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Words, Meanings, and Styles.

II.

THE first element of good style is clearness, and this may or may not be combined with literary elegance. It is usual to regard a split infinitive as a sign of indifference to pure English, yet this misplacement will be found in the works of some of our leading writers. The practice is discussed in an open-minded manner in Tract No. XV. recently published by the Clarendon Press for the Society for Pure English; and though no precise conclusions are reached whether it is permissible or no, the general view taken is that when a split infinitive is the best form of avoiding ambiguity it can be justified. It is admitted that the separation of *to* from its infinitive is not in itself desirable, but, on the other hand, obvious artificiality may be introduced when the practice is regarded as a fetish. "To see clearly" is certainly preferable to the split infinitive "To clearly see"; and "To be clearly seen" or "To be seen clearly" to the form "To clearly be seen," but it is difficult sometimes, without splitting the infinitive, to retain the meaning desired. Thus, the pamphlet referred to gives as an example the phrase "we must expect the Commission to at least neglect our interests." To place the words "at least" anywhere else in the sentence would not convey exactly the same idea, and instead of changing their position it would be better to recast the sentence. People who deliberately avoid split infinitives have often an objection to divide a compound verb by adverbs, so that they would write "earnestly may be hoped" instead of "may be earnestly hoped." There is, however, no grammatical reason against such splitting as there is in splitting an infinitive; indeed, the proper place for the adverb is between the auxiliary and the principal verb.

From the point of view of correct grammar, the conjunction "and" ought not to be used to begin a sentence, in spite of its common use in this place in the Authorised Version of the Bible. The function of the word is to add one word or clause to another in a sentence, and this rule is broken when the word opens a new sentence. The incorrect use of "and which" is very common. Generally, either the pronoun or the conjunction should be omitted, or the former is misplaced. When entirely different statements are expressed by two clauses of a sentence, or the cases are different, the relative may be repeated, but not otherwise. Thus it is correct to write, "The results, which support my earlier views, and which I will describe," or "His work on behalf of the scientific world, which he has served so well, and which esteems him so highly," but not "These phrases, which are irritating to read, and which are met every day," or "It is a principle which is easily understood and which is also easily forgotten." The best way to avoid flagrant errors in regard to the use of "and which," "but which," "and who," and similar combinations, is to omit whatsoever word is intrusive or redundant. That is, indeed, the touchstone by which most questions of literary style may be tested.

As to particular words and phrases, some of these in common use are indefensible, while the use of others must be left to personal taste to decide. It is fatuous to write "to the foot of the letter" instead of "literally," and clumsy to use "it goes without saying" for "it need scarcely be said" or "needless to say." "In the circumstances" is obviously a more correct phrase than "under the circumstances," and "to direct attention" is preferable to the usual form "to call (or draw) attention." "Last," which denotes position, should not be used in the sense of "latest," which signifies time. To use the word "phenomenal" to describe remarkable things or events having nothing to do with phenomena is to adopt inept journalese of the same type as the use of the verb "to transpire" in the sense of "to happen." For the use of "over" in the sense of "more than" there is no justification; and "scarcely" is always the correct word to use instead of "hardly" in expressing quantity. "To try an experiment" for "to make an experiment" is, of course, wrong. "After" or "later" is usually preferable to "subsequently"; "total" or "whole" to "aggregate"; "viewpoint" or "point of view" to "standpoint"; "first" to "firstly"; "person" to "individual" except where a single or separate person is specified; "common" to "mutual"; "largely" to "materially"; and there are many other preferences of a like kind.

Purists object strongly to the word "reliable" because of its irregular formation, though the same objection can be made to the words "laughable" and "indispensable." Some authors make the distinction of applying the word "reliable" to things or statements, and "trustworthy" to persons, and that is the general practice followed in these pages. It would be pure pedantry to refer to an engine as "trustworthy" instead of "reliable," and stupidity to describe "reliability tests" as "trustworthiness tests." Mr. B. J. Hayes, writing from Burlington House, Cambridge, objects to the use of the word "humanoid" in NATURE of February 7 (p. 201, bottom of column 1), and suggests that "hyperanthropoid" would make the use of the hybrid word unnecessary. His word, however, though correctly formed, would signify that the type referred to as humanoid was in the same direct line of development as anthropoid, whereas it belongs to a separate line.

Most of these distinctions are, however, relatively minor matters from an editorial point of view compared with diversities of paragraphing, punctuation, use of capitals, inaccuracy of quotation, and incorrect references, which come under consideration every day. It is, of course, undesirable to insist upon a uniform style of paragraphing or punctuation; and all that we would urge is that long paragraphs and long periods put too much strain on the powers of attention of the reader. There is little possibility, in scientific articles, of offending in the other direction by over-shortening paragraphs and periods until they reach the staccato style of the sprightly part of the daily press.

A quotation may be used as an apt illustration of a particular point, or as a statement of the nature of evidence on one side or the other bearing upon the case upon which judgment is being expressed. Of the former class, the authors of "The King's English" describe as trite: balm in Gilead, *e pur si muove*, a consummation devoutly to be wished, the irony of fate, the psychological moment, the pity of it, and many others; and they give the following among common misquotations, the corrections being in brackets: A *poor* thing, but mine own (an ill-favoured); *small* by degrees and beautifully less (fine); *the* last infirmity of noble *minds* (that, mind); make assurance *doubly* sure (double); a goodly apple rotten at the *core* (heart).

We are, however, more concerned with material than with formal quotations, and our experience is that very many writers fail to realise the necessity of reproducing with literal accuracy the extracts they quote, whether for approval or criticism. The number of variations which writers make, deliberately or inadvertently, from the original text is really astonishing to any one who goes to the trouble of verifying what is quoted. It cannot be too strongly insisted upon in a scientific journal that not merely the sense but the actual words and form should be reproduced exactly in a quotation, and that punctilious care should be taken in this respect when the quotation is from a book under review, or from a contribution upon which comments are being made. No wiser advice could be given than that of "verify your references," whether these signify volumes, dates, and pages, or actual quotations.

While an editor can scarcely be held responsible for the accuracy of all the quotations made by his contributors, it is his duty to secure reasonable uniformity in various elements of grammatical and typographical style. For example, certain collective nouns, such as Ministry, Government, Council, Board, Commission, Committee, are used by some writers with a singular verb and by others with a plural. In official practice the plural is commonly used, as "The

Ministry have decided" ; here the noun signifies the members of the Ministry and its sense is, therefore, plural. When, however, plurality is not intended, and reference is to a single body, it would seem to be equally correct to use a singular verb. We prefer the verb and the pronoun to be singular, as with a "nation" or "people," where they are always used rightly. On the other hand, nouns like the United States, Physics, and Mathematics, though plural in form are singular in meaning and a singular verb is, therefore, used with them. Here it is not a matter of preference or consistency but of accurate diction.

This brings us to the use of capitals, and there does not seem to be any general rule for capitalisation other than that of the initial letter of the word beginning a sentence. Some authors tend towards the German style of writing every noun with an initial capital, but few follow a definite plan, and it is left to editors or printers to secure reasonable uniformity in this respect. Our custom is to use capitals in Latin scientific names of orders, genera, and so on, but not in corresponding English words. Thus, we should print Coniferæ, but without the capital letter in conifers, and similarly, Amphibia or amphibians, Crinoidea or crinoids. Every week, however, brings difficulties in the application of any general rule to contributions of different authors, and we have to exercise the editorial prerogative in deciding whether initial capitals should be used or no in such words and terms as Radium-D, Department, Faculty, State, Parliament, Superintendent, Director, Report, Tertiary age and Stone Age, Neolithic Man, Miocene Period and Celtic period, London Clay (or clay), Ångströms, Theory of Relativity, Quantum Theory, Correspondence Principle, names of elements and minerals, and a host of other examples of a similar kind.

In general, our rule is to use initial capitals only when specific institutions, bodies, divisions, and so on, are referred to, and not when these are described in a generic sense. Thus, we should print, the University of Cambridge, but British universities; the British Scientific Instrument Research Association, but industrial research associations; the House of Commons, but the state legislature; the Middlesex Education Committee, but local education authorities; the State of New York, but the northern states; the Galaxy, but the stellar universe. It may be said, therefore, that initial capitals are used only when they are positively necessary for precise description, and are avoided unless there is an essential reason for them. We realise that our decisions are sometimes purely arbitrary, but in the absence of established principles they cannot be otherwise.

There is only one other matter to which we wish to refer in concluding this discursive article: it is that of the common belief that writers on scientific subjects compare unfavourably with workers in other intellectual fields in the capacity to express themselves in suitable words, or in their appreciation of good English. We cannot accept this view for a moment, and we resent strongly the supercilious attitude which literary people often present towards scientific works. It seems to be taken for granted by some writers who survey published literature from week to week, that no work of science can possibly be classed as literature. We do not hesitate to say, however, that, judged by literary standards alone, scientific books are published every week more worthy of comment than many of those selected to represent the week's literature. Though classical scholars and men of letters may not think it derogatory to be without a knowledge of science, most men of science are familiar with one or two languages in addition to their own, and they have, at any rate, a certain acquaintance with the art of literary expression and often the desire to perfect themselves in it. The vocabulary of a man of science is probably more extensive than that of a man of letters of equal authority, but it includes many technical words which are understood only by workers in particular fields and cannot be used effectively, therefore, when addressing a wider circle.

That is the chief distinction which need be made between scientific articles and books and those of a purely literary kind. It is not necessary for a chemist who is writing for chemists to describe the scientific words and phrases he uses any more than it is for the literary man to explain his allusions, or the historian the significance of his periods and characters. When, however, a chemist is addressing the world of science as a whole, he must avoid the special language of his branch of science if he is to be intelligible, and if he is writing for the general public he has to do so in everyday words and phrases. The standard of suitability of contributions to *Chemistry and Industry* differs, therefore, from that of a general scientific periodical such as NATURE, and this differs again from that of a daily newspaper or of a parish magazine. It ought not, however, to be too much to expect in these days that educated men and women should be acquainted with words and phrases which are part of the common vocabulary of science; and if that desideratum be granted, we may safely claim that the writings of many men of science are truly literary in style as well as scientific in substance, while as regards originality of fact and idea, they are far in advance of all other published works.

The Australian Opal.

Opal: the Gem of the Never Never. By T. C. Wollaston. Pp. xi+164+15 plates. (London: T. Murby and Co., 1924.) 10*s.* 6*d.* net.

OF precious gems the opal and the pearl take pride of place, for they seem to become part of their wearers, throwing up their beauty and receiving from them additional lustre. Our author has tried both, for he once ran a pearling fleet from Torres Straits to Timor-Laut, but sold out in favour of developing the opal, which seems to him "to be alive and almost as precious as a rose or daffodil." This expresses the motive of the book, the author a naturalist first—a true Wollaston—secondarily, the exploiter of the Australian gem, which he clearly regards as primarily connected with living organisms.

The opal is usually described as an hydrated silica which has consolidated unequally, contracting in different directions. It shows iridescent reflections from surfaces, irregular both in dimensions and arrangement, which by some authorities have been regarded as microscopic pores, arranged parallel (Crookes), while others suppose the inclusion of thin laminæ of foreign substances of different indices of refraction (Behrens), this meaning rich interference phenomena. The amount of water varies up to 13 per cent., and the product fluctuates from a colourless or black glassy substance to the most wonderful play of colours. There has, however, been little recent research on the opal, and these statements as to its structure are based on Hungarian, Mexican, and Honduras stones, which are not necessarily the same in structure as the Australian.

The position would seem to be that there was a sea which in Cretaceous times connected the Gulf of Carpentaria and the Great Australian Bight. It extended over the western halves of Queensland and New South Wales and covered most parts of the Northern Territory and South Australia, ending to the west at an undefined line in Western Australia. Then came the upheaval and the whole was covered with a desert sandstone. This has mostly disappeared by denudation, but its remains are found in a line of low ranges and tablelands down the middle of Queensland and New South Wales, close to the eastern edge of the desert; there is also a big patch, Coberpedy, in the centre of South Australia. These are the bare bones of facts, which the author amusingly clothes throughout his book with an unblushing and charming fantasy.

Everywhere in this desert, sandstone is found showing a tendency to opalisation, but the precious opal occurs principally in its basal part in a thin band or "casing" over underlying clay. Concretionary boulders or nodules of siliceous ironstone are also found containing precious opal, but a usual occurrence in the sandstone is in pipes of about the length and thickness of a pencil; these frequently show colour repetitions along their lengths, more likely, we think, to be metameric repetitions in deposition than due to "unequal pressure." All sorts of cracks and crevices in the sandstone are filled up, and the best colours are frequently shown in small sheets, only 1 to 2 mm. thick.

At the British Empire Exhibition at Wembley the author and others showed an immense variety of specimens. Some were opalised wood, while opals in spaces naturally formed in the decay of wood were also shown. Then there was a great variety of bivalve and coiled shells, some of which appeared to have the shell replaced by opal, but most, perhaps, were rather of the nature of casts. Some specimens, particularly of the blackest opal, on superficial inspection irresistibly suggested sponges and corals. Yet in others, more transparent, transmitted light revealed dark mossy growths, bearing a peculiar resemblance to the boring growths of algæ and sponges in coral, as seen after decalcification. Then there were numerous casts of the small bones and vertebræ of reptiles and of fish, in some cases surrounded by actual bone. Most of the opal had no visible connexion with organic remains, but yet, as our author points out, nearly all Australian opal has a pattern of some sort in it, often in squares or parallel lines; the colour boundaries, too, are generally determinate. Metameric repetition is very usual in the structure of animals, and we saw much in these opals that suggested such structure, but it is hard to suppose that the basal opalised band is directly connected with former organic life. In any case, Mr. Wollaston's account and specimens leave one with the impression that the combined effects of light and structure, from which the opal derives its beauty, are quite probably not the same in the Australian as in the older known opals and demand further investigation, for which the author offers to put material at the disposal of competent researchers.

For the rest, the book contains no systematic and dry-as-dust account of the opal country; there are an extraordinarily interesting series of word pictures, painted with great freshness and vigour. We have rarely read a more vivid diary than that of a visit paid to the opal country in 1888, roughly 1000 miles from Adelaide along the eastern edge of the Great Desert, mostly camel-riding. The journey had all the elements of adventure about it, dangers of direction and of drought, but above all it is a picture of the

"Never-never" land as seen by a real man. Nature is sketched in with a full brush, and the result on the reader's mind is a vivid picture of one of the least known parts of the world, made interesting by a wealth of scientific problems, physical, geological, and biological, crying out for investigation. The many touches of fancy and personality, which make this book so suitable for popular reading, must not be allowed to obscure its value as a distinct contribution to knowledge. J. Stanley Gardiner.

Endocrine Organs and Secretion.

(1) *The Endocrine Organs: an Introduction to the Study of Internal Secretion.* By Sir E. Sharpey-Schafer. Second edition. Part 1: The Thyroid, the Parathyroids, and the Suprarenal Capsules. Pp. ix+175. (London: Longmans, Green and Co., 1924.) 15*s.* net.

(2) *An Introduction to the Study of Secretion.* By Prof. Swale Vincent. Pp. 168. (London: E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

(3) *The Parathyroid Glands in Relation to Disease.* By Dr. H. W. C. Vines. Pp. viii+128. (London: E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

SIR EDWARD SHARPEY-SCHAFER'S well-known book on the endocrine organs, which was founded on a course of lectures (Lane Medical Lectures) delivered at Stanford University in California in 1913, is being rewritten in two volumes, of which the first only (1) has so far been published. This volume deals with the general considerations of internal secretions and the organs which furnish them, and then proceeds to a detailed treatment of the thyroids, parathyroids, and suprarenal capsules. Part 2, which deals with the remaining endocrine organs, will appear later.

Part 1 of the new edition is rather larger than the whole of the first edition, and its greater bulk has been necessitated by a more complete description of the organs and their secretions, and by the addition of many excellent illustrations. The more important literature, and particularly recent literature, is given in footnotes on the pages on which it is referred to in the text. The references are numerous, and while they do not obtrude in any way upon the text, will be found very convenient to any one who wishes to consult the original papers. The literature on endocrinology is enormous, and wide knowledge, personal experience, and a critical judgment are required of any one who attempts to disentangle salient facts from hypothesis. No one is better qualified than the author to undertake such an analysis, for there are few problems in endocrinology of which he has not a first-hand knowledge. The result is a full, authoritative, yet not dogmatic presentation of the subject, which, when completed by the issue of Part 2, will make these volumes the standard work on the endocrine organs.

(2) Prof. Swale Vincent's book is an account of the process of secretion based upon a series of lectures given to medical students at the Middlesex Hospital during 1922–23. Much of it is of necessity elementary, but certain forms of secretion which do not appear in ordinary physiological literature are included, *e.g.* the secretion of gases by the gas bladders of teleostean fishes, hirudin by the leech, silk, the webs of spiders, poisons, the inky secretions of cephalopods, and the luminous substances of light-producing organisms. The anatomical and histological characteristics of the glands are fully described, and most of the illustrations in the book are of histological appearances.

Much interesting matter has been collected by the author which has never been brought together before, but is of importance in a general consideration of the subject of secretion. Rather more than half the book deals with external secretion; the remainder is a short summary of the histology and processes of internal secretion.

The author reviews the methods which have been adopted for the investigation of the problems of internal secretion, and has some wholesome criticism to make of modern "organotherapy," a practice which is based upon the assumption that the active substance of the gland is absorbed unaltered into the circulation when administered by mouth. It may be objected that Prof. Swale Vincent is too critical, but in the absence of experimental proof that preparations of the ductless glands, other than thyroid, and, to a much less extent, the active substance of the Islets of Langerhans of the pancreas, have any action when administered orally, his is the only scientific attitude.

In regard to internal secretion generally, Prof. Swale Vincent also sounds a note of caution. It is by no means proved that all the organs classified as endocrine really exert their influence by secreting active substances into the blood, and because this is found to be true of one gland it does not follow that all act in a like manner. The parathyroids are specially mentioned as furnishing an example of a gland which, while it influences metabolism in certain directions, may do so, not by an internal secretion, but by an action comparable to that of the liver cells in their influence upon protein metabolism. One feels that the probability of action by an internal secretion is greater in the case of small glands like the parathyroids, but no harm is done in stressing the fact that much is assumed without proof in regard to the supposed functions of some of the ductless glands.

(3) Dr. Vines has undertaken a difficult task in compiling a monograph upon the parathyroid glands. The difficulty lies in the conflicting views which are held as to their functions. At one time the parathyroids were confused with the thyroids, and most of the older literature is permeated with this error. More recent views regard the glands as playing some ill-defined rôle in the metabolism of calcium salts, or as concerned with the detoxication of certain nitrogenous bodies, such as guanidine, normally formed in metabolism. Dr. Vines assigns both functions to the parathyroids, and considers they are carried out by different means. He gives an excellent summary of the different views put forward, and references to the more important original papers on the subject. His conclusions, however, do not always carry conviction upon the evidence produced.

Dr. Vines recognises that the means whereby calcium metabolism is controlled are very obscure and that other ductless glands may be involved. The evidence that the parathyroids are specially involved in calcium metabolism is far from satisfactory. The proofs of their having a detoxicating influence upon guanidine are more certain, and Dr. Vines has elaborated a method of testing this action *in vitro*. A table is given showing the considerable variations which he found by this means in the activity of commercial preparations of parathyroid. The possible inactivity of parathyroid preparations is freely discussed, as also is the fact that parathyroid feeding in normal animals has no definite physiological effect. Dr. Vines does not agree with Prof. Swale Vincent that parathyroid therapy is therefore worthless, and gives experimental evidence that parathyroid feeding, even in small doses, has a distinct effect both in diminishing an excess of guanidine in the blood and in promoting an increase of calcium salts in the plasma of the human subject in certain pathological conditions.

The difference of opinion is a fundamental one. Dr. Vines claims that a negative effect of parathyroid is to be expected in the normal animal, for in such case guanidine is not present in excess in the blood. Insulin, the active principle of the Islets of Langerhans of the pancreas, has a very potent effect upon the normal animal where there is no excess of glucose in the blood, but the analogy may not be a fair one. Until much more is known about the mode of action of the parathyroid and the nature of its active principle or principles, it is unsafe to express definite opinions. Such criticism is inevitable in the present lack of knowledge about the parathyroids, but is not intended to detract from the value of the work of Dr. Vines, who has rendered a distinct service to medicine in issuing this volume.

P. T. H.

A Composite Work on Physical Chemistry.

A Treatise on Physical Chemistry. A Co-operative Effect by a Group of Physical Chemists. Edited by Prof. Hugh S. Taylor. In 2 vols. Vol. 1. Pp. xi+603+41. Vol. 2. Pp. ix+701-1359+41. (London: Macmillan and Co., Ltd., 1924.) 50*s.* net.

WHILST the group method of writing has in the past been confined almost exclusively to treatises in various branches of medicine and surgery, Prof. Taylor is to be congratulated on a most successful application of the method to physical chemistry. This subject, which unfortunately for Great Britain did not develop with such rapidity as its sister subjects pure chemistry and physics, is now entering a period of a new revival which renders the appearance of this work most opportune. It is interesting to note not only a number of British nationality among the seventeen contributors to the various chapters, but also that uniform English spelling is adopted.

The volumes are conveniently so divided in subject matter that the first volume forms the basis for developing the more fundamental laws and properties of matter, whilst in the second a more advanced and in certain portions a somewhat speculative treatment of some of the newer aspects in the development of physical chemistry is presented.

Prof. Taylor has almost achieved the aim of the ideal editor in forming a composite text-book without serious change in either the standard or style of treatment from chapter to chapter. The treatment of the gaseous and liquid states of aggregation in the first volume, and of colloid chemistry in the second, might possibly be singled out as somewhat inadequate; whilst the chapters on the solid state of aggregation and electrical conductance in the first volume, on the electro-chemistry of solutions, catalysis and the quantum theory in physical chemistry in the second volume, are really good both in clarity of expression and in the range of material covered.

The text is remarkably free from misprints, of which perhaps the most striking is Helmholz for Helmholtz, whilst Debrouste, p. 133, should surely read Labrouste.

In a book of this character a certain amount of repetition is unavoidable; one might suggest that perhaps a little too much space is given in the first volume to the discussion of Henry's law, which appears both on p. 238 and p. 344, and to the now exploded radiation theory of chemical change in the second.

In discussing dilute solutions in the first volume, the student is led on to the concept of activity and potential functions. If such a treatment were extended to the introduction of the phase rule, p. 367, the reading by the student of books specially devoted to this subject would be greatly facilitated, whilst the plotting of the temperature as abscissa in the phase diagrams (Figs. 23 and 29) does not seem a very happy innovation.

It is a pity that the erroneous conceptions concerning the determination of the surface tension of solutions by the drop weight method are finding a place in standard text-books. Harkins' extension of Löhnstein's work on this subject might well be replaced by that of Iredale in a future edition.

The important paper of Debye and Hückel on the ionisation of strong electrolytes has been largely utilised in the second volume, and it would form a good substitute for the discussion of the erroneous hypothesis of Ghosh, to which three pages are devoted in Chapter xi. Also, in view of the ever-increasing importance of the amphoteric electrolytes, such as the proteins, a more detailed discussion of some of the electrical properties of such substances would not be out of place. In the chapter on colloid chemistry, Antonov's important rule and the alternative forms of the Gibbs' equation for non-ideal solutions might well have been included.

One of the most valuable features of the book is the inclusion of a number of experimental methods, together with a discussion on the probable and possible errors in physical chemical measurements, which serves not only to emphasise the need for consideration of the accuracy of measurements obtained in the laboratory, but also assists the student in visualising the subject both in its theoretical and its practical aspects.

Prof. Taylor, his co-workers, and the publishers are to be heartily congratulated on the production of this text-book, which, at any rate on the desk of the reviewer, will replace all others.

ERIC K. RIDEAL.

Our Bookshelf.

