. Sprague, Prof. F. E. Weiss, and Dr. A. Smith Woodward.

IT is stated in the *British Medical Journal* that the Ontario Legislature has established a research chair for Dr. Banting, the originator of the idea that diabetes might be controlled by extracts of the islands of Langerhans, for which the name "insulin" had been suggested by Sir Edward Schafer a good many years ago, and under which it has now become a commercial product. The income of the chair, to which Dr. Best will act as assistant, will be 10,000 dollars a year. Dr. Banting intends to be present at the discussion on diabetes in the Section of Medicine at the annual meeting of the British Medical Association in Portsmouth.

THE first attempt to broadcast a picture by wireless telephony was made on May 24 at the London Station of the British Broadcasting Co. The experiment was made by Dr. Fournier d'Albe, who used a special code method adapted to a juvenile audience of "listeners-in." It being Empire Day, the picture chosen for broadcasting was a portrait of King George V. The picture was coded by dividing it into thirty horizontal strips and splitting up each strip into twenty squares. A letter was assigned to each square to indicate its average shading, and these letters were written out in thirty lines of twenty letters each. Each line was divided into four groups of five letters, and each group was dictated into the microphone in turn. The lines were numbered, so that mistakes could be easily avoided. The total time of transmission, with instructions, was twenty-two minutes, but it was found that the code message itself could be taken down in eight minutes. The picture was reproduced either by graduated dots on squared paper or on an ordinary typewriter, using letters of graduated size and making the line space equal to the letter space. Recognisable reproductions were made in from twenty to twenty-five minutes. In the complete method a special typewriter or "dot-writer" is to be employed.

NEWS has reached Copenhagen of the progress of Mr. Lange Koch's expedition to north-west Greenland. The *Times* reports that Mr. Koch wintered at Upernivik on Baffin Bay and in March 1922 left for

Cape York, where his survey began. He continued his work to about lat. 82° N., but was forced to abandon his project of charting Peary Land. A large tractor proved very useful for transport, and easily pulled over snow a sledge loaded with food supplies and ten barrels of petroleum. After several hundred miles it broke down and had to be abandoned. Progress then became difficult. A bad epidemic of influenza in the Cape York district has caused such heavy mortality among the Eskimo that it is impossible at present to start any expedition from that base. Mr. Koch intends to return to Denmark in the course of the present summer.

THE arrangements for the International Air Congress to be held in London at the Institution of Civil Engineers, Great George Street, London, S.W.1, on June 25-30, are now approaching completion. The papers to be presented cover every field of aeronautical development, and are thoroughly international in character, as contributions have been received from America, Belgium, Denmark, France, Holland, Italy, Spain, and Sweden, among other countries, in addition to Great Britain. Applications for membership of the Congress will be accepted up to Saturday June 9. A number of visits to various Government experimental and research establishments and Royal Air Force Stations have been arranged, and several of the leading aircraft and engineering firms have expressed their readiness to receive members of the Congress at their works. Communications regarding the Congress should be made to the International Air Congress, London, 1923, at 7 Albemarle Street, London, W.1.

Bulletin 54 S issued by Messrs. Watson and Sons (Electro-Medical), Ltd., Sunic House, 43 Parker Street, Kingsway, London, W.C.2, is a descriptive list of second-hand X-ray and electro-medical apparatus which the firm has for sale. Complete units for X-ray work are offered, in addition to numerous accessories, such as induction coils, Coolidge filament transformers, mercury interrupters, X-ray tubes, screens, and so on.

THE Medical Supply Association, Ltd., of Gray's Inn Road, London, now supply "Radio-Wave" receiving apparatus of all kinds, from a "junior" crystal set, up to a "Radio-Wave Plutocrat" receiver with a range of 300 miles. Modern radio sets are now so simple that no special education or skill is required to work them. Some of the sets also can receive the roughest usage without damage. The receivers made by the Association are of the approved type and the valve apparatus supplied is fully licensed. The lengthy list given of radio parts in their catalogue will be welcomed by amateurs.

MESSRS. LONGMANS AND Co. have in the press, for appearance in their series of "Manuals of Telegraph and Telephone Engineering," "The Inspection and Testing of Materials, Apparatus, and Lines," by F. L. Henley, which will describe the methods employed in the British Post Office in the inspection and testing of supplies of the various materials used in line construction, cables, telephone and Morse telegraph instruments, and furnish the inspector with a basis of sound information upon which to form a judgment in those cases where electrical, mechanical, or chemical tests are either not available or are not conclusive. In the same publishers' "Rothamsted Monographs on Agricultural Science" will appear "Manuring of Grasslands for Hay," by Dr. Winifred E. Brenchley of the Rothamsted Experimental Station.

Our Astronomical Column.

THE DIAMETERS OF SATURN'S SATELLITES.—Major P. H. Hepburn contributes a paper on this subject to B.A.A. Journ. for March. The only one that is large enough to measure with a micrometer is Titan, for which Barnard and Lowell agreed in finding a diameter of some 2600 miles, say 0·7″ in arc. Major Levin found 3500 miles by the eclipse of Rhea by Titan, April 8, 1921; probably the truth lies between the two. For the other satellites estimates can be made (1) from the masses determined by H. Struve, combined with assumed densities, and (2) from the stellar magnitudes of the satellites determined by Guthnick and at Harvard, combined with assumed albedoes. In practice each method was found to help the other; it was established that all the smaller satellites must have small densities, not much greater than that of Saturn itself, which is $\frac{1}{8}$ of the earth's density, or 0·7 of water. In particular, Mimas must have both low density and high albedo, and Major Hepburn suggested, half seriously, that it might be a gigantic snowball; he had in a former paper suggested that the Ring might be composed of ice crystals. The values of the diameters considered most probable are: Mimas, 300 miles; Enceladus, 450; Tethys, 700; Dione, 800; Rhea, 1000. Data are lacking for trustworthy estimates of Hyperion and Iapetus. As Jupiter's satellites have also low densities, some colour is given to the old suggestion that the outer parts of the solar system are built of less dense materials than the inner parts. It will be remembered that the inner satellites of Saturn are much the smallest bodies the masses of which have been determined gravitationally, hence determination of their densities throws new light on our knowledge of that of small bodies generally. Bodies that have never been in a molten state might well have interstices between their particles which would be filled up in a molten condition.

ANNUAIRE DE L'OBSERVATOIRE ROYAL DE BELGIQUE, 1924.—Publication of this well-known Annual was suspended during the War, but the present volume is a very successful effort to make up for the lost years. It begins with the ordinary calendar, astronomical, and tidal information for the year, all given in great detail, and then follows a full summary of astronomical progress since 1915; thus Wolfer's monthly sunspot numbers are given for six years; they show a clearly defined maximum in the middle of 1917. The stages in the dissolution of the great eclipse prominence of May 1919 are fully illustrated. A full account is also given of work on the polarity of sunspots, the magnetic field of the sun, and Einstein's theory, and the discussions to which it has led. There are, in addition, tables and detailed accounts of planetary, cometary, and stellar work during the six years dealt with. The volume is thus very useful as an index and guide to contemporary astronomical progress.

Research Items.

Dating the Hebrew Exodus from Egypt.—In the April issue of the *Fortnightly Review* Dr. H. R. Hall attempts to estimate the value of the recent startling discoveries in Egypt, but he defers a full appreciation until next winter's work and an examination, which must be protracted, of the objects in the tomb. More definite conclusions are reached by Mr. Arthur Weigall in the *Empire Review* for May. He identifies the 80,000 "unclean" people, whom Manetho says that one of the Pharaohs deported to the east bank of the Nile, with the heretic Aton-worshippers. Thus arises the question of the Hebrew exodus, which tradition has associated with Rameses the Great, the best known of the Pharaohs. But it more probably occurred in the reign of Tutankhamen, 1358–1350 B.C., and this is corroborated by the Karnak inscription, which states that he was employing Asiatic slaves in his great work of rebuilding the temples ruined by Akhnaton, a result which raises the question of the connexion of Hebrew monotheism with the earliest known monotheism of the Egyptians. It is also interesting to note that Tutankhamen in the same inscription speaks of Egypt as being plague-ridden in his reign.

Flints in Malta.—In the May issue of *Man* Miss M. A. Murray describes the results of excavations at a group of megalithic ruins of Borg en Nadur, overlooking the little harbour of Fort St. George, which forms part of the great bay of Marsa Scirocco on the south-east of Malta. During the excavation of this site last summer about thirty stone implements were found under the pavement west of the dolmen. They include three specimens the appearance of which suggests that they are part of an apparatus for producing fire. Throughout Malta flints of this kind, generally recognisable by the fact that they contain no cutting edges and have a characteristic semi-circular hollow on one side, where the stone had been struck by the steel, are often found. Until the last fifty years or so, flint was imported into Malta from Sicily for fire-producing purposes, and during the War, when there was a shortage of matches, these flints came into use again, and were sought for in the fields where they had been thrown away. The flints found at Borg en Nadur may have formed part of such a consignment.

Civilisation and Primitive Peoples.—Mr. H. Balfour in his presidential address delivered before the Folklore Society, published in *Folk-Lore*, vol. xxxiv. No. 1, discusses the results of the expedition to the Naga Hills, Assam, whence he has returned with a rich store of material for the Pitt-Rivers Museum. In his address, he discusses the danger of interfering with the institutions and customs of primitive tribes. "To root up old-established indigenous trees and plant in their place alien substitutes to which the soil is unsuited is a useless and unproductive work; and equally futile and unprofitable is it to abolish ruthlessly old-established beliefs and practices, and to endeavour to replace them with imported doctrines and customs, which have developed under totally different conditions, and which merely puzzle the natives without enlightening them." In the districts most exposed to foreign influence—that of Christian missionaries and that of the Bengalis—he noticed "marked evidence of a comparative lack of that virility, alertness, and zest which I had observed in the more eastern districts, and the partial atrophy of these qualities is certainly correlated with the loosening of the grip upon traditional customs and ritual. I firmly believe that the comparative inertness is mainly the outcome of change of habit consequent upon contact with alien peoples and alien cultures." These conclusions, arrived at by a singularly competent and sympathetic observer, demand the attention of all British officers placed in control of primitive races.

