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The Technical Expert in the Civil Service.

IN his presidential address, given on April 17, on the occasion of the annual meeting of the Institution of Professional Civil Servants, Sir Richard Redmayne dealt briefly with the work of the Institution, the annual report of which for the past year supplies an impressive review of the whole field of national activities. He made, at the same time, some interesting remarks on the present position of the technical expert in the Civil Service.

In the annual report in question, the Institution, it is stated, has long held the view that an adequate solution of the problems affecting the employment of specialist officers in the Civil Service will only be arrived at as the result of an independent public inquiry. The reason given for this view is that although the increase in the numbers and in the importance of the work of the professional, scientific, and technical classes has been very considerable in recent years, nevertheless the public departments are still entirely controlled by 'administrators,' who not only constitute a close caste, but also have been unable satisfactorily to adapt themselves to the changed conditions which have come into existence in the activities of the public service. The chief problem relating to the technical expert in the Civil Service is essentially one of status, and it is recognised that its solution is unquestionably an undertaking of the first magnitude.

Realising that, in order effectively to attain its objectives, the membership of the Institution should be thoroughly representative of the professional, scientific, and technical groups in the several government departments, one of the chief aims of its council has been, almost from the earliest days of the inception of the Institution, to persuade the numerous associations which have come into existence in government departments for the protection of the interests of the specialist officers since the termination of the War, to link up with the main body of their colleagues organised in the Institution. Sir Richard Redmayne was able to announce that the policy of the council in this matter had in recent years met with marked success ; he further indicated that the membership of the Institution, which at the end of 1925 numbered 3000, would within a few months exceed 5000.

The technical expert must, Sir Richard urged, be recognised as indispensable for the carrying on of the complex task of government in the modern

State, and be afforded full and free opportunity for rising to the highest offices the public service could offer. He emphasised the fact that the position of the technical expert in the Civil Service is at the present time far from being a satisfactory one. The subordination of the technical experts now threatened in the Scottish Boards by the Reorganisation of Offices (Scotland) Bill affords an example of the need for a proper reconsideration of the functions and status of the technical expert in relation to the administration.

The objectives of the Institution of Professional Civil Servants have, needless to say, a wider importance than that of merely serving the purely personal interests of its members; they aim, in fact, also at the attainment of true economy and increased efficiency in the public service. It is common knowledge that the present organisation of government departments and their procedure promote neither of these two very desirable ends; indeed, in some respects, they militate against the attainment of them. What is wanted to-day is the complete modernisation of government departments with the view of bringing about such changes that the affairs of the public service may be conducted on the model of a well-managed business.

The claim for an improvement in the status of the technical expert is really intimately bound up with the subject of a root and branch reorganisation of the government departments, for the issue raised thereby ultimately resolves itself into a question of making a better use than is the case at present of the knowledge and abilities of the specialist officers in the employment of the State. This can alone result by introducing radical changes in the present hierarchical system of the Civil Service and in the methods now adopted in dealing with scientific and technical work in government departments. The method in vogue at present, whereby scientific and professional matters are discussed in writing, sometimes at inordinate length, between non-technical and technical officers, in practice too often creates a situation in which technical officers are called upon to afford instruction in some branch or another of technology to non-technical officers by a process somewhat akin to that of the much-advertised 'correspondence course.' On the face of it, such a method of conducting business cannot, and in fact does not, conduce to the attainment of either economy or efficiency; apart from the delays caused in arriving at a decision on the matters under discussion, owing to the time consumed in carrying on the correspondence, it will be evident that a larger number of non-technical and also technical officers must be employed by the State under these conditions than would be the case if a rational organisation existed in government departments. The spheres of responsibility of the administrative and technical branches should be so clearly laid down as to ensure in practice that the chief technical officer of a department should personally be solely responsible for the soundness of all technical projects and schemes prepared in his branch and submitted by him for the approval of the minister, as well as for the correctness of the advice on technical matters tendered by him.

The necessity for the modernisation of the organisation and the procedure of government departments is not a matter which rests on the views of those alone who are advocating the cause of the professional and technical groups in the public service. It is also made strikingly apparent in the reports issued during the past twenty years by numerous parliamentary and other official committees which have been called upon to investigate certain matters connected with some of the governmental activities, and, further, by the public speeches of ex-ministers delivered in recent years. These reports and speeches have made the public familiar with some of the unsatisfactory features connected with governmental enterprises of a technical nature; and, in particular cases, a need for a complete reorganisation of them has been stated in express terms.

The immediate question, then, is how to find an expeditious means for remedying a situation which unquestionably is prejudicial to the public interest. The members of the specialist groups in the Civil Service have very properly decided to act strictly on constitutional lines; this does not, of course, mean that they intend to fall into that state of pathetic contentment which is so disturbing to the mind of the ardent reformer. On the contrary, the majority constituting these groups have already organised themselves into regularly constituted associations and are gradually bringing about improvements in their separate organisations, and eventually, no doubt, the whole of the specialist officers in the Civil Service will be effectively organised, and ranged also under the banner of a central service institution. However, in view of the fact that government departments are controlled on traditional lines by a ruling caste whose inertia is proverbial, it seems improbable that the steps necessary for the modernisation of the public services and for securing a status for the scientific and technical experts in the employment in the State compatible with the real needs of the situation will be set on foot by a movement for reform inaugurated within the public service.

The Institution of Professional Civil Servants has, it is true, played a considerable part in securing benefits on behalf of the professional and technical groups, owing to the large share it has taken in the work of the National Whitley Council; and it certainly has no intention of relaxing its efforts in this direction. However, the procedure of referring matters to the Industrial Court is cumbersome and dilatory. Moreover, the functions of the Industrial Court are strictly limited; it is not empowered to deal with the question of the modernisation of government departments, which is fundamental if the public services are to be placed on a sound footing. Indeed, even as regards matters now falling within the powers of the Industrial Court, the Institution of Professional Civil Servants is so far from satisfied with the existing arrangements that it has set up a special committee with the view of securing improvements of the arbitration and Whitley machinery. Further, it is certainly not in the interest of the State that improvements in the status of an important body of its officers should be won piecemeal and by slow degrees. A reform obtained in such a manner must in the long run prove costly to the nation.

The measures which have been taken by the specialist officers for bringing about the reforms so necessary in the organisation of government departments, and in their methods of conducting business, deserve the full support of the public; it seems to be a matter in which the leading professional and technical institutions can well take an initial step. These institutions now show a considerable interest in questions affecting the occupations covered by their members, and some of them have already intervened on behalf of the professional group in the Civil Service by making suitable representations to the Prime Minister on matters dealt with in the Report of the Anderson Committee (Report of Committee on Pay, etc., of State Servants, 1923. H.M.S.O. 6*d*. net). The prestige which these institutions enjoy, not only among professional men, but also in the eyes of the public generally, renders them very suitable bodies for taking up the cause of the specialist officers in the public service; moreover, in doing so, they would be performing a task of immense benefit to the nation. The first step would seem to be the preparation by them jointly of a memorandum dealing with the whole subject of the status of the professional and technical officers; having taken this step, they could appropriately press for the appointment of a Royal Commission to inquire into the subject and to recommend remedial measures.