Atomtheorie in elementarer Darstellung. Von Prof. Dr. Arthur Haas. Pp. viii + 204 + 2 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1924.) 5·40 gold marks.

DR. HAAS is a gifted exponent, with a particular talent for compression. In this book of some two hundred pages he deals with the experimental establishment of the existence of the electron, the quantum theory of spectra, the modern work on X-rays and crystal structure, isotopes, and, in short, all that fascinating body of modern work which centres round the structure of the atom. He touches on such details as the selection principle of Sommerfeld and Landé, with its inner quantum number; the metastable state of the helium atom established by Franck; and the quantum theory of band spectra. There are, of course, only a few words devoted to each of such subjects, but these words are always pertinent and well chosen, and reveal the essence of the results obtained. Bohr's work of the last few years on the grouping of electrons in the general atom, and the interpretation of the periodic table in terms of quanta, is handled at comparative length, the periodicities revealed by the X-ray terms and the bearing of the spectra of potassium and calcium on the electron grouping in the first long period being well explained. The book concludes with an eight-page summary of its contents.

Dr. Haas is particularly concerned with the quantum theory of optical spectra, and devotes comparatively little space to the work of Rutherford and his school on scattering and disintegration, and the work of Aston on isotopes, although, of course, this is not to say that these aspects are entirely neglected. The general exposition is excellent, although the comprehensiveness of the scheme and the shortness of the book necessarily entail a certain abruptness. For a reader already acquainted with some of the fundamental methods and results of the quantum theory, but yet not a specialist in this field, the book offers a very agreeable means of revising his knowledge and extending it in certain directions. While the physicist will appreciate the review which the book affords, it is possible that the chemist and the layman, whom the author mentions in his preface, will find the simplicity which the lack of mathematics appears to lend to the book somewhat deceptive. The book has, however, many great merits: it is original in selection and arrangement of matter, concise in expression, includes very recent work, and is written with a knowledge and appreciation which are abundantly evident.

E. N. DA C. A.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 28. *Refractory Materials: Fireclays. Analyses and Physical Tests.* By F. R. Ennos and Dr. Alexander Scott. Pp. iv + 84. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 3*s*. net.

THIS report is intended to supplement volume 19, the well-known report on refractory materials. Volume 28 contains notes on the mode of occurrence of fireclays; analyses of about 250 fireclays; and the results of tests on the refractoriness, porosity, tensile strength, and contraction of about 70 clays. The refractory tests for about 50 clays are applied to Ludwig's chart with very fair success. To this it may be added that there is generally a difficulty in interpreting the fusion temperature of a fireclay. No specification is able to give clear unequivocal instructions as to when a fireclay exhibits "signs of fusion." Discrepant results by different observers show that the "signs" are interpreted differently by different men. This also may explain some difficulties encountered in the general use of Ludwig's chart.

The novelty in the report is the statement that "probably the simplest and most useful chemical method of estimating the refractoriness of fireclays such as those investigated is to determine the combined water." The evidence plotted on p. 72 is far from convincing. From this it would be inferred that a fireclay with between 5½ and 12 per cent. of combined water would have a refractoriness of cone 28; or, taken from another angle, a clay with 5 per cent. of combined water might have a refractoriness extending from cone 10 to 26! It will be necessary in the next edition to show in what way the proposed novelty can be of any use whatever. It is claimed that the "report should prove to be a convenient work of reference in the brick-making and refractory-using industries." This claim will be abundantly justified; the Geological Survey is to be congratulated on the utility of these Special Reports. J. W. MELLOR.

The Pharmacists' Botany. By Dr. George B. Rigg. Pp. xvii+303. (New York: The Macmillan Company, 1924.) 16s. net.

MANY of the drugs in common use as medicines are derived from the vegetable kingdom, and are to a great extent supplied to the public by the pharmacist, who has to guarantee their identity and freedom from adulteration. For this reason the pharmacist is required to undergo an adequate training in the science of botany, for which a number of excellent text-books have been published, and institutes exist in which lectures and instruction in practical work are available. Indeed, so large is the number of text-books that it is difficult to understand the necessity for an additional one unless it presents the subject in a manner specially adapted for a particular class of students. Prof. Rigg says that his aim has been "to include not only those phases of botany that are of specific use to the pharmacist, but also to give a general view of the subject which will serve as a background for him in his professional work."

A knowledge of the morphology and anatomy of the parts of plants used in medicine is particularly essential to the pharmacist, and in these respects a pharmacists' botany should give fairly complete, accurate, and precise information. Prof. Rigg's book does not satisfy this condition; and inaccurate statements occur so frequently as to constitute a serious blemish. The book is well printed, and is illustrated by a number of photographs which, for the most part, answer the purpose for which they are employed. It cannot, however, be recommended for pharmaceutical students or pharmacists until it has been thoroughly revised, erroneous statements corrected, and the details more systematically arranged.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 27. Pp. xv+142+60+80 plates. (London: Percy Lund, Humphries and Co., Ltd., 1925.) 8s. net.

ALTHOUGH, as stated in the review of process work, there has been no outstanding achievement during the past year, the editor has provided a very pleasing and useful volume, as his custom is. The making of half-tone blocks seems to have arrived at a degree of perfection that it is very difficult even if possible to surpass, though the method may perhaps be simplified by the efforts made to render it more systematic. Rotary photogravure is being applied to multicolour printing, and the method is being successfully worked on sheet-fed machines producing excellent work up to speeds of 2500 copies per hour for each colour. A higher output may be expected from the same cylinders when rotary web machines are available. The replacement of the costly solid or tubular copper cylinders used for rotary gravure by iron cylinders faced with thin copper sheets has considerably advanced during the year.

The type used for the letterpress of the volume appears to be a modern reproduction of the Aldine type of the Hypnerotomachia Poliphili issued in 1499, concerning which there is an introductory article. The private press dealt with in an illustrated article is this year the Daniel Press owned by the late Rev. C. H. O. Daniel, of Oxford. Among the very numerous illustrations is a series of examples of posters, mostly in colours, twenty-four reproductions of the celebrated woodcuts of the 'sixties, many examples of offset printing and of colour work, all of which are excellent and of considerable technical interest, and some admirable also because of the beauty of the originals.

A Bibliography of Printed Maori to 1900. By Dr. H. W. Williams. (Dominion Museum Monograph, No. 7.) Pp. xvi+198. (Wellington, N.Z.: W. A. G. Skinner, 1924.) n.p.

DR. WILLIAMS' bibliography of printed Maori publications contains nearly 1100 items. The mere number, however, does not nearly represent the amount of labour which has been expended in its compilation, as each entry is annotated with information additional to the formal particulars, and in many cases some indication is given of the character of the contents. The author has departed from the strict rule followed by many bibliographers and has included items which he has not personally examined, but as such entries are indicated, those who use the bibliography will in these cases be on their guard. The entries are in chronological order —a disadvantage if the date of the book about which information is sought is not known, or if it is undated —but as the entries are naturally of a very miscellaneous character, ranging from Bibles and prayers to newspapers, dictionaries, and government documents, any satisfactory classification would be a matter of extreme difficulty. Further, the deficiency is to some extent made good by a very full index and a list of authors and translators. In the preface, Dr. Williams reviews previous attempts at Maori bibliography, and his introduction is a valuable account of Maori presses in which the work of the various missionary societies, both in reducing Maori to a written language and in printing it, is fully recognised. The first book to be printed in the language was "The New Zealander's First Book," by Thomas Kendall, the missionary (1815), for the instruction of the natives. It is, Mr. Williams says, scarcely to be recognised as Maori at all.

An Introduction to the Mathematical Analysis of Statistics. By Prof. C. H. Forsyth. Pp. viii+241. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 11s. 6d. net.

THIS work is intended primarily as a text-book for a course in mathematics and not as a reference book for the statistician. It is to be doubted, however, whether the mathematician as such will be quite satisfied with it. In its scope it is modest, commencing with useful chapters on numerical computation, finite differences, and interpolation, and proceeding by easy stages through probability, averages, a treatment of the normal frequency curve, to correlation. While there are copious and useful examples, the mathematical treatment is patchy and uneven; it is a useful, interesting, but unsatisfying production.

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.]*

The Ages and Masses of the Stars.

SOME of the questions raised by Prof. Lindemann's interesting letter (NATURE, February 14, p. 229) can, I think, be answered at once out of our present store of astronomical knowledge.

The sun radiates in round numbers two ergs per second for every gram of its mass, a total of 4×10^{33} ergs a second, of which $1 \cdot 7 \times 10^{24}$ ergs fall on the earth. If the earth had no other source of energy, it would radiate away $1 \cdot 7 \times 10^{24}$ ergs per second from its $5 \cdot 1 \times 10^{18}$ sq. cm. of surface, and this would keep the surface at an average temperature of 276° abs. or 3° C. This about accords with the facts. If the earth's surface is not a perfect radiator the argument is slightly different but the final result is the same. If, however, the earth generated energy at the rate of even a thousandth of an erg per second for each gram of its mass, it would have to radiate away $7 \cdot 7 \times 10^{24}$ ergs a second, requiring the quite inadmissible surface-temperature of 131° C. or more in so far as the earth's surface is not a perfect radiator. Even a generation of a 10,000th of an erg per gram per second, requiring a surface-temperature of 29° C. or more, would seem to be out of the question.

Clearly, then, the mechanism which produces the sun's radiation is absent from our earth, or at best acts very feebly under terrestrial conditions. In giant stars, on the other hand, the mechanism is either more abundant or more potent. As against the sun's radiation per gram per second of 2 ergs, the bright component of Capella radiates 30 ergs, α Orionis about 200 ergs, *V* Puppis over 300 ergs, and Canopus probably over 1000 ergs.

This leads on to Prof. Lindemann's problem as to how the generation of energy per unit mass, E/M, depends on the temperature and density. I think the examples just given suffice to show that E/M is not a function either of the temperature or of the density, which is what ought *a priori* to be expected if the annihilation of matter is the source of energy. The energy transformed into radiation when an electron drops into a nucleus is about 0·003 erg, or a quantum of wave-length $6 \cdot 55 \times 10^{-14}$ cm., corresponding to a temperature of $1 \cdot 5 \times 10^{13}$ degrees. For the production of effects of this intensity, it is scarcely likely to make much difference whether the atomic temperature is 10^6 or 10^7 degrees.

The only satisfactory hypothesis I have been able to frame is that E/M in a star is a function of the state of development of the star. This hypothesis seems to fit all the facts; it would itself be explained if we could suppose matter as originally created to have consisted of a mixture of different types, some of which annihilated themselves rapidly, some only slowly, some perhaps not at all. As matter aged, the more destructible types would disappear, and the whole mass would in time consist only of the less destructible and non-destructible varieties. In a paper read at the January meeting of the Royal Astronomical Society, I showed that this supposition explains the observed facts of the giant-dwarf theory; indeed it seems almost to be demanded by these facts. We have to suppose that only the non-destructible or almost non-destructible varieties of matter are left on our earth, so that there must be kinds of matter in the sun and stars of which we have no knowledge.

The matter of which the earth is formed must, however, be of the same age as that of the sun. Whence, then, the enormous disparity in the two values of E/M? The only answer appears to be that the matter which formed the earth was not a fair sample of the solar substance. On any theory of its origin, the earth must have been formed from the outermost layers of the sun, so that we have to suppose the more destructible parts of the sun's substance to have been confined to its central regions; the heavier elements in the sun must have been more destructible than the light elements which were skimmed off to form the earth.

This leads to a consistent and comparatively simple scheme. The heaviest element known on earth is uranium of atomic number 92, but no known reason compels the series of elements to stop abruptly at N = 92, and we may quite well suppose that in the sun there were, and still are, additional elements of higher atomic numbers. It is easily calculated that the nuclei of these elements cannot be entirely stripped of electrons; indeed the ionisation potential for the last electron in the uranium atom is about 230,000 volts, corresponding to a temperature of about 17×10^8 degrees (for resonance, 170,000 volts and 13×10^8 degrees). In elements heavier than uranium the quantum orbit (∞, 1) which approaches nearest to the nucleus comes so near as almost, if not quite, to touch. Even in uranium, as Rosseland has pointed out (NATURE, March 17, 1923), the distance of nearest approach is only $1 \cdot 5 \times 10^{-11}$ cm., which cannot be much greater than the radius of the uranium nucleus (cf. Neuburger, *Ann. d. Phys.*, 70 (1923), p. 145). Thus the atomic number 92 may well mark the division between atoms in which the electron orbits are all clear of the nucleus and those in which collisions, or at least very close encounters, between electrons and nucleus are possible. The mechanism of annihilation of matter may be found in these collisions or close encounters between electrons and nucleus, in which case atoms of atomic number 92 and less may be immune. It should, however, be noticed that if the rate of annihilation is strictly independent of the temperature, the quantum orbit (∞, 1) cannot be involved, and annihilation must result from spontaneous drops from orbit 1 to orbit 0, as I originally suggested in NATURE (December 6, 1924). In any case we are free to suppose that matter as originally created consisted of elements of atomic numbers both above and below 92, but that electronic annihilation reduces the number of electrons in the heavier atoms until finally only atoms of atomic number 92 or less are left.

This brings us to a solution of Prof. Lindemann's first problem: to explain the existence of uranium on earth in view of its comparatively short half-life period of 6×10^9 years. Before the earth was born we imagine the heavier elements in the sun having their atomic numbers lowered by the annihilation of electrons, and emitting radiation in the process. A certain amount of uranium would be created out of the heavier elements by their degradation and probably also, as Prof. Lindemann suggests, a further (and much larger) amount out of the lighter elements by nuclear photosynthesis. The amount of uranium present in the sun would be determined by the condition that the total rate of creation should equal the rate of decay by ordinary radioactivity.

When the earth was formed out of the sun's uppermost layers, the creation of uranium would cease in the earth, for the supply of heavier elements would be cut off, as also the supply of radiation of high enough frequency to produce uranium photosynthetically. The earth's store of uranium would now gradually disappear by ordinary radioactive disintegration. But Prof. Lindemann's upper limit of 6×10^{11} years now appears merely as an upper limit to the time since the earth was born out of the sun. By a more detailed but similar calculation Prof. H. N. Russell has estimated this upper limit at 3×10^{10} years (Proc. Roy. Soc., 99 A (1921), p. 86).

Our hypotheses doubtless suffer from over-precision, and a more general discussion might permit of a greater age for the earth. It does not seem to me that the presence of uranium and thorium discloses any insoluble difficulties, although it would obviously have been more gratifying if the earth's age had come out a larger fraction of the estimated age of the sun.

J. H. JEANS.

February 16.

Robert Browning as an Exponent of Research.

THE comment in NATURE of January 10, p. 58, on poets who have touched the field of science may fitly be supplemented by some reference to Robert Browning, whose utterances in this field are often overlooked, although he has shown a deeper insight into the spirit of research than any other poet known to me, and has expressed it many times in glowing words. This trait is the more remarkable since Browning evidently knew little and cared little about the particulars of science, and probably found them somewhat repellent; being in this respect widely different from Tennyson, who was well versed in the scientific literature of his day, and used his knowledge of it freely. Yet Tennyson's attitude remained always that of the orthodox cultured "naturalist" of Victorian times, skilful in observation, but recoiling in alarm from the outlook to which observation led. Browning on the other hand took little heed of the path, but pressed on boldly toward the outlook and gauged the qualities required to reach it. Even in his conception of a poet, as expressed in "How it Strikes a Contemporary," he sees an investigator pure and simple, with an aptitude for understanding and recording: vividly pictured in the person of the elderly man of Valladolid, the true "Corregidor" of the city, whose

"—very serviceable suit of black
Was courtly once and conscientious still";

who

"—walked and tapped the pavement with his cane,
Scenting the world, looking it full in face";

everywhere taking such keen "cognisance of men and things" that you might even

"—surprise the ferrel of his stick
Trying the mortar's temper 'tween the chinks
Of some new shop a-building—."

The most frequently quoted though scarcely the most cogent expression by Browning of the spirit of research is contained in that noble threnody "A Grammarian's Funeral," which ought by now to have drawn from some great composer a stately "Searcher's Funeral March." It is unnecessary to recall the many familiar passages—the whole poem is an emotional rendering of delight in the pursuit of knowledge, and pride in its acquisition, whether the apparent gain be great or small:

"He settled *Hoti's* business—let it be!—
Properly based *Oun*—
Gave us the doctrine of the enclitic *De*"

—achievement enough for a Hymn of Triumph.

Browning's power in the field of psychology has always been recognised, though his psychology is, of course, tinged deeply with emotion, as in that celebrated and much-discussed example "The Ring and the Book." His grip of the scientific mentality is perhaps nowhere better displayed than in his subtle analysis of the mind of an investigator confronted with a supernormal phenomenon, given under the guise of "An Epistle," from Karshish, the vagrant Arab physician—

"—the picker-up of learning's crumbs,
The not-incurious in God's handiwork,"

to his Sage at home—

"To Abib, all-sagacious in our art,
Breeder in me of what poor skill I boast."

Antique in form but modern in application, the "Epistle" reveals the imagined writer as the possessor of exactly the mental qualities which would do credit to a young travelling medical man of the present day.

This appreciation of research is not, however, noticeable in Browning's earlier poems; one searches vainly for any clear expression of it in "Paracelsus," where one might expect to find it; but it crops up again and again, with increasing intensity, in his later work, and often in unexpected places. Take this, for example, from "Apollo and the Fates":—

"—'Tis Man's to explore
Up and down, inch by inch, with the taper his reason:
No torch, it suffices—held deftly and straight.
Eyes, purblind at first, feel their way in due season,
Accept good with bad, till unseemly debate
Turns concord—. . ."

Or this, again, from "Fust and his Friends":—

"—Man Ignores—thanks to Thee
Who madest him know, but—in knowing—begin
To know still new vastness of knowledge must be
Outside him—to enter, to traverse, in fee
Have and hold! 'Oh, Man's ignorance!' hear the fool whine!
How were it, for better or worse, didst thou grunt
Contented with sapience—the lot of the swine
Who knows he was born for just truffles to hunt?—
Monk's Paradise—'*Semper sint res uti sunt!*'
No, Man's the prerogative—knowledge once gained—
To ignore,—find new knowledge to press for, to swerve
In pursuit of, no, not for a moment: attained—
Why, onward through ignorance! Dare and deserve!
As still to its asymptote speedeth the curve,
So approximates Man—Thee, who, reachable not . . ."

Is it not by glowing rhapsody of this kind, rather than by the rendering in verse of specific results in science, be it ever so skilfully and accurately, that the poet can best touch the imagination with a sense of what science is, and may be? G. W. LAMPLUGH.

St. Albans, January 31.

The Origin of Sponge-Spicules.

IN the preliminary account by my friend Prof. Dendy (NATURE, February 7, p. 190) it is difficult to see evidence for the independent organic life of his "scleroplastids." There is nothing to prove this hypothesis in the observation that the first rudiment of the spicule in Stelletta is a skeleton-crystal on the tetrahedral system, afterwards overlaid (as we have long known in the tetracrepid desma of Lithistida) with siliceous deposit in amorphous aggregation. Obviously twinning and repetition of branches (also long known) are not arguments against the crystalline character of form in spicules. In 1898 I pointed out certain resemblances to the relations between a symbiotic organism and its host in the relations between a crystal, utilised as a spicule, and the sponge which has secreted it (Proc. Roy. Soc., vol. 64, p. 71). These resemblances seem to have misled Prof. Dendy to his new theory, but he adduces no facts which give evidence for separate organic life in the spicule, or impeach the evidence for its crystalline structure.

I advocated crystallographic explanation of their symmetry for siliceous as well as for calcareous spicules (*l.c.* p. 70), and the brusque reply then often given that "opal is a colloid" would scarcely now be tendered. Minchin, who at that time followed Schulze in thinking the form of spicules a result merely of the geometry of the canal-system, later accepted the crystallographic theory for calcareous and hexactinellid spicules, though not for those of Demospongiæ (1905, *Zool. Anz.*; 1908, *Q.J.M.S.*; 1909, *Ergebn. u. Fortschr. Zool.*, ii. pp. 251, 265).

Later work on suberitids, and on the sponge the name of which Prof. Dendy has strangely changed to Donatia, has convinced me that the case is as strong for these sponges as for the hexactinellids. The Suberitidæ, though included by Prof. Dendy in his hospitable group of Tetraxonida, have triaxon spicules; while Donatia shows very interesting evidence of tetraxon crystallisation. The conjecture is possible that crystallisation takes place on the tetrahedral system when the spicopal contains 6 per cent. of water in chemical union (Siphonidium, Sollas, 1888; Geodia, Butschli (Jannasch) 1901) and on the cubic system when it contains 7 per cent. of water (Suberites, Sollas, 1888; Poliopogon, Schulze (Moly) 1887), which might be complementary (cf. Sollas) to $(SiO_2)_5$ and $(SiO_2)_4$ respectively.

I welcome in paragraph (1) [second series of numbers] the word "Mendelian" as showing that our foremost systematist recognises now that the sponges which he investigates are not guaranteed to be thorough-bred. Classifiers in general have taken too little account of the *prima facie* promiscuity of the ocean, and for the innumerable "species" of sponges which infest our books "hybridisation must play great part in the characters we laboriously tabulate" (Bidder, Journ. Linn. Soc., vol. 34, p. 302). If Prof. Dendy will recognise also that the existence and character of spicule-forms can be modified in the individual as the direct physiological consequence of changes in the chemical constituents of sea-water, in temperature, or in light, the nomenclature in his admirable monographs may become simpler.

As regards the independent genesis of spicules, the last sentence of Prof. Dendy's letter indicates that he has not observed "scleroplastids" outside cells, and I cannot see that the remainder offers any evidence that they originate outside cells; though I know no reason against silica being deposited in the interstitial jelly of sponges, as lime is in vertebrate cartilage. Physiologists have not thought it necessary to suggest that we should recognise as symbiotic bacteria the calcareous granules in the ground-substance of cartilage, or in other tissues the crystals of urate of soda "which are at first gelatinous, but become crystalline" (Noel Paton, Enc. Brit., 18, 137) like Prof. Dendy's "scleroplastids."

GEO. P. BIDDER.

Cambridge, February 14.

Instability of Viscous Fluid Motion.

By the courtesy of Mr. C. S. Elton, Dept. of Zoology, University Museum, Oxford, the writer has seen photographs taken at Spitsbergen of loose stones on mud flats forming striking patterns of polygons. On inspecting these photographs, Capt. D. Brunt of the Meteorological Office at once recalled a paper by Rayleigh "On Convection Currents in a Horizontal Layer of Fluid" (*Phil. Mag.* 1916). The present writer in turn recalled Bénard's thesis on the same subject (Gauthiers-Villars, Paris 1901).

On referring to these papers, it was found that Rayleigh in fact gives an approximate mathematical theory of Bénard's experimental work, and shows that where a vertical flow of heat produces a temperature and density gradient in a horizontal layer of fluid, an apparently unstable arrangement, with greater density above, acted on by gravity, may actually be stable until the relation is satisfied,

$$\rho_2 - \rho_1/\rho_1 > 27\pi^4\kappa\nu/4gh^3,$$

where ρ, κ, ν, h are the density, conductivity, viscosity and depth.

Multiplying both sides by $gh\rho_1/6$ and dropping the suffix to denote that the mean density may be taken, we get,

$$gh(\rho_2 - \rho_1)/6 > 27\pi^4\kappa\nu\rho/24h^2.$$

The expression on the left-hand side is the energy released by inverting the fluid so that the density gradient downward is the same as the original gradient upward. This expression may be used as an approximation even when the gradient is not linear.

When the critical gradient upward is exceeded, instability must appear, at first in a chaotic manner; but certain modes of motion have greater rates of increment characterised by the (real positive) value of q in the factor exp.(qt), and these modes finally prevail over all others.

When the bottom boundary is a solid surface, and the upper boundary a free surface, the chance centres of instability seem always to form on the solid boundary, and to send up threads of fluid vertically which reach the surface and there spread out on all sides until they meet the neighbouring outward flows. These meetings determine boundary sheets also vertical or nearly so, down which return flow takes place, the circulation being completed along the bottom.