Red Sea-water due to a Dinoflagellate.—Another instance of discoloration of the sea by a Dinoflagellate is recorded by K. Hirasaka (*Annot. Zool. Japon.*, x., Art. 15, Dec. 1922). In December 1921 discoloration of the water in Gokasho Bay, Japan, was observed and was found to increase until by January 10, 1922, the entire bay presented "a deep bloody or a chocolate colour," which continued to the end of February, when it began to diminish, and by the middle of March had disappeared. The depth to which the discoloration extended was from three or four to six feet. The organism, a new species of Dinoflagellate of the genus Gymnodinium, seemed to migrate diurnally according to the temperature and intensity of light, the colour of the water being deepest in the afternoon. The author states that the discoloured sea water was highly luminous.

Japanese Marine Triclads.—T. Kabouraki (Journ. Coll. Sci. Imp. Univ. Tokyo, xliv., Art. 3, Sept. 1922) gives an account of the anatomy of the three marine triclads known from Japan, namely, *Procerodes lactea, Stummeria trigonocephala,* and *Ectoplana limuli*. The former two live beneath stones, but the last named occurs abundantly on the cephalothoracic appendages and on the gill-books of *Limulus longispina,* is 4 to 6 mm. long and about 1 mm. broad, and usually milky white. The author concludes a brief discussion of the integument with his opinion that the turbellarian epidermis is homologous with the cuticle of the trematodes, and he regards the rhabdites as the equivalent of gland secretions, and as being of use to the worm in securing food as well as in offence and defence. He states that all three worms are very sensitive and they usually move to a dark place, and that even on a slight shock they stop instantly, contract, and remain immovable. Ectoplana is not a parasite, and causes no injury to the Limulus on which it occurs; it lives on the fragments of food left over by the Limulus, and hence is a commensal. It lays its eggs on the gill lamellæ. Appended is a note on the classification of the marine triclads and a key to the genera.

Some Antarctic Crustacea.—The latest in the series of reports on the British Antarctic (*Terra Nova*) Expedition (Zoology, vol. iii. No. 10), published by the British Museum (Natural History), is by Prof. W. M. Tattersall and deals with the Crustacea of the order Mysidacea. The usual but indefensible grouping of these with the very different Euphausiacea under the name "Schizopoda" is here abandoned. In addition to the purely antarctic collections, the report deals with a large amount of material obtained during the winter cruises of the *Terra Nova* off the north of New Zealand. A review is given of all the known antarctic Mysidacea, and it is pointed out that they were all taken in deep water and form part of the cold water fauna which is found in the depths of all the oceans. The littoral antarctic species, if any exist, are still unknown. So far as the evidence goes, however, the distribution of the group supports Regan's delimitation of the Antarctic Zone. From New Zealand only three adequately described species of Mysidacea have hitherto been known. In this report the number is increased to fifteen, of which eight are described for the first time. Seven of the new species belong to the genus Tenagomysis, to which only two species had previously been referred. This genus is only known from New Zealand and the

Auckland Islands. The *Terra Nova* also collected a few species in the Atlantic, of which one, obtained off Rio de Janeiro, is especially interesting. It is referred to Dana's long-forgotten genus Promysis, with which Hansen's Uromysis is identified. The other two species of the genus are from the East Indian Archipelago, but the seeming discontinuity in the distribution may be obliterated by further research.

BOTANY AT THE CARNEGIE RESEARCH STATIONS.—The Carnegie Institution maintains two special research laboratories, at Tucson, Arizona, and Carmel, California, where desert and coastal vegetation are readily studied, but in addition, as Year Book No. 21 of the Carnegie Institution of Washington shows, its workers are far more widely spread. In the Department of Botanical Research, under the general direction of Dr. W. T. MacDougal, fundamental researches by H. A. Spoehr and his collaborators are being carried out upon photosynthesis and respiration. Some of this work has been published in full since the issue of the Year Book, as Carnegie Publication No. 325 (Studies in Plant Respiration and Photosynthesis, Washington, February 1923). Space only permits the mention of the following points from the brief summary in the Year Book, which is packed with interesting facts and views: lævulose is not found to be so readily used in respiration as glucose: an explanation of the increased diastatic activity of leaves kept in darkness is found in the increased production of amino-acids and their effect on diastatic action: respiration and photosynthesis are found to be strikingly inter-dependent and affected alike by changes in various external factors. Chemists as well as botanists will be interested in the methods developed by Dr. F. A. Cajaro for the quantitative estimation of small amounts of the separate sugars in mixtures of glucose, lævulose, sucrose, and maltose; these methods depend upon oxidation under standardised conditions and upon estimation of cupric reducing power. Dr. W. T. MacDougal's work upon permeability leads him to consider lipins and pentosans as important constituents of the plasma membrane; the effect of different kations upon permeability is being considered from this point of view, with many new experiments in progress to elucidate the puzzling phenomena of "antagonism." Many ecological investigations by Forrest Shreve are in progress, and W. Cannon has been studying the evaporating power of the air and of the plant in South Africa. Dr. F. E. Clements directs another group of researches. One notes studies of the water cycle of the plant, of vascular conductivity by Prof. J. B. Farmer's method, and the effect of sap movement upon bud development; this work has supplied no evidence for the once very popular assumption of an inhibiting factor released by actively growing buds.

NEW FOSSIL TURTLE FROM ARIZONA.—Attention was recently directed (NATURE, March 31, pp. 443-4) to the remarkable assemblage of vertebrate remains collected by Dr. J. W. Gidley in the Pliocene of Arizona, and to the promise of further information concerning the reptiles. C. W. Gilmore now supplies the description and numerous figures of a new fossil turtle from that district (Proc. U.S. Nat. Mus., vol. lxii., art. 5). *Kinosternon arizonense*, n.sp., the first extinct representative of the genus in America, is most nearly allied to the recent *K. flavescens* (Agassiz), which, with one other of the eight living American examples, is said to range into Arizona.

METEOROLOGICAL STATIONS IN HIGH LATITUDES.—The U.S. *Monthly Weather Review* for January contains an article by Sir Frederick Stupart, director of the Meteorological Service of Canada, on the above subject, which formed a presidential address, given before the American Meteorological Society at Boston, Mass., on December 30, 1922. The author, while acknowledging the furthering of meteorology when aiding commerce and finance, suggests that difficulties arise in granting funds for the equipment of an out-of-the-way Arctic station, although the latter may materially improve weather forecasting. In the early days of forecasting in Canada and the United States the weather services were handicapped by the lack of data from the North. This great want has more recently led to the establishment of stations in Iceland and Spitsbergen, and still later in Jan Mayen Island. The Alaskan stations are said to have been of the greatest use for forecasters in the United States and Canada. Reference is made to the influence of radiation during the winter months over the land areas of Siberia and northern America, which leads to the formation of high pressure and intense cold, while in some winters the low pressure of the North Pacific tends greatly to modify the pressure distribution in northern America, and in these cases mild winters may be looked for. In some winters the Siberian high pressures extend across as one system into America, and great cold waves sweep southwards. The study of the dominant anticyclonic and cyclonic conditions seem so full of promise that the author emphasises augmenting the number of stations in the Arctic zone. The study of the conditions in high latitudes would help also to a better understanding of the severe storms along the Atlantic steamship routes.

HISTORY OF AN OIL-WELL.—Probably few individual oil-wells are of sufficient technical, apart from commercial, importance to warrant their being the subjects of communications to learned societies. Yet the paper read by Mr. A. E. Chambers to the Institution of Petroleum Technologists on April 10, dealing with one of the earliest, largest, and most celebrated wells in Mexico, namely, Potrero No. 4, constituted not only an interesting but also a valuable dissertation on a matter of more than mere local importance. Mexico, in regard to oil-production, is a country of surprises; its wells, even if not always big producers, at least provide plenty of variety both in behaviour and in the problems they present during development and production. Not the least of these problems is that connected with salt-water, a particularly formidable one at the present time. The well under discussion was no exception. Situated in Vera Cruz State, 50 kilometres N.W. of Tuxpam, it was brought in as a gusher at the end of 1910 and not got under proper control till March 1911. Thenceforward it produced oil until 1914 when, after developing extensive seepage areas in its vicinity, it caught fire, owing to lightning, in August of that year. This fire was not finally extinguished until early in April of the following year, when the well started producing again and continued till the end of 1918. Emulsification set in in 1919, and this closed the history of the well. During this chequered career it produced no less than one hundred million barrels of oil, and the technical difficulties which had to be overcome in connexion with its control were of no mean magnitude, considering the fact that drilling methods in those days were somewhat crude compared with present-day practice. The oil originally produced was of an asphaltic base, s.g. 0·931 at 60° F. The pressure (closed well) amounted to 825 lbs. per square inch. Its ultimate appearance in the storage tanks was as an emulsion having a s.g. of 0·979 and containing 54 per cent. of salt water. In this departure it unfortunately foreshadowed the behaviour of many more recent wells in Mexico, a feature the significance of which has latterly been so widely debated.

The Rockefeller Foundation's Gift of the Institute of Anatomy to University College, London.