The Artificial Silk Industry.

(1) *The Manufacture of Artificial Silk: with Special Reference to the Viscose Process.* By E. Wheeler. (Monographs on Applied Chemistry, Vol. 1.) Pp. xv + 150 + 27 plates. (London: Chapman and Hall, Ltd., 1928.) 12*s*. 6*d*. net.

(2) *The Rayon Industry.* By Moïs H. Avram. Pp. xxi + 622. (New York: D. Van Nostrand Co.; London, Bombay and Sydney: Constable and Co., Ltd., 1927.) 42*s*. net.

(3) *Acetate Silk and its Dyes.* By Chas. E. Mullin. Pp. 473. (London: Constable and Co., Ltd., 1928.) 26*s*. net.

ARTIFICIAL silk, despite its name, has not assumed the place of the product of the silkworm in the textile industries, for the visible output of natural silk is increasing, although much less rapidly than that of artificial silk, which now exceeds it in annual amount. It appears, therefore, that the new fibre has found a place of its own, unless in so far as it may have dispossessed the other natural fibres, and its designation by some other name would have conveniences; but the word 'rayon,' invented and adopted in the United States, has not found favour in Great Britain, though the Drapers' Chamber of Trade recently decided to recommend the adoption of the word instead of the misleading term 'art silk.' Such a replacement of the natural fibres by artificial silk cannot yet have gone very far, as the amount produced during 1928 is not expected to exceed two per cent. of the total amount produced of all the natural fibres.

The rate of increase in the production of the new material, exemplified by the 99,500 metric tons produced in 1926 being twice the amount produced in 1923, continues, however, to be high; and the future possibilities of the new industry must appear to be great when it is considered that, apart from the more purely scientific researches which may have a bearing on the industry, systematic technical investigations are in progress with the object of producing a fibre more suitable for use in clothing; the employment of other derivatives of cellulose than those now used may become practicable, or even the manufacture of artificial fibres from other than a cellulose base. Meanwhile, the processes that hold the field are the viscose, the cuprammonium, and the nitro-cellulose processes, which yield fibres composed of regenerated cellulose, and the acetate process which yields fibres composed of acetyl cellulose.

(1) The object of Mr. Wheeler's monograph is "to present a description of the essential chemical and engineering details" of these processes "and of the properties and uses of artificial silk," with special reference to the viscose process, which is used for the production of about 90 per cent. of the world's output. As sources of cellulose, only cotton waste or linters and wood come into consideration at present; bleached sulphite wood pulp with a specified content of α-cellulose, prepared from spruce, fir, or hemlock, is commonly used for the manufacture of viscose, but the dearer cotton has the advantage of yielding a stronger artificial fibre; for the other processes cotton is generally employed, although wood pulp has been found to be suitable for the cuprammonium and acetate processes.

The viscose process depends upon the coagulation of an alkaline solution of cellulose xanthate by causing it to emerge from fine jets into a solution containing acids and salts, the composite thread formed from numerous filaments being afterwards desulphurised and otherwise prepared; the xanthate is made by the interaction of carbon disulphide and cellulose which has been impregnated with sodium hydroxide. Each of the numerous stages of the manufacture is carefully controlled; but the success of the viscose process is due in great measure to the ingenious mechanical arrangements, especially those employed for the spinning or conversion of the viscose into filaments. Mr. Wheeler accordingly, in his very clear and concise account of the normal process as carried out to-day in many factories, devotes considerable attention to the details of these arrangements; the text, supplemented by flow sheets, is freely illustrated by plates and diagrams, and reference is made to the patents and technical literature for further details and descriptions of alternative methods.

The other processes at present operated industrially are described equally skilfully, but more shortly. Of these the cuprammonium process, in which cellulose dissolved in an ammoniacal solution of copper hydroxide is regenerated in the form of filaments by passage into acid or alkaline solutions, is showing renewed vitality, although the proportion of artificial silk produced in this way is small; the nitro-cellulose process, which is the oldest, is on the wane; and the acetate process, which is referred to further below, is becoming increasingly important. Reference is also made to other methods proposed for the manufacture of artificial fibres, of which that depending on the production of cellulose ethers, now being developed on a large scale, is the most promising. The properties of artificial silk, both general and in relation to dyeing, its uses, besides other topics, are adequately discussed relatively to the scale of the book, which is a well-arranged and well-written outline of the subjects.

(2) The financial aspects of the industry are prominent in "The Rayon Industry," which appears to be intended mainly to inform the "groups of financial interests" who may be proposing to undertake the manufacture of artificial silk in the United States, although there is a list of the other numerous classes of readers for whom the book is designed. About one-quarter of the book of 600 pages is devoted to the history, finance, and economics of the industry, which are described with enthusiasm, tempered with warnings against unconsidered enterprises; forty pages are given to the natural textile fibres; thirty to the purification of water; fifty to yarn tables, and tables of weights and measures and such like; but only fifteen to dyeing. Useful features are the lists of patents and the bibliography of textiles generally, which together occupy about eighty pages. The actual processes of manufacture of artificial silk, described in a manner easily followed, occupy about one-quarter of the book; suggestions are made as to the plant required by an intending producer. Although the viscose process naturally occupies the chief place, the nitro-cellulose and cuprammonium processes are also described in some detail, but the discussion of the acetate process is somewhat meagre.

(3) Even in Mr. Mullin's conscientious and exhaustive work on "Acetate Silk and its Dyes," few details are given of the manufacture of this type of artificial silk, as "very little outside of the patent literature has been published." The preparation of cellulose acetate, and its properties, are, indeed, discussed at some length, but the book is essentially one on dyeing. As an ester of cellulose, acetate-silk is distinguished from the artificial silks composed of regenerated cellulose by special characteristics which at first hindered its dyeing. This book records the history of the development of suitable processes and describes the methods now employed, with copious citations of authorities. It will be of value to the dyer as a text-book and work of reference.

Modern Spectroscopy.

Handbuch der Experimentalphysik. Herausgegeben von W. Wien und F. Harms. Band 21 : *Anregung der Spektren, spektroskopische Apparate,* von Georg Joos und Ernst v. Angerer ; *Starkeffekt,* von Johannes Stark. Pp. xiii + 562. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 49 gold marks.