Polygonal prisms are thus formed in each of which circulation takes place. The number of sides may be 3, 4, 5, 6, or 7. The triangles are rapidly crushed out of existence, the squares follow more slowly, and if the conditions are kept sufficiently uniform, hexagons finally cover the whole surface with great regularity of form and size.

If, however, there is a general flow, v, across the plane, the vertical threads are drawn out into vertical sheets parallel to the v-flow. The return flow also takes place downwards along vertical sheets parallel to the former. These sheets divide the layer into long compartments of rectangular cross section.

The problem becomes two dimensional, and the motion of instability takes the form of u-w flow in closed paths within the compartments formed by the sheets. The most vigorous mode is with the distance between adjacent sheets, one rising, one descending, equal to the depth.

When the v-flow comes to rest, cross divisions appear forming squares on the surface, the most vigorous mode for squares being with side $2\sqrt{2}$ times the depth according to the theory, but before there is any sign of this being reached the squares give way to the more vigorous hexagonal mode. There is no mathematical solution available for the hexagon, but we may infer from experiment that when the mean diameter is from three to four times the depth, the hexagonal mode is more vigorous than all others.

In applying these results to the stone polygons on mud flats, it may be remarked that the ground, deeply frozen in winter, thaws superficially in summer to a depth varying from a few centimetres upwards. The frozen surface beneath is called the ground ice, and is at 0° C. in the absence of salt water. The density of the water will therefore increase upwards with temperature until 4° C. is reached. When we consider the solid matter in suspension, the mixture will have complicated properties in respect of proportion of water, mean effective density, conductivity, specific heat and viscosity, and attempts to form a quantitative estimate of the condition of instability meet with a formidable array of unknown quantities. According to the theory, however, only a trivial gradient is required for depths exceeding a decimetre to produce instability, and slowly it may be, but in the long run inevitably, the water must circulate, sorting out the lighter materials and conveying them to the polygonal boundaries of the downward flow.

On these assumptions the following predictions were made:

(*a*) That the surface would not depart much from the temperature of maximum water density, 4° C.

(*b*) That in the absence of stones which were merely indicators of the motion, polygonal marks would be formed on the mud.

(*c*) That where the mud flowed down gentle slopes, lines of stones would be formed parallel to the flow, but that where the mud came to rest, cross divisions would appear forming rectangular divisions which would give place later to polygons.

(*d*) That the diameters of the polygons would be from three to four times the depth.

(*a*), (*b*) and (*c*) were confirmed by Mr. Elton, and (*d*) was in accordance with rough observation, the depth being about a metre, the mean diameters about three or four metres.

Mr. Elton has since written that according to B. Högbom, from whose paper "Ueber die geologische Bedeutung des Frostes" (*Bull. d. geol. Inst. Upsala*,

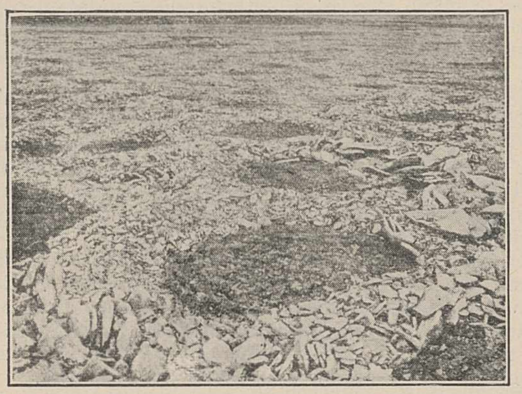

FIG. 1.—Stone Polygons on Erdmann's Tundra, Icefjord, Spitsbergen.

vol. xii. 1914), the illustration (Fig. 1) is reproduced, an explanation based on Bénard's work was put forward by Otto Nordenskiold in "Die Polarwelt und ihre Nachbarlaender" (Leipsig und Berlin, 1910), but was withdrawn in a paper in the "Wiss. Ergebn. d. Schwedische Sudpolarexpedition." 1911. Mr. Elton also gathers from a paper by Huxley that Eakin (U.S.A. Geological Survey Bulletin, No. 631, 1916) has proposed a similar explanation.

On applying an arithmetical comparison between Rayleigh's criterion and Bénard's experiments, it appears that instability sets in with less than one-tenth of the gradient required by theory. The fluid used was melted spermaceti, for which the viscosity and conductivity are not known, and for this and other reasons connected with the mounting of the experiments, the comparison is not satisfactory.

Of more general interest is the application of the criterion to the atmosphere. Using the value of $\kappa=5\nu/2$, given by the kinetic theory of gases and assumed by Rayleigh, the following table of temperature departures from the adiabatic lapse of neutral equilibrium is obtained:

Depth of layer.	1 cm.	1 m.	100 m.
Temperature difference in excess of adiabatic	9° C.	9° C. $\times 10^{-6}$	9° C. $\times 10^{-12}$

To account for observed stable layers in the atmosphere with a lapse rate far exceeding the adiabatic for many metres, it is necessary to look for an effective conductivity far exceeding the slow diffusion of the kinetic theory, and this may possibly be found in radiation and absorption, which account for the transfer of heat on an immensely greater scale. Convection of heat is excluded by the assumption of stability.

Even if stability breaks down almost instantaneously, the modes of instability will still be controlled by the considerations discussed above, but further comment must be left to meterologists.

It is remarkable that an analogous criterion may be extended to Prof. G. I. Taylor's experiments on the stability of fluid motion between coaxial circular cylinders rotating with given angular velocities ω_1, ω_2. If r is the radius, $\omega r=v$ the velocity perpendicular to radius and axis, then the equilibrium of a perfect fluid rotating steadily about the axis is stable, neutral, or unstable as vr increases, is constant or decreases radially outwards.

If a particular value of vr were an inherent permanent property of each element, the same statement would be true for a viscous fluid. But just as the density gradient in Bénard's experiment is due to the flow of heat, so here the vr gradient is due to the diffusion of v according to the relations for heat transmission, from the faster moving cylinder to the other.

Both the two dimensional case above and Taylor's case come under Rayleigh's extension of Helmholtz's theorem of minimum dissipation, so that the steady dissipation due to the not necessarily small v-motion, and the additional dissipation due to the small u-w motion are independent. Thus we have merely to replace $\kappa\nu$ by ν^2 and the analogy is applicable at once.

Rayleigh has pointed out that with two fixed solid boundaries, the effect of viscosity in increasing the dissipation will be increased. In the simple case of laminar motion v across a plane with one free surface, the dissipation is increased four times, for the same mean v, when a second fixed surface takes the place of the free surface.

Taking this as an approximation to the effect in the more complex case of u-w circulation, the criterion becomes:

Energy released by inverting the vr gradient radially $>27\pi^4\nu^2\rho/6h^2$, *i.e.* four times the previous value.

In this form the boundary line between stability and instability in the ω_1, ω_2 plane is found to be a hyperbola in accordance with Taylor's result, and the diameter is given with an accuracy which is perhaps a trifle fortuitous.

So far this holds only when ω_1, ω_2 have the same sign. When they are of opposite signs, nodes may appear in the u-w circulation, and it becomes necessary to introduce terms of the form $\sin(2\pi z/h)$ as well as of the form $\sin(\pi z/h)$ corresponding to the gravest mode of instability which alone Rayleigh considered.

Enough has been done to allow the analogy between the two-dimensional case worked out by Rayleigh, and Taylor's case to be drawn in full detail.

There are many applications of the criterion which suggest themselves, and seem to make it worth while to bring forward this provisional discussion for wider consideration.

A. R. LOW.

The Library, Air Ministry,
London, December 29.

THE experiments of Bénard, and the theoretical discussion by the late Lord Rayleigh, referred to by Major Low, deserve careful consideration from the point of view of their application in meteorology. Rayleigh showed that a layer of fluid can remain stable, even with the denser fluid above, in virtue of its conduction and viscosity. In the atmosphere it is customary to regard stability as associated with a fall of temperature with height limited by the adiabatic lapse-rate, 1° C. per 100 metres for dry air, a greater lapse-rate, or fall of temperature with height, denoting instability. It is, however, an accepted fact that lapse-rates greatly in excess of this value are of frequent occurrence, especially in the lowest 10 or 20 metres, at which height they can be observed at some time of day on almost any day of the year.

An analogy with Rayleigh's result suggests that these large lapse-rates are able to exist only in virtue of the viscosity and conduction of the air. When, however, we put figures into Rayleigh's formula, we find that in a layer 10 metres thick, the lapse-rate could not exceed the adiabatic by more than a very minute fraction. But Rayleigh's treatment only deals with conduction in the strict sense, the coefficient of conduction for air being derived theoretically from the kinetic theory of gases. Now in air the transfer of heat by radiation is enormously greater than by molecular conduction, and for air we should therefore use some higher factor than the ordinary coefficient of conductivity κ in Rayleigh's formula. An attempt is being made to derive an expression corresponding to that of Rayleigh for a compressible fluid, taking into account the various factors outlined above.

When we come to discuss the form of circulation which enters when the equilibrium breaks down, we find several examples in meteorology. The cellular form in which the breakdown of the unstable arrangement takes place is most clearly shown in mammato-cumulus clouds. A very fine example of this type of cloud is shown in a photograph by Dr. W. J. S. Lockyer, reproduced in NATURE for November 17, 1923, p. 725. This type of cloud was further discussed by Dr. G. C. Simpson in NATURE for January 19, 1924, p. 82. Such clouds occur usually in the rear of thunderstorms where there is a general slow settling of air. If there is in this region a layer of cloud or damp air, with a layer of dry air beneath it, then, as pointed out by Dr. Simpson, in consequence of the descent the dry air is warmed adiabatically at a higher rate than the damp air, and instability results. The small cloudlets are comparable with the polygonal prismatic compartments of Bénard's experiments.

There is one possible difference, in that in Bénard's experiments the lower boundary of the fluid is a solid surface, and the circulation in each compartment is upward at the centre. In the case of the unstable layer which forms the mammato cloud, the boundaries above and below are interfluid surfaces, and it is possible that the circulation in the individual cell is in the reverse sense to that of Bénard. There is no obvious criterion for determining this. It may be a question of which sense of circulation gives the smaller dissipation of energy. The analogy with Bénard's cells would require that the instability should extend through a layer the depth of which is determined by the physical constants, and is relatively shallow.

It is possible also that some of the phenomena associated with thunderstorms can be explained in the same way. Thunderstorms may be ascribed to vertical instability in the atmosphere, and the violence of thunderstorms would appear to indicate that a high degree of instability is built up before the breakdown occurs. It is suggested that this is brought about by the stabilising effect of transfer of heat and viscosity, up to a critical stage, beyond which the arrangement is unstable, and breaks down with violence. The analogy with Bénard's experiments is borne out by the frequent occurrence of a network of thunderstorms, which break out at the same time over a wide area. Further, the ratio of horizontal to the vertical dimensions of thunderstorms is of the order suggested by the analogy with Bénard's cells.

The form in which the instability breaks down near the ground, in the frequent superadiabatic lapse-rates which occur in the bottom layer of the atmosphere, affords an interesting problem; but as this problem is under investigation by others, it can only be referred to in passing. Certain details of the records shown by the microbarograph can probably be explained in this manner.

D. BRUNT.

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Blood Pressure in Early Life.

IN a friendly review of my work on "Blood Pressure in Early Life" appearing in NATURE of January 10, criticism is directed to a deduction I made on pp. 50-51 regarding the average expenditure of work by the heart in maintaining the circulation at different ages. Though this was only one of the sixteen main conclusions, and I admitted it to be the most doubtful of them, I should be glad to have the opportunity of replying to the points which are raised.

I intended to make it clear that my argument regarding the proportionality between cardiac energy expended per minute and the product of pulse pressure and pulse rate was limited to a comparison between *mean values* for large groups of individuals of the same age; that there is any basis for thinking that such a relation necessarily holds good in comparing one individual with another I did not suggest. The initial assumption was that energy expended by the heart was approximately proportional to volume of systole × pulse pressure × pulse rate. I then stated (p. 50) that "the value of V (volume of systole) cannot be measured readily and it is no doubt variable within certain limits in individuals of the same age, weight, and height, but we may perhaps make two assumptions: (1) that during the period of growth the mean values of V for large groups of growing individuals are directly proportional to the mean body weights of these groups; (2) that the average value of V remains fairly constant in adults up to middle life." From assumption (2) plus the original one it followed that "in comparing large groups of young adults aged 20 and upwards of the same sex, the *mean* product of pulse rate and pulse pressure is directly proportional to the *mean* work done by the heart per minute." This deduction is not merely one of my original assumptions, as the review states, since we have got rid of V from the original equation. From assumption (1) plus the original one I further deduced that the "mean expenditure of cardiac energy per minute for a group of individuals of a given age" is proportional to mean weight at that age × mean value of product of pulse pressure and pulse rate for that age. The word "mean" was monotonously repeated and also emphasised by italics because the application of the same reasoning to a comparison between individuals would be unsound, since there is every reason to suppose that V is as variable amongst individuals of a given age as any other anthropometric factor, and probably more variable than most factors.

Without disparaging experiments on the isolated mammalian heart, I should have grave doubts whether the complex conditions met with in the human subject could be reproduced with sufficient certainty to pronounce for or against the truth of any of these assumptions or deductions. Even granting that they could, if the pulse-pressure × pulse-rate product is made to vary in the same heart by artificial means, other factors may come into play, and I know no evidence to suggest that the equation would hold good under any but normal conditions; on the other hand, if only a few different hearts are compared under constant conditions, we are not dealing with mean values but with individuals.

The real point at issue is whether the pulse pressure is a factor at all in the actual work done. I cannot agree to the contention that the energy expended "is in no direct manner connected with the pulse pressure." It seems reasonable, however, that the mean pressure should also be taken into account. In the somewhat analogous problem of a pump working against gravity, the work done per "beat," ignoring the kinetic factor, is proportional to cross-section of pipe × mean height of fluid × change in level of fluid; and if the fluid level be restored to its original height by a siphon before the next beat, a further multiplication by number of beats per minute gives an expression for energy output per minute. Applying the analogy to the circulation, the mean cross-section of the arterial system at ages during growth may be assumed to vary as the mean cross-section of the body, or as the mean square of a linear measurement such as the stature at those ages, and the other factors in the expression are represented by mean blood pressure, pulse pressure, and pulse rate. The values of the fourfold product at ages from 10 to 21 (using smoothed figures from the curves and dividing the results throughout by 10^6) are:—

10. 4466.	13. 6863.	16. 11,264.	19. 10,992.
11. 5075.	14. 8155.	17. 11,765.	20. 10,670.
12. 5861.	15. 9927.	18. 11,465.	21. 10,490.

This method leads therefore to precisely the same conclusion as before, namely, that "when the age of 16 has been reached the average heart is performing as much or more gross work per minute than in adult life in spite of the fact that it has presumably not attained full size"; the maximum, as before, occurs about 17.

PERCY STOCKS.
Dept. of Applied Statistics,
University College,
London, January 26.

I REALISE that Dr. Stocks, when making his initial assumption that the energy expended by the heart per minute was proportional to the product of the volume of blood expelled at each systole, the number of beats per minute and the pulse pressure, intended this assumption to apply merely to the relationship of the mean values of these factors in large groups of individuals. I do not see, however, how this makes the assumption any the more justifiable. The real point at issue is, as Dr. Stocks himself mentions in his letter, whether the pulse pressure is a factor in the expression for work done.

In the "somewhat analogous problem of a pump working against gravity," the work done per beat is admittedly proportional to the product of the capacity and intensity factors, namely, cross-section of pipe × change in level of fluid and the mean height of the fluid respectively. In the case of the heart the pulse pressure, if it is of any significance as an indication of energy expenditure, must be shown to be related to either the capacity or the intensity factor of this energy. There seems to be no justification for including it in the former, especially since the mean output per beat for large groups of growing individuals is assumed to vary directly as the mean body weight. Similarly, to include it in the latter seems equally unjustifiable, seeing that the intensity factor in cardiac work, as was pointed out in the review, is the mean blood pressure during the ejection phase of systole. Accurately to determine this mean it would, of course, be necessary to know the average time course and to take the integral of this. This is, however, impossible in man, but the true figure may be approximated to sufficiently accurately if we take in its stead the mean between systolic and diastolic pressures.

If this is done and the product of body weight and mean pressure between the systolic and diastolic levels determined for different age groups, it will be clear that the figures do *not* show any maximum at the age of 16 or 17 years. One may conclude from this that at no period during adolescence is the average heart performing as much work per beat, or taking pulse rate into consideration, per minute, as in adult life.

THE REVIEWER.

Diamagnetic Orientation.

GLASER, in a recent paper (*Ann. der Phys.*, 21, 459, 1924), of which a short account was given in NATURE, January 10, p. 64, has shown that the apparent molecular diamagnetic susceptibilities of H_2, N_2 and CO_2 are three times as great at low as at ordinary pressures. He attributes this to orientation, the tendency to orientate being counteracted at higher pressures by the effects of molecular collisions. He is unable, however, to account for the factor 3 in this way.

If the molecules tend to orientate with their axes along the direction of the field, this factor may be easily accounted for. Owing to the relatively large mass of the nuclei, it is only about the line joining them that the molecule will acquire an appreciable magnetic moment under the influence of the field, the effective field being the component of the external field along the direction of this axis. The ratio of the apparent susceptibility for fully orientated molecules to that for molecules orientated at random will then be $1 / \int_0^{\pi/2} \cos^2\theta \sin\theta d\theta = 3$.

The importance of extending the measurements to monatomic gases need scarcely be emphasised.

EDMUND C. STONER.
Department of Physics,
The University, Leeds,
January 21.

Animal Mechanism.

WHEN a swan is rushing to the attack of an adversary, the head is lowered and the neck is protended almost horizontally. I had always associated this posture with mere anger, but, during the excessive Thames floods of last December, when swans could often be seen striving against the stream, sometimes, so far as could be judged, in the apathetic state of desperate exhaustion, the same pronation of the neck was frequently evident.

The explanation seems to be dynamical, for the reactions on the feet of the bird would, without the counterpoising action of the neck, tend to rotate the body about a horizontal axis, head backwards. Air resistance also plays a part.

It is of interest to note that the racing motorcyclist, in his unreasoned but experimentally justified preference for forward weight, has found a solution akin to that of the swan. Many sprinters, especially when starting, use the same principle.

H. S. ROWELL,
Director of Research,
Research Association of British
Motor and Allied Manufacturers,
15 Bolton Road, W.4,
February 11.

The Skull and Ancestry of Robert the Bruce.

WE know men better when we have seen them in the flesh, even if we have no speech with them. A knowledge of their homes fills out our mental picture of them. Darwin becomes more alive to us when we have been round his home at Down. There have always been a few who cherish the belief that the skulls of our famous dead, the homes in which their brains lived, and the bony screens on which their living visages were spread, can speak with a precision and with an intimacy beyond even the efforts of the best artist. For the human skull has a language of its own; one which is hard to decipher. After centuries of endeavour we can construe only its simpler hieroglyphics; yet we do continue to improve, and our progress justifies the belief that the day will arrive when a rational craniology will become the handmaid of biography. This is the belief of Prof. Karl Pearson; in a monograph he has published on "the skull of Robert the Bruce, King of Scotland," he has written thus:

"I can imagine a time, when public opinion being sufficiently educated, it shall be looked upon not as a desecration but as a solemn duty, reverently to exhume and study the crania of the departed great with a view of adequately correcting portraiture, or of supplying it where it is deficient." [1]

As all good Scotsmen know, Robert the Bruce was born in 1274 and died in 1329, aged fifty-five. He was buried in Dunfermline Abbey, and there his bones lay until 1819, when they were uncovered during certain rebuilding operations. The traditional and circumstantial evidence leave little if any doubt that the skull and skeleton found were those of the great king. Accurate moulds of the skull were taken before it was reburied; a cast taken from this mould is in the Museum of the Royal College of Surgeons, England, where it is placed cheek by jowl with a King Robert of a later date—Robert Burns. Another and, in Prof. Pearson's estimation, a better cast of Bruce's skull is preserved in the Museum of Edinburgh University, and it is this which he has made the subject of his monograph.

The writer of this notice has also made a study of the cranial cast of the Bruce,[2] and although his methods differ from those employed by Prof. Pearson, yet the main conclusions reached by each are in agreement. The skull of the Bruce has characters of the most outstanding kind, chief of which are the rugged robustness of its face, the outstanding ridges over the eyes, the enormous width across the face from jowl to jowl, and the strength of jaws. He was bull-necked, as is plainly indicated by the extent and strength of the bony platform on the base of the skull whereto the neck is fixed. Such an extensive platform signifies large and strong muscles in the neck, and such muscles in the neck require equally strong muscles of the spine and body. There is in the Museum of the Royal College of Surgeons a rib of King Robert; it is the 9th of the left side. It had been broken in some mischance which had befallen the King, but had healed well and soundly.[3] The rib shows him to have been a big-chested man, one we should expect to have a relatively long body; and yet his thigh and leg bones were not long. Prof. Pearson finds that their dimensions answer to those of a man about 5 ft. 6 in. in height. Bruce may well have been one of those men who seem tall when seated and yet of medium height when standing up, in which case we may add two or three inches to the estimate given by Prof. Pearson.

Bruce's skull is long and particularly wide—its width being about 78 per cent. of its length. His brain was large; Prof. Pearson estimates his cranial capacity to have been 1595 c.c.—about 8 per cent. above that of the average Briton. Neither Prof. Pearson nor the writer attach importance to the size of the brain; what has impressed both are the massiveness and strength of the cranium itself. "Bruce's skull," writes Prof. Pearson, "suggests a man of most exceptional muscularity and strength, with a bull-neck and ardent passions." The writer has expressed his conclusions thus: "It would be the strength and configuration of the face rather than the size of the brain that would weigh with most students if they sought to hazard a guess as to the nature of the man of whom such a skull had formed part. We should suppose him to have been a forceful leader of men." [4] Herein Prof. Pearson and the writer are drawing their inferences not from any systematised body of knowledge but from the everyday observation open to all—that men with such cranial characters as we find in Bruce are swayed by the strong appetites and passions of the natural man. If tradition speaks true, Bruce was no exception to this widely held belief.

Of what race was Bruce? Prof. Pearson, following tradition, looks upon him as a hybrid between Norseman and Celt, and adds: "He was able by Celtic imagination, with a certain dash of slimness, to win the Scottish nation to his side, and by aid of Nordic physique and persistency to be triumphant over his enemies." This statement might well be a quotation from the speech of a political historian; it certainly is not the language of craniology. The term Celt has been applied to diverse breeds of men, but Bruce's cranial type is not prevalent in any of them. Nor is it a type which is found in Saxon or Danish graveyards, although samples do occur in the Frankish burials of the north and west of France. Bruce's skull has more in common with what has been named by British anthropologists in recent years the "beaker" type than with any other known to the writer. Men with this type of skull began to take up their habitation along the eastern coasts of Britain early in the second millennium B.C. They are known as "beaker" men because of the peculiar kind of earthenware vessel buried with them. Before they appeared in Britain they had penetrated to Baltic lands and spread southwards into France. Bruce's ancestry may have acquired the "beaker" blood in Baltic lands, in France or in Cleveland, where the type still persists.[5]

It is this persistence of type which lends interest to the comparison of ancient and modern skulls. Those familiar with the skulls of beaker men obtained from

[1] *Biometrika*, December 1924, vol. xvi., Pts. III.-IV., p. 260.

[2] Phrenological Studies of the Skull and Brain cast of Sir Thomas Browne of Norwich, Henderson Trust Lectures, No. 111. Edinburgh, 1924.

[3] This rib was taken from the open tomb in 1819 by Dr. William Mackenzie, whose life appears in the "Dictionary of National Biography." He died in 1868. He was both accurate and learned, and was regarded in his day as the leading ophthalmic surgeon in Scotland.