THE erection of the new building for the Department of Anatomy, which also provides an extension for the Department of Physiology of University College, London, completes the scheme for the development of the building for the Faculty of Medical Sciences which had long been contemplated. The proposal was first definitely formulated in 1907 on the initiative of Prof. E. H. Starling, who took an active part in collecting the money for the erection in 1908 of the Department of Physiology, which was opened in 1909 by the Right Hon. R. B. (now Viscount) Haldane. The generosity of the late Mr. Andrew Carnegie made it possible in 1912 to add to the eastern end of the Institute of Physiology a building to house the Department of Pharmacology, which was formally opened on December 4 of that year by Sir Thomas Barlow, president of the Royal College of Physicians. When the War seemed to have destroyed all hope of any immediate completion of the original scheme by the addition at the western end of a building to house the Department of Anatomy, the Rockefeller Foundation became aware of the difficulty and offered to provide the means for completing a scheme which harmonised with its ideals in medical education. It was eager to give some striking expression of American friendship to the British Empire, and was also anxious to enlist the help of the British medical schools in its great schemes for "the promotion of the well-being of mankind throughout the world."

The Rockefeller Foundation has long recognised how much the well-being of mankind is dependent on the advancement of medical knowledge and on the training of men who can spread the benefits of this knowledge among their fellow creatures, and to this end has spent large sums, not only in the United States, but also in South America and China, for the establishment of medical schools in which research and the education of medical men should go hand in hand.

At the end of 1919 two representatives of the Rockefeller Foundation, Dr. Wickliffe Rose, general director of the International Health Board, and Dr. Richard M. Pearce, adviser in medical education to the Foundation, came to Europe to inquire into the methods, problems, and needs of medical education in this country and on the Continent. While in London they were informed of the new developments in medical education which had taken place there under the stimulus and with the financial help of the Board of Education. This development consisted in the establishment at several of the medical schools of clinical "units" in medicine, surgery, and gynæcology, which were staffed by whole-time teachers, so that these subjects could be treated like the cognate scientific subjects, the professor being able to devote all his working hours to teaching and research without being obliged to undertake private practice. This innovation especially excited the interest of the representatives of the Rockefeller Foundation, since the Foundation had already played a large part in the encouragement and endowment of this system of medical education in America.

FIG. 1.—Institute of Anatomy, University College, London.

The essential feature of the system is the close co-operation between all departments concerned in the medical curriculum. It is recognised that medicine and surgery cannot advance except in association with other departments hitherto regarded as more purely scientific—in particular, pathology, anatomy, physiology, and bio-chemistry.

At University College, Drs. Rose and Pearce found a hospital which had been founded for the express purpose of medical education. They found also active and well-equipped institutes for the study of some branches of medical science and definite plans for the completion of the whole scheme of medical education as soon as the necessary funds were available. Thus in the College there was fair provision for physiology, pharmacology, and bio-chemistry, but no proper facilities for teaching and research in anatomy, embryology, and histology. In the clinical subjects of the curriculum, while medicine and surgery were represented by the whole-time professors at University College Hospital, there was a lack of beds devoted entirely to the work of these units, and the accommodation for research into the chemistry of disease was deficient; there was no provision at all for scientific investigation and teaching in midwifery and the diseases of women. Plans for remedying these gaps in the scheme were ready; the only thing necessary for the realisation of the scheme was money. The representatives of the Rockefeller Foundation were impressed with the possibilities of the scheme for the creation of a complete and scientifically equipped School of Medicine which had been worked out by the College and Hospital Medical School, and reported favourably thereon to the Rockefeller Foundation. As a result of their report the Foundation decided not only to place at the disposal of University College sufficient funds for the realisation of the scheme formulated in 1907, but also to provide the additional endowment required to maintain the increase in staff which the scheme entailed. At the same time the Rockefeller Foundation made an even larger gift to University College Hospital Medical School for the promotion of the work of the clinical units.

The new building provides adequate accommodation and equipment for the study of anatomy and the prosecution of research. It also gives tangible expression to a wider conception of the scope of anatomy, which will now include histology, embryology, experimental embryology and neurology, the study of animal movements by cinematography, radiology, and anthropology, and in fact the study of man in the widest interpretation of the term, his evolution, structure, and the history of his movements.

The completion of the building for the three closely allied sciences of anatomy, physiology, and pharmacology represents far more than the mere provision of accommodation and equipment for teaching and research in anatomy and of an extension of the physiological laboratories. It is the expression of a far-reaching scheme of co-operation, involving on one hand the closer correlation of teaching and research in anatomy, physiology, and pharmacology, and on the other the linking up of the work done in the Faculty of Medical Sciences in the College with that done in the Medical School of University College Hospital. Moreover, the new building is a permanent symbol of the bond of sympathy that unites British medicine in a common aim with the medical schools of America and with the Rockefeller Foundation.

By housing the departments of anatomy (with histology, embryology, and anthropology), physiology, bio-chemistry, and pharmacology in one Institute with a library and staff-room in common, the way has been prepared for a closer co-operation between teaching and research in these subjects than has been possible hitherto. The new anatomy building is linked by means of a tunnel passing under Gower Street with the Medical School of University College Hospital, and it is anticipated that this physical avenue of communication will facilitate a freer intercourse between the workers upon the two sides of Gower Street, to their mutual benefit.

The extension of the department of physiology affords ampler provision for teaching and research in experimental physiology, and makes it possible for Prof. Starling to remain in the College as Foulerton research professor of the Royal Society, even though he relinquishes the Jodrell chair of physiology and the directorship of the Institute which he created.

Of the five floors in the building, the lowest is devoted mainly to practical work in anatomy, that is, dissecting and radiography; the next floor to teaching accommodation and museums, as well as to anthropological investigation; the third and fourth to research in anatomy, histology, and embryology; and the top floor to teaching in microscopic anatomy. A basement contains the heating chambers, coke cellars, tank, and specimen rooms.

The building, designed by Prof. F. M. Simpson, faces Gower Street, and has a frontage of 154 feet exclusive of the end gateway, which gives access to the south quadrangle. At the back it joins the physiology building. On a level with the students' entrance from the south quadrangle are the large top-lighted dissecting room, with prosectorium and annexe, the X-ray rooms, injection room, workshop, and cloakrooms for men and women students.

The rooms for the X-ray examination of the living subject and for the study of X-ray plates are near at hand, so that the students may be able, when dissecting any region of the body, to correlate the X-ray appearance with what they see and handle in their dissections. The X-ray equipment, the chief features of which are mentioned later in this account, has been superintended by Major Charles E. S. Phillips, who has spared no trouble in devising the best possible means for teaching anatomy by radiography.

The main entrance from Gower Street is at the ground-floor level, and leads by an oak-panelled vestibule to the hall and central staircase which serves all floors. On the ground-floor are the museum and preparation room, lecture theatre, fitted with the latest Zeiss epidiascope, demonstration theatre, and rooms set apart for teaching and research in anthropology.

On the first floor are the medical sciences library and periodical room, oak-panelled, with a book-store adjoining the room for the lecturer in the history of medicine, the private room and laboratory for the professor of anatomy, the dean's office, and a series of research rooms, including a laboratory for comparative neurology. In the latter will be housed a collection of neurological preparations, the nucleus of which consists of sections made by the late Dr. Page May and Sir Victor Horsley, and others presented by the Central Institute for Brain Research in Amsterdam at the instance of Dr. Ariens Kappers.

On the second floor are located the research laboratories for the professor of embryology, and a lecture room seated for about ninety students, with an apparatus for the projection of histological preparations. Also on this floor are situated a small chemical laboratory, a laboratory for research in experimental embryology, and the micro-photographic and dark rooms, while two rooms provide accommodation for collections of preserved material and microscopical preparations. Prof. J. P. Hill has made a very rich collection of mammalian embryos, and aims at making as complete a series as possible of human embryos. For research in comparative embryology the Institute offers unique opportunities.

The main students' laboratory for microscopical anatomy is situated on the third floor. It affords accommodation for about ninety students. Adjacent to the laboratory are the preparation room, the research laboratory for the assistant in histology, modelling and aquarium rooms. Accommodation for keeping live animals is also provided on the third floor, and provision has been made of facilities for experimental embryology and for the study of degeneration effects in the nervous system.

In a room set aside for the cinematographic study of animal movements, there is to be installed a cinematographic apparatus (so-called ultra-cinema) designed by M. Nogues, of the Marey Institute of Paris, by means of which it is possible to take up to 300 photographs per second of moving objects. This is perhaps the best method of analysis of reflex movements and muscular adjustments, such as those of posture. In presentation such movements can be made to occupy ten to fifteen times their normal time. Heavy electric leads are carried to this room so that brilliant illumination by arc or mercury lamps may be employed; while the flat roof is admirably adapted to the purpose of cinematography in summer.

The X-ray department is equipped with the latest type of apparatus for radiography in all its medical branches. Facilities are provided for rapid work as well as for the study of movement and anatomical structure as revealed by the latest X-ray technique of the day. The power unit consists of a 10 kw. transformer X-ray set, which supplies energy to the X-ray tubes either when working from below or above the operating tables, or when used for fluoroscopy; and arrangements are made whereby the portable trolley control may be connected either at a position near the tables or at a separate wall plug adjacent to the fluorescent screening-stand at the far end of the room.

One of the X-ray operating tables is fitted with automatically moving plate carriers beneath the top, which itself is hinged so as to render the tube box and diaphragm mechanisms readily accessible. The other operating table is fitted with a Potter-Bucky grid, and is the second table of the kind that has come to this country from the United States. As well as a large screening apparatus, there is a heavy type tube stand for general use, and a number of minor accessories. Apparatus for the special radiography of the head is also provided.

The high-tension overhead leads are made of nickel-plated tubing of sufficient diameter to reduce the formation of corona to a minimum, and a high-tension switch actuated by strings serves to connect the transformer terminals with the set of leads required for each apparatus as desired. The protection of all engaged in the work of the department has been carefully provided for, and stray radiation prevented from entering adjacent rooms by a covering of lead six feet high upon the walls. The lead sheet carefully lapped at the joints is hidden beneath stout boarding which serves to absorb the soft component of any secondary radiation which may be produced from the lead by stray radiation. The floor is covered with rubber. An adjoining dark room and large viewing room, together with a plate store, completes the department.