ALL those engaged in research in physical optics, and spectroscopists in particular, must feel deeply indebted for the publication of this volume. Although some of its contents were available already in other publications (such as Kayser's "Handbuch" and Baly's "Spectroscopy"), it was often only in a much more diffuse form, and the more important part has only been published hitherto in a vast number of papers in the different journals.

Notwithstanding that the title of the work is experimental physics, there is an admirable account of the theory of the origin of spectra by Georg Joos, which even contains a brief summary of and many allusions to the results of the new wave mechanics. For the most part, however, this account deals with the theory of spectra in terms of the Rutherford–Bohr atom model and the old quantum mechanics modified to account for the complex spectra. There is, for example, a good, though rather too condensed, account of the 'doublet problem,' the first great difficulty of the older theory, and the development of the situation is carried on to include atoms with several electrons and the solution by the assignment of an intrinsic moment to each electron of one-half of a unit of $h/2\pi$.

This section of the book forms an admirable introduction to such a book as Hund's "Linienspektren."

The excitation of spectra is fully discussed, including the methods of electron impact (and the determination of ionising and resonance potentials), absorption spectra, subordinate series absorption, resonance and fluorescence, and finally collisions of the second kind, and brief mention is made of sensitised fluorescence and photo-chemical reactions. The only similar account in English known to the reviewer is Foote and Mohler's "Origin of Spectra," and this is by now necessarily incomplete and omits much of the recent important work.

In the discussion of the widths of spectral lines we think that, though this is essentially a book for specialists, for the benefit of students perhaps, the point might have been made that strictly monochromatic absorption and emission is impossible since it involves zero probability for the recapture or radiation by atoms.

There follows a very useful account of the different sources of light available for spectroscopic experiments.

The second part of the book, by E. von Angerer, is an account of the apparatus and methods of spectroscopy. In the discussion of prism spectrographs the great practical importance of a straight line focal curve for the camera objective is rightly emphasised, and a most useful account of several actual systems given. The treatment of grating spectrographs is equally comprehensive, and includes good practical instructions for cleaning gratings. We should like to have seen mention made of Newall's method of the 'diffractional index' for setting the slits of spectroscopes (*Mon. Not. R.A.S.*, **65**, 610; 1904); its value lying in the possibility of exactly reproducing of a setting. We welcome the account of the illumination in spectrographs and would have liked more on this topic. The problem of the use of a spectroscope in conjunction with an astronomical telescope is not discussed.

There follows a chapter in which are collected together accounts of the various interference spectroscopes, and their combinations with other instruments, and also of crossed interferometers.

The account of the determination of wave-lengths includes a valuable summary of the work on primary standards, but the actual method of finding wave-lengths by means of a standard comparison spectrum (of iron, say) is not explicit, in so far as the method of choosing standard lines for the calibration curve and correction curve of wave-lengths from Burns's table (in *Lick Observatory Bulletin No. 247*) and St. John's report to the I.A.U. (1923) is not given.

The chapter on photometry, and in particular photographic photometry, is opportune, and well up-to-date. The time has come when all tables of wave-lengths should also contain accurate measurements of intensity. It is astonishing how well some observers have been able to convert themselves into photometers, but the old system of eye estimates of intensity demanded a very considerable knowledge from the user of it, if he were not also its maker, if any results were to be deduced from it. Anderson's method (*Astro. Jour.*, **59**, 76; 1924) of obtaining an intensity scale is very much better, and we would have liked to have seen its use urged in this book, as being very little more trouble than crude eye estimates, but of course whenever the extra labour can be afforded (and we grant that it is considerable), a scale independent of wave-length is desirable.

The third part of the book is an account of the theory and experimental investigation of the Stark effect by the one most qualified to give it, namely, J. Stark himself, and the reviewer can only remark that comment on it by him is superfluous.

The book abounds throughout with references to the literature of the subject, which are very complete and are brought so well up-to-date that the only supplement needed should be recent numbers of *Science Abstracts*. The printing and illustrations are all that could be desired.

J. A. C.

Academic Mycology.

The Structure and Development of the Fungi. By Dame H. C. I. Gwynne-Vaughan and B. Barnes. Pp. xvi + 384. (Cambridge: At the University Press, 1927.) 15*s*. net.

The increasing recognition of the significance of the fungi in agriculture and industry makes the publication of a treatise on this group of plants an event of notable importance. This is the more manifest when it is realised that, since the translation of De Bary's great work on the fungi in 1886, there has appeared no book in English which covers the subject as does the present volume, or which has been suitable as a mycological text-book for advanced students of botany. Further, during this period only one book—Gaumann's "Vergleichende Morphologie der Pilze," published in 1926—has appeared on the continent of Europe. The present volume by Prof. Gwynne-Vaughan and Mr. Barnes partially occupies, therefore, a niche which has been empty for some considerable time.

The authors have kept strictly to their title, which is "The Structure and Development of the Fungi," and have not attempted to consider wider issues such as the physiology, ecology, and general biological relationships of the group. This is, perhaps, a little unfortunate, for readers will gain little conception of the part played by these organisms in Nature, of their vast importance as disease-causing agents in agriculture, forestry, etc., or of the dependence of many great industries upon fermentative processes brought about by them.

The book is thus in no sense a general treatise on the fungi, but it is a well-written and readable account of their reproductive structures and processes. Accepted as such it is a notable success and is assured of a cordial welcome.

Beginning with the more primitive forms in each of the three great classes of fungi, and working through to the more advanced types, the authors present a clear picture of the present state of our knowledge. The systematic arrangement they have adopted is more simple than that of many continental mycologists, but with the increasing recognition of the entirely artificial basis of much, at least, of our fungal systematics and phylogenetic schematisation, simple diagrammatic arrangements have at present almost everything in their favour. The book contains a useful chapter on mycological technique and a bibliography that will be found of value by students desirous of consulting original sources. Two hundred and eighty-five illustrations, many of them original, add greatly to the value of the book, which is excellently produced and commendably free from misprints and errors. A certain amount of loose wording here and there which might give rise to ambiguity can easily be amended in the several editions into which the volume is sure to run.

W. B. B.

Our Bookshelf.

Electro-Farming: or the Application of Electricity to Agriculture. By R. Borlase Matthews. Pp. xvii + 357. (London: Ernest Benn, Ltd., 1928.) 25*s*. net.

The introduction of mechanical power to the farming industry has proceeded more slowly than in other industries. Apart from the natural conservatism of the agriculturist, the main reason for this is the diffuse and spasmodic power requirements on the farm. In other industries, the processes are localised in a factory and are not subject to the constant change of plans that the weather conditions impose on the farmer. Nevertheless, steam power for cultivations, and the internal combustion engine for cultivations, haulage, and general work in the farm buildings, have all found a place in agriculture and the use of power is now rapidly extending.