[4] *Loc. cit.*

[5] The spread of the "beaker" type has been discussed in an address given by the writer on "The Bronze-Age Invaders of Britain," Journ. Roy. Anthrop. Institut., 1915, vol. 45, p. 12.

the round barrows of Wilts have no difficulty in recognising their counterparts among their companions of to-day. After a hundred matings or more in a land where long heads have vastly outnumbered the round heads, this beaker type still persists. Darwin was almost a representative "beaker" man; wherever leading British men are met together there is certain to be an undue proportion of round-heads. In more senses than one the beaker type is dominant.

The first article[6] in the number of *Biometrika* which contains Prof. Pearson's study of the Bruce's skull, helps us to understand such a persistance of a human type. This article by Dr. Ernest Warren deals not with human beings but with foxgloves, but we can legitimately transfer his results from the one to the other, for we have every reason to believe that heredity works in the human stirp just as it does on that of the foxglove. Dr. Warren observed that parental characters may form a perfect blend in the progeny, or there may be no blending—the characters of one parent dominating or ousting the corresponding character of the other parent. To use his own words: "Mendelian inheritance and perfect blending inheritance may be regarded as the two end terms of a series, and all grades of partial blending or partial segregation lie between." The same must be true of human matings; at least such a supposition accounts for the facts which are brought daily to the notice of anthropologists. The man of the Magdalenian period, unearthed recently near Bonn, had just such a development of cheek and jaw as reappeared in Robert Bruce some ten or eleven thousand years later.

In his search for authentic portraiture of the Scottish king, Prof. Pearson consulted the image on the Scottish coins of Bruce's reign. He found that the stamped image was in no sense a portrait. "As for the eye," writes Prof. Pearson, "it is remote from the orbit, but this is an artistic (?) convention even in the case of modern designers' profile portraits. On a penny postage stamp or a half-crown of his present Majesty the King, the distance from nasion to outer border of orbit is about one-third of the distance from the nasion to auricular passage, whereas in the profile of a skull it is nearer one-fifth." Herein Prof. Pearson does the designer of His Majesty's image a certain degree of injustice. The extent to which the nasion (or root of the nose) projects in front of the side wall of the orbit, when a skull is viewed in true profile, is a guide to race, and hence the writer has given this facial character some attention. In Bruce's skull the nasion lies 97 mm. in advance of the mid-point of the ear passages; the sides of his orbits 72 mm.; the difference between these measurements—the *naso-orbital depth*—is 25 mm., this being 25·8 per cent. or rather more than a fourth of the auriculo-nasal projection.

Herein King Robert was typically British, for in ten male British skulls taken at random, the mean of the corresponding measurements were 95·8 mm. and 71·2 mm.—the naso-orbital depth being 24·6 mm.—or 25·7 per cent. of the naso-auricular line. To obtain a face in which the naso-orbital depth falls to Prof. Pearson's standard, a fifth or 20 per cent., one has to go to skulls of Chinamen. Ten male skulls of this race, taken at random, gave these measurements, 92·8 mm. and 74·4 mm.—the naso-orbital depth being 18·4 mm.—almost exactly one-fifth of the naso-auricular projection. In the image on the half-crown which lies before the writer, the nasion is 8 mm. distant from the ear passage and the margin of the orbit 5 mm. The naso-orbital depth given by the designer of the coin is 38·5 per cent. of the naso-auricular distance—certainly 12 per cent. more than it should be were His Majesty's head represented in true profile. But then it is not a true profile; the artist has purposely turned the head far enough towards him to make the opposite (right) eye-brow visible, and his drawing gives His Majesty's features in their just position. It is otherwise with the photographs which Prof. Pearson has reproduced of the Bruce's skull; the camera, as cameras always do, has given a distorted view of the skull, reducing Bruce's naso-orbital distance to one-fifth of the naso-auricular line, thereby committing an error of nearly 6 per cent. The photograph of a skull cannot take the place of an accurate drawing; in the writer's opinion, photographs are useless as craniological documents.

It is a curious circumstance that although Scotland has produced an undue share of anatomists, she has had to depend, until lately, on Englishmen for a knowledge of her own people. It was Dr. John Beddoe who made the first anthropological survey of Scotland; it was Sir William Turner who first made a study of the craniology of its inhabitants past and present. Now Prof. Pearson has given the first adequate account of the skull of their great king. To those who have studied Prof. Pearson's monograph it must seem particularly ungracious on the part of a Scotsman to allow such carping criticism as he has just made above to escape from his pen, for in his final paragraph Prof. Pearson makes an appeal which must dissipate the "Scots-wha-hae-ism" of the most stony-hearted native of North Britain. There the great biometrician writes thus: "Even the aged dream dreams, and I should like to see a national monument to Bruce at Westminster, an effigy based on the skull as only a great sculptor could conceive it. But it should be the gift of Englishmen only to the united nations. . . . The union of our nations needs no artificial cement, but it would be a graceful act for Englishmen to present Scotsmen with what at present they lack, a real characterisation—which I hold is still feasible—of one of their great heroes."

Far be it from the writer to damp in the slightest degree so gracious a proposal; and yet there may be some who will think that Prof. Pearson, while he gives with one hand, does take somewhat away with the other. He suspects that Robert Bruce may have been the subject of syphilis—a suspicion which never crossed the minds of the very able medical men who examined the king's skull and bones when they were disinterred. The writer has searched the pre-medieval graves of England and Scotland for traces of syphilis and found none, and those who know our medical records believe that Robert Bruce had been asleep in Dunfermline Abbey for two centuries before this fell disease appeared in Britain.

A. KEITH.

[6] "On an Interspecific Hybrid of Digitalis," by Dr. Ernest Warren.

Biographical Byways.[1]

By Sir Arthur Schuster, F.R.S.

9. George Gabriel Stokes (1819–1903).

THE collection of Sir George Stokes's published papers, together with the "Memoirs" and scientific correspondence edited by Sir Joseph Larmor, contain such an excellent account of Stokes's activities and personality that nothing remains but to confirm, illustrate, or emphasise what is already on record.

Stokes was elected as one of the secretaries of the Royal Society six years after the constitution of the Society had been altered by the limitation of the number of fellows elected annually. It was a critical time, and though there was no sudden change in the policy of the Society, new traditions had to be established. The range of his knowledge, the width of his sympathies, and his almost infallible judgment peculiarly fitted Stokes for a position which offered so many opportunities of advising striving and sometimes stumbling men, and guiding their work into profitable directions.

My own experience was similar to that of many others. In the account I gave of Osborne Reynolds, I mentioned a certain experiment which I had performed demonstrating that the motion of the radiometer was due to internal stresses. The paper describing the experiment was sent to the Royal Society and I received, in due course, a communication from Stokes forwarding some suggestions made by the referee. I complied to the best of my ability, and in informing me that the paper had been ordered to be printed, Stokes added, that in his judgment the paper was not improved by the changes I had made in deference to the referee. He further made a significant remark, which is worth remembering by those charged with the difficult and responsible task of reporting on papers. It was to the effect that, in his opinion, it was best to allow the authors of papers to express what they had to say in their own words, even when improvements might be effected. When I quoted this remark to Maxwell a year or two later he told me that he had been the referee, but I believe he agreed with the general principle. The suggestions which Stokes himself so frequently made to the authors dealt with matters of principle rather than with the manner of expression.

I have in my possession five letters written by Stokes during March and April 1885, and dealing with a subject on which there has been, and still is, a good deal of misapprehension. The question at issue is referred to in the correspondence of July and August 1899, reprinted in the "Memoirs," vol. ii. pp. 123-125. Stokes writes to Rayleigh in July 1899:

"Some years ago Thomson or Kelvin (I forget which he was then), you, and I were together at the Royal Society, and Kelvin asked me what I thought of a result you had arrived at that the appearance of bands of interference in a spectrum did not prove regularity in the light, but only high definition in the spectroscope. If this meant what it appeared to mean I utterly disbelieved it, it seemed so manifestly untrue."

In his reply Rayleigh writes:

"I am afraid that I shall stand condemned, for I do think that 'a vast succession of independent impulses following one another casually' would show interference, of course with the aid of a spectroscope."

My correspondence with Stokes, which took place fourteen years earlier, deals with a design for an experimental arrangement suggested by him, which it was hoped would give "a large retardation of one of two interfering streams of light relatively to the other, and yet having the bands in one part of the spectrum so broad as to be easily observed, unless that should be prevented by the irregularity of the vibrations of the incident light."

The method depended on introducing into one of the interfering streams of light a dispersive medium, having a length adjusted so as to make the difference in path measured in wave-lengths in the two streams equal to each other within a certain range of the spectrum, in a manner suggested by that adopted in achromatising lenses. I do not now remember what ultimately prevented the investigation from being carried out. When I examined the question some years later (*Phil. Mag.*, June 1894) in the light of Gouy's and Rayleigh's discussion of the subject, I was fully converted to their opinion, but I do not believe that Stokes was ever convinced. In my judgment, the effect anticipated by Stokes in his arrangement would have been observed with sufficiently great resolving power, but it would have taught us nothing on the regularity of the incident light, because the observed regularity would have been introduced by the resolving power.

During my stay at Cambridge, many tales were current with regard to Stokes's taciturnity. My own experience is in the other direction. On several occasions I sat next to him at College dinners, but never had any difficulty in finding a subject of conversation on which he would enter with pleasure and sometimes with animation. He had several interesting tales of his intercourse with Brewster, who never could be made to abandon the corpuscular theory of light. Even when Foucault had proved that light was transmitted more slowly through water than through air, Brewster refused to give in.

Stokes was an old man when he died, but his scientific outlook always remained young. New ideas pleased him, and he delighted in hearing of experiments that did not fit in with any of the accepted theories. His peculiar form of wit is referred to in the "Memoirs," and I recollect one instance of it. At an excursion, during the celebration of the Kelvin Jubilee at Glasgow, Röntgen's discovery of the X-rays was referred to in the presence of some of the foreign delegates. Quincke stood up for the claims of Lenard, whose work according to him had to some extent anticipated Röntgen. Stokes replied: "Lenard may have had the rays in his brain but Röntgen got them into other people's bones." Whenever I afterwards met Quincke he never failed to repeat this remark with enjoyment.

The strong religious opinions held by Stokes are well known. I am told, on trustworthy authority, that he voted against the extension of university privileges to

[1] Continued from p. 271.

non-conformists, but this should not be taken as an indication of any want of religious tolerance. His whole life would contradict such interpretation. He could only have acted under a strong sense of personal responsibility.

In the sketch of her father's life, Mrs. Humphrey writes (vol. i. p. 6): "As a little boy he was subject to violent though transient fits of rage . . ." I was interested in this remark, but not altogether surprised, because I once saw an almost ferocious look on Stokes's face. It was at a meeting of the British Association when he thought that some one was taking a liberty with him. But this look was quickly replaced by his usual smile, as he turned round and saw that it was only Lord Kelvin patting him on the back.

Stokes lived a long and useful life, alert and vigorous almost to the end. There are few men who have secured the esteem and love of their fellow workers to the same extent. I shall always remember Lord Kelvin, as he stood at the open grave, almost overcome by his emotion, saying in a low voice: "Stokes is gone and I shall never return to Cambridge again."

The Vision of Nocturnal Animals.

By Prof. S. Russ.

IN some experiments, conducted with Dr. J. C. Mottram during the War, upon the best conditions for night vision, the question arose as to what part the transparency of the media of the eye plays in determining acuity of vision in dim lights. It is known that individuals vary between wide limits in their night vision, some appearing almost blind in a night of average darkness. Further, it is known that many wild animals have very little difficulty in making their way about or in finding their prey in dim lights, though the sense of smell may not, in the latter category, be neglected. In the night owls this sense is, I understand, excluded, for they find their prey solely by the sense of sight.

Experiments of a direct character were made upon the enucleated eye by cutting away a small portion of the retina at the back of the eye and cementing over this aperture a thin quartz plate. It was generally possible to do this without loss of fluid or deformation of the eye; this was now mounted in front of the slit of a quartz spectrometer, and the extent to which the radiation from an arc (cadmium or tungsten) was transmitted through the eye was measured photographically. It was soon evident that all of the eyes tested exerted, as was expected, a considerable degree of absorption for the major portion of ultra-violet radiation from the arc, but that what appear to be significant differences were shown by the eyes of different animals.

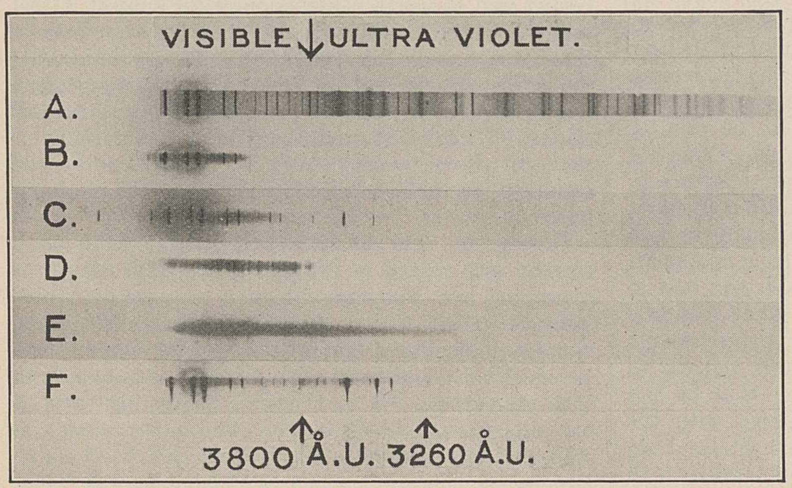

FIG. 1.

In Fig. 1 are collected the results of a number of such experiments: The strip A is a photograph of the ordinary arc spectrum of cadmium; the remaining photographs are with the experimentally mounted eyes interposed between the arc and the slit of the spectrometer. B shows the transmission by a human eye; and the other strips transmission by eyes of a lioness, C; a bear, D; great eagle owl, E; and a tiger, F. Others tested were the eye of an ox, which showed about the same degree of absorption as the human eye, and a cat, which closely resembled that of the tiger. Three human eyes were tested, and they showed no important differences from one another. How far the different degrees of transparency shown are dependent upon post-mortem changes, it is scarcely possible to say; it may be mentioned, however, that the human specimens were probably fresher than any of the others, yet they showed the greatest opacity to the short wave-lengths.

On testing in the same way the various parts of the eye, it was found that the lens was a more absorptive element than the cornea, the humors of the eye being more transparent. It is interesting to note that, if a person is examined in pure ultra-violet radiation, the lens is seen to fluoresce vividly, the cornea less so. The sensation when one is subject to this invisible radiation is that of the eye being filled with a pale blue light.

At a meeting of the Ophthalmological Section of the Royal Society of Medicine on January 9, these observations were discussed in their relation to night vision. If it be a fact that the eye of the nocturnal animal or bird is transparent to a certain range of ultra-violet radiation, and that this reaches the retina in an appreciable quantity, it may be that it is a valuable aid to vision. In the discussion, Sir John Parsons questioned the value of such a radiation to an eye chromatically adjusted to the visible region, but little is known about the range of radiation for which the optical parts of these eyes are most efficiently adapted. Prof. Hobday mentioned that, during the War, Australian horses were used in Palestine for night work, because they did not suffer from night-blindness.

Obituary.

Dr. Horace T. Brown, F.R.S.

A PENALTY of living is to outlast one's friends, especially the oldest, earliest and most esteemed. Not long ago, I engaged in the impossible task of painting a picture of James Dewar, whom I first met in 1875. Now, the call comes for a portrait of Horace Brown, my fellow-student in 1865, the last of the great Burtonian chemical quartette—Peter Griess, Cornelius O'Sullivan and the brothers Brown. My palette must be cleaned and charged anew with very different colours—the lights and shades to be depicted are of another order. No two persons stand in greater contrast. The one a man of fire and fury, a volcano of surging impetuosity, astounding in his individuality—the other, one of Nature's gentlest men, though adamant in purpose, gifted with a placid personality and a refined urbanity and charm of manner which won for him a large circle of devoted friends, scarce a detractor. Both were philosophers but the one was a consummate artist and actor, the other a naturalist from birth and, though not born to blush unseen, sparing in criticism, reticent and retiring, a conformist in most matters.

Horace Brown was congenitally fitted to walk the paths of chemistry on vital territory. Few are, strange to say: the mentality of most chemists being definitely mechanical and physical; only the elect seem to be able to sit quietly on "the dear old Nurse's knee." He was pre-eminently happy when wandering in her company, whether in the open field or in the laboratory—unveiling the activities of micro-organisms and separating the sheep from the goats, wet-nursing the barley-embryo or tracking the nimble molecules of carbon dioxide, through the stomatal openings, on their way to destruction and burial as sugar and starch in the vegetable cell. The secret of his success lay, I think, in his great powers of application and concentration and the faculty he had of getting up the subject he wished to explore, by prolonged preparatory study.

I have told the story of the family in my notice of Adrian Brown, his half-brother. He was a posthumous child, born July 20, 1848. His father began life as a farmer, so he came from the soil, as he once said to me. His mother's remarriage, to Edwin Brown, brought him under the care of a man of high attainments and wide culture, an ardent naturalist—so he grew up under most favourable conditions. His scientific leanings were such that he began to study the stars seriously in his out-of-school hours when only twelve years old. A year or so later, electricity caught his fancy. Following a book which he found in his stepfather's library, he made a frictional machine and a Leyden jar, which gave him great joy; he even went so far, that he constructed a galvanic battery, with which he studied electrotyping. The fortunate gift of a microscope, when he was twelve or thirteen, made him an ardent and systematic microscopist—thus qualifying him to use the instrument with facility and success in his later technical career. When about fourteen, the discovery of a retort and pneumatic trough among his stepfather's possessions led to his preparing oxygen. This he regarded as the turning point in his career. He then came to the conclusion that he must be a chemist: in early life he had aspired to be a railway signalman. Beginning his experimental work in the kitchen, he soon came to regard a whiff of sulphuretted hydrogen as more precious than the odour of violets—but not so the cook: so he migrated to a store-room. He left school at sixteen and a half. By then, in his attic workshop, quite unaided, he had mastered simple qualitative analysis, with the help of Fresenius. He also did a little quantitative work, under guidance of the great Peter Griess, in the laboratory at Allsopp's brewery.

Contrast Brown's training with that of the public schoolboy of to-day—who is not allowed to do anything of his own accord but constantly drilled into dull habits of conformity and helpless thoughtlessness: moreover, there are no waste places in the Flat-land of to-day. Where then is the "Dear Old Thing" to find followers in our times? Even country schoolboys are forced to play games and be examined by literary Dryasdusts, instead of willingly wooing and examining her. Little wonder that we complain that we no longer have leaders. The made-blind will never lead.

Horace Brown left school at the end of 1864, in the Sixth. In April 1865 he passed from Burton-on-Trent to the Royal College of Chemistry, Oxford St., London, to become a student first under Hofmann, then under Frankland. He left at the close of the year, however, to enter the brewery of Worthington and Co. at Burton, as an apprentice, the youngest of three assistant brewers. He was to receive 50*l.* the first year and only 90*l.* in the fifth. The young chemist to-day grumbles at 250*l.*-300*l.* There was no brewing chemistry in those days, even a prejudice against it; the brewer, in fact, was an empiric. Brown could only work in his scanty leisure hours, *sub rosa, privatim,* in a garden laboratory, which his stepfather had built for him, in 1866. He here began some research work, at Griess's suggestion. It took him nearly two years to persuade the authorities to purchase a balance and apparatus with which he might determine the original gravities of beers but this was installed in the office. Then came an opportunity which he at once took. In those days, liquor (water) was the dominant spirit in beer—everything that happened—every bad thing—was set down to water. So when Frankland and I, early in 1868, made known our method of determining organic matter in water, he readily obtained leave to spend the slack summer period in London, in Frankland's private laboratory. Having learnt to use the special appliances our method involved; among others, the Sprengel pump—which we were the first, after Graham, to adapt to practical purposes—and its tricks, he returned to the brewery and was allowed to fit up a laboratory. What that laboratory has been worth indirectly to the industry, it would be difficult to say—certainly a good round number of millions.

Brown forthwith made a survey of the Burton water supply, including the river. He thus became an authority on the subject and was instrumental in securing the abolition of the parish pumps, veritable cesspools—although only of age. As the ills that beer was heir to could not be traced to the water, he now devoted himself to the microscopic study of yeasts and soon became aware of their "mixed" character. At this period, though not until 1870, Pasteur's great work, perhaps his greatest, "Études sur le vin" (1866), came into his possession and the already loosened scales soon fell from his eyes. It became clear that the souring of stock ales was comparable with the souring of wines. When Pasteur's "Études sur la bière" was published in 1876, he had little to learn from its microscopy. Meanwhile, he had perfected a method of "forcing" beers. This involved the use of a rectangular copper box or tray containing water, kept at a regulated temperature, considerably above the average atmospheric (80°-85° F.). Samples of the beers, in small closed flasks, provided with a side tube dipping into a mercury seal, were kept on the tray during several days; the deposit was then examined with the microscope and the extent determined to which pirate organisms had developed. It was then easy to forecast the behaviour of the beers in store and so determine the order in which they should be put on the market. The monetary value of the method to the industry was very great.

Largely owing to Horace Brown's work and influence, brewers quickly learnt to appreciate the value of Pasteur's teachings and soon began to put their houses in order. The progress of bacteriology in Great Britain, especially its application to water supply, was also hastened. Horace Brown, in fact, played the same part in brewing, in leading brewers to clean up their plant and adopt aseptic methods, that Lister played in surgery—he was even in advance of Lister in appreciation of Pasteur, though a much younger man. He became manager of the whole of the manufacturing department of Worthington's in 1873, at the age of twenty-five, and occupied this responsible post until 1889, when he became one of two managing directors on the incorporation of the firm as a limited liability company. He resigned in 1893 and left Burton for London, after which time his work was done privately.

What more Horace Brown accomplished before and after he left the brewery cannot usefully be told here. Suffice it to say that he was recipient in succession of the Chemical Society's Longstaff Medal, of a Royal Medal and eventually of the Copley Medal of the Royal Society—only given in recognition of outstanding service to science. His work is noteworthy on account of its thoroughness, the elegance of his methods and the philosophical manner in which he discussed the fundamental problems which engaged his attention. He was one of the few chemists who have done pioneering work of real importance in the biological field, notably in botany.

In the interval since Brown and I became friends, science is certainly risen: its power is certainly proven. Still, it is in some measure fallen—the public effect is not that anticipated by Huxley, Tyndall and others. The clerics openly scoff at our failure and do not sense our one supreme object—the discovery of truth, how infinitely superior belief through such discovery must be to all belief through mere faith, how perfect a religion must eventually be framed through it.

The lesson of Horace Brown's education and life is to be pondered by those who realise how complete a failure is the teaching of "science" in our schools and even in our universities, as a means of inculcating in the community an appreciation of its method and majesty and its usefulness. HENRY E. ARMSTRONG.

DR. E. KLEIN, F.R.S.

WITH the death of Dr. E. Klein at Hove on February 9, one passed away who had played an important part in English medical science for more than half a century. It is not an easy thing to give a complete account of him or to estimate accurately the value of his work. He had been with us so long that but few of his early contemporaries survive, while the younger workers from whose lives the War subtracted years knew him merely as a name, and had probably never seen him. Indeed, he was a somewhat elusive personality to all of us, as he kept a good deal to himself. The present writer knew him as a fellow-worker in the same branch of study, and had also dealings with him of a scientific kind. Much of what has been written of him since his death will be found to be incomplete and inaccurate. Our claims to write of him rest on information derived from two friends who knew him intimately half a century ago, on a personal acquaintance with him for half this time, and on an intimate study of almost all his works, a study with which we have refreshed our memory since his death.