The installation has been carried out by Messrs. Watson and Sons (Electro-Medical), Ltd., London, who not only did the work of equipping the X-ray rooms, but also gave Major Phillips the benefit of their experience in designing X-ray apparatus.

The Rockefeller Gift has also rendered it possible to effect certain much-needed alterations and extensions in the departments of bio-chemistry, pharmacology, and physiology. On the ground floor the general bio-chemical laboratory receives an extension behind the anatomy theatre, providing additional places for advanced students in bio-chemistry. The bio-chemical research laboratories are also enlarged by taking in the whole ground floor of the pharmacology building, providing in this way two additional research laboratories and a private room for the professor of bio-chemistry. In pharmacology further accommodation for research is provided by dividing the present pharmacology lecture theatre into two laboratories. The pharmacology lectures will be delivered in future in the physiology theatre. This department receives also two extra laboratories on the second floor of the physiology building in compensation for the ground-floor laboratories surrendered to bio-chemistry.

A large part of the first, second, and third floors of the building connecting the present Institute of Physiology with the Institute of Anatomy is used for increasing the laboratory accommodation for research in physiology.

Concerning the architecture, the Gower Street front is entirely in Portland stone; the back portions in Arlesey brick with stone dressings to match the existing physiology and pharmacology buildings. The floor of the dissecting room, annexe, and prosectorium is of white mosaic, and the walls of white glazed brick. On the corridors is a strip three feet wide of quarter-inch cork carpet, with margins of white terrazzo in the basement, and of oak or pitch pine on other floors. A dado of terrazzo with green panels and white frames runs up the whole of the staircase and along the sides of the principal corridors. The floors of most of the working-rooms are cement, covered with linoleum. The steps and landing of the staircase are oak on concrete, with iron balustrade; and the museum, library, periodical room, and entrance vestibule from Gower Street have oak floors.

A passenger lift runs from the basement to the top of the building, serving all floors, and hand-power lifts are provided from the injection room down to the tank room, and from the tank room up to the annexe of the dissecting room. The whole of the building is steel frame construction.

It is of interest that the house in which Charles Darwin began the compilation of the notebooks for his "Origin of Species" is only four doors away from the new building, and it is hoped that eventually upon this site will be built a Darwin Institute of Anthropology and Biology which will worthily commemorate the greatest of English biologists.

Applications of Physics to the Ceramic Industries.

THE ceramic industries formed the subject of the fourth of the series of lectures on "Physics in Industry" which are being given under the auspices of the Institute of Physics, and the lecture was given by Dr. J. W. Mellor on May 9 at the Institution of Electrical Engineers. Sir J. J. Thomson, president of the Institute, was in the chair. Eliminating such applications of physics as are common to other industries, Dr. Mellor dwelt only on specific applications of sound, light, heat, electricity and magnetism, and mechanical science in the manufacture of pottery and glassware. He made it clear that, while in these industries much has been done to utilise physical principles and knowledge, there remains a very wide field in which present practice is crude and unscientific, and where all the help which the physicist can give is needed to replace obsolete, rule-of-thumb procedure by methods which are exact, efficient, and trustworthy.

Up-to-date manufacturers are following with keen interest the various attempts now being made to produce a mode of illumination to imitate natural light, for the matching of coloured glazes under artificial light is usually difficult and sometimes impossible. In one example quoted where the colour of a nickel-blue tile had to be imitated, it appeared that the copy was green in gas-light and blue in daylight. Many chrome colours which appear green in daylight are crimson, pink, or purple in gas or electric light. During the War, blue lamp bulbs were needed, but they had to appear blue when illuminated by the glow of a red filament. Had absorption spectra of colouring oxides been available, much money and labour spent in fruitless experiments would have been saved.

It was due to the measurements made by physicists on the indices of refraction of small crystals that the two crystalline forms of silica were detected, and the knowledge of the transformations has placed the whole manufacture of silica bricks on a sound scientific foundation. Recent work on X-ray spectra promises shortly to do for the fire-brick manufacturer what a knowledge of indices of refraction has done for the silica-brick manufacture.

Applications of magnetism have been but partially explored. One problem that has been almost solved is the separation of particles of metallic iron from clay slip. A system of electromagnets made by the Rapid Magnetting Company is ingeniously arranged so that if the magnets cease to work, the dirty slip will not pass into the purified slip. Success, however, has not yet been attained in removing particles of cupriferous pyrites from fire-clays.

The physicist-engineer specialising in heat problems has an illimitable field for his knowledge and skill. Dr. Mellor estimates that in firing biscuit-ware only 2 per cent. of the fuel is usefully employed, although the processes of brick-firing are much more efficient. Another series of problems awaiting solution is connected with the drying of clays and clay-ware, where serious losses occur owing to the development of drying cracks unless an inordinately long time is allowed. It appears that little progress is possible until the physicist has worked out the distribution of water in the interior of a drying mass of clay, and he will obviously have to take into account the relation between the surface of the drying solid and the humidity of the surrounding atmosphere.

Dr. Mellor referred to the studies of the thermal strains in "ideal" kilns upon which Prof. Lees is engaged; later it is hoped to apply these results to actual kilns, and he expressed the wish that Prof. Lees would pass on to consider contraction strains set up during the uneven drying and firing of special shapes. The results of such an investigation will not only explain why some shapes fracture and others do not, but they will also indicate to the designer of chemical and sanitary apparatus, furnaces and coke ovens, the shapes to be avoided on account of the narrow margin of safety in manufacture and use. Numerous interesting problems relating to the grain of clay await solution. It appears, for example, that the particles can be oriented differently so that the drying and firing contractions are different in different directions. Then there is the plasticity of clays to be studied, and, indeed, the whole problem of the hydrostatics and dynamics of liquids with an indefinitely large number of particles in suspension. Akin to this are the colloidal problems—now ever with us—but for some unaccountable reason, which he ascribed to chance, Dr. Mellor preferred to label this branch of his subject as chemistry and not physics.

Electricity is usefully employed in high temperature testing work, and also for crucible furnaces, but a satisfactory electric furnace for firing pottery has not yet been evolved, and in any case the cost of power is here a paramount consideration. Dr. Mellor indicated the novel problems connected with the effects of convection currents of hot air that would have to be solved if electrically-heated furnaces or kilns came into use. The conditions are quite different from those in gas- or coal-fired furnaces.

In conclusion Dr. Mellor referred to the physical problems connected with the glazing of pottery. The governing condition here is that the thermal expansion of glaze and body should be the same. Data so far obtained have not taken sufficiently into consideration the complex adjustment of glaze and body; for example, there is the tensile strength of the glaze to be considered, as well as the rate at which the glaze attacks the body and the effect of solution of the body in the glaze and its coefficient of expansion.

The lecturer's statement of the case for much closer co-operation between the ceramist and the physicist than has hitherto obtained was forcible and convincing.

The Meteorology of Scott's Last Journey.

THE Halley lecture for 1923 was delivered at Oxford on May 17 by Dr. G. C. Simpson, the director of the Meteorological Office, who took for the subject of his lecture "The Meteorology of Scott's Last March."

The polar party left Hut Point on November 3, 1911, and first traversed the Barrier, where it experienced a remarkable daily variation of temperature. In spite of the fact that the sun was continually above the horizon, varying only from 10° above the southern horizon at midnight to about 30° above the northern horizon at mid-day, the regular daily temperature variation on cloudless days reached the enormous value of 20° F. This necessitated travelling by night and resting by day. Several serious blizzards were encountered.

It is now clear that the Barrier blizzard is extremely local, being confined to the western half of the Barrier. During ten months with simultaneous observation at Framheim—Amundsen's winter quarters in the east—and at Cape Evans in the west, winds of more than thirty miles an hour occurred during 30 per cent. of the time at Cape Evans, and only 2 per cent. at Framheim. This is due to the fact that when the pressure is higher over the Barrier than over the Ross Sea the air tends to flow from the Barrier northwards to the sea, but is deflected to the west by the earth's rotation. The edge of the western plateau extends like a wall 8000 feet high for more than a thousand miles along the west of the Barrier and of the Ross Sea. This prevents the air moving freely to the west, with the consequence that the air-flow from the whole of the Barrier is concentrated in the west, and moves northward with high velocity, giving rise to the familiar blizzard.

When the polar party was at the foot of the Beardmore Glacier it experienced a serious blizzard which gave the greatest snowfall ever recorded in high southern latitudes. The cause of this bad weather was the formation of a deep depression over the Ross Sea, which produced a great flow of warm air from the Ross Sea to the south of the Barrier.

On reaching the plateau, low temperatures were experienced. During the five weeks that Scott and his party were on the plateau the mean temperature was −19° F., with a maximum of −3° F., and a minimum of −30° F. As they descended from the plateau, the temperature at first rose in the normal way, but while the party was still on the glacier a great change in the weather occurred. From this date—February 11—until March 20, extremely abnormal conditions were experienced. There was little or no wind, the temperature fell rapidly to the neighbourhood of −40° F., and ice crystals were deposited from the cold air upon the surface which acted like sand on the runners of the sledge. These thirty-nine days were the deciding factor in the fate of the party. " We all associate Scott's disaster with the terrible Barrier blizzards, and in the end a blizzard did prove fatal, but at this time a blizzard, a succession of blizzards would have been the salvation of them all."

The temperatures experienced by Scott on the south of the Barrier were between 10° and 20° F. below the normal for the time of year. In these conditions the returning party struggled on, becoming weaker and more dispirited every day. On March 16, Oates made his heroic sacrifice in order to give his companions a chance of safety. Then at last—on March 20—the blizzard did come. But it came too late, and continued too long. When it commenced the party had food and fuel enough to reach the depôt at One Ton Camp only eleven miles away, but as the blizzard continued to rage day after day the fuel was used and food consumed.