The latest claimant is electric power, and the author of this book, who is a well-known pioneer in the subject, has produced a thoroughly up-to-date review of the position. The characteristic of electric power that most commends it to agriculture is the extreme simplicity of the motor as compared with other prime movers. For all work that can be done by fixed or portable engines the electric motor will no doubt seriously rival all other forms of power, immediately an adequate supply of electricity becomes available in rural areas. The weak point is its use for work on the land, which absorbs by far the greater proportion of the total power used in agriculture. Flexible cables must be provided between the moving machine and the fixed distribution lines, together with some auxiliary form of power (or a heavy and expensive battery) for movement about the farm. Although several ingenious systems are in use on the Continent for reducing to a minimum the inevitable inconvenience of the flexible cables, the British farmer will need much persuasion before he adopts the system.

Electric stimulation of plant growth is discussed more optimistically than the present position of scientific investigation in this intricate subject really warrants, and the same is true, although to a lesser degree, of the chapters dealing with light treatment of plants and animals. A full account is given of the undoubted improvement that electricity could provide in the amenities of the farm homesteads and the rural areas generally.

Although the object of the book is to pave the way for electro-farming, perhaps its chief immediate value is that it directs attention to the numerous ways in which the forms of power at present available could be applied with advantage on the farm.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1926–27 by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-fourth Annual Issue. Pp. vii+416. (London: Charles Griffin and Co., Ltd., 1928.) 18*s*. net.

IT is with much pleasure that we welcome once more this useful annual; the publishers deserve our sincere thanks for the labour and expense they devote to it. Moreover, they realise that a reference book must be distinctively and strongly bound; lightly bound reference volumes, which fall to pieces after a few weeks of use, are most irritating.

An important part of the volume is the note on the title-page—"Compiled from Official Sources." It shows that the information provided can be depended upon, and our thanks should also go to the officials of societies, many of them busy men serving in an honorary capacity, who take the time and trouble to make it available. As regards the contents of the book, it is sufficient to say that the various societies are classified according to subject, and under each one is given its address, officers, meetings, publications, and so on. Local photographic and medical societies are dealt with briefly at the ends of the appropriate groups. Particularly valuable are the reports from the Government institutions. There is a good index.

The penalty of providing useful information is that it invites suggestions for improvements. We still lament the omission of most of the industrial research associations, an omission that is doubly strange in view of the increased attention that is given to research in the industries themselves and among the public. We also think that the Viking Society and the Spelæological Society would be more appropriately grouped under archæology than under biology, and that the Sociological Society and the Eugenics Society would come better under biology, which includes anthropology, than under psychology.

The Circle and the Cross: a Study in Continuity. By A. Hadrian Allcroft. In 2 volumes. Vol. 1: *The Circle.* Pp. x+370+4 plates. (London: Macmillan and Co., Ltd., 1927.) 12*s*. 6*d*. net.

MR. ALLCROFT'S interesting book is devoted to the thesis that the sacred pagan symbol, the circle, surviving from prehistoric into Christian times, can be detected not only in occasional circular churchyards, but also in the modern word *church* itself. Beginning with the round barrow as the first expression of the sacred circle, Mr. Allcroft traces the evolution of the holy sepulchral ring, and maintains that this acquired additional importance from its frequent use as a moot. It is as moots, indeed, that he would explain the stone circles of Great Britain, and he couples with this interpretation the assurance that they are in reality of much later date than is commonly supposed; in fact, he seems to think most of them were built so late as the fourth century B.C., if not later still.

On this point the verdict will assuredly be that Mr. Allcroft's case is not proven, but his survey of the stone circles and earthen 'amphitheatres' in Great Britain is none the less an important and thorough piece of work. Moreover, he cannot be accused of too narrow an outlook, for he has chapters on the Achæan and Latin moots, and on the Danish *ting*; and he gives, furthermore, an interesting account of the Nordic peoples, about whom he holds views that are often in opposition to orthodox theory.

Especially interesting are Mr. Allcroft's remarks on the difficult subject of the Picts; but it should be observed that as a guide to the course of the Celtic invasions of these islands, his book must be read with considerable caution. However, he may reasonably claim the indulgence due to those engaged in pioneer work—for such is the nature of his book—and this is no less than his due. Indeed, it would be churlish to deny that he has given us a learned and entertaining work.

Lehrbuch der Geophysik. Herausgegeben von Prof. Dr. B. Gutenberg. Lieferung 4. Pp. 609-796. (Berlin: Gebrüder Borntraeger, 1927.) 11·40 gold marks.

PART 4 of Gutenberg's "Lehrbuch" deals mainly with atmospheric phenomena. A section on the structure of the atmosphere, by Prof. L. Weickmann, gives a very thorough account of existing theories of its composition, the distribution of temperature and density with height, and the propagation of sound. Atmospheric optics is then treated in considerable detail by Prof. F. Linke and Prof. A. Wegener (who was not included in the list of collaborators as originally announced). Atmospheric electricity is discussed by Prof. H. Benndorf.

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.*]

Two Kinds of Martensite.

MARTENSITE is a structure characteristic of quenched steels and consists of an aggregate of very minute needle-shaped crystals. It is a solid solution of carbon in α-iron and is very hard. During tempering at a gradually increasing temperature, the precipitation of the carbon from the solid solution in the form of cementite takes place in two steps at about 170° and 270°, as shown in Fig. 1 by the two stepped changes in the electric resistance–temperature curve, or by similar abnormality in the magnetisation–temperature curve, etc. Since the precipitation or the decomposition of martensite takes place in two steps, it is necessary to distinguish two kinds of martensite, α and β, the former being less stable, and hence more easily attacked by acid, than the latter. By X-ray analysis, Westgren and others have found that the martensite has a body-centred cubic lattice, carbon atoms being present within the interspace of the lattice.

Recently it has been found that beside the body-centred cubic martensite, a body-centred tetragonal martensite with an axial ratio $c/a = 1{\cdot}03 \sim 1{\cdot}06$ is contained in quenched steels. We have found by X-ray analysis that the former martensite, which is more stable than the latter and is to be identified with β martensite, is found in the inner portion of a quenched specimen; while the latter martensite, which is to be identified with α martensite, is always found in the surface layer of the specimen. The existence of the two kinds of martensite being thus far confirmed, the mechanism of their formation may be considered.

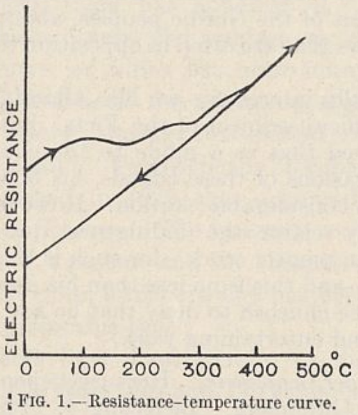

FIG. 1.—Resistance–temperature curve.