Emanuel Klein (the name Edward was assumed only after his arrival in England) was born in 1844 at Osijek (Essek), the chief town of Slavonia, situated near the junction of the Drave and Danube. His father was a tanner of Russian leather. Nothing is known of his early years, but he related himself that he was in London when about eighteen—possibly in the capacity of a tutor. His medical education was in Vienna, and after graduation he carried out original investigations, chiefly embryological, in the laboratory of Salomon Stricker (1834–98), at that time professor of general and experimental pathology in the University. In 1871–73 Stricker was publishing his great "Handbuch der Lehre von den Geweben des Menschen und der Tiere," and for this work Klein wrote the articles on the thymus gland, the external generative organs, the serous membranes, and, in collaboration with Verson, the article on the histology of the intestinal canal, and, with Stricker and Stieda, on the conjunctiva and sclerotic. Klein's original work was, however, mainly embryological in connexion with the development of the vascular system of the chick. Stricker's Handbuch was translated into English by Henry Power for the New Sydenham Society, and Klein came into contact with several English workers.

When the Brown Institution was started in 1871–2 by the purchase of two houses in Wandsworth Road, Burdon-Sanderson applied to Stricker for a suitable resident assistant director, and Klein being recommended, he came to England and lived in one of the houses (now turned into shops). He was well received, and proved a *persona grata* from the start. In those days a number of the more ardent young consultants, such as J. F. Payne, Cavafy, and Pye-Smith, used to forgather at his house to discuss science, and incidentally to play whist. Klein had also some private pupils, among whom were Francis Darwin, Frederick Treves, Jeremiah MacCarthy, and James Adams. In 1873 he was appointed to give a course of lectures on histology in Morrant Baker's physiological course at St. Bartholomew's Hospital, and thus began his long association with this ancient and noble institution, first as teacher of histology and later of advanced bacteriology. Here also was done most of his work for the Medical Department of the Local Government Board after he left the Brown Institution.

Almost all Klein's early work was on histology, a branch in which he was and is an acknowledged authority. In 1873 he wrote the section on histology for the "Handbook for the Physiological Laboratory," edited by Burdon-Sanderson, Foster, Brunton, and Klein. In the same year he published an authoritative work, in two parts, entitled "Anatomy of the Lymphatic System." These volumes were profusely illustrated with beautiful drawings by Klein from his own preparations, and he exploited with great success the method of silver impregnation which was introduced into histological technique by von Recklinghausen (1860). In 1875 Klein was elected a fellow of the Royal Society. His reputation as a histologist was greatly increased by the publication, in conjunction with the orthopædic surgeon Eldred Noble Smith (1847–1906), of the classical "Atlas of Histology" (1880). The forty-eight magnificent plates in this work were drawn by Noble Smith from Klein's preparations, and some of the illustrations have been copied into almost every English book on anatomy and physiology down to the present time. Klein also published a standard "Elements of Histology," which ran through many editions and was translated into several foreign languages.

We have dealt in some detail on Klein's activities in histology because we feel convinced that, although this occupied chiefly his earlier years, it is the work by which he will be best and longest remembered. He was brought to England not as a normal histologist, but to engage in the histological problems connected with disease, and he drifted into experimental pathology and bacteriology, as we think, *malgré lui*. He lived and worked untiringly throughout the whole of the classical period of bacteriological science from 1876 to 1900, and it is greatly to be regretted that his name cannot be placed alongside those of Pasteur, Lister, Koch, Loeffler, Roux, Pfeiffer, Weichselbaum, Kitasato, Behring, and Ehrlich, as the discoverer of any really important ætiological agent of disease. Indeed, it may sound like a paradox, but on more than one occasion he failed at first to confirm work which has become part of established bacteriological knowledge. This is difficult to understand, for, at any rate in his later years, he was a splendid technician, and frequently exhibited beautiful cultures of bacteria. We are inclined to think that his failure to make any bacteriological discovery of the first rank was due to the fact that he arrived on the field just a few years too soon. When he began the investigation of disease the methods in vogue were microscopic only. Cultivation was practically unknown or carried out by methods now admitted to be insufficient. Bacteriology really emerged through the genius of Koch, and at a time when Klein was labouring with the old methods. Had he been in a position to become associated with a master of technique like Koch, he must with all his skill have succeeded in grasping at least one of the golden prizes which were falling into the hands of the workers in Germany and France.

There is a good deal of evidence in Klein's writings that his control experiments were too scanty or incomplete, and this led him to hasty conclusions on more than one occasion. Although it is to be regretted that Klein had not the luck to make a really important discovery in bacteriology, he exercised a profound and beneficial influence in England on the applications of the science to public health problems, and may be said to have controlled this branch for nearly half a century in a manner which was greatly to his credit. In personal intercourse with the younger workers he was always most helpful and generous, and placed his great experience at their service. All the memories of him in the country of his adoption will remain favourable. He was a tall, handsome man who spoke broken English to the end. Of affable manners, he was often polemical, but took defeat in a thoroughly sportsmanlike fashion. Throughout life he showed the characteristics of his race in a passion for music and chess.

W. B.

HUGO VON SEELIGER, who died on December 2, was born at Bielitz-Biala, Austria, on September 23, 1849. After studying at the universities of Heidelberg and Leipzig, he was appointed observer at Bonn Observatory in 1873 and remained there for four years, taking part in the observations of the zone 40°-50° for the Astronomische Gesellschaft Catalogue, and being a member of the expedition to observe the 1874 transit of Venus. After a short period at Gotha he went to Munich in 1882 as Director of the Observatory and professor of astronomy. He remained there for the rest of his life, and became famous as a teacher, Schwarzschild having been one of his pupils. He also made several theoretical researches both on stellar problems and those relating to the solar system. He was a pioneer in the application of statistical methods to the study of star density, and the size and shape of the stellar system; his estimate of the absorption of light in space was 0·3 mag. in 12,000 light years. He was interested in the excess of the motion of Mercury's perihelion over its theoretical value. He examined whether any distribution of the matter forming the zodiacal light could explain this, without introducing other anomalies in the motion of the nearer planets. Another study related to the brightness of Saturn's ring. Basing his work on Maxwell's deduction that the ring was composed of small particles, he obtained expressions for its change in brightness at different distances from opposition, which were verified by Müller's photometric observations.

WE regret to announce the following deaths:

The Right Hon. Sir Thomas Clifford Allbutt, K.C.B., F.R.S., Regius professor of physic in the University of Cambridge since 1892, on February 22, aged eighty-eight.

Mr. T. H. W. Idris, president in 1903 and 1904 of the British Pharmaceutical Conference, on February 10, aged eighty-two.

Sir T. Edward Thorpe, F.R.S., emeritus professor of chemistry in the Imperial College of Science and Technology, South Kensington, and president in 1921 of the British Association, on February 23, aged seventy-nine.

Current Topics and Events.

THE President and Council of the Royal Society decided at a meeting on February 19 to recommend for election into the Society the following fifteen candidates: Dr. W. R. G. Atkins, Prof. C. A. Lovatt Evans, Mr. R. H. Fowler, Dr. F. A. Freeth, Dr. Walcot Gibson, Dr. Harold Jeffreys, Prof. F. Wood Jones, Prof. J. Kenner, Prof. E. Mellanby, Mr. J. A. Murray, Prof. J. Proudman, Mr. R. V. Southwell, Dr. L. J. Spencer, Dr. R. J. Tillyard, Prof. R. Whiddington.

THERE has been so much adverse criticism of the Wireless Telegraphy and Signalling Bill recently introduced by the Postmaster-General that we are beginning to wonder whether after all something cannot be said in favour of it. Every one must admit that some control of "etheric" waves is absolutely necessary, even if the terms in which the Postmaster-General asks for authority are open to question. Scientific men, although they know perfectly well what the framers of the Bill mean by "etheric waves," have taken a Puckish pleasure in destructive criticism of the nomenclature. When asked to give a scientific definition they have to confess their inability. A proposal has recently been made for a large and powerful radio station which will control the time-keeping of clocks. Railway engineers want to use radio signalling to control their trains. It is obvious that if some one were not put in authority, the ether—if there is an ether—would soon be in a chaotic condition. If anything affects telegraphy or telephony, the Postmaster-General has been given in the past, and still possesses, the most absolute powers to prevent this interference taking place. During the War, the public welcomed the autocratic powers given to the Post Office. If there were another war these powers would be at once resuscitated for the public benefit. The Bill has been in preparation for two or three years, and most of those affected by it have been consulted. If suitable amendments be introduced so that the regulations do not affect amateur research injuriously, and section 7, which perhaps goes too far in putting the methods of radio power transmission under the control of the Post Office, be suitably amended, we see little to criticise in the Bill. Regulations are always grievous at the start, but they may nevertheless be for the public good.

IT is of interest, just now, to recall the connexion of the Royal Society with various experiments made in 1664 from the steeple of old St. Paul's, under the guidance of Robert Hooke. Oldenburg, the Society's secretary, writing to Boyle, on August 25, 1664, reports that having found the top of Paul's steeple a convenient place for experiments, order was given at the previous day's meeting of the Royal Society (held at Gresham College) to try there the descent of falling bodies, the Torricellian experiment, and the vibrations of a pendulum suspended so as to reach to the floor of the church, a perpendicular height of about 200 ft. Hooke began at once to make trials, enlisting, as helpers, "some other company," which, we gather, included Lord Brouncker, Dr. Wilkins, Sir Robert Moray and Dr. Goddard. Hooke comments on sundry difficulties in a letter to Boyle, dated Sept. 8, 1664. He says: "the steeple being without any kind of lofts, but having here and there some rotten pieces of timber lying across it, I caused a rope to be stretched quite cross the top, and fastened; in the midst of which I fixed a pulley, through which I let down the string and weight to the bottom, for only in the very middle of the steeple was there a broad clear passage from top to bottom." The vicissitudes of issue of the "Philosophical Transactions" have curious connexion, too, with old St. Paul's and the Great Fire of London in 1666. The Royal Society's printers (Mr. Martyn and Mr. Allestry) and the booksellers in St. Paul's Churchyard lost their stock of books in the conflagration, after carrying them from their own houses into St. Faith's Church, under St. Paul's. Among the losses were all the copies then printed and unsold of the "Philosophical Transactions." It is small wonder that early copies of this scientific journal are rare.

WE have recently had occasion to consider in these columns the recommendations of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. The Minister of Health has now published draft regulations based on these recommendations, and in framing them he has apparently adhered closely to the latter. The preservatives formaldehyde and boric and salicylic acids are completely prohibited: benzoic acid and sulphur dioxide are allowed in certain cases only and in strictly limited amounts. The following may contain sulphur dioxide: sausages, jam, fruits, beer, cider, wine and cordials and fruit juices: benzoic acid is only permitted in coffee extract, fruit juices and cordials and sweetened mineral waters, including brewed ginger beer; but no article is permitted to contain both sulphur dioxide and benzoic acid. As regards colouring matters, all colours which are compounds of the following metals are prohibited: antimony, arsenic, cadmium, chromium, copper, lead, mercury, zinc. In addition, gamboge and half-a-dozen coal-tar dyes, including picric acid, are also forbidden. Further to protect the consumer, it is laid down that sausages, jam, and coffee extract must be labelled if they contain preservative, whilst articles sold as preservatives must be labelled with the percentage of sulphur dioxide or benzoic acid present. The regulations will apply to imported as well as to home products. Full powers are taken to carry out inspections and take samples. The regulations, when put in force—no date is as yet mentioned—should do much to improve the quality of Great Britain's foodstuffs.

THE American Association for the Advancement of Science has about 13,000 members, and in his address as retiring president (*Science*, January 2), Dr. Charles D. Walcott considers how this great body can render science of service to mankind. It should, he says, "act as a liaison agency between professional science and the public, as well as between the various sciences." Whether it be in the traffic and social problems of modern life, or in the conservation of natural resources, the great need is the education of all citizens in the scientific method of approach. "All scientific men and women may do their bit—first, by training themselves to observe accurately, to think straight, and then to record clearly and honestly, and to draw warranted conclusions based on the facts presented . . . ; second, by reviewing the mass of technical information with which they are familiar and telling the story they have learned in simple, clear language, free from obscure, complicated, technical and verbose wording." They should engage in co-operative public work, applying the scientific spirit in all branches of social endeavour, and notably in all agencies concerned with the education of the people from the university to the cinema. Could not, Dr. Walcott concludes, the Association organise a committee to deal with the popularising of scientific knowledge, bringing its lessons and its principles home to all—and particularly to children, to women, and to business men? This is admirable counsel, and just as applicable to those on the eastern side of the Atlantic as to Dr. Walcott's fellow-citizens.

AT the sale of the Crisp Collection of antique microscopes on February 17, high prices were realised for some of the instruments. The silver "universal" by G. Adams was obtained by Mr. Webster for 360*l*. This instrument, on account of its highly ornamental construction, its scientific interest, and the fact that it is made throughout of silver, was easily the most valuable item from the auction point of view. The original modification of the Hooke microscope, dating from about the year 1675, realised 160*l*. The name of the maker of this very fine early example of English opticians' work is unknown. An original compound microscope made by Guiseppe Campani, the great Italian optical instrument maker, was obtained by the Science Museum, South Kensington, for 45*l*. Other instruments of historical and scientific value secured for this museum included the improved "universal" microscope by G. Adams, the Cuno form of hand microscope made by Depovilly of Paris, and a modified form of John Marshall's microscope. For the new Museum at Oxford, several instruments were obtained, including a replica of Hooke's original compound microscope, as figured and described in his "Micrographia," 1665. This item realised 20*l*. Mr. T. H. Court, whose valuable collection in the Science Museum is well known, secured a large number of the instruments. Of these, the elaborately decorated microscope made for Pope Benedict XIV. (31*l*.), the very fine microscope made in 1752 by D. Joannes de Guevave (33*l*.), and an early Italian microscope inscribed "Elaboratum a Blasis Burlini Venetiss Optico" (31*l*.), may be mentioned. Three fine examples of the Marshall microscope, made in the early part of the eighteenth century, were sold at prices ranging from 13*l*. to 22*l*.

PROF. T. H. PEAR, in a discourse at the Royal Institution on Friday, February 20, on "Acquiring Muscular Skill," stated that his purpose was, first, to examine an urgent practical aspect of the problem; the desirability of describing and recording skill in a universally acceptable language and notation. The photographic, stereoscopic, cinematographic, and ultra-rapid cinematographic study of the ideal postures and movements desirable in certain skills, and the result of describing and discussing such records in words, have occasionally led to a degree of "intellectualisation" which is not generally recognised. The accidental fact that some skills have been more fortunate in their exponents partly, but only partly, accounts for this. By the aid of these various devices and of certain utilisations of "picture-diagrams" and films it is possible not only to record actual performances, but also to criticise them analytically. The study of modern figure-skating in the international style is a good illustration of this point. Suitably prepared diagrams should help the learner, before he attempts to execute a complicated series of movements, to grasp them visually, both in parts and as a whole. This method of transmitting skill is probably in its infancy. Its progress in the hands of suitable instructors should be rapid. Whether such visual means of approach to the mind are specially suitable only to the person who "thinks in pictures" is an important and unsettled problem. By these means it should be possible to compose new skilled movements and new combinations of them. Before the days of musical notation and of writing, musical composers and poets had to be performers. Nowadays they may inspire other more gifted executants. This may be possible for skilled movements when a combination of workers, players, anatomists, physiologists and psychologists produce a grammar, a syntax, a harmony and a recorded poetry of movement.

IN his presidential address to the Optical Society on Thursday, February 12, Prof. Archibald Barr referred to the optical instrument maker as the tool-maker for all branches of scientific investigation including his own. He stated that scientific investigators depend to a great extent on the knowledge and skill of the optician for the provision of their tools. Every improvement made in the optician's products enables the user of these tools to go farther and deeper in his researches. It is the duty of the optician to keep himself familiar with the latest advances in science, so as to be ready to forestall the needs of the investigator, or to be able fully to understand the requirements that arise, and to bring to bear on the production of the new tools an intimate knowledge of the means by which, and the extent to which, the requirements can be fulfilled in a practicable device. Opticians are primarily concerned with less than one octave out of the sixty or more of known radiation, though for some purposes they have to take account of one or two octaves on each side of that of visibility, into the infra-red and the ultra-violet. Narrow as it may be on the scale of radiology, the one octave of the visible spectrum has and always will have a very special significance in the scheme of things as they are, and that octave includes a wide range of problems of all degrees of complexity. Within the limits of optics properly so called, there is still scope for development to which no limits can be set.

PROF. WILLY WIEN, of Würzburg, has been elected an honorary fellow of the Physical Society of London.

MR. E. HILTON YOUNG, M.P., has been appointed chairman of the Departmental Committee on the University of London, in succession to Lord Ernle, who has resigned.

DR. LOUIS A. BAUER, director of the department of terrestrial magnetism of the Carnegie Institution of Washington, has been elected a corresponding member of the Russian Academy of Sciences.

WE learn from *Science* that Mr. John F. Stevens, of New York City, has been awarded the John Fritz Gold Medal of the Engineering Foundation, New York, "for great achievements as a civil engineer, particularly in planning and organising for the construction of the Panama Canal, as a builder of railroads and as administrator of the Chinese Eastern Railway."

A TEMPORARY assistant and a temporary junior assistant are required in the metallurgical research department of the Royal Arsenal, Woolwich. Candidates should be graduates with university training in metallurgy. Applications for the posts should be sent, with copies of not more than three testimonials, to the Chief Superintendent, Research Department, Royal Arsenal, Woolwich, S.E.18.

A TECHNICAL assistant is required at the Royal Aircraft Establishment, South Farnborough, Hants, for experimental and development work in connexion with aerial beacons and aerodrome illumination generally. Candidates should possess an honours degree in electrical engineering, design experience in the application of optical and illuminating engineering, and, if possible, experience in lighthouse work. Applications, marked A.47, should be sent to the superintendent of the establishment.

APPLICATIONS are invited for the position of organising secretary to the standing committee on special libraries and bureaux of information. His duties will consist of attending meetings of the standing committee and its executive, the compilation of a directory of special libraries and intelligence bureaux in the United Kingdom, and preparation for the second conference to be held in September 1925. Applications giving full particulars, and endorsed "Special Libraries," should be sent to reach Mr. J. G. Pearce, Central House, 75 New Street, Birmingham, not later than March 10.

THE annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Wednesday and Thursday, March 11 and 12, commencing each day at 10 A.M. Twelve communications are due for presentation at the meeting. The annual dinner will be held at the Trocadero Restaurant on Wednesday, March 11, at 7 P.M. Amongst those who have accepted the Council's invitation to be present at the dinner are the Right Hon. Neville Chamberlain (Minister of Health), the Right Hon. the Lord Morris (vice-chairman, Imperial Mineral Resources Bureau), and the presidents of many kindred societies.

DR. H. C. WILLIAMSON has been appointed to investigate the salmon of British Columbia at Prince Rupert. Dr. Williamson was a distinguished student and graduate of St. Andrews as well as holder of a research studentship of the Exhibition of 1851. Trained in fisheries work at St. Andrews, then for nearly two years at Naples, and afterwards in Germany, he entered on the scientific work of the Fishery Board for Scotland equipped as few have been with special knowledge and experience. For twenty-eight years he has carried on a continuous series of researches, illustrated by his own skilful pencil, on food-fishes, edible and other crustaceans, and has made careful experiments on the eggs of salmon and herring in connexion with their transmission to the antipodes, besides other fisheries' subjects, and has at present a work on fishes in the press. The loss of a highly trained scientific investigator in Scottish fisheries, following so soon after the retirement of his able senior Dr. Fulton, is unfortunate for the Department, yet Canada will be the gainer. Dr. Williamson's publications in the Reports of the Fishery Board extend from 1893 to the present year.

THE council of the Institute of Chemistry announces that the Meldola Medal for 1924, awarded for meritorious work in chemistry during the year, has been awarded to Dr. Leslie J. Harris, of the School of Biochemistry and Emmanuel College, Cambridge. Dr. Harris's investigations have been concerned largely with the theoretical basis of acid-base titrations and in special relation to amphoteric electrolytes. His results have been published mainly in a series of papers appearing in the Proceedings of the Royal Society, B, during the past few years. He has shown that the protein constituents, amino-acids, may be estimated from a consideration of their individual acid and basic constants, by titrating within definite P_H limits. The same principle has been utilised also by Dr. Harris for estimating proteins and other ampholytes. Recently he has shown that such methods are of general application in chemistry, and serve to estimate substances containing the feeblest basic or acidic groups, it having previously been supposed that acids or bases of less than a certain strength were incapable of estimation by acidimetry. Incidentally he has disproved for many cases the theory of acid-base binding at peptide linkages, and he has brought forward fresh data upon the ionic nature of the protein molecule. Denaturation of proteins he has shown to involve a chemical change which occurs at a hitherto undescribed sulphur grouping in the protein molecule. Dr. Harris has also carried out investigations upon milk and infant nutrition.

IN the notice of the second edition of "An Introduction to the Study of Cytology," by the late Dr. L. Doncaster (NATURE, February 14, p. 224), the reviewer regretted that the scope of the book was not enlarged. We understand from Mr. J. Gray that the omissions mentioned are entirely due to the fact that their inclusion would have involved a considerable increase in the cost of the book. It seemed desirable to keep the book within the means of the average student, and this would not have been possible in a new edition including even a brief account of recent knowledge of cell inclusions and somatic cells. The new edition has recently been translated into Italian by Prof. L. Cognetti de Martiis, of the University of Turin, and can be purchased for seven shillings.

As a result of the amalgamation of the Ipswich Scientific Society and the Ipswich and District Field Club, there has been formed, under the presidency of Mr. J. Reid Moir, the Ipswich and District Natural History Society. The honorary secretary is Mr. F. W. Brinkley, 31 Oxford Road, Ipswich. Fortnightly meetings are held, taking the form of lectures in winter and spring and excursions in the summer, and various sections, each under the guidance of a "leader," deal with different aspects of the Society's activities. The Society claims a membership of about 250, and it is hoped to issue shortly the first volume of Proceedings. According to the programme for the 1925 session, Sir Charles Sherrington, president of the Royal Society, who is himself associated with Ipswich, has consented to become patron of the Society, and there is little doubt that the sympathy and encouragement expressed by his interest in the Society will do much to promote appreciation of the value of science in the neighbourhood.

IN addition to the Monthly Bulletin of the Hawaiian Volcano Observatory, a weekly *Volcano Letter* is now issued. Each letter contains the Kilauea report for the previous week on the volcanic phenomena and on the earthquakes recorded at the Observatory, in addition to miscellaneous news. On its reorganisation a short time ago, the Volcano Research Association was placed under the U.S. Weather Bureau. It has now (since last July) been transferred to the U.S. Geological Survey. Since 1920, it has established earthquake stations at Kone, Hilea, and Hilo, all in Hawaii, in addition to the central observatory at Kilauea; it has conducted boring experiments at Kilauea, equipped a chemical laboratory at the Observatory, and maintained a research fellowship at the station for one year. It is now engaged in preparing for publication the scientific results of its fifteen years' work on the volcano.

WE have received No. 2 of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Cambridge. As its title implies, it is a product in a lighter vein than is usual in biochemical journals: it contains short articles in prose and rhyme, contributed by various members of the staff of the Laboratory, whose identity is revealed by the initials at the foot of each contribution. As might be expected, a local colour is reflected from most of the articles, and some of the allusions will probably only be fully appreciated by those who have an intimate acquaintance with the members of this school and their works. Perhaps the most amusing contribution is a short one in verse, entitled "The Great Push: another version," giving a brief, though doubtless accurate, account of recent experiments conducted by one of the staff of the Laboratory. A series of cautionary tales for biochemists, and the story of John Montgomery Wardley, are other good things in the number, whilst, as might be expected, blood sugar methods and their authors—we had almost said perpetrators—have not escaped satire at the hands of those who have to use them.