" There is little doubt that this blizzard removed the cold stagnant air and the conditions over the Barrier became much better for sledge travelling. But it was too late; by the time the blizzard ceased, every man of the polar party had passed away, and in doing so had left a record and created a tradition of which every Englishman is, and always will be, proud."

Movements of the Earth's Crust.

PROF. HANS STILLE of Göttingen has issued, under the title of " Die Schrumpfung der Erde " (Berlin: Borntraeger; price 1s. 8*d*.), a " Festrede " given to his university, in which he aptly reviews old and new theories as to the effect of the earth's contraction on the features of the surface. He holds that the conception of a general contraction towards the interior is well founded; but there are many ways in which it may become manifest by wrinklings of the outer crust. He finds that what G. K. Gilbert styled " epeirogenic " (now written " epirogenetic ") movements, the sinking or uplifting of the crust over wide areas, are more in need of explanation than the folding of mountain-ranges, which has been differentiated as " orogenetic." The rhythmic pulsation, however, that causes mountain-building to occur simultaneously and even catastrophically over the whole earth presents an unsolved problem. Prof. J. Joly has suggested in a recent lecture (NATURE, May 5, p. 603) that the heat generated by radioactive minerals accumulates at intervals of some millions of years and so causes a catastrophe. Cooling of the uplifted layers by their being brought into proximity with the overlying oceans starts a new era of quiescence.

We may ask, with an equal sense of adventurous speculation, if the pulsation may not be still more primordial and connected with the beating of the last heart of an undivided universe. Prof. Stille keeps us from any such rash imagining; but he points out that the facts of orogenetic episodes are opposed to the uniformitarian doctrines of von Hoff and Lyell, which are applicable only to the intervals between great crustal foldings. Epirogenetic movements occur during these intervals, and characterise the epoch in which we live. On the whole, the earth loses heat by radiation faster than it acquires it by contraction; in this remark we recognise an adherence to views that some geologists regard as quite old-fashioned.

Prof. Stille's ten pages of " Anmerkungen " are almost as readable as the text of the pamphlet, since he adds to a wide range of references critical observations on many of the opinions cited. He remarks that Wegener's epochs of continental drift do not coincide with those in which orogenetic movements actually occurred. In these notes the author writes, as others have lately done, " Thetys " for Suess's well-chosen name " Tēthys," possibly by a confusion of Thetis, daughter of Nereus, with the wife of Okeanos, lord of the great outer seas. A. Sander's review of diastrophism and earth-history (*Geol. Rundschau*, vol. 13, p. 217, November 1922) should be read in connexion with Stille's memoir. Its author concludes similarly in favour of the contraction-theory, but regards epirogenetic movements as not necessarily very slow. Like Stille, he points out that we are moving a little way back to the views of the catastrophists.

The Steel Works of Hadfields, Ltd.

VISIT OF H.R.H. THE PRINCE OF WALES.

MUCH scientific interest is attached to the visit paid by H.R.H. The Prince of Wales to the works of Messrs. Hadfields at Sheffield, on May 29, when he started up the new 28-in. rolling mill, which has been installed at the firm's East Hecla works. This marks an important phase in the transition from war to peace production of this great establishment, the head of which is Sir Robert Hadfield, whose discovery of manganese steel in 1882 may justly be said to have originated the development of modern alloy steels. The new reversing 28-in. blooming and finishing mill is unique in several respects, having been designed to deal satisfactorily with steels of special nature, and in particular it is equipped with all the necessary improvements and labour-saving devices to obtain the most economical production. The mill motor has a maximum rating of 11,600 horse-power, and is supplied with current from a fly-wheel motor generator set, the cast-steel fly-wheel of which is 11 ft. 6 in. in diameter and 30 tons in weight. The mill motor is capable of being reversed from full speed in one direction to full speed in the other direction in three or four seconds. The rolls are 28 in. in diameter, and from 6 ft. 6 in. to 7 ft. long, being manufactured by Messrs. Hadfields of their special forged steel, and the mill is capable of rolling 15-in. square ingots, weighing 25 cwt., and reducing them to 2½-in. square billets at one heat. It will also be used for rolling special alloy steels, and rails up to their heaviest sections and 55 ft. long in manganese steel. The rolling plant accessories are all of the most modern type, including the necessary appliances for special treatment of manganese steel. The whole works show that British engineering is quite capable of designing, manufacturing, and running rolling mills and other steel plants second to none in the world. In addition to the 28-in. mill, the rolling plant also includes 11-in. and 14-in. mills for rolling round and square bars of alloy and other special steels.

An interesting feature of the Prince of Wales's visit was that he cast his own portrait on a plaque or medallion 22 in. in diameter of Hadfield manganese steel. The medallion was designed by Mr. S. Nicholson Babb, who has several sculptures in this year's exhibition of the Royal Academy. In the course of his tour the Prince was shown a number of exhibits illustrating the scientific work of the Hadfield Research Department. These included a complete equipment for all branches of the mechanical testing of iron and steel, and the latest apparatus in use for iron, steel, and fuel analysis, and oil testing. The scientific instruments used in the exact control of the heat treatment of special steels were also shown, and it is of interest to note that at one time no less than 15,000 pyrometer readings per week were taken in the works in the various steel making and treating departments. A demonstration was also given of the effect of low temperature on the properties of steel. Other interesting research exhibits included furnaces and methods of testing refractories; also apparatus for testing the electrical and magnetic properties of steel and its micrographic structure. A visit was paid to the firm's experimental proof butt in which are developed the large calibre projectiles for which Messrs. Hadfields are notable. Exhibits of historical interest included old metallurgical books from the valuable collection of Sir Robert Hadfield, and a number of ancient iron specimens from Egypt, India, etc. The Prince was also shown the original small transformer made in 1903 of the low hysteresis steel invented by Sir Robert Hadfield, which material, on the authority of Dr. T. D. Yensen, has since saved the world a sum equal to the cost of the Panama Canal.

Technology and Schools.

THE Association of Teachers in Technical Institutions held its annual conference on May 21 at Leicester. The new president, Mr. W. R. Bower, of Huddersfield Technical College, delivered an address on the position of technical education, in the course of which, after quoting with approval the views on this subject expressed in the Board of Education's Draft Regulations of 1917 for Continuation, Technical, and Art Courses, he described the aim of technical teachers as "to blend education with the life and work of the people." The special characteristic of their method is to bring education by means of part-time courses, not only to the homes of the people, but also into their workshops and offices. Comparing their work with university work, he said, "Our principal function is to develop character and mentality by means of higher education amongst the many: the university should be more concerned with the individual and his fitness to become a specialist of the first order; their successes so far have been in letters, mathematics, and science rather than in technology, even if physicians and lawyers are included amongst the technologists." The principal problem of technical education is "the satisfaction of the ambition of the young adult as a scholar, a craftsman, and a citizen."

Among other matters touched on in the address were: the increase since 1859 of the number of students in technical institutions from 500 to nearly a million; and science courses in secondary schools. "Dabbling in technology" is strongly condemned, as is the planning of school science courses for direct connexion with possible university courses or advanced professional study. On the other hand, close correlation with the work of the local technical college is commended. Mr. Bower also referred to the imminent prospect of publication by the Burnham Committee of a list of technical qualifications of teachers to be deemed equal to degrees—a prospect regarded with mingled feelings by the teachers, who foresee excessive stress being laid on paper qualifications. It was stated that the source of supply of prospective technological teachers is to be found only in industrial districts. The admission of advanced technical students to share in post-graduate and research work in universities, even when they do not hold the ordinarily pre-requisite degrees, was mentioned, and it was maintained that this concession would be of considerable benefit to the universities.

A resolution was passed by the Conference pressing for a committee of inquiry with the view of correlating technical education with education generally.

University and Educational Intelligence.

ABERDEEN.—Prof. Matthew Hay has resigned the position of Medical Officer of Health to the City of Aberdeen, which he has held for thirty-five years.

CAMBRIDGE.—Mr. S. M. Wadham, Christ's College, has been reappointed as senior demonstrator in botany. It is proposed to confer an honorary M.A. degree on Mr. H. F. Bird.

LONDON.—A course of four free public lectures on "Tropical Hygiene" will be delivered by Dr. A. Balfour, of the Wellcome Bureau of Scientific Research, at St. Bartholomew's Hospital Medical College on June 12, 14, 19, and 21, at 5 o'clock.

Notice is given that the election of a Sharpey physiological scholar will shortly take place. The scholarship, which is of the value of 200*l*., is for one year, but renewable, tenable in the department of physiology at University College. Applications, with particulars of academic training and list of publications, if any, must be sent by, at latest, June 23, to the Secretary of University College, Gower Street, W.C.1.

MANCHESTER.—The Court of the University has approved of the institution of a special diploma in bacteriology. This is the first diploma in this subject instituted in this country, and the courses of instruction which candidates will be required to attend before presenting themselves for examination are designed to supply a thorough training in the general principles of the subject, together with advanced courses in one or more special branches. Graduates in medicine and in science of any approved university may enter for the course, and the syllabus has been designed to meet the requirements of medical graduates who wish to qualify for bacteriological posts or to obtain a special knowledge of medical bacteriology, and of graduates in science who desire to take up some branch of bacteriological work. The diploma will be awarded to candidates who, after graduation in science or in medicine, have attended the prescribed courses over at least one academic year, satisfied the examiners in the written and practical examinations, and presented a satisfactory thesis on an approved subject. It is hoped that the action of the University in instituting this new diploma will meet the needs of a considerable number of post-graduate students for whom no adequate provision has hitherto been made, and will help to supply efficiently trained bacteriologists for the numerous posts for which they are now required.