Since a face-centred cubic lattice may be considered a body-centred tetragonal one with an axial ratio $c/a = \sqrt{2}$ and also a body-centred cubic lattice as a body-centred tetragonal lattice with an axial ratio $c/a = 1$, the transformation from austenite to martensite takes place very probably in the order :

Tetragonal lattice ($c/a = \sqrt{2}$)
→ tetragonal lattice ($c/a = 1{\cdot}06$)
→ tetragonal lattice ($c/a = 1$),
or austenite → α martensite → β martensite.

Thus the mechanism of the formation of these martensites from austenite is very simple; the tetragonal lattice ($c/a = \sqrt{2}$) is first to be compressed uniformly in the direction of the c-axis and at the same time uniformly expanded in the perpendicular direction. α martensite is obtained when the axial ratio of the tetragonal changes from $\sqrt{2}$ to 1·06, and β martensite when the ratio changes farther to 1.

In the outer layer of a quenched steel, where the cooling is very rapid, the first change, austenite → α martensite, is partially arrested, and the second change, α martensite → β martensite, is completely hindered, so that the outer layer must contain α martensite mixed with a small quantity of retained austenite; while in the inner portion, where the cooling is less rapid, the first and the second change will take place almost completely, so that the inner portion must contain almost pure β martensite. These conclusions agree satisfactorily with the results of our experiments.[1]

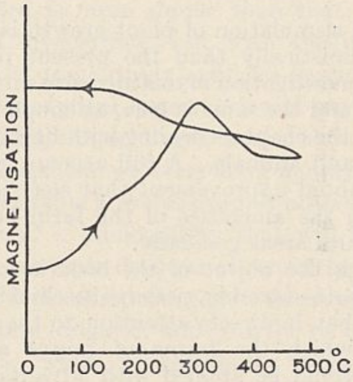

FIG. 2.—Magnetisation–temperature curve.

As regards the properties of α and β martensites, the following may be said with certainty :

Specific volume (V) :

$$V_{\text{au.}} < V_{\alpha\text{ mart.}} < V_{\beta\text{ mart.}}$$

Magnetisability (I) :

$$I_{\text{au.}} < I_{\alpha\text{ mart.}} < I_{\beta\text{ mart.}}$$

Specific electric resistance (R) :

$$R_{\alpha\text{ mart.}} < R_{\beta\text{ mart.}} < R_{\text{au.}}$$

Hardness (H) :

$$H_{\text{au.}} < H_{\alpha\text{ mart.}} < H_{\beta\text{ mart.}}$$

The following remark regarding the stepped change in Fig. 1 is very important. According to our view, the first step at about 170° is not due to the precipitation or the decomposition of the martensite, as it is usually believed to be, but to the transformation of α martensite to β martensite. Of course it is to be assumed that the decomposition of β martensite begins to take place far below 100°, its ratio being at first very small and rapidly increasing with the rise of temperature. In other words, the first step in Fig. 1 is not an abrupt change in the rate of decomposition of the martensite, but is due to the transformation of α martensite to β martensite, the rate of decomposition being assumed to increase steadily. The abrupt change in different physical properties in the vicinity of 170° agrees in its direction with what is to be expected from the inequality relationships given above.

KOTARÔ HONDA.
SINKITI SEKITO.

[1] See also the communication to *Werkstofftagung*, Nov. 31, 1927 (Berlin).

Directional Wireless and Marine Navigation: the Rotating-Loop Beacon.

IN a previous contribution to NATURE (vol. 120, p. 774, Nov. 26, 1927) under the title "Directional Wireless as an Aid to Navigation," a survey was given of the present position of the application of wireless signalling methods to the navigation of ships and aircraft. Towards the end of that article brief mention was made of the rotating-loop method of directional transmission, with the intimation that the application of the method to marine navigation was then under investigation. As these experiments have now given results which make it possible to state that the method will prove of great importance in the future application of directional wireless to marine working, it is considered to be desirable to complete the above survey by summarising briefly the main conclusions arrived at.

The rotating beacon system of directional transmission has been developed to a high degree in Great Britain by the Royal Air Force, as providing a method of navigating aircraft without the necessity of carrying additional and elaborate apparatus in the machine itself. The transmitter employs a vertical frame coil which rotates at a uniform speed about a vertical axis, and which is supplied with radio-frequency oscillations from a suitable valve. The radiation in any direction varies as the cosine of the angle between the direction and the plane of the coil, and thus the signal intensity at a fixed receiving point varies from a maximum when the plane of the coil is in the direction of the receiver to a minimum or zero when the coil is perpendicular to this direction. Bearings are obtained on this transmitter by observing the time at which the signal minimum occurs after the transmission of a characteristic signal, which is sent when the plane of the coil is perpendicular to the geographical meridian. From a knowledge of the time of rotation of the coil, usually sixty seconds, the bearing of the receiver from the transmitter can be calculated. The bearing so obtained can be checked for every 180° rotation of the coil, that is, at half-minute intervals. Since the accuracy of observation is directly dependent upon the speed of rotation it is necessary that this shall be maintained very uniform. A combination of a tuning fork and phonic motor has been found to provide a simple and efficient means of speed control giving an accuracy superior to that required in the practical use of the beacon. Since the timing is but an intermediate process in obtaining a bearing, it is possible for the observer to use a stop-watch or chronograph provided with a dial marked in the form of a compass card, with both degrees and points of the compass. By starting such a watch on the North signal and observing the position of the index hand at the occurrence of the signal minimum, the bearing can be read straight off the dial.

Using such a type of rotating beacon in a series of experiments carried out in ships, it was found that for clear open-sea ranges up to 50 or 60 miles the observed wireless bearings agreed within an extreme limit of 5° with bearings estimated by other navigational methods, and in about 70 per cent. of the cases the agreement was within 2°. In subsequent experiments it was shown that for ships at anchor at distances of 90 to 100 miles, the wireless bearings observed in the day-time agreed to within 4° with the bearings calculated from the ships' positions. At distances exceeding 60 miles, however, wireless bearings from the rotating beacon were found to be subject to night effects similar to those experienced in wireless direction-finding. The errors resulting from these effects were not found to be very serious until the range of transmission exceeded 90 miles over sea, beyond which the errors of individual bearings amounted to 21°. Even in these circumstances, however, a moderately accurate bearing could be obtained by taking the average of a series of consecutive readings over a period of ten to fifteen minutes. The minimum range at which night errors were encountered was considerably reduced when the transmission was entirely or partly over land.