THE German Scientific and Medical Association (Gesellschaft deutscher Naturforscher und Aerzte) has been greatly encouraged by the success of the Innsbruck meeting in September last. No general meeting will be held in 1925. Severe economy is still necessary. A meeting at Düsseldorf is planned for 1926. *Die Naturwissenschaften* has been made the organ of the Association, and monthly communications are distributed with this journal. The issue of November 21 was devoted to the proceedings of the Innsbruck meeting and included the lectures delivered at the joint meetings of the Society, together with the more important of those delivered to the medical and natural science sections. Men of science of all shades will find something of interest in one or other of these lectures, for the range of subjects covers a wide field. A thousand members have accepted the offer of a reduced subscription rate to this journal. The membership subscription is 5 marks in Germany, 50,000 kroner in Austria. Foreigners may send notes or cheques in registered envelopes to the G.D.N.A. at Chemie-Treuhandgesellschaft, Berlin W.10, Sigismundstr. 3. For all other business the Secretariat is at Leipzig, Nürnberger Strasse 48[1]. Publications are issued through the Hirschwaldsche Buchhandlung, Berlin, N.W., Unter den Linden 68.

WE have received Nos. 9-10 of vol. i. of the *Bulletin d'Histologie Appliquée*, edited by Prof. A. Policard, of Lyons. It contains original papers on physiological and pathological histology, a section on methods, a critical review, and a bibliographic index. It is well printed, but the illustrations could be improved considerably. A somewhat original feature is a quotation from some author after each paper: the excerpts cover a variety of subjects, from the use of a theory (Gide) to a diet for white rats (Steenbock). The number contains four original papers: A. Lumière and R. Noël describe the lesions produced in guinea-pigs by the actual method of killing, and conclude that simple bleeding by cutting the carotids, or removal of the heart and lungs after opening the thorax, produce the least alteration in the tissues; all asphyxial methods cause congestion and hæmorrhages. E. Grynfeltt describes the erectile tissue in the fimbriæ of the Fallopian tube, by means of which the abdominal ostium of the latter can be brought close to the ovary. Mlle. A. Van Herwerden gives a short account of a reversible gelation produced in the protoplasm of the living tadpole by means of weak acetic acid. H. E. V. Voss describes the ossification and calcification sometimes observed in portions of ovary grafted into the testicle or kidney of a male guinea-pig, and concludes that connective tissue cells are responsible, typical osteoblasts not being observed. In the section on methods, A. Ch. Hollande discusses the oxidase reaction, and finds, as the result of his experiments, that the formation of indophenol blue in cell-granules is not diagnostic of the presence of an oxidase in them, since the granules take up the blue colour when the dye itself is presented to them. The actual formation of the blue colour, however, shows that oxidases must be present in the cells or their surroundings. M. Bernheim reviews the functions of the germ centres of Flemming in the lymph-glands, and concludes that they play an important part in the defence mechanism of the body. The bibliographic index is under headings such as embryology, tissue culture, etc., sections v. to ix. appearing in this number.

THE Medical Supply Association, Ltd., 167-185 Gray's Inn Road, London, has recently placed on the market a compact X-ray outfit of unusual design. It is described by them as the "Radiosearch" Complete X-ray Apparatus and is intended for general laboratory work. Electricity at 70,000 volts is supplied by a small oil-immersed transformer, enclosed in a rectangular wooden box with ebonite top, which stands in front of a hard-wood panel about three feet high. From the upper part of this panel two well-separated stout porcelain insulators project horizontally and forwards. To the end of one of these a practical type of milliampere meter with open scale is attached, while the other column carries a variable resistance by which the heating current for the Coolidge tube may be adjusted while the apparatus is in action, a dial enabling the setting to be noted. The high tension leads from the secondary of the transformer are suitably connected to these instruments and pass on over spring pulleys to the X-ray tube itself. The tube is the self-rectifying radiator "Coolidge" with current-carrying capacity of 10 milliamperes at 70,000 volts. It is held axially within a cylindrical box with only the electrode sleeves projecting on either side. The arrangement, adequately protected with lead rubber, is mounted upon a separate and portable table stand so as to enable a beam of X-rays to be projected in any desired direction. The outfit is well and strongly constructed. Its simplicity and solidity are distinct features, and there seems little to get out of order with reasonable care. It should be noted that no means is provided for the variation of the potential difference at the tube terminals. An attachment can, however, be supplied for this purpose at an additional cost. It would also make the outfit more complete for experimental work if a sphere-gap with resistance were fitted so that the potential difference across the tube could be directly measured. Most physicists using the set, however, would probably prefer to make this measurement by means of an X-ray spectrograph.

Our Astronomical Column.

ENCKE'S COMET.—*Astr. Nach.* No. 5345 contains some observations by G. A. Tikhov of Pulkovo on the spectrum of Encke's comet made on Oct. 20, 1914 (46 days before perihelion), and Oct. 4, 1924 (27 days before perihelion). An objective prism was employed. The following are the intensities of the principal bands, on a scale from 1 to 10.

Wave-length.	Intensity. 1914.	Intensity. 1924.	Source.
388	10	10	Cyanogen
405	8	4	
473	1	6	Carbon
516	...	1	,,
563	...	1	,,

The 1924 spectrum is of a type often found in comets. That of 1914 is unusual in the feebleness of the carbon bands, which is perhaps due to the longer interval before perihelion. The continuous spectrum is weak, especially in 1914.

THE NATURE OF SPECTROSCOPIC BINARIES.—According to the theory of binary stars, there is a simple relation between the period and the semi-amplitude, K, of velocity variation. This relation involves the masses of the stars; but by assuming an average mass, and treating the stars in groups, it becomes possible to investigate this relation without introducing serious errors. This has been done by Dr. O. Struve in the *Astrophysical Journal*, vol. 60, p. 167, who has found that for spectroscopic binaries with periods greater than 2·5 days, the relation between P and K agrees satisfactorily with theory. The Cepheid variables have comparatively small values of K which show no relation to the periods—thus incidentally affording evidence in favour of the pulsation theory, which assumes that Cepheids are not true binaries. In adddition, the author has discovered an interesting group of stars (to which he has applied the rather unfortunate name of "Pseudo-Cepheids") which closely resemble the Cepheids in the behaviour of K. These are all spectroscopic binaries of short period (less than 2·5 days), and if they are to be regarded as true binaries, the peculiar behaviour of K would seem to imply either that the total masses are very much smaller than the average, or that the mass-ratios are very large—neither of which assumptions is supported by evidence from the long-period binaries.

The evidence brought forward by Dr. Struve thus seems to show that short-period spectroscopic binaries may be classed in two groups; some, characterised by large values of K, are true binaries, while others (the more numerous group) are probably not binary stars at all, and bear a close analogy to the Cepheid variables.

THE DIAMETER OF VENUS.—*Astr. Nach.* No. 5348 contains three articles on this subject by members of the staff of the Berlin-Babelsberg Observatory. It is a matter of considerable interest, owing to Venus being the only known orb that closely resembles the earth in size. The measures are difficult, owing to the extreme brightness of the disc, which produces irradiation, the amount of which is difficult to determine; it has generally been assumed that the amount of irradiation in arc is constant at all distances of the planet, but the researches here described (by G. Struve, J. Dick, and A. Kühl) show that this assumption is untenable. They used the large Babelsberg refractor with various powers up to 1000. G. Struve's final diameter is 17·523″ at unit distance; comparing this with the usually adopted value for the earth, 17·61″, we see that the planet's diameter is less than that of the earth by some 40 miles only. That, however, may be modified if the visible disc of Venus is bounded by a cloud surface, as this is likely to be some miles higher than the solid ball of the planet.

Research Items.

Ancient Rock-Sculptures in the Libyan Desert.—A journey of considerable geographical interest across the southern Libyan Desert from Bara to Bir Natrun in Dongola Province is described by Mr. D. Newbold in *Sudan Notes and Records*, vol. 7. At an early stage of the journey, the author witnessed the departure of the Kababish on their great seasonal migration, when the tribe moves some 20,000 camels and 150,000 sheep and goats to the "gizzu" or grass country for six months. Evidence of early occupation of the country crossed was abundant, including cairns, pottery, some of which was afterwards identified as Meroitic, a small brick pyramid at Abu Sofian, and a find of five glauconite implements of neolithic type. Rock sculptures were first found at Zobat el Hammad, where drawings roughly incised on boulders showed tailed and phallic men, elephants, giraffes, ostriches, oryx, cattle, and several other animals which could not be identified. At Um Tasawin on the return journey, the cliffs, even in the most inaccessible positions, were found to be engraved with innumerable figures of cattle, giraffes, elephants, oryx, and other indeterminate animals. There were also a number of human figures, some tailed, some armed with bows, a few phallic and one steatopygous. At Abu Sofian, two groups of pictures, obviously of the same date and "school," were within a day's march of one another. Here the drawings were incised on round boulders, and were very numerous. Camels are shown literally in hundreds of drawings; giraffes and ostriches still appear; but the cattle dwindle in numbers, while the elephant is not represented and the bowmen give place to men armed with spears and carrying shields. The absence of the camel at Tasawin and el Hammad suggests that the drawings there cannot be later than the first century B.C. They may be the work of the Southern Libyan Tamahu, the ruling caste in Ethiopia in the Meroitic period, and might be dated any time from 300 to 750 B.C. or even earlier. The Abu Sofian groups are obviously later, as shown by the presence of the camel, but must equally be the work of Libyan artists, and are probably between 1500 and 2000 years old. The archaeological evidence as a whole supports the theory of continued migration into the northern Sudan of desert peoples of the west and north-west from the earliest times, and the introduction thence of a Hamitic element into the riverain populations, which is still strongly marked.

Sex-transformation in Birds.—Crowing hens have long been known, but the first case of the complete transformation of a hen which had laid eggs into a functioning male was described by Crew in 1923. Gatenby and Brambell (*Journ. of Genetics*, Vol. 14, No. 2) have added to the list of less complete transformations. They describe a white Leghorn hen which developed the comb and wattles and part of the behaviour of a male. This was accompanied by a great accumulation of fat on the viscera, together with the presence of testicular tissue. Apparently in birds such transformations only take place from the female, which is the heterozygous sex, to the male. The writers discuss the relation of such cases to the chromosome theory of sex determination. Cunningham (*Sci. Progress*, Jan. 1925) has also discussed the problem of the sex characters of birds in its general bearings on the Lamarckian theory and other questions. He refers to the condition in certain breeds of fowls in which the cocks are henny-feathered. Morgan showed that the castration of such cocks causes the development of the normal cock-feathering. Punnett suggested that the hen-feathered condition of the cocks in these breeds is due to the presence of a non-sex-linked factor which causes the testis to develop a hormone suppressing cock-feathering, which is normally produced only by the ovary. Cunningham proposes an explanation of this condition based on the assumption that non-disjunction of the sex chromosomes has taken place, so that in a heterozygous Sebright Bantam hen, the sex chromosomes would be WZZ and not WZ. The test of this hypothesis by examining the chromosomes would be extraordinarily difficult because of the large number and variable form of the chromosomes in the chick. Morgan considered that his castration experiments removed the necessity for a theory of sexual selection or Lamarckian inheritance to account for somatic sexual characters. Cunningham points out certain objections to this view and emphasises, for example, that the pad of a frog's foot is not merely a by-product of a hormone producing some other character, but is definitely related in position and structure to the use to which it is put.

Oogenesis in a Centipede.—S. D. King (Sci. Proc. Roy. Dublin Soc., xviii. pp. 29-36, 2 plates, Nov. 1924) records observations on oogenesis in *Lithobius forficatus*. Yolk-formation in the oocytes takes place by extrusion of particles (the fate of which has not yet been determined) from the central nucleolus, and later by fragmentation of the nucleolus, the particles of which, after proliferation, grow into the definitive yolk-spheres. The Golgi bodies and the mitochondria do not take any direct share in yolk-formation. The mitochondria are at first diffuse, but become concentrated in the early stages of growth, when they form in the oocyte several clusters, some of which proliferate very rapidly, giving rise to round bodies which are not comparable to the yolk-nuclei of ascidians or to the mitochondrial masses described in the oocytes of insects. Later the mitochondria become evenly distributed in the cytoplasm. The Golgi apparatus behaves in the usual way; in the youngest oocytes it is concentrated, but later spreads through the cytoplasm and breaks into fine granules.

Seasonal Changes in the Water of Ponds.—Messrs. W. R. G. Atkins and G. T. Harris (Sci. Proc. Roy. Dublin Soc., 18, pp. 1-21, Nov. 1924) compare the seasonal changes in the heleoplankton of two fresh-water ponds with alterations in the solutes, and show that in each pond there is a vernal rise in P_H followed by a period of stagnation with lowered P_H. In one pond this condition persisted until the autumn, but in the other—Staddon reservoir—it was succeeded by a period of high alkalinity lasting until October. These changes are associated with the spring increase in plankton and the development of masses of floating algæ in the reservoir. In both ponds the supply of phosphate is exhausted in spring and this sets a limit to the further growth of algæ, but phosphate increases again in winter, partly by regeneration and partly by the inflow of water rich in phosphates. It is highly probable that lack of phosphate, rather than of nitrate or of ammonium salts, limits the plankton in fresh water as it does in the sea. The rapid increase in plankton in the spring is associated with the increase in light rather than in temperature.

Cultivating a Plant "Virus" in Vitro.—Peter K. Olitsky, of the Rockefeller Institute of New York, has a note in *Science* for December 26, pp. 593-4, which will attract the attention of plant pathologists. In experimental work with the mosaic disease of tobacco, he has drawn about 0·01 c.c. of the juice from infected plants, by careful technique with sterile pipette, etc., and inoculated this into a medium consisting of the fresh aqueous extract, prepared from carefully selected tomato plants free from mosaic. The medium then, in seven to ten days, showed "a faint, uniform, translucent, almost imperceptible haze." No microscopic technique revealed definite formed elements in the medium, but as the result of dilution by subcultural methods, the conclusion is reached that at dilutions far beyond that at which the original 0·01 c.c. of virus containing sap would still be active, successful inoculation of the disease could be achieved. These results are particularly interesting as being obtained with the virus of tobacco mosaic, upon which Allard carried out his well-known experiments showing the filterable nature of the virus, and its highly resistant nature to heat and ordinary precipitants, etc. The more detailed account of these experiments that is promised will be awaited with interest.

Silver Leaf on Rhododendrons.—Mr. A. D. Cotton has a record in the *Gardeners' Chronicle* of February 14 of the appearance of silver leaf upon rhododendrons in cultivation in Great Britain. The characteristic silvering of the foliage is missing, but after removal of the dead and dying branches, fructifications of *Stereum purpureum* developed upon the stumps. The disease seems to spread very slowly in the wood of the rhododendron, but there seems little doubt that in some of the cases observed by Mr. Cotton the organism was acting as a parasite and responsible for the dying back of the branches. Now that attention has thus been directed to the attack, doubtless other growers of rhododendrons will pay special attention to signs of dying back of branches in rhododendrons.

Variation in Blue-green Algæ.—In a paper on variation and species in Cyanophyceæ, Mr. W. B. Crow (*Journ. Genetics*, vol. 14, No. 3) describes observations and cultures of these organisms and draws a number of interesting conclusions. The cell structure in this group of unicellular and filamentous algæ is very simple, there being no true nucleus or karyokinetic division, and sexuality is also absent. Mr. Crow correlates the continuous variation with these features. The systematic differences are shown to be similar to those variations produced by changes of environment in cultures. The characters of the group are regarded as belonging entirely to the kind called by Gates organismal, the absence of karyogenetic or Mendelian characters being correlated with the absence of nuclei and sexuality. Various parallelisms in variation with Isokontæ and other groups of algæ and fungi are also pointed out, and the general constancy of the forms when grown artificially is emphasised. Such studies are valuable for comparison with the genetics of higher organisms.

The Origin of the Cycads.—English botanists, remembering the caution with which that veteran palæobotanist Dr. D. H. Scott now speaks, will read with some scepticism the confident pronouncement with which the address of Prof. C. J. Chamberlain, chairman of Section G of the American Association for the Advancement of Science, commences (*Science*, January 23). Prof. Chamberlain is quoted as saying that "the widest gap in the evolution of plants used to be the one between the ferns and seed plants; but the researches of the past thirty years have bridged the gap so completely that the two groups are now separated only by the artificial definitions of the taxonomist." None is better qualified, however, than Prof. Chamberlain to discuss the salient features of structure and distribution in the Cycadales; and with reference to the deficiency of our knowledge of their fossil history, there will be general agreement that at the present day a study of distribution of a group in geological times may often be a study of the distribution of the enthusiastic and trained palæobotanist. In exemplifying this thesis Prof. Chamberlain pays a well-deserved tribute to the productive labours of the American palæobotanist Prof. Wieland.

Survey Work in Northern Canada.—The Topographical Survey of Canada is pushing its work farther north every summer and has parties at work in the barren lands and the northern islands of the Arctic Archipelago. Some notes in the Journal of the Dominion Land Surveyors Association by Mr. G. H. Blanchet give a preliminary account of the drastic changes in the map that accurate survey is making in regions relatively so accessible as the Great Slave Lake and the upper part of the basin of the Coppermine River and Backs River. The position and extent of Lakes Clinton-Colden, Aylmer, Mackay and de Gras up to the present have figured on maps chiefly from hearsay reports. Last summer Dominion surveyors found them very much out of position and corresponding but little with previous notions. The party found the outlet of the upper Coppermine River from Lac de Gras, but was unable in the short season to go down the valley. Another paper in the same publication notes the beginning of surveys in and around the new station of the Canadian Mounted Police in Ellesmere Land, Devon Island, and Ponds Inlet.

The Problem of Atmospheric Electricity.—The issue of the *Physikalische Zeitschrift* for January 1 is a Jubilee number of 92 pages. It contains an account of the life and work of Georg Hirzel, by whom the *Zeitschrift* was planned and founded in 1899, with Profs. Riecke and Simon of Göttingen as editors. The issue also contains an account by Dr. R. Seeliger of the report on the fundamental problem of atmospheric electricity made by Prof. Hans Benndorf to the meeting of the German Scientific and Medical Association at Innsbruck. The variation of electrical potential with height in the atmosphere and the electrical conductivity of the atmosphere itself imply a flow of electric current to the earth, which for the whole earth amounts to about 1000 amperes. To explain how this current is maintained has been the problem of atmospheric electricity for some years. It has, however, been reduced to insignificance by the larger problem raised by the measurements of Dr. L. A. Bauer, who finds that the lines of magnetic force on the earth's surface necessitate a current of about 3 million amperes. Prof. Benndorf ascribes this current to β-rays from the sun too swift to produce ionisation of the atmosphere.

Directional Quantification in a Magnetic Field.—Prof. W. Gerlach describes, in the F. Paschen "Festschrift" of the *Annalen der Physik* published in January, an improved apparatus for studying spatial or directional quantification, and so measuring the magnetic moment of the atoms of metallic vapours. With copper, silver, and gold, the vapours of which are monatomic, the magnitude of the shift of the atomic stream in a magnetic field shows that they behave exactly as single quantum atoms, or more generally, as atoms with an apparent (effective) moment of one magneton, should do according to the theory. Thallium vapour is also monatomic, but the magnetic effect in this case is much smaller. There is no magnetic effect for lead or tin, though lead vapour is monatomic and the same is probably true of tin vapour; this is partly due to the low temperature employed, though it was high enough in the case of tin to have enabled $\pm 0\cdot 5$ of a magneton to be observed. Bismuth and antimony vapours consist wholly or partly of molecules and multiple molecules; a definite theoretical explanation of the results is therefore impossible for these metals. Nickel vapour is monatomic; the experiments show that in the normal state the atom has a magnetic moment of several units; 0 and $\pm i$ magnetons (i about two) have been proved certainly; apparently there are also atoms with still higher moments. The result of the magnetic analysis is rather complicated, and it is hoped that it will be possible to obtain a more complete analysis of the plates for this metal. There were considerable experimental difficulties in the case of iron, and the appearances expected from a consideration of its spectrum could not be obtained in the plates.

THE X-RAY ABSORPTION BAND HEADS OF NICKEL AND OF ZINC.—A method of determining the wave length of an X-ray absorption band head is described by Dr. W. Walter in the *Zeitschrift für Physik*, December 31. An X-ray tube is used, giving a line spectrum with numerous lines, one of which lies as near as possible to the wave length of the band head to be measured. When the X-rays are passed through screens made of the element to be investigated, lines corresponding to longer wave lengths than this show no absorption, while those correspondin g to shorter wave lengths are strongly absorbed. In the case of nickel, the following table gives the estimated intensities of three lines, photographed directly, and after passing through nickel filters *b* and *c*.

Line.	$\lambda \times 10^{11}$ cm.	Intensity.		
		a.	*b.*	*c.*
Ni_β . . .	1497·03	10	10	10
$W_{\alpha'}$ . . .	1484·52	8	5	2
W_α . . .	1473·48	50	8	1
Thickness of filter, mm. .	...	0·0000	0·0095	0·0163

Ni_β is not absorbed by nickel, since its wave length is greater than that of the band head, which according to Kossel's theory must have a wave length a little smaller than that of the $K\gamma$ line of nickel, $1485\cdot 4 \times 10^{-11}$ cm. The $W_{\alpha'}$ line satisfies this condition, and it will be seen that its behaviour agrees with its lying in the band head, since the relative change of intensity caused by the filters is considerably less than in the case of W_α, which lies well inside the absorption band. Duane and Hu give 1489·0 for the position of this band head, which is clearly much too large. Similar results were obtained for zinc, though in this case the X-ray tube employed gave no line which agreed so closely with the position of the band head as in the case of nickel. The difference between the value obtained and that of Duane and Hu is considerably greater for zinc than for nickel.

NEW SYNTHESIS OF UREA.—Dr. K. C. Bailey, in the Proceedings of the Royal Dublin Society, November 1924, describes a new synthesis of urea from carbon dioxide and ammonia. The mixed gases, preferably in the ratio 4 : 1, are passed at atmospheric pressure through the annular space between two concentric tubes, the outer, quartz, tube being heated to 500-700°, and the inner, glass, tube being kept water-cooled. The yield increases with temperature up to at least 700° C.

OXY-CELLULOSE.—In the Journal of the Textile Inst., vol. 16, No. 1, January 1925, Constance Birtwell, Douglas A. Clibbens, and Bert P. Ridge publish as Part I. of "The Chemical Analysis of Cotton" a comprehensive study of oxy-cellulose. As the result of carefully controlled oxidation of cotton with mild oxidising agents, they are able to analyse the different results of such agents upon cotton cellulose, and they point out that two main types of oxy-cellulose should be distinguished. In one type, the product resulting from oxidation shows great affinity for methylene blue and high retentive power for alkalis; this type of oxy-cellulose is not chemically altered by boiling in dilute alkali. The other type of oxy-cellulose has enhanced reducing properties, best measured by the weight of copper reduced under standard conditions. This type loses entirely its chemical characteristics as an oxy-cellulose on boiling with dilute alkali, losing abnormally in weight at the same time; it is afterwards indistinguishable chemically from pure cotton cellulose, though the physical properties, *e.g.* tensile strength, may be altered. Which type of oxy-cellulose is produced predominantly during the technical process of bleaching depends chiefly upon the acidity or alkalinity of the hypochlorite solution; on the alkaline side of the neutral point the product tends to be of the first type, with high absorption of methylene blue and low copper number; on the acid side the type with high reducing power is obtained.