A NUMBER of research studentships are being offered to university graduates by the Empire Cotton Growing Corporation, and will be awarded in July next. The studentships, which are each of the annual value of 250*l*. plus certain extra allowances, are intended to provide opportunities for additional training in scientific research bearing on plant genetics and physiology, entomology, physics, etc., or for the study of those branches of tropical agriculture which may be of service in agricultural administration or in inspection in cotton-growing countries. A studentship is offered by the British Cotton Industry Research Association to candidates having special knowledge of physics, engineering, or technical technology. Accepted students must be prepared to spend the period of their studentship at the West Indian Agricultural College, Trinidad, or in some other institution abroad selected by the Corporation. Particulars of the studentships and forms of application (which must be returned by, at latest, June 18) may be obtained from the Secretary, The Empire Cotton Growing Corporation, Millbank House, Millbank, S.W.1.

The annual report of the University of London University College Committee (1922–23) records important developments in several directions. The new Rockefeller building for anatomy, histology, and embryology, and the engineering building, including the Charles Hawksley hydraulics laboratory, begun in 1919, are nearing completion and will be ready for occupation in October. A new department of chemical engineering will shortly be established. The student enrolment, abnormally swollen during the three years following the War, showed a decrease of 4 per cent. in 1921–22, but has since then remained steady: on January 31, 1923, it was 2513. The proportion of post-graduate and research students (16 per cent.) is very high. The undergraduates were distributed in 1921–22 as follows: arts 58 per cent., science 19, medicine 13, engineering 8, law 2. The number of students from abroad—518—is very large. Of this number 100 were vacation course students, of whom 33 were from France, 15 from Holland, 12 from Scandinavia, and 10 from Switzerland. There were 108 students from India, 27 from the United States, 23 from S. Africa, 26 from Japan; 30 per cent. of post-graduate and research students were from abroad, including 54 from India. The evening work of the College, mainly of a post-graduate character, is steadily increasing, so that the buildings are now open five evenings a week. Free public lectures by the provost, 15 professors, and 20 other members of the college staff, and by 29 visitors, were attended by more than 6000 persons, the approximate aggregate number of attendances being 13,500.

"One of the most important events in the history of higher education in Belgium," according to the president of the administrative council of the University of Brussels, was the decision of the government last June to grant a subsidy of one million francs to each of the two "free" or non-state universities—Brussels and Louvain. He cites the recent grants by the British Treasury to Oxford and Cambridge as precedents justifying the acceptance of such patronage, and asserts that, far from being menaced, the independence of his university is remarkably strengthened—apparently because the ministers understand that a subsidy implies no title to exercise control over university teaching. In each of these two universities five chairs have recently been endowed for 15 years by Mr. Hoover's C.R.B. (Commission for Relief in Belgium) Educational Foundation. Thanks to this endowment, to a grant of 20 million francs from the City of Brussels, and to gifts of several millions from the heirs of Ernest Solvay and their relatives, the École Polytechnique of the University of Brussels is now excellently equipped for training in civil and electrical engineering. A subvention of 30 million francs from the Rockefeller Foundation has enabled the medical school to modernise its seven-years' medical curriculum, more comprehensive courses in physics and chemistry being included in the earlier part, the final year being reserved exclusively for clinical work. Of the 24 Americans studying in Belgium under the "Fondation Universitaire" (C.R.B.) bursary scheme 20 were last year at the University of Brussels, where also were 71 other foreign students including only one from Great Britain.

Societies and Academies.

London.

Linnean Society, May 10.—Dr. A. Smith Woodward, president, in the chair.—Paul **Kammerer**: Breeding experiments on the inheritance of acquired characters (see Nature, May 12, p. 637).

Physical Society, May 11.—Dr. Alexander Russell in the chair.—J. H. **Jeans**: The present position of the radiation problem. (Guthrie lecture.) Classical dynamics are in conflict with experience with respect to the radiation problem. The discrepancies suggest that the laws of Nature must be discontinuous. To explain the observed nature of black-body radiation Planck propounded the quantum theory; in the hands of Bohr it soon became apparent that the quantum theory contained also the clue to the line spectrum. Einstein's hypothesis of light quanta appeared to possess obvious advantages, but has had to give way before the destructive criticism of Lorentz and others, and the direct experimental test of G. I. Taylor. The different methods of interchange of energy between matter and ether, or radiation, may be classified as sub-atomic, atomic, and mass transfers. Typical of the first is the emission or absorption of radiation by a Bohr atom; of the second, the motion constituting heat in a solid; and of the third, the transmission of momentum occurring when a beam of radiation falls upon the surface of a perfect reflector. Physical and chemical transfers take place by quanta, while mechanical transfers take place according to the classical laws. Applying the general principles to a special problem, the case of the exchange of energy between a free electron e and a field of radiation X, it seems probable that no exchange of energy can occur. A conception in regard to this which was used by Einstein in 1917 appears difficult to interpret except on the view that electric forces are a manifestation of a sub-universe more fine-grained than anything we have yet imagined.

The Faraday Society, May 14.—Sir R. Robertson in the chair.—E. P. **Perman** and H. L. **Saunders**: The vapour pressures of concentrated cane-sugar solutions. Few measurements have been made in the case of concentrated solutions except at low temperatures. In the present observations the concentrations were from 10 per cent. to saturation and the temperatures 70°-90° C. The vapour pressure was measured directly, the actual pressure being balanced against a column of mercury. The pressure-concentration graph is not a straight line, as in previous determinations by a dynamic method, and the results are in harmony with Callendar's theory that definite hydrates are formed in solution. The results also show that Babo's law holds for sugar solutions.—E. W. J. **Mardles**: The elasticity of organogels of cellulose acetate. The phenomena of the strain, variable with time and partly reversible, and the persistence of deformation and optical anisotropy, have been ascribed to the formation with time, while under stress, of a metastable phase, due to the altered orientation of the molecules composing the complexes which have aggregated to form the gel structure. The relation between the modulus of elasticity and concentration for the organogels of cellulose acetate is expressed (approximately) by the expression $E = kC^n$, at higher concentrations over limited ranges; n decreases with fall in temperature. The relation between log E and temperature is approximately rectilinear over the range of temperature examined. Addition of substances to the gel mainly affects the modulus in proportion to the change in the number of particles which aggregate.—A. L. **Norbury**: Some experiments in the hardness and spontaneous annealing of lead. When Brinell hardness tests are made in lead the "time factor" is an important variable. The load, therefore, has to be applied and removed almost instantaneously and loads up to 300 kg. only can be used with a 10 mm. ball. Loads were maintained for varying lengths of time and the results are interpreted according to Meyer's formula $L = ad^n$, where L is the load, d the diameter of the impression, and a and n constants. It appears that the more annealed the lead the more the results are affected by the time factor. With cold-hammering, lead is spontaneously annealed at room temperature, and the rate of annealing increases with the amount of deformation, so that lead which has been severely hammered shows no increase in hardness.—D. **Stockdale**: An example of polymorphism in an intermetallic compound. A study of the liquidus of the copper rich aluminium-copper alloys shows that the compound Cu_2Al exists, but is unstable above 1015° C. The compound can probably exist in two polymorphic forms.—F. C. **Thompson** and E. **Whitehead**: Some notes on the etching properties of the α- and β-forms of carbide of iron. The transformation of iron carbide at 200° C. has been studied from the point of view of the etching properties. The effects, positive or negative, of numerous reagents are recorded. The best reagent for differentiating between the two forms of carbide was found to be potassium copper cyanide. Incidentally the self-tempering of samples of white iron quenched from below 300° C. was confirmed.

CAMBRIDGE.

Philosophical Society, May 7.—Mr. C. T. Heycock, president, in the chair.—G. D. **Liveing**: The recuperation of energy in the universe.—J. E. **Purvis**: (1) Infra-red spectra. (2) The absorption spectra of some organic and inorganic salts of didymium. (3) The absorption spectra of solutions of benzene and some of its derivates at various temperatures. (4) The absorption of the ultra-violet rays by phosphorus and some of its compounds.—E. C. **Stoner**: A note on the electromagnetic mass of the electron. —R. R. S. **Cox**: Chemical constants of diatomic molecules.

May 21.—P. A. **MacMahon**: (1) The partitions of infinity. (2) The prime numbers of measurement. —M. H. A. **Newman**: On approximate continuity.—J. P. **Gabbatt**: The pedal locus in hyperspace.—D. R. **Hartree**: On some approximate numerical applications of Bohr's theory of spectra.—A. G. **Thacker**: Some statistical aspects of geographical distribution.—J. **Walton**: On the structure of a middle Cambrian Alga from British Columbia (*Marpolia spissa*, Walcott).—F. T. **Brooks** and W. C. **Moore**: On the invasion of woody tissues by wound parasites.

DUBLIN.

Royal Irish Academy, April 23.—Prof. Sydney Young, president, in the chair.—W. McF. **Orr**: Solutions of systems of ordinary linear differential equations by contour integrals. The writer starts with the equation $\phi(D)x = f(t)$, where ϕ is a polynomial of degree r. The solution, subject to the conditions that initially x and its derivatives up to $(r-1)^{th}$ shall have given values, may be written

$$2\pi i x = \int_c \frac{e^{\lambda t}}{\phi(\lambda)}\left[\frac{\phi(D)-\phi(\lambda)}{D-\lambda}\right]_{t=0} d\lambda + \int_c \frac{d\lambda}{\phi(\lambda)}\int_0^t e^{\lambda(t-t')}f(t')dt',$$

where the integrals with respect to λ are taken round a contour which encloses all zeros of $\phi(\lambda)$. Not only is this solution verified, but it is also obtained from the original equation. This is done by changing the independent variable to t', multiplying across by $e^{\lambda(t-t')}dt'$, integrating from 0 to t, multiplying across by $d\lambda/\phi(\lambda)$, and integrating round an infinite contour. Simultaneous equations are solved similarly.