It will be evident from these results that the rotating beacon gives bearings comparable in accuracy with those obtainable with an ordinary direction-finder. This conclusion has been verified in the course of the investigation by some special experiments in which a direct comparison was made between the bearings observed on the rotating beacon and those obtainable with a direction-finder used on board the ship in the ordinary manner. When used in fixed positions on land, the direction-finder gives a somewhat superior accuracy, as it is not easy to obtain bearings on the rotating beacon to a better accuracy than two degrees; whereas a good land D.F. station should give bearings reliable to one degree. When wireless bearings are taken on board a ship at sea, however, the case is somewhat different. The D.F. bearing is taken relative to the ship's head, and its accuracy depends upon the steadiness of the ship and also upon the accuracy with which the direction of the ship's head is given by the compass reading at any desired instant. The bearing obtained by the rotating beacon is entirely free from this limitation, and its accuracy is practically the same whether the ship is at sea (in motion or at anchor) or in dock. Furthermore, no correction or compensation is necessary corresponding to the quadrantal error associated with the ship direction-finder. The limitation of range of accurate bearings due to night effect has been shown, both theoretically and experimentally, to affect both systems to the same degree.

From a scientific point of view, it thus appears that while there is little to choose in direction-finding between the rotating-loop transmitter and the rotating-loop receiver, the former may have a slight advantage for navigation purposes. It must remain for the mariner himself to become familiar with the operation and performance of each system and determine the sphere of their application as scientific aids to modern navigation. R. L. SMITH-ROSE.

National Physical Laboratory,
Teddington, April 12.

Devices for Increasing Accuracy in Weighing.

WHEN high precision in weighing is essential, a considerable improvement is effected by constructing a rider which is supported on a point instead of resting on the beam by contact at two or more places as in the ordinary pattern. In order that the graduated beam scale may carry such a rider, the former must be of reasonable thickness.

This method of construction eliminates the uncertainty regarding the position of the beam at which the weight of the rider is applied. With certain precautions a reading to less than 0·1 mgm. can be made, and slight readjustments of the rider to give an exact balance, if required, can be carried out much more easily than with the standard rider.

Whilst it is true that few chemical balances as ordinarily used will enable weight determinations to be made to an accuracy greater than 0·1 mgm., the sensitiveness of the balance is in many cases actually such that it will allow of this if certain precautions are taken. The inconsistency that is noticeable when working to the limit of sensitiveness is due to the lateral shift of the whole beam to left or right each time the beam is released from its fixed supports. This of course gives a perceptible shift in the zero when observing swings on the fixed scale at the base of the main pillar.

If small differences in weight (of the order of a few milligrams) are being observed, where it is possible to obtain equilibrium by altering the position of the rider *without* raising the beam knife edge, this error does not arise, and a method of reading the exact position of the rider is at once of value. Where, however, it is necessary to raise the beam, accuracy can be obtained by making several observations of the zero of swings, between each of which the beam is raised and lowered again, and the mean of the zero positions taken. In this case a knowledge of the sensitiveness of the balance is of course essential for calculating the required difference in weight.

The rider in question can be constructed by using two pieces of clean nickel-chromium wire, one of which is bent as in Fig. 1*a*. One end of the other piece is wound round the horizontal part of the first, starting at the centre and leaving a small downward projection which acts as the *point support* of the rider. After a few turns, the wire is bent round to form a loop which is finished off by winding the free end towards the centre of the horizontal portion. Adjustment of the weight is made by cutting from the legs. The finished rider appears as in Fig. 1*b*.

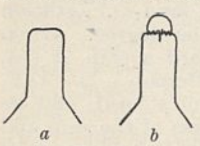
FIG. 1.

To avoid parallax in reading the exact position of the rider, a paper scale of the same dimensions as that of the rider scale can be pasted on to the glass front or back of the balance case, so that the eye reading the position of the rider may be placed at right angles to the beam at the point where the rider is situated.

Similarly, a suitable paper scale attached lower down, to the front glass of the balance case, enables accurate readings of the swings to be made even though the beam pointer be some distance in front of the scale at the base of the pillar.

Another device which has been found useful is a glass tube inserted through the side of the balance case and resting on the base. The tube is turned up underneath the left balance pan, and a rubber bulb is attached to the end of the glass tube outside the balance case. A slight pressure on the rubber bulb causes a puff of air on the under side of the pan, and this enables the beam to be set swinging to any desired degree, and the amplitude can be increased or diminished with ease.

F. C. GUTHRIE.

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Liverpool.

Light-scattering at Critical Opalescence.

MESSRS. Ornstein and Zernike have published in a series of articles, notably one in *Phys. Zeits.* (**27**, 76; 1926), a theory of light-scattering, correcting that of Einstein, with the idea of accounting for the experimental fact that the scattered intensity at the critical opalescence of a pure substance or a binary mixture is not infinitely great. Their formula refers to the scattering at 90° of the incident beam. One can easily generalise it, for a direction of which the angle with the incident beam is θ. One therefore finds for Lord Rayleigh's ratio, and in their notations:

$$i = \frac{4\pi^2\mu^2\left(\frac{\partial\mu}{\partial v}\right)^2}{\lambda^4} \cdot \frac{\frac{RT}{N}\cdot v}{-\frac{\partial p}{\partial v} + \frac{8\pi^2}{3}\frac{RT}{v^2}\left(\frac{\epsilon\mu\sin^2\theta/2}{\lambda}\right)^2} \cdot \quad (1)$$

$-\partial p/\partial v$ vanishes at the critical point. For a binary mixture, $-\partial p/\partial v$ must be replaced by another term, which also vanishes at the critical point of complete miscibility. It is known that Messrs. Ornstein and Zernike have deduced from their theory that the opalescence ought to be in $1/\lambda^2$ instead of $1/\lambda^4$ for the ordinary scattering; that is, during the passage through the opalescence, the scattered light ought to be seen less blue. We were unable to verify that law in the literature, but we deduce from the formula (1) other consequences, capable of experimental proof:

(1) By integration of the scattered light in all directions at the point of critical opalescence, formula (1) gives an infinite absorption coefficient.

(2) If one observes in two directions θ and $180° - \theta$ the same part of the beam, the ratio of the brightnesses would be according to (1) $1/tg^2\theta/2$, that is to say, 7 or 8 for θ near 40° (instead of 1 as in the theory of ordinary scattering).

(3) If we are not quite at the critical point, $-\partial p/\partial v$ does not vanish, and, if the incident beam is white, the scattered light in the direction θ (between 0 and 90°) ought to be bluer than that scattered in the direction $180° - \theta$.