FLOW AND RUPTURE OF METALS DURING CUTTING.—The report of the Cutting Tools Research Committee of the Institution of Mechanical Engineers, read on January 23 by Dr. W. Rosenhain and Mr. A. C. Sturney, contains an account of experiments made to determine the behaviour of material in the vicinity of the edge of the cutting tool, and is illustrated with several unique photomicrographs of cross sections taken through chips in process of formation. By using a simple type of cut and varying only two factors, namely, depth of cut and top-rake angle, certain definite regularities of behaviour have become manifest. According to the conditions of cutting, the separated metal takes the form of three distinct types of chip: (*a*) the "tear" type, in which rupture of the metal occurs by the formation, well in advance of the nose of the tool, of a tear or crack tending to run inwards from the periphery of the stock. Since such a tear cannot progress very far, a succession of fresh starts are made by the tool, and the surface of the work is left in the form of rough projections, each of which probably corresponds to successive shearing of the chip. (*b*) When the conditions are changed by either reducing the depth of cut or increasing the top-rake angle, or both, the ultimate result is the formation of the "flow" type of chip. (*c*) Intermediate conditions produce an intermediate type called the "shear" type, since it is formed mainly by a process of shearing on a plane making an angle of roughly 30° with the direction of motion of the tool. So far as the present investigation goes, it indicates that the best results in cutting in regard to the removal of the maximum amount of metal per unit distance of tool travel, the least irregularity of surface, the closest agreement between intended and actual depth of cut, and the minimum wear of tool, are obtained by using a top-rake angle a very little smaller than that at which the heavily deformed zone before the nose of the tool just disappears, in conjunction with the greatest depth of cut which still allows the formation of the flow type of chip.

The Future of the Motor Ship.

By Engineer-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE introduction of the "Otto" cycle for gas-engines by Nicolas August Otto in 1876, the construction of the compact light spirit engine by Gottlieb Daimler in 1884, and the publication of his memoir, "The Theory and Construction of a Rational Heat Motor," by Rudolf Diesel in 1893, are three of the landmarks in the history of the internal combustion engine. The first led to a great extension in the use of gas-engines, the second paved the way for the motor car and aeroplane engine, while Diesel's work gave us the most efficient of modern heat engines. Just as the petrol-engine has revolutionised transport by road, so the Diesel engine bids fair to revolutionise transport by sea. Otto died in 1891, Daimler in 1900, and Diesel was drowned in the North Sea in 1913, but each lived long enough to see his work bearing good fruit.

Diesel, who was born in Paris of German parents in 1858, was induced to take up the study of thermodynamics by von Linde, and ultimately assisted Linde in his work on refrigerators. He also worked in the shops of the well-known firm of Sulzer Brothers of Winterthur, and after completing his theoretical investigations was enabled to build an experimental engine. Many interesting details of his early work were given by Diesel himself to the Institution of Mechanical Engineers in 1912, but it was his account of a 20 H.P. engine communicated in 1897, which first attracted general attention, and it was then that, upon the advice of Lord Kelvin, a Scottish firm of engineers took up the manufacture of Diesel engines. Though, like the steam turbine of Sir Charles Parsons, it found its first useful sphere in the power-houses of the day, its application to ships was only a matter of time, and after being used in various craft, a Diesel engine was fitted in the *Toiler* by the Tyne firm of Swan, Hunter, and Wigham Richardson, and in 1911 that vessel crossed the Atlantic.

The *Toiler* was but a small vessel of 3000 tons carrying capacity and 360 horse power, but she was soon followed by the *Jutlandia* and *Selandia*, engined by Burmeister and Wain of Copenhagen, and then by the British vessels *Arum*, *Arabis*, and *Abelia*, all three of which were the victims of German submarines during the War. At the beginning of the War in 1914 there were nearly three hundred Diesel-engined ships afloat. The War, however, hindered progress in this direction, but during the last year or two much greater strides have been taken, and there are now nearly 2000 motor ships of a total tonnage of 2,000,000 tons, and about half the ships under construction to-day are designed for driving by Diesel engines. It is true this 2,000,000 tons is but about a thirtieth of the world's tonnage, but the facts are significant, and many consider that what the Americans have called the "Dieselisation of the sea" has definitely set in.

How the steam reciprocating engine and the steam turbine are being displaced can be seen from the following figures, gleaned from the returns of Lloyd's Registry of shipping, which show the tonnage classed each year and the types of machinery adopted.

Year.	Steam Reciprocating Engine.	Steam Turbine.	Oil-engine.
	Tons.	Tons.	Tons.
1918–19	2,633,570	1,051,302	75,934
1919–20	2,821,031	1,286,046	79,805
1920–21	2,373,067	754,513	101,608
1921–22	1,420,524	870,037	226,552
1922–23	842,358	603,037	165,229
1923–24	610,851	99,464	164,336

In view of these facts, especial interest attaches to the presidential address of Sir Westcott S. Abell, the chief ship surveyor of Lloyd's Registry, to the Institute of Marine Engineers, delivered on February 10, and to the lecture of Sir Fortescue Flannery to the Royal Society of Arts on the following day. "The Motor Ship in the Light of the History of Marine Propulsion" was the title of Sir Westcott Abell's address, while Sir Fortescue Flannery took as his subject "The Diesel Engine in Navigation." So firmly convinced are both authors that the Diesel engine is the ships' engine of the future, that the former remarked that "the disappearance of the steam-engine from overseas trade is largely a matter of time," while Sir Fortescue Flannery said that an examination of the figures "gives support to the belief that in a comparatively short time the Diesel engine will almost wholly displace the steam boiler at sea."

Though both containing the same conclusions, the two addresses were very different in character. Starting with the point of view that the Diesel engine has demonstrated its reliability—an essential feature in any marine engine—Sir Westcott Abell discussed what he termed the economic efficiency of the motor ship. At present, Diesel engines cost much more than steam machinery, and the cost of the oil per ton is enormously greater than the cost of coal per ton. But the reduction in the amount of fuel expended is so great that "with the present availability of and cost of oil fuel there is a distinct margin in profit in favour of the Diesel-engined ship compared with the coal-fired boiler and the steam-engined vessel." Sir Westcott's figures and diagrams illustrate this point, for with a ship of 8000 tons deadweight carrying capacity, the oil-engined ship can carry 10 per cent. more cargo than the steamship. Discussing the mechanical and thermal efficiencies possible with modern machinery, Sir Westcott Abell comes to the conclusion that even with the heavy Diesel engine at present fitted, where only 5 B.H.P. is obtained for every ton of machinery, "the principal economic gain arising from the introduction of the Diesel engine has already been obtained." The problem now is "to devote considerable attention to obtaining the maximum simplicity, gaining thereby in reliability and ease of maintenance." Also, there are the auxiliaries, in which many improvements can be made. Among the diagrams illustrating the address is one showing the decline of the sailing-ship and the rise of the steamship, and it will be interesting to see if the Diesel engine supersedes the steamship in the same way.

The crowded lecture-room of the Royal Society of Arts and the gathering of distinguished shipowners, shipbuilders, and engineers on the occasion of Sir Fortescue Flannery's lecture were ample testimony to the importance of the subject. The interest of the occasion was increased by the presence in the chair of Lord Bearsted, the pioneer of the present-day system of carriage of petroleum in bulk in tank steamers. The lecture was a review of the introduction of the use of oil and the action of the Diesel engine, and contained explanations of the types of Diesel engines, of which there is a somewhat bewildering variety. Compared with a good steam plant, which uses about 1·8 lb. of coal or 1·4 lb. of oil per B.H.P. per hour, the Diesel engine burns about 0·4 lb. Apart from the saving in the fuel bill, a Diesel-engined ship can go farther afield or more cargo can be carried. All early motor ships had twin screws, but experience has shown the oil engine to be reliable and single screws are now being fitted where suitable. Sir

Fortescue Flannery dealt with the main points in the different designs of single-acting and double-acting, and of four-stroke and two-stroke engines such as the Burmeister and Wain, North British, Tosi, Vickers, Werkspoor, Doxford, Fullagar, Polar, and Sulzer, and also of that most interesting development, the Still engine, which is a Diesel engine and steam-engine combined. Developments are still proceeding with rapid strides towards the double-acting type and the consequent increase of power in proportion to the weight, but there is at present no approach to the standardisation such as is attained in the triple-expansion engine.

During the course of the evening, Lord Bearsted read a characteristic letter on the oil question from the late Lord Fisher, written in 1911, and he also gave some figures respecting the oil-engines suitable for a light cruiser. The cruiser, it is true, would have a speed of 26 knots as against a speed of 28 knots of her sister ship with steam machinery, but she would have a very much greater radius of action. He seemed to think that the Admiralty has not done so much as it might to further the progress of the oil-engine for propulsion.

In the discussion that followed, Engineer Admiral Sir Robert Dixon, the Engineer-in-Chief of the Fleet, recalled the work done in the Navy on the Diesel engines for submarines and referred to the experimental plant founded at West Drayton. Before an oil-engined battleship is feasible, however, the Diesel engine must give far more power for its weight than those in existence at present.

It may be remarked that even the late Lord Fisher would scarcely have cared to command a light cruiser of 26 knots, even if fitted with oil-engines, when trying to overtake an enemy ship of the same class wth a speed of 28 knots. In building the famous *Dreadnought*, a thousand tons in weight and 100,000*l*. in money were saved by the adoption of steam-turbine machinery, but there seems little prospect at present of doing anything similar by the adoption of Diesel engines in a man-of-war.

The Effects of Posture and Rest in Muscular Work.[1]

THE problems of muscular activity have been investigated for many years from an academic viewpoint, yet it is only in recent times that a demand has arisen for the application of exact means of measurements of the physiological cost of muscular work in industry. The Medical Research Council's report for the years 1923–24 states that "The studies of muscle function which were almost notorious for their supposed uselessness to the student or physician have laid down basic knowledge which now underlies many parts of medical science and art, and are beginning to remove empiricism from practical studies of physical training and of industrial labour."

The output of energy of an individual may be calculated by measuring the amount of oxygen and carbon dioxide present in the expired air, and from these data the physiological cost of the work can be assessed. This method of estimating the "cost" of work or muscular activity places at our disposal a means of comparing the efficiency and capacity of the human machines under different conditions.

Two methods are available for the measurement of energy output—(*a*) direct and (*b*) indirect calorimetry. The unit of measurement used is the large or kilo calory. In direct calorimetry the individual is enclosed in a special chamber so constructed that the heat given off is measured. The apparatus is also arranged for the collection of the expired air, so that direct and indirect calorimetry may be combined.

In indirect calorimetry the subject wears a mouth-piece fitted with two valves. One valve serves for inspiration, while the other valve allows the expired air to pass down through a wide tube into a rubber bag, which the subject carries during the experiment. The expired air can be drawn off and analysed in a Haldane apparatus. The ratio of carbon dioxide given off to oxygen absorbed can then be obtained, and from these data the heat units are calculated. If the measurements are carried out on the subject at rest and during work, an exact estimation can be made of the energy required for this particular task.

In a recent publication of the Industrial Fatigue Research Board on "The Effects of Posture and Rest in Muscular Work," Miss E. M. Bedale has investigated the energy expenditure of a woman carrying loads in different positions. Miss Bedale has used the indirect calorimetric method for estimating the physiological costs of the work. It is shown from the measurements made that the energy expenditure varies with the position in which the load is carried. The physiological cost of carrying with a yoke is low and involves less physiological disturbance than any other. The experiments suggest that the continuous carrying of a load exceeding 35 per cent. of the body-weight is likely to cause rapid impairment of working capacity. A series of photographs of the different modes of weight-carrying bring out the importance of the study of body posture. Some of the methods, if used continually, will rapidly lead to body deformities, with impairment of the normal physiological functions. The use in industries of methods least injurious to the body would be an aid in the prevention of disease, and undoubtedly lead to greater efficiency. The results of further investigations will be awaited with interest. The data collected will tend to remove empiricism from studies of industrial labour, and will give a standard of measurement more accurate than that of output.

Prof. E. P. Cathcart contributes a preface which deals in a clear and concise manner with methods of measurement, and points out the pitfalls which beset the investigator in work of this type.

In the same publication, Dr. H. M. Vernon gives the results of an investigation on "The Influences of Rest Pauses and Changes of Posture in the Capacity for Muscular Work." The conclusions drawn by Dr. Vernon suggest that the promotion of circulation plays an important part in the prevention of fatigue, the value of a rest pause being increased if the worker moves about during the interval. Postural changes during work are shown to be as necessary as rest pauses if efficient work is to be carried out.

An interesting point is raised concerning the effect of additional movements during muscular work. The application of motion study to industrial processes has resulted in the elimination of many unnecessary movements and a marked increase in output. The results now obtained suggest that the removal of too many unnecessary movements may be too drastic, and even better results might be obtained if a few extra movements, sufficient to promote circulation, were allowed. The proof of this suggestion will probably only be obtained by investigating each process separately by the old method of trial and error.

[1] Medical Research Council: Industrial Fatigue Research Board. Report No. 29: "The Effects of Posture and Rest in Muscular Work: (*a*) Comparison of the Energy Expenditure of a Woman carrying Loads in Eight Different Positions," by E. M. Bedale; (*b*) "The Influence of Rest Pauses and Changes of Posture on the Capacity for Muscular Work," by Dr. H. M. Vernon. Pp. 55. (London: H.M. Stationery Office, 1924.) 2*s*. 6*d*. net.

University and Educational Intelligence.

BRISTOL.—Last year the Council set aside a portion of a bequest from the late Mr. H. H. Wills for the purpose of providing additional staff and equipment in the Department of Physics when the erection of the Henry Herbert Wills Physics Laboratory is completed. Though the building is not yet ready for occupation, it has been decided to create a readership in mathematical physics as from August 1, and Dr. J. E. Jones has been appointed the first reader.

CAMBRIDGE.—Mr. Ll. H. Thomas, Trinity College, and Mr. H. Horrocks, St. Catherine's College, have been elected to Isaac Newton Studentships in astronomy and physical optics.

EDINBURGH.—At the meeting of the University Court on Monday, February 16, a letter was read from Sir Richard Lodge intimating his resignation from the chair of history as from the end of the current academical year. The Principal expressed great regret on behalf of the Court. In Sir Richard Lodge the University had an ornament of whom it was proud and an invaluable helper in every branch of University activity. His departure would be a severe loss not only to the School of History, which owed its present high reputation to his unremitting efforts, but also to the whole University, to the interests of which he had devoted his great abilities during a period of more than twenty-five years.

Mr. W. Oliver was appointed to be the first occupant of the chair of the organisation of industry and commerce, which was founded by a recent Ordinance of the University Court.

It was intimated that the Senatus had unanimously resolved, on the recommendation of the Faculty of Medicine, to award the Cameron Prize for the year 1925 to Prof. R. Magnus, the Royal University, Utrecht, Holland. This prize, of the value of about 200*l*., is awarded annually to a person who in the course of the five years immediately preceding has made a highly important and valuable addition to practical therapeutics.

The resignation, as from September 30, of Mr. W. L. Ferrar, lecturer in mathematics, on his election to a tutorial fellowship at Hertford College, Oxford, was accepted.

LEEDS.—Dr. T. Wardrop Griffith has placed before the Council of the University his resignation of the professorship of medicine.

Prof. T. Wardrop Griffith was appointed to the chair of anatomy in 1887 and transferred to the chair of medicine in 1910. He began work in the old Medical School in Park Street and took an active share in the construction of the new School in Thoresby Place, in which he established one of the best anatomical departments in Great Britain.

OXFORD.—There will be an election at Keble College on March 16, on the results of an examination, to a Natural Science Scholarship on the Gibbs Foundation, of the value of 80*l*. per annum. Candidates must be more than twenty years of age on March 16, and if already members of the University, of not more than two terms of University standing on that day. By the terms of the benefaction, the scholarship is tenable only by members of the Church of England. Inquiries should be addressed to Mr. G. D. Parkes, at Keble College, on or before March 2.

SHEFFIELD.—Applications are invited for the chair of mining. They should be sent to reach the registrar by, at latest, March 31.

DR. W. HIEBER, of Würzburg, has been appointed director of the department of inorganic chemistry at the University of Jena.

A NUMBER of scholarships in connexion with Bedford College for Women, Regent's Park, N.W.1, are being offered, particulars of which are obtainable from the principal.

APPLICATIONS are invited for two posts at Auckland University College, New Zealand, namely the professorship of forestry and a lectureship in civil engineering. Particulars may be had from the High Commissioner for New Zealand, 415 Strand, W.C.2.

THE Leathersellers' Company's Technical College, 176 Tower Bridge Road, S.E.1, invites applications for the post of chemical lecturer and demonstrator. Candidates must possess a good science degree, but a knowledge of leather is not essential.

THE annual general meeting of the Association of Technical Institutions will be held at the Institution of Mechanical Engineers, Storey's Gate, London, on Friday and Saturday, March 6 and 7. The proceedings will commence with a reception by the acting president, Mr. W. H. Patchell, which will be followed by the presidential address of the president elect, the Right Hon. Lord Montagu of Beaulieu. Friday afternoon and Saturday morning will be devoted to the consideration of business matters and the reading of papers by: The Right Hon. Lord Emmot and Principal W. M. Varley, on "The Local College and its relation to surrounding Education Authorities"; Mr. G. Mavor, Head of the Department of Continuative Education, Loughborough College, on "Training and Education for Apprenticeship"; Mr. J. E. Montgomrey, assistant secretary of the Institution of Mechancial Engineers, on "The Working of the Schemes for National Certificates and Diplomas in Engineering." Sir John Dewrance is entertaining members of the Association and others attending the meeting to luncheon on Friday, March 6, at the Trocadero Restaurant.

THE Royal Technical College, Glasgow, has received a gift of 50,000*l*. from an anonymous donor, who has given the governors of the College complete freedom to expend the revenue derived from it as they may see fit. The industrial depression in the south-west of Scotland, particularly severe in the engineering, shipbuilding, and iron and steel industries, with which the College is closely associated, has resulted not only in a diminution in the number of local students, although it has still double the number of the regular students of session 1913–14, but also there has been less capacity on the part of the industries to give financial support to the College. There is little doubt that the wise and far-seeing policy of the late Sir George Beilby, who was chairman of the governors for many years and the guiding spirit in the remarkable development of the College, both in its teaching organisation and the provision made for research work, has led the anonymous donor to consider the College worthy of this most welcome addition to its resources. Sir George Beilby's connexion with the College is to be marked by the foundation of a memorial medal in technical chemistry and by the generous gift by Lady Beilby of his excellent organ, which is to be reconstructed and placed in the College hall. Other recent donations are the continuance by the Bellahouston Trustees for another three years of an annual grant of 1000*l*. which they have given during the past five years, and substantial additions to the electrical engineering equipment in the form of modern machines presented by about twenty leading British firms of electrical engineers.

Early Science at Oxford.

February 29, 1683/4. Dr. Wallis was pleased to inform us, that ye way commonly used in opening frozen pumps, with salt, has been known to make pumpwater, under his house, apt to curdle in boiling, and unfit for washing, which naturally is fit for use, and bears soap very well; but ye water probably will recover itself as soon as ye salt shall be drawn off.

Dr. Pit acquainted ye Society, that sallet oyl cannot be made to boyl over; this has been observed by late experiments, and will give some light to that custom of ye sugar boilers, who used to throw a piece of sewet, candle, etc into their sugar; and by these means keep it from boiling over.

Some Queries concerning the splitting of Trees by ye late great frost, were brought in by Dr. Plot: they are as follows:—Whether any of these trees have split with a noise? Whether they are split quite through, or only on one side? Whether they are all split to ye same point of ye Compass? Whether ye splitting be more common in ye Trunk, or in ye Boughs? Whether any Ice has been found in ye vessels of ye wood? Whether ye trees split be any of them dead? Whether any of ye trees split have closed since ye thaw? Whether ye Bark be loosned by ye splitting, from ye wood?

Dr. Wallis mentioned vast numbers of dead Congers, which were thrown up by ye sea, at Dim-Church wall, along ye coast of Kent, during the late hard frost, as also about eight years ago; the same was observd on ye Severn shore in Somersetshire, about twenty years ago.

March 1, 1686/7. Upon mentioning of Mr. Hooke's Discourse about the changes which he supposes to have been made upon the surface of the Earth, Mr. President observed that the latitude of Oxford is not sensibly altered in these four hundred or five hundred years last past, as appears by the Alphonsine Tables and some MSS. in Oxford, in which though there may be about one minute more, or one minute less than ye present latitude, yet that may well be attributed to the unaccurateness of the observations.—It was stated at this meeting that the age of one Mother George, now living in Oxford, is about one hundred and eleven years.

March 2, 1685/6. Dr. Plot shewed ye Society two Swedish Runestocks or Primestocks, and one book almanack; also severall old English almanacks, of which some were for families, others for private persons; some of brasse, others of wood, all perpetuall.

March 3, 1684/5. Mr. Leigh gave a farther account of ye Balsamic Earth. It will take fire at a candle, and, if tost in ye air, will burn exactly like a torche, an oyl dropping from it scarce distinguishable from ye oyl of amber. Any other earth whatsoever, if put into ye place, where this is dug, will in a year's time be exactly the same with this. 4 drops of this oyl is a present Cure for ye Colic, and may therefore in all probability be proper in those distempers, which affect the nerves.

A letter from Mr. John Aubrey, dated London Feb. 27, mentioned an opinion that some merchants were of; that beasts are generally offended at a Barbary Lion's skin. There being one of these skins in ye Musæum Ashmolianum, he desires, ye truth of this matter may be enquired into, which was ordered to be done.

March 6, 1687/8. An account was delivered of what appeared to Mr. Pit upon the dissection of a *dog*, that had Mercury injected into one of the jugulars. The mercury was thrown out of the blood into the cavity of the abdomen, as likewise some appearance of it in the other cavitys of the body.

Societies and Academies.

LONDON.

Royal Society, February 19.—O. W. **Richardson** and A. F. A. **Young**: The thermionic work-functions and photoelectric thresholds of the alkali metals. The photoelectric threshold for normal potassium is close to 7000 Å.U., which agrees with the known wave-length of maximum activity λ_{max} and the equation $\lambda_0 = \frac{3}{2}\lambda_{max}$. Uncertain traces of a thermionic threshold agreeing with this have been found at about 200° C. in one experiment, but the thermionic thresholds usually effective at this and lower temperatures are of a much lower magnitude, even under the best vacuum conditions. A common thermionic threshold effective at about 200° C. corresponds to λ_0 = about 10,000 Å.U. A photoelectric emission with this infra-red threshold has been got by exposing potassium to a luminous discharge in hydrogen or water vapour. This may be due to the growth of small patches normally present. There is no evidence of photoelectric activity further out in the infra-red, although there is a thermionic threshold which corresponds to $\lambda_0 = 30,000$ Å.U. The glow discharge not only brings out undeveloped thresholds, but it also augments the normal emission.—J. H. **Brinkworth**: On the measurement of the ratio of the specific heats using small volumes of gas. The quantity actually measured is the cooling effect in adiabatic expansion, *i.e.* the ratio of the drop in temperature to the drop in pressure. These two quantities are measured directly, the former by using a suitable platinum thermometer, and the latter from the readings on an oil gauge. The values of the ratio of the specific heats thus experimentally obtained are used for the calculation of the specific heats of air and of hydrogen. The specific heat of air at constant pressure is practically constant, and equal to 0·2395 cal./gm. ° C. over the temperature range 155° to 290° A. The molecular heat of hydrogen falls rapidly from 4·88 at 290° A. to 3·30 at 90° A. None of the theoretical curves representing the variation in the molecular heat of hydrogen agrees with the experimental curve, the divergence, at some temperatures, being certainly five times greater than an outside estimate of the inaccuracy of the experimental results.—F. H. **Constable**: The catalytic action of copper. Part VI. Chemical reaction occurs only when an alcohol molecule is adsorbed over a characteristic arrangement of copper atoms, called a reaction centre. There is a large variation in the number of atom centres lying beneath one adsorbed alcohol molecule on various crystal faces: thus the reaction centre density varies also. The activity of the surface is controlled by the exponential activation factor, and by the reaction centre density on the surface.—Part VII. The rate of dehydrogenation of ethyl and butyl alcohols has been studied at pressures from 10 cm. of mercury to two atmospheres. The reaction velocity was found to be independent of the pressure.—V. H. **Stott**, Edith **Irvine**, and D. **Turner**: Viscosity measurements with glass. For the range 10^6 to 10^{17} poises, the apparatus is a modification of the method of Trouton and Andrews, in which the resistance to torsion of a circular rod is determined. This apparatus may be readily modified so as to extend its applicability down to 10^4 poises. Measurements of lower viscosities down to about 10^2 poises depend on determinations of the rate of fall through the glass of a partially counterpoised iridio-platinum ball. Temperature uniformity in the latter case has been achieved by the use of an electrically heated "black body" furnace possessing novel features.—W. G. **Palmer** and F. H.