PARIS.

Academy of Sciences, May 7.—M. Albin Haller in the chair.—The president announced the death of Sir James Dewar, corresponding member of the general physics section.—Henri **Lebesgue**: The singularities of harmonic functions.—M. **Mesnager**: Observations on a communication by M. Sudria (April 23).—L. **Joubin**: The cruises proposed by the Office scientifique et technique des pêches during 1923. A programme of the work proposed for the coming season on the *Pourquoi Pas?* under M. Charcot and on *La Tanche*, under M. Rallier du Baty.—M. **d'Ocagne**: Equations with four variables representable both by simple and double alignment. —C. **Depéret** and L. **Mayet**: The phyletic branches of the elephants.—M. Marin Molliard was elected a member of the section of botany, in succession to the late M. Gaston Bonnier.—Pierre **Humbert**: Certain orthogonal polynomials.—Paul **Lévy**: The stable laws in the calculus of probabilities.—Bertrand **Gambier**: Systems of superabundant points in the plane: application to the study of certain surfaces. —Jean **Dufay**: The spectrum of the nocturnal sky. In the part of the spectrum studied (plate excludes the green and yellow) the light of the sky at night has qualitatively the same composition as sunlight. E. **Fichot**: The peculiarities of the amphidromic regime of open seas.—S. **Rabinovitch**: The geometrisation of electromagnetic forces.—Pierre **Auger** and A. **Dauvillier**: The existence of new lines, one a Sommerfeld doublet, excluded by the principle of selection, in the L series of the heavy elements.—Victor **Henri**: The ultra-violet absorption spectrum of the vapour of benzene chloride. A reproduction of the spectrum is given, together with a diagram showing its decomposition into groups and series. From the spectrum the molecule would appear to be asymmetrical.—Mlle. I. **Curie** and G. **Fournier**: The γ radiation of radium-D and radium-E. The results are in good agreement with those found by Rutherford and Richardson. In addition the existence of a penetrating radiation due to radium-E has been established and its coefficient of absorption determined.—Suzanne **Veil**: The evolution of the molecule of chromium hydroxide in water.—H. **Pélabon**: The thermoelectric power of alloys. For alloys not forming definite compounds the thermoelectric power usually lies between the values corresponding to those of the pure metals, but the thermoelectric power can never be calculated by the mixture rule. Results for lead-antimony alloys are given.—M. **Aubert** and G. **Dixmier**: The stability of alcohol-petrol mixtures in the presence of water. The results are summarised in two diagrams showing the effects of the gradual addition of water to alcohol-petrol mixtures, with special reference to the point at which separation into two layers takes place.—M. **Sauvageot** and H. **Delmas**: The possibility of tempering extra mild steel at a very high temperature. As the amount of carbon in steel diminishes, approaching pure iron, the critical tempering temperature rises rapidly, and coincides with the melting-point when the carbon is a little less than 0·09 per cent. (with manganese 0·33 per cent.).—Paul Mondain **Monval**: Eutectic points in saline solutions.—Robert **Stumper**: The corrosion of iron in the presence of iron sulphide. Experiments showing that iron in contact with sulphide of iron is more rapidly corroded than when the sulphide is absent. The action is electrolytic, since the presence of the sulphide in the same water was without effect unless the iron and the sulphide were in direct contact or connected by an iron wire.—Pierre **Jolibois** and Pierre **Lefebvre**: The dehydration of gypsum. Gypsum heated in a current of dry air at varying temperatures gives no indication of the formation of the semihydrate. On the other hand, if heated in steam at 160° C., the semihydrate $CaSO_4 . \frac{1}{2}H_2O$ is formed.—Mme. Pauline **Ramart** and J. **Blondeau**: The molecular transformations accompanying the dehydration of the primary α-α-disubstituted phenylethyl alcohols.—MM. **Chaumeil** and V. **Thomas**: Researches on picryl sulphide. Study of the binary picryl trinitroanisol sulphide.—Raymond **Delaby**: The action of the magnesium halides on the epibromhydrin of ethylglycerol.—MM. **Bordas** and **Touplain**: Specific characters of the heavy oils of beechwood creosote. The presence of cerulignol in these tars, giving a blue coloration in alcoholic solution with lime or baryta, suggests that these heavy oils may form a suitable ingredient in the mixture used for denaturing alcohol.—Maurice **Piettre**: The estimation of humic and fatty materials in the soil by means of pyridine. Pyridine is an excellent solvent for humus. Diluted with an equal volume of water, it can be used to extract and determine the fixed and free humus in soil.—Ch. **Mauguin**: The reflection of Röntgen rays on certain remarkable reticular planes of calcite. The experiments described form a new confirmation of the hypothesis of W. L. and W. H. Bragg on the structure of calcite.—L. **Cayeux**: The phenomenon of imprints in the Mesozoic iron minerals of France. So far as the oolitic iron minerals are concerned, the impressions may have been caused by pressure alone, or by solution with or without pressure effects.—Léon **Bertrand**: The rôle of the Provençal advance folds in the tectonic of the Maritime Alps.—Pierre **Bonnet**: The existence of the Coniacian in the Daralageoz massif (Southern Transcaucasia).—Americo **Garibaldi**: Thyroidectomy and immunity. A comparison of the results by various workers on this subject leads the author to modify the view put forward by him in 1920. The removal of the thyroid causes an increased sensibility towards substances foreign to their internal medium, but at the same time the defensive power of the organism undergoes a marked increase.—M. **Tiffeneau** and H. **Dorlencourt**: A new series of hypnotics, the aryldialkylglycols. These glycols, of which phenyldiethylglycol, $C_6H_5 . CH(OH) . C(OH)(C_2H_5)_2$, may be taken as the type, show marked hypnotic properties both towards mammals and fishes. These properties are due to the glycol group, and are strengthened by trisubstitution: they vary, between certain limits, with the number of carbon atoms in the molecule, and are modified by the relative positions of the substituting groups.—Raphaël **Dubois**: Gyratory antikinesis.—P. **Vignon**: The mimetism of the Pterochroza.—Louis **Roule**: The peculiarities of the Rhône basin with respect to its ichthyological fauna.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 9, No. 3, March).—H. S. **Reed**: A note on the statistics of cyclic growth. The lateral shoots on a young apricot branch develop typically in three groups along the branch, and their size and number are greatest in the group nearest the proximal end of the branch. The mean lengths of corresponding lateral shoots are symmetrical about a mean for each group.—R. A. **Millikan**: Stokes' law of fall completely corrected. The form of Stokes' law proposed is

$$F = \frac{6\pi\eta a v}{1 + A' l/a},$$

where F is the force acting, v the velocity produced, η the viscosity of the medium, l/a is the mean free path over the radius, and A' is a factor which varies theoretically from 0·7004 to 1·164 as, with decreasing density, l/a changes from very small to very large values and allowance is made for a percentage of specular reflection at the surface of the oil. The change in A' means physically a change from viscous resistance to resistance due to molecular impact. Experimental values of A' obtained by the oil-drop method in several gases at varying pressures vary from 0·864 to 1·154.—C. **Barus**: Gaseous viscosity measured by the interferometer U-tube. For air, a capillary tube is attached to the closed limb of the U-tube containing air at slightly more than atmospheric pressure. The displacement of the interference fringes decreases exponentially with time, and the decrease is timed over equidistant scale parts of an ocular micrometer. The value found for air in a heated room is 0·000180.—T. W. **Richards**: Compressibility, internal pressure, and atomic magnitudes. Internal pressure is defined as the pressure exerted by the force of affinity. Curves were obtained, partly by extrapolation, for the pressure-volume relations of sodium, potassium, chlorine, and bromine, reduced to a gram-atom basis, and the atomic diameters of these elements in the chloride and bromide of each metal were computed. The compressibility of the products calculated from these data is said to agree with the experimental values. The results are in accord with the theory that atoms are subject to different pressures in different chemical combinations, and their bulks depend on this and on the compressibility of the elements concerned.—J. **Kendall** and E. D. **Crittenden**: The separation of isotopes. As applied to chlorine, a solution of sodium chloride in agar-agar jelly is made the middle section of a tube used as an electrolytic cell built in three sections each three feet long. Between the anode and the chloride is a sodium hydroxide gel and solution, and separating it from the cathode is a sodium acetate gel and solution, the latter containing acetic acid. The boundary surfaces remain distinct because the chloride ion is preceded by a faster hydroxyl ion and followed by a slower acetate ion. The sections of the cell are renewed as the boundary surfaces move, so that the chloride ion eventually travels through about 100 feet of gel; 110 or 220 volt lighting circuit is suitable. The isotopes, if of different ionic mobilities, will appear at opposite end of the sodium chloride gel column. It is also suggested that since the discharge potentials of the isotopic chloride ions in any naturally occurring solution differ by 0·03 volt, it should be possible to effect electrolytic fractionation.—J. W. **Churchman**: The mechanism of selective bacteriostasis. Acid fuchsin at 45° C. appears to kill Gram-negative organisms, while Gram-positive organisms are unaffected; gentian violet has the reverse effect. A mixture of two similar dyes showing this selective bacteriostasis may prove better for the treatment of infection than either alone.—H. C. **Sherman**: An investigation of the chemical nature of two typical enzymes: pancreatic and malt amylases. Malt amylase appears to consist of a coagulable protein and a proteose or peptone. Deterioration is due to hydrolysis. Pancreatic amylase is similar though less stable in solution. With both substances, hydrolysis was checked by the addition of amino acids. There appear to be two stages in the enzyme activity of pancreatic amylase, the latter of which is promoted when lysine and tryptophane are added, indicating that these acids are closely bound in the enzyme molecule as in typical proteins.—A. J. Lotka: Note on the relative abundance of the elements in the earth's crust. Arranging the elements appearing in the lithosphere, hydrosphere, and atmosphere in the order of the percentage in which they occur according to Prof. Harkins's data, some curious arithmetical properties of the percentages and atomic numbers appear. The results suggest that the earth's crust may be the product of subatomic disintegration of the nucleus on which it rests.—S. Lefschetz: Continuous transformations of manifolds.—J. W. Alexander: A lemma on systems of knotted curves. Every 3-dimensional closed orientable manifold may be generated by rotation about an axis of a Riemann surface with a fixed number of simple branch points, such that no branch point ever crosses the axis or merges into another.—W. M. Smallwood: The nerve net in the earthworm (preliminary report). Structures considered to be nerve fibres pass round the cells in the circular and the longitudinal muscles of the body wall and each blood-vessel appears to have a nerve net. The nerve net in the layer covering all the internal organs is very extensive, originating apparently in the body wall. The nephridia appear to have a particularly good nerve supply.