We have tried to check experimentally these last two consequences, comparing by means of a simple optical apparatus the light scattered in two directions θ and $\pi - \theta$, symmetrical in respect to the beam. We ascertained that the brightnesses were the same on both sides, as well as the tint of the light, and that only so long as the observations were really made on a uniform phase of opalescence, before the precipitation of the 'critical fog,' which is, of course, no longer opalescence. Observations were made principally on a water-phenol mixture. The necessary optical adjustments were previously made with a solution of fluorescein in an identical container.

We made no measurement of the whitening of the critical opalescence; we had the impression it exists, but that it results more from the disappearance of Purkinje's effect than from an inherent cause.

It would therefore be a fault in the very ingenious theory of Messrs. Ornstein and Zernike which prevents them from getting the best out of their new principle: the influence of the cohesion forces on the fluctuations in density. We think we can see that fault when they *admit* a proportionality between the quantity $1 - F$ to $-\partial p/\partial v$ (see paper cited above), which means, they suppose that the classical theory of fluctuations in density is valid for big volumes, but not for small ones, and, specially, the mean square of the fluctuations might become infinite in a big volume and not in a small one: that is not at all certain.

Y. ROCARD.

Collège de France, Paris.

M. PONTE.

École Normale Supérieure, Paris.

The Velocity Coefficient for Bimolecular Reactions in Solution.

IN a paper of the above title, in the January *Journal of the Chemical Society*, Norrish and Smith have attempted to find a relation between second-order velocity coefficients for reactions between organic molecules in solution and the temperature coefficients of the reaction rates. As is well known, Hinshelwood has found that for second order gas reactions the rate of reaction can be found by multiplying the number of collisions between reactant molecules by a term $e^{-E/RT}$, where E is the experimentally determined energy of activation. Such an expression might arise from any of several mechanisms of activation and reaction. Norrish and Smith have now found that when it is attempted to calculate reaction rates in this same way for reactions in solution, the calculated rates are too large, and that a probability factor, P, must be introduced, which represents the chance of reaction at a collision involving activated molecules. The values found for P in a few reactions range from 4×10^{-11} to $4{\cdot}92 \times 10^{-5}$. The explanation which they offer for these very small values of P is that simple binary collisions seldom occur, and that a third molecule will often remove a portion of the energy and thus cause deactivation.

It seems to me that the effect of the third molecule should be activational in some cases, perhaps as often as it is deactivational, and that in any case the explanation of the small values found for P does not lie entirely in the frequency of ternary collisions. There are two other reasons, which were not suggested by Norrish and Smith, which would lead to small values of P, and to a great range of variation in these values. The first of these is the solvation of the reactant molecules, which should be expected to shield them from each other, reducing the chance of reaction upon collision by a factor which does not appear to be predictable. This effect should have a temperature coefficient, and there is thus the possibility that in some cases the value of E calculated from the overall temperature coefficient of the reaction will be too large; the calculated value of P would then be too large also, since the exponential term would be too small. An effect such as this is thus capable of accounting for large variations in the value of P.

The other reason why P should be small in all the reactions considered is to be found in the complexity of the reactant molecules. One of the reactions, for example, is between nitrobenzyl chloride and trimethyl amine. It is surely to be expected that a very special orientation at collision is a necessary condition for reaction in such a case; in the bimolecular gas reactions, which involve quite simple molecules, such as nitrous oxide, the orientation is of course of much less importance, but for these complex organic molecules a contribution to P of the order of 10^{-6} from this factor would not seem to be unreasonable.

There thus seems to be ample reason for expecting P to be small for reactions of the type studied by Norrish and Smith, and for it to vary markedly from one reaction to another, and even with change of solvent for the same reaction. There appears, however, to be slight chance of deriving even rough theoretical values. Indeed, the simple kinetic theory expression for the number of collisions is of doubtful validity in condensed systems.

Louis S. Kassel.
Gates Chemical Laboratory,
California Institute of Technology,
Feb. 22.

Clot Bey and the Cairo School of Medicine.

My attention has been directed to two paragraphs in the News and Views columns of Nature of Jan. 14 concerning the centenary celebration of the School of Medicine, Cairo, and the International Congress of Tropical Medicine and Hygiene. It is stated in those paragraphs that "The story goes that one afternoon the Viceroy Mohammed Ali was driving through the streets of Cairo on the way to Shubra Palace when he ordered his coachman to stop, and summoning a well-dressed Frenchman who was walking along the streets, informed the stranger that he wanted him to create a Medical School in Cairo. . . . Clot Bey, in spite of his ignorance of medicine, was an able man, who accomplished the task thus entrusted to him with conspicuous success, which was recognised later by the conferring of the M.D. degree on him by the University of Paris."

The facts are that Dr. Clot, who was already a qualified French medical man, was called in 1825 to come to Egypt to organise the Medical Service of the Egyptian Army. He was followed by 154 European medical officers and apothecaries. It was only in 1827, that is, two years after his arrival in Egypt, that he started the Medical School. There is at the School of Medicine most of the literature of the time bearing out the authenticity of these facts. Dr. F. M. Sandwith, in a paper on the history of Kasr-el-Aini Hospital, A.D. 1466–1901, that appeared in the records of the Egyptian Government School of Medicine in 1901, mentions the details of the foundation of the School and gives many references on the subject.

In view of these facts, I can scarcely imagine that there could be any authentic source for the romantic account of the foundation of the Cairo Medical School referred to above.

M. Khalil.
Faculty of Medicine, Cairo.

I am sorry that Prof. Khalil has demolished the romantic tradition of Clot Bey, which for many years I had firmly believed to be the true story of the founding of the Cairo School of Medicine. In extenuation of my lapse in giving a new and wider circulation to this myth, I should explain that the brief statement referred to summarised my recollection of an elaborate and very circumstantial story given me years ago, when the late Dr. Sandwith was writing his history, by men who seemed to speak with intimate knowledge and authority. I am willing to admit that the British members of the staff of the Cairo School of Medicine in those days included several raconteurs of quite exceptional inventiveness, but I never had any reason to assume that this narrative was not true. The whole point of the story, as I heard it, was to emphasise the argument that the high efficiency of a medical school such as Clot Bey had created in Cairo was due to his administrative ability and judgment in selecting the right men for his staff.

The Writer of the Notes.

The Correction of Astigmatism.