Constable: The catalytic action of copper, Part V. The reaction velocity-temperature curves for ethyl, *n*-propyl, butyl, *iso*butyl and *iso*amyl alcohols (which have in common the grouping $-CH_2OH$) are identical within the limits of experimental error. This identity involves also the equality of the temperature coefficients and of the heats of activation. The higher alcohols caused rapid "poisoning" of the catalyst, but this secondary effect was circumvented.—P. A. M. **Dirac**: The adiabatic invariance of the quantum integrals. The postulate of the existence of stationary states in multiply periodic dynamical systems requires that if the condition of such a system, when quantised, is changed in any way by the application of an external field, or by the alteration of one of the internal constraints, the new state of the system must also be correctly quantised. It follows that the laws of classical mechanics cannot in general be true, even approximately, during the transition. During the so-called adiabatic change, which takes place infinitely slowly and regularly, so that the system practically remains multiply periodic all the time, classical laws may be expected to hold. In this case the quantum numbers cannot change, and it has been possible to deduce from the classical laws that the quantum integrals remain invariant.—D. L. **Watson**: The thermal decomposition of derivatives of oxalacetic ester: a unimolecular reaction. The decomposition, on heating, of derivatives of oxalacetic ester into a malonic ester derivative and carbon monoxide obeys the unimolecular (or simple probability) law, $dx/dt = k(a-x)$, and the velocity is uninfluenced by diluting with solvents or adding acidic substances, though retarded by high concentration of carbon monoxide. None of the substances could be stimulated to react by light of wave-length predicted from the Lewis-Perrin theory, or by ultra-violet radiation, which they absorb very strongly. They had energies of activation between 33,000 and 36,000 calories, and an "active life" of the order of 10^{-14} second, in agreement with many other first-order changes. The velocity of decomposition of phenyl-oxalacetic ester, however, was proportional to the amount of phenyl-malonic ester formed by the change (except when the latter substance was present in excess). This law, characteristic of simple reactions in pure liquids, may be explained by the hypothesis of "reflex activation," namely, that highly energised products of reaction are largely responsible for formation of fresh "active" molecules. Here, as in all known unimolecular reactions, two species of molecules evidently take part in the change. —K. R. **Rao**: (1) On the fluorescence and channelled absorption of bismuth at high temperatures. The absorption spectrum has been photographed at temperatures of the order of 1500° C. Some of the absorption bands in the visible region exhibit distinctly a fine structure, showing that these are due to the triple quantification. The vapour emitted a fluorescent radiation, and the fluorescent banded spectrum ranging from $\lambda 6570$-$\lambda 5040$, containing about 20 bands, shaded towards the red, has been photographed. This banded fluorescent spectrum indicates probably that the critical potentials of elements which are polyatomic are related to the molecule and not to the atom.—(2) A note on the absorption of the green line of thallium vapour. The green line of thallium consists of an intense central doublet accompanied by two satellites. Absorption by a column of non-luminous vapour indicates complete absorption of the central doublet at about 800° C., at which temperature the satellite was but very feebly absorbed. The total absorption of the satellite took place at about 950° C.—B. F. J. **Schonland**: The passage of cathode rays through matter. Cathode rays of velocities up to 0·55 that of light (100,000 volts) in quantities easily measurable on a galvanometer, were produced. These rays have been used to extend measurements of cathode-ray absorption to the β-ray region. The difference in variation of apparent absorption with velocity for different elements depends upon the fact that this is not a true absorption, since it includes the effect of the scattering back of rays on the side of incidence. The existence of a range for these rays has been established, and the values found for ranges at various velocities in aluminium are in close agreement with those calculated on Bohr's theory of absorption, which has now been tested from $\beta = 0·20$ to $\beta = 0·90$, with rays of penetrating power varying in the ratio of 1 to 5000. Cathode-ray absorption is due to gradual loss of energy of moving particles by collisions with electrons in matter. An examination of the principles underlying Bohr's theory of absorption shows that interchange of energy in such collisions must take place more freely than the usual conceptions of atomic structure allow. Absorption of cathode rays of various speeds by atoms of a given element does not appear to show any discontinuities corresponding to those observed in X-ray spectra.

PARIS.

Academy of Sciences, January 19.—The president announced the death of L. Maquenne, member of the section of rural economy.—Maurice **de Broglie** and Jean **Thibaud**: The exceptionally intense absorption of a radiation by the atom which has just emitted it. —Maurice **Lugeon**: Fluvial erosion. Example of the Rio Negro in Uruguay.— — **Calichiopulo**: The harmonic law of distribution of the errors of observation.— — **d'Ocagne**: Remarks on the preceding communication.—Enea **Bortolotti**: Extension of the Beltrami-Enneper theorem to conjugated networks from V_2 to V_3.—D. **Mordouhay-Boltovskoy**: The primary factors of the integral function.—J. **Dufay** and A. **Couder**: The photometric study of the total eclipse of the moon of August 14, 1924. This eclipse was observed in a clear sky at Saint-Geniez (Basses-Alpes, 1070 metres). At 10′ from the centre of the shadow the stellar magnitude of the moon was, in red light ($\lambda = 0·61\mu$), $-2·8$ in October 1921, and $-1·3$ in August 1924.—J. H. **Shaxby**: The diffusion of particles in suspension. As spheres of uniform size the cocci of the pyogenes staphylococcus were utilised, suspended in water. The value of the Avogadro number deduced from the experiments was 59×10^{22}. —Beaulard **de Lenaizan** and J. **Granier**: The specific inductive capacity of ice. The value 2·17 was found for the specific inductive capacity of ice, at a temperature of $-4·5°$ C., and with a wave-length in air of 363·2 cm.—Marcus **Brutzkus**: A new mode of production of chemical reactions.—D. K. **Yovanovitch** and J. **d'Espine**: The magnetic spectrum of the high-velocity β-rays of thorium B+C. Seven of the high-velocity β-rays measured by L. Meitner are confirmed: three additional rays have been detected for which $H\rho = 6800$, 18,000, and 40,000. These new rays are very faint.—Henry **de Laszlo**: The absorption of ultra-violet rays by the methyl derivatives of naphthalene. The absorption spectra of α- and β-methylnaphthalene, 2.6-dimethylnaphthalene and 2.7-dimethylnaphthalene were measured, and the results are given on a diagram.—P. **Vaillant**: The law of variation with temperature of the (electrical) conductivity of solid salts and its possible relations with the characteristic spectrum of the metal of the salt.—Mme. Pierre **Curie**: The estimation of radium in uranium minerals containing tantalum, niobium, and titanium. The mineral is mixed with barium sulphate, fused with potassium bisulphate, extracted with water and filtered. The precipitate on the filter is treated with dilute hydrofluoric acid. The insoluble portion containing the radium is boiled with sodium carbonate, to convert the barium and radium into carbonates, and the latter dissolved in dilute hydrochloric acid. After concentration to ice, the emanation is removed by a current of air and estimated in the usual manner.—Mlle. Suzanne **Veil**: The evolution of the hydrate of nickel sesquioxide in the presence of water.—André **Charriou**: The use, in catalysis, of alumina which has absorbed various other substances. The decomposition of ether at 250° C. in the presence of alumina was studied. With one exception, the blue oxide of tungsten, the presence of foreign substances (SO_3, P_2O_5, CuO, CaO, CoO) reduced the catalytic power of the alumina in this reaction.—G. **Dubar**: The formations of the Lias and the upper Jurassic in Asturia.—L. **Eblé** and J. **Itié**: The values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on January 1, 1925.—L. **Blaringhem**: The production of new hybrids between the wild species of Triticum and the principal cultivated wheats. Analysis of their affinities.—A. **Guilliermond**: The instability of forms and the permanence of the mitochondria.—P. **Delauney**: The glucosides of several species of native orchids.—Emile F. **Terroine** and Jean **Roche**: Heat production and respiration of the tissues *in vitro* in the homeotherms.—A. F. **Roffo**: The action of the Röntgen rays on cholesterol. Cholesterol, in solution, is destroyed by the action of the X-rays, but the crystallised alcohol is unchanged by this treatment—Edouard **Chatton** and André **Lwoff**: The etiology and structure of the Spirophyra. Their relationship with the Fœttingeria. The origin and evolution of the parasitism of these infusoria.

VIENNA.

Academy of Sciences, December 11.—H. **Pettersson**: Communication from the Radium Institute, No. 173. On the reflection of α-particles from atomic nuclei, α-particles were scattered through nearly 180° by five different elements. With three of these elements, which are known to be disintegrated, no reflected α-particles were observed, even at ranges considerably smaller than those calculated by the collision-theory. With two heavier elements α-rays were observed, but with much smaller ranges than would correspond to an elastic collision. Possible explanations are given on the assumption that the α-particle penetrates into the nucleus. H-particles were detected after bombarding nickel and copper with α-particles.—H. **Handel-Mazzetti**: New Chinese plants (30th communication). An index list of some 100 descriptions published during 1924 is given.—J. **Albrecht**: Palæontological and stratigraphical results of the journey of Dr. Ampferer and Dr. Hammer in Western Serbia in the year 1918.—M. **Kohn** and S. **Strassmann**: Ninth communication on bromophenols, bromo- and bromo-nitro-phenols.—M. **Kohn** and R. **Marberger**: Tenth communication on bromophenols: On chloro-nitro-ether and bromo-nitro-ether of hydroquinone and of tolu-hydroquinone and the mobility of the halogen atom in the same.—M. **Kohn** and S. **Grim**: Eleventh communication on bromophenols. Bromination of hydroquinone-monomethyl-ether and of nitro-hydroquinone-dimethyl-ether.

Official Publications Received.

New South Wales. Department of Mines: Geological Survey. Mineral Resources, No. 32: The Coal Resources of the Douglas Park Area, and Tabulated List of Coal Bores, Counties of Cumberland and Camden. By L. F. Harper. Pp. 22. (Sydney: Alfred James Kent.) 1*s*.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 277: Radio Acoustic Method of Position Finding in Hydrographic Surveys. By Comdr. N. H. Heck and E. A. Eckhardt and M. Keiser. (Special Publication No. 107.) Pp. iv+23. Serial No. 278: Velocity of Sound in Sea Water. By Comdr. N. H. Heck and Ensign Jerry H. Service. (Special Publication No. 108.) Pp. iii+27. (Washington: Government Printing Office.) 10 cents each.

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 2, 1925. Pp. 122. (London: Ernest Benn, Ltd.) 5*s*. net.

British Association for the Advancement of Science. Report of the Conference of Delegates of Corresponding Societies, 1924: including List of Papers bearing upon the Zoology, Botany and Prehistoric Archæology of the British Isles. By T. Sheppard. Pp. 489-554. (London: British Association, Burlington House, W.1.)

The Carnegie Trust for the Universities of Scotland. Twenty-third Annual Report (for the Year 1923-24) submitted by the Executive Committee to the Trustees on 11th February 1925. Pp. iv+77. (Edinburgh: The Merchants' Hall.)

Bulletin of the American Museum of Natural History. Vol. 47, Art. 7: Primates collected by the American Museum Congo Expedition. By J. A. Allen. Pp. 283-499+plates 79-167. (New York City.)

The Indian Forest Records. Vol. 10, Part 11: Burma Oak and Chestnut Tans; being the Report of an Investigation from the Tannin standpoint of the different parts of the various Oak and Chestnut Trees, principally those species growing in the Maymyo and Kalaw Areas. By J. A. Pilgrim. Pp. vi+90. (Calcutta: Government of India Central Publication Branch.) 1.1 rupees; 1*s*. 6*d*.

Nigeria. Third Annual Bulletin of the Agricultural Department, 1st July 1924. Pp. 96. (Lagos.) 5*s*.

Memoirs of the Colombo Museum. Edited by Dr. Joseph Pearson. Series A, No. 3: Ceylon Coins and Currency. By H. W. Codrington. Pp. viii+290+7 plates. (Colombo.) 10 rupees.

Publikation der Sternwarte in Kiel. 13: Berechnung der Ablenkungen der Lichtstrahlen in der Atmosphäre der Erde auf rein meteorologisch-physikalischer Grundlage. Von Paul Harzer. Pp. 89. 14: Gebrauchstabellen zur Berechnung der Ablenkungen der Lichtstrahlen in der Atmosphäre der Erde für die Beobachtungen am grossen Kieler Meridiankriese. Von Paul Harzer. Pp. 23. (Kiel: C. Schaidt.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 495: A Radiometric Investigation of the Germicidal Action of Ultra-violet Radiation. By W. W. Coblentz and H. R. Fulton. Pp. 639-680. (Washington: Government Printing Office.) 20 cents.

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce, for the Year ended June 30, 1924. Pp. iv+80+21 plates. (Washington: Government Printing Office.) 10 cents.

Diary of Societies.

SATURDAY, February 28.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (I.).

Hull Association of Engineers (at Technical College, Hull), at 7.15.—E. S. Rayner: Road Passenger Transport.

MONDAY, March 2.

Cambridge Philosophical Society, at 4.30.

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

Society of Engineers (at Geological Society), at 5.30.—R. I. Money: Notes on Preparing a Tender.

Royal Society of Medicine (Tropical Diseases and Parasitology Section), at 5.30.—Dr. H. E. Meleney: Kala Azar in China, with special reference to its Histo-pathology in Experimentally Infected Hamsters.

Institution of Electrical Engineers (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 6.—L. Breach and H. Midgley: Drive of Power Station Auxiliaries.

Institution of Mechanical Engineers (Graduates' Section, London) (Annual Lecture), at 7.—W. H. Patchell: A Visit to America.

Aristotelian Society (at University of London Club), at 8.—J. H. Harley: The Theory of the State.

Royal Society of Arts, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (III.) (Cantor Lectures).

Society of Chemical Industry (London Section, jointly with the Institute of Chemistry (London Section)) (at Chemical Society), at 8.

Institution of the Rubber Industry (London Section) (at Engineers' Club, Coventry Street, W.), at 8.—F. Jones: Standardised Rubber-ware.

Royal Society of Medicine (Epidemiology, Comparative Medicine, and Disease in Children Sections), at 8.—G. P. Male, Dr. M. J. Rowlands, Dr. Stenhouse Williams, Dr. David Nabarro, Sir Layton Blenkinsop, and others: Special Discussion: The Control of Tuberculosis and the Milk Supply.

Institute of Chemistry (Manchester Section).—Dr. A. Renshaw: Chemical Poisoning occurring amongst Industrial Workers.

TUESDAY, March 3.

Royal Institution of Great Britain, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (IV.). The Colour of Fish.

Zoological Society of London, at 5.30.—E. Banks: Variation in the Colours of European Birds in relation to the Conditions under which they live.—O. Thomas, M. A. C. Hinton, and Capt. G. C. Shortridge: On Mammals collected in 1923 by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to South-West Africa. With Field-notes by the Collector.—Dr. C. F. Sonntag: A. Monograph of *Orycteropus afer*. I. Anatomy except the Nervous System, Skin, and Skeleton.—Mary L. Hett: A New Species of Temnocephala (Trematoda) from West Australia.—V. S. Vinogradov: The Structure of the External

Genitalia in the Rodents Dipodidæ and Zapodidæ as a Classificatory Character.—A. Loveridge: Notes on East African Scorpions and Solifugæ.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. W. L. Nicol: Fuel Economy.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough Technical College), at 6.45.—R. C. Clinker: The Constants of an Electric Circuit.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Major E. I. David: Electricity in Mines.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—J. H. Russell: Slags and Fluxes: their Composition and Uses.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.15.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—A. G. Lobley: Electric Furnaces.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—Dr. W. M. Cramp: Pneumatic Transport of Materials.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—Dr. L. A. Levy and D. W. West: The Photometry of Fluorescent Screens.

WEDNESDAY, MARCH 4.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology, Epidemiology, Medicine, Therapeutics and Pharmacology Sections), at 5.30.—Dr. W. Edgecombe, Dr. J. A. Glover, Sir William Willcox, Dr. P. Hamill, Dr. Ackerley, Dr. Middleton, Dr. Kerr Pringle, Sir Percy Bassett-Smith, Dr. R. Hill, J. E. R. McDonagh, Dr. Oliver Heath, Dr. C. E. Sundell, and Dr. Higgins: Special Discussion on The Nature, Prevention, and Treatment of Fibrositis.

THE NEWCOMEN SOCIETY (for the Study of the History of Engineering and Technology) (in Prince Henry's Room, 17 Fleet Street, E.C.), at 5.30.—C. E. Greener: Gun Handicraft.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—D. Dye: Current Transformer Methods of Producing Small Known Voltages and Currents at Radio Frequencies for Calibrating Purposes.—Lieut.-Col. K. E. Edgworth and Lieut. G. W. N. Cobbold: The Measurement of Frequency and Allied Quantities in Wireless Telegraphy.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—H. W. Bannister: Water Softening in relation to Heating and Domestic Hot Water Supplies.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. Van B. Gilmour: A New Method for the Determination of Butter Fat.—R. C. Frederick: The Investigation of Ventilation Conditions.—R. C. Frederick and E. R. Webster: A Simple and Self-contained Spectroscope Lighting Unit.—P. K. Fröhlich: The Carbon Error in the Quantitative Deposition of Nickel and Iron from Complex Oxalate Electrolytes.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. E. S. Turner: The Modern Production of Sheet-Glass.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Bernard Spilsbury: Wounds and other Injuries (II.) (Lettsomian Lectures).

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.—Sir Arthur Schuster: The Life Statistics of Fellows of the Royal Society.—Prof. G. I. Taylor and Miss C. F. Elam: The Plastic Extension and Fracture of Aluminium Crystals.—A. Fage: An Experimental Study of the Vibrations in the Blades and Shaft of an Airscrew.—J. H. Vincent and A. L. Beak: Experiments on the Effects of Resistance in the Oscillating Circuit of a Triode.—*To be read in title only*:—Prof. G. H. Hardy: The Lattice Points of a Circle.—Prof. H. M. Macdonald: The Transmission of Electric Waves around the Earth's Surface.—R. M. Wilmotte: The Field of Force near the Neutral Point produced by Two Equal Coaxial Coils with special reference to the Campbell Standard of Mutual Inductance.—W. R. Dean: The Theory of Elastic Stability.—R. A. Frazer: The Motion of Circular Cylinders in a Viscous Fluid.

LINNEAN SOCIETY OF LONDON, at 5.—G. C. Robson: (*a*) Seriation and Symmetry in the Cephalopoda; (*b*) Exhibition of *Opisthoteuthis depressa* (Mollusca).—K. H. Barnard: Revision of the Family Anthuridæ (Isopoda) with Remarks on certain Morphological Peculiarities.—C. C. Lacaita: (*a*) Some Critical Species of Marrubium and Ballota; (*b*) Two Rare Spanish Species of Echium.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. MacNalty: Epidemic Diseases of the Central Nervous System (Milroy Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir Arthur Smith Woodward: Dinosaurs.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Lt.-Col. C. B. Heald: Some Medical Aspects of Air Transport.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology, Epidemiology, Medicine, Therapeutics and Pharmacology Sections), at 5.30.—Dr. W. Edgecombe, Dr. J. A. Glover, Sir William Willcox, Dr. P. Hamill, Dr. Ackerley, Dr. Middleton, Dr. Kerr Pringle, Sir Percy Bassett-Smith, Dr. R. Hill, J. E. R. McDonagh, Dr. Oliver Heath, Dr. C. E. Sundell, and Dr. Higgins: Special Discussion on The Nature, Prevention, and Treatment of Fibrositis.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. C. Richards: Art in the Schools.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Col. T. F. Purves: The Post Office and Automatic Telephones.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—M. W. Jones: Paint and Paint Making (Chairman's Address).

CHEMICAL SOCIETY, at 8.—I. J. Faulkner and Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XVII. The Mutarotation of Aluminium Benzoylcamphor.—Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XVIII. The Mechanism of Mutarotation, and of Hydrolytic and Prototropic Change; with a criticism of Baker, Ingold, and Thorpe's Doctrine of Non-intervention.—Prof. T. M. Lowry and E. M. Richards: Studies of Dynamic Isomerism. Part XIX. Experiments on the Arrest of Mutarotation in Tetramethylglucose.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. J. S. Fairbairn and Dr. Z. Mennell: Toxæmia in Early Pregnancy with Jaundice, Hyperemesis and Multiple Neuritis.—E. Williams and Dr. R. Reynolds: A New Method of Determining the Patency of the Fallopian Tubes by means of X-rays. — Dr. S. Forsdike: Investigation of the Uterus and Fallopian Tube by Inflation with Air and X-rays.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Prof. F. G. Donnan: Colloids.

FRIDAY, MARCH 6.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Institution of Mechanical Engineers), at 11 A.M.—Lord Montagu of Beaulieu: Presidential Address.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Henry Sharp: The Development of Indian Universities.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. S. Chapman: Magnetic Phenomena in Polar Regions.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—C. T. Onions: Dictionary Evening.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section, jointly with the Liverpool Section) (at 16 Mary's Parsonage, Manchester), at 7.—Dr. A. Schedler: Chemical Constitution and Properties of Azo Dyestuffs.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Pitfalls for Patentees.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea Technical College), at 7.30.—E. A. Tyler: Fine Chemicals.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. F. Etchells: How to apply for a Job and how not to do it.

INSTITUTE OF METALS (Sheffield Section) (at Sheffield University), at 7.30.—J. A. Lee: The Evolution of the Furnace.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—Debate: Industrial System, English, opened by K. Porter and J. Mathieson; *versus* American, opened by T. W. Worth and H. McIvor.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Arthur Keith: Concerning the Rate of Man's Evolution.

SATURDAY, MARCH 7.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Institution of Mechanical Engineers), at 11 A.M.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (II.).

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—Dr. F. W. Crossley-Holland: Science and the Criminal.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Ancient Mariners of the Pacific.

MONDAY, MARCH 2.

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL, at 5.—Prof. B. P. Watson: Puerperal Sepsis (I.). (Succeeding Lectures on March 3, 4, 5.)

LEEDS UNIVERSITY, at 5.15.—R. E. Priestley: The Glacial Cycle as illustrated by Antarctica.

UNIVERSITY COLLEGE, at 5.30.—P. Fleming: The Story of Regent's Park and Regent Street.

TUESDAY, MARCH 3.

KING'S COLLEGE, at 3.30.—Rev. R. Hanson: The Philosophy of Religion (VI.): Is there an *a priori* Religious Judgment?

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30. — Prof. C. A. Edwards: Chemical Combination in Metallic Alloys and its Nature (I.). (Succeeding Lectures on March 4, 10, 11.)

UNIVERSITY COLLEGE, at 5.30.—W. J. Perry: The Spread of Culture.

LEEDS UNIVERSITY, at 8.—Prof. W. Garstang: The Terrestrial Zoology of Yorkshire.

WEDNESDAY, MARCH 4.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—F. Pick: The Principles of Design as applied to our Cities and Towns.

SCHOOL OF ORIENTAL STUDIES, at 5.15.—E. Richmond: Early Moslem Architecture: Fâtimid Architecture in Egypt.

KING'S COLLEGE, at 5.30.—Sir E. Denison Ross: Travel and Travellers of the Middle Ages (VIII.). Travellers' Tales and the Kingdoms of Prester John, A.D. 1150–1550.

UNIVERSITY COLLEGE, at 5.30.—C. R. Sanderson: The Library Resources of London.—Prof. T. B. Wood: The Nutrition of the Young Animal (I.). (Succeeding Lectures on March 11 and 18.)

THURSDAY, MARCH 5.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 4.15.—Dr. C. Singer: The History of Influenza, Diphtheria, and Typhoid Fever. (Succeeding Lectures on March 12, 19.)

SATURDAY, MARCH 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Modern Excavations in Egypt.