Official Publications Received.

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1918. Neue Folge, 55 Band. Pp. xiv+A24+B38+C30+F15. (Wien: Gerold und Komp.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. Vol. 29: Rapport Atlantique 1921. (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Par Dr. Ed. Le Danois. Pp. 75+19 planches. (Copenhague: A. F. Høst et Fils.)

Department of Commerce: Circular of the Bureau of Standards. No. 138: A Decimal Classification of Radio Subjects—an Extension of the Dewey System. Pp. 33. 10 cents. No. 142: Tables of Thermodynamic Properties of Ammonia. Pp. 48. 15 cents. (Washington: Government Printing Office.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 216: Use of Geodetic Control for City Surveys. By Hugh C. Mitchell. (Special Publication No. 91.) Pp. v+80. (Washington: Government Printing Office.) 20 cents.

Smithsonian Institution: Bureau of American Ethnology. Bulletin 77: Villages of the Algonquian, Siouan, and Caddoan Tribes West of the Mississippi. By David I. Bushnell, Jr. Pp. x+211+55 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 720: Economic Geology of the Summerfield and Woodsfield Quadrangles, Ohio, with Descriptions of Coal and other Mineral Resources except Oil and Gas. By D. Dale Condit. Pp. 156+12 plates. 30 cents. Bulletin 737: Manganese Deposits of East Tennessee. By G. W. Stose and F. C. Schrader. Pp. x+154+30 plates. 50 cents. (Washington: Government Printing Office.)

Department of Commerce: Technologic Papers of the Bureau of Standards. No. 235: Thermal Stresses in Steel Car Wheels. By George K. Burgess and G. Willard Quick. Pp. 367-403. (Washington: Government Printing Office.) 15 cents.

Diary of Societies.

SATURDAY, June 2.

Royal Institution of Great Britain, at 3.—Dr. A. W. Hill: The Vegetation of the Andes.

MONDAY, June 4.

Oil Conference at the Sixth International Mining Exhibition (at Royal Agricultural Hall, Islington), at 12 and 2.30.—E. H. Cunningham Craig: The Riddle of the Carpathians.—Dr. M. Kraus: Oil Deposits and the Tectonics of Vertical Pressure.—R. d'Andrimont: Note on the Genesis of Hydrocarbons and their Localisation in certain Zones of the Earth's Crust.

Institute of Actuaries, at 5.—Annual General Meeting.

Royal Institution of Great Britain, at 5.—General Meeting.

Aristotelian Society (at University of London Club), at 8.—Sir Leslie Mackenzie: What does Dr. Whitehead mean by "Event"?

Royal Society of Chemical Industry (London Section) (at Chemical Society), at 8.—Dr. H. S. Hele-Shaw: The Stream-line Filter.

Royal Geographical Society (at Æolian Hall), at 8.30.—F. Rodd: Journeys in Air.

TUESDAY, June 5.

Oil Conference at the Sixth International Mining Exhibition (at Royal Agricultural Hall, Islington), at 12.—A. Beeby Thompson: Oilfield Waste.

Royal Institution of Great Britain, at 3.—Prof. W. M. Flinders Petrie: Discoveries in Egypt (3).

Royal Society of Arts (Dominions and Colonies Section), at 4.30.—Sir Edward Davson: The Economic Conference and Crown Colony Development.

Fellowship of Medicine (at Royal Society of Medicine), at 5.30.—R. A. Hendry: The Value of Antenatal Supervision.

Röntgen Society (at Institution of Electrical Engineers), at 8.15.—Prof. S. Russ: The Effects of X-rays of Different Wave-Lengths on Animal Tissue.—T. Thorne Baker: The Establishment of a Definite Relationship between Exposure and Density in an X-ray Plate.

WEDNESDAY, June 6.

Royal Society of Medicine (Surgery Section), at 5.30.—R. H. A. Whitelocke: The Treatment of Fractures of the Patella.—W. White: The Closure of the Supra-pubic Fistula following Prostatectomy: Observations on Sixty-eight Cases.

Geological Society of London, at 5.30.—Dr. H. Bolton: A new Blattoid Wing from the Harrow Hill Mine, Drybrook, Forest of Dean.—Dr. C. E. Tilley: Contact-Metamorphism in the Comrie Area of the Perthshire Highlands.

Institution of Electrical Engineers (Wireless Section), at 6.—C. E. Horton: Wireless Direction-finding in Steel Ships.

Entomological Society of London, at 8.

THURSDAY, June 7.

Oil Conference at the Sixth International Mining Exhibition (at Royal Agricultural Hall, Islington), at 12 and 2.30.—Prof. J. Voitesti: The Mode of Appearance of the Petroleum Deposits in the Carpathian Region, with general consideration on the Genesis of the Petroleum and the Source of the Actual Deposits.—Major J. A. Lautier: An Economic Study of Petroleum Mining by Underground Drainage.

Royal Institution of Great Britain, at 3.—Sir William M. Bayliss: The Nature of Enzyme Action (2).

Royal Society, at 4.30.—Sir Charles Sherrington and E. G. T. Liddell: Stimulus Rhythm in Reflex Tetanic Contraction.—K. N. Moss: Some Effects of High Air Temperatures and Muscular Exertion upon Colliers.—F. A. E. Crew: The Significance of an Achondroplasia-like Condition met with in Cattle.

Linnean Society of London, at 5.

Royal College of Physicians of London, at 5.—Prof. J. B. Leathes: The Rôle of Fats in Vital Phenomena. (Croonian Lectures (1).)

Chemical Society, at 8.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rational Study of Optical Properties: Refraction a Constitutive Property.—A. E. Goddard: Researches on Indium. Part I. Diphenyl Indium Chloride and Phenyl Indium Oxide.—E. P. Perman and W. J. Howells: The Properties of Ammonium Nitrate. Part VI. The Reciprocal Salt Pair, Ammonium Nitrate and Potassium Sulphate.—E. W. Lanfear and J. F. Thorpe: Ring Chain Tautomerism. Part VI. The Mechanism of the Keto-cyclol Change in the Propane Series.—E. H. Usherwood: The Reversibility of Additive Reactions. Part I. The Aldol Reaction.—C. K. Ingold: Mechanism of the Pinacone-pinacoline and Wagner-Merrwein Transformations.—A. E. Goddard: Researches on Antimony. Part I. Tri-m-xylylstibine and its Derivatives.

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.—V. Bonney: Diurnal Incontinence of Urine in Women.—L. Phillips: The Treatment of Dysmenorrhœa, with Analysis of 100 Cases.

FRIDAY, June 8.

Oil Conference at the Sixth International Mining Exhibition (at Royal Agricultural Hall, Islington), at 12 and 2.30.—O. A. Young and S. D. Tuthill: The Standardisation Movement in America, and its Relation to and Application towards the Elimination of Waste in the Petroleum Industry.—G. Howell: The Caribbean Oil Region.

Diesel Engine Users' Association (at Institution of Electrical Engineers), at 2.30.—Eng.-Commdr. W. P. Sillince: Losses in Heat Engines and Means of Avoiding Them.

Royal Astronomical Society, at 5.—W. S. Adams and G. Strömberg: Stellar Velocity and Absolute Magnitude: Note on a Paper by Prof. Eddington and Miss Douglas.—A. Buxton: Note on the Effect of Astigmatism on Star-Discs.

Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. J. G. Gray: A General Solution of the Problem of Finding the True Vertical for All Types of Marine and Aerial Craft, to be followed by a discussion.

Malacological Society of London (at Linnean Society), at 6.

Royal Society of Medicine (Ophthalmology Section) (Annual General Meeting), at 8.30.—Miss Ida C. Mann: Some Suggestions on the Embryology of Congenital Crescents.—P. Doyne: The Tournée Reaction.

Royal Institution of Great Britain, at 9.—Miss Joan Evans: Jewels of the Renaissance.

SATURDAY, June 9.

Royal Institution of Great Britain, at 3.—Dr. A. W. Hill: The New Zealand Flora.

PUBLIC LECTURES.

MONDAY, June 4.

University College, at 5.30.—Prof. H. A. Lorentz: Problems in Relativity. (Succeeding Lectures on June 5 and 7.)

TUESDAY, June 5.

King's College, at 5.30.—Miss Hilda D. Oakeley: The Conflict within the Greek Moral Ideal. (Succeeding Lectures on June 12 and 19.)

WEDNESDAY, June 6.

University College, at 5.—Prof. G. N. Lewis: The Structure and Behaviour of the Molecule. (Succeeding Lectures on June 8 and 12.)

THURSDAY, June 7.

St. Mary's Hospital (Institute of Pathology and Research), at 4.30.—Prof. F. G. Hopkins: An Oxidising Agent in Living Tissues.