Even the more scientific members of the optical profession scarcely seem to be aware of their debt to mathematics for the discovery of the modern method of adjusting spectacle-lenses to suit astigmatic eyes. It is generally known that the first person to use cylindrical lenses for this purpose was Sir George Airy. During his tenure of the Lucasian professorship at Cambridge (1826–28), he had a pair of cylindrical lenses ground which corrected his own eye-sight. But we owe the complete general theory to a later Lucasian professor, Sir George Stokes (1849–1903), who was the first to prove mathematically that *any* eye (whether long-sighted or short-sighted) can be corrected for astigmatism (as well as these other defects) by using a lens which has one face spherical and the other cylindrical.[1]

To explain the importance (on the practical side) of Stokes's theorem, a few simple calculations may be added: an adequate outfit for an oculist may be taken to consist of 100 lenses (60 spherical and 40 cylindrical, the other faces being plane, in each case), combined with instruments to measure the

[1] For more details, any of the more advanced books, for example, Herman's "Geometrical Optics," ch. x. art. 174, may be consulted.

angle of rotation (of the second lens) round the line of sight. It is not very easy to give an exact estimate of the accuracy of the angles measured in practice; it would seem to vary from about 1° with high powers (5 to 7 diopters [2]) to about 5° with low powers ($\frac{1}{4}$ to $\frac{1}{2}$ diopter). As an *average*, we may perhaps assume that the apparatus admits of about 80 to 100 distinctive positions for the cylindrical lens; then the oculist has at his disposal the equivalent of

$$60 \times 40 \times 80 = 192{,}000$$

or

$$60 \times 40 \times 100 = 240{,}000$$

separate astigmatic lenses. In round figures, we may take the outfit as providing 200,000 lenses: and plainly, if each lens had to be ground separately, the cost of such an equipment would be prohibitive. Even at 1*s*. each, the cost would be of the order of £10,000; the actual cost of 100 lenses (at the same rate) would be £5, and we may perhaps add £5 to £10 to represent the cost of the instruments for measuring the angles of rotation. Further, the labour involved in choosing the lens best suited to a given eye would be increased very considerably; and much care would be required in storing the lenses, so as to be readily accessible when testing a patient's eyesight.

It was stated recently that more than a million pairs of astigmatic lenses are prescribed in Great Britain every year: but (without the discovery made by Stokes) it is doubtful if even a thousand pairs of eyes could be tested in the same time.

T. J. I'A Bromwich.

Cambridge, April 7.

[2] The diopter is the power of a lens the focal length of which is 1 metre: thus, when the centimetre is the unit of length, the diopter is represented by $\frac{1}{100}$.

Science and Nature.

Returning last week from attending an International Moral Education Conference at the Paris Sorbonne, where the ambiguity of philosophical and scientific terms in current use was considered as being a serious bar to true international understanding, it was with especial pleasure that I read Dr. J. E. Turner's letter in Nature of April 21. We did not, on this occasion, at the Sorbonne deal specifically with the word Nature, although we might well have done so in view of its notorious ambiguity. Dogmatism and ambiguity are generally contrasted, but they are nevertheless often allied.

May I direct readers' attention to John Stuart Mill's essay on Nature, which was published after his death. In this essay Mill contends that it would be difficult to find a word that is responsible for "more bad morality and bad law." He points out that a critical examination of all the confused uses to which this word has been put, reveals two main definitions:

1. That held by the early Greek and Roman philosophers, who enjoined, as a fundamental principle, that we should "follow Nature"; implying by Nature the entire system of things, including not only the blind physical and biological forces acting spontaneously, but also all human intelligence, belief, perception, understanding, and action. Mill argues that an injunction to follow Nature, thus comprehensively expressed, is obviously superfluous, seeing that no one could in any circumstances by any possibility do otherwise. He says, however, that to endeavour to understand Nature in that sense is another and indeed quite profitable task.

2. The popular definition, *Nature* considered as opposed to *art*: That is to say, *Nature* signifying the spontaneous course of blind physical and biological forces acting presumably in complete independence of human intelligence. Mill then argues that to follow this kind of Nature is clearly immoral, in that all the noblest human endeavours throughout the ages have invariably been directed towards stemming and counteracting its ruthless depredations. Mill makes this proposition clear by means of a large number of cogent and striking illustrations.

We must conclude, therefore, that Nature is often employed euphemistically as an evasive term, either to cover our ignorance or to express some passing feeling or predilection misconceived as a fundamental principle. When, more than fifty years ago, I was one of his devoted students, the great Thomas Huxley was wont to remind us that words and phrases were instruments of thought, not substitutes for clear thinking.

St. G. Lane Fox Pitt.

47 Chester Terrace,
London, S.W.1, April 24.

The Buoyancy of Whales.

In letters recently published in Nature (Mar. 17, p. 421; May 5, p. 710) Mr. R. W. Gray records the interesting fact that whales dying 'at a depth' invariably sink, while those (of certain species) which die at the surface always remain floating. He suggests that the failure to rise after death may be due to the escape of air from the lungs, and in his second letter he attributes this to the water-pressure, which at a certain depth becomes sufficient to overcome the resistance of the valves of the blow-holes.

It does not seem probable that these statements are based on actual observation of the escape of air, and I think the explanation should not be accepted unless Mr. Gray can bring forward definite evidence that his suggestion is correct. He has informed us that a Greenland Whale barely floats after death at the surface, and it follows that its specific gravity does not differ greatly from that of sea-water. At considerable depths, whether the animal be dead or alive, the volume of its thorax must be appreciably reduced by the pressure of the water. The diminution of size involves an alteration of the specific gravity, which might well become greater than that of the water, in which case the dead whale would remain at the bottom. The fact that the carcase may rise to the surface later, after gases of decomposition have generated in the tissues, does not seem to preclude this suggestion.

The statement (p. 710) that when a whale wishes to sink it compresses its lungs is also open to criticism. I think it descends by swimming downwards, and it seems unnecessary to assume that it must deliberately alter the size of its thorax before it can leave the surface.

In another issue (April 14, p. 576) Mr. T. H. Taylor suggests that the filling of the lungs of whales may be due to the elastic recoil of the thoracic wall and not to a muscular effort. Is this not also improbable? The diaphragm is highly developed in the Cetacea, and definite evidence is surely required before it can be concluded that its function is not the same in these and other mammals. The extent of its projection into the cavity of the thorax (in the dolphins at least) should make it specially efficient in enlarging the chest by its contraction. The ribs of a large whale are, moreover, so heavy and massive that it is difficult to imagine an elastic recoil of sufficient force to expand the cavity of the thorax fully. There is no difficulty in supposing that the movement of the ribs during the act of inspiration is due to muscular action, as in other mammals.

Sidney F. Harmer.

Melbourn, Cambs.

An Optical Paradox.

The paradox propounded by Mr. T. Smith in Nature of Feb. 25 lays emphasis upon an important aspect of physical measurement and demands explanation. The considerations recorded in Nature of April 7, in the letters of Dr. Campbell and Mr. Smith, leave the question unsettled, and I venture to give an explanation which would appear to be less forced and touches principally the process of reasoning.

The solution to the paradox seems to lie in a critical regard for the nature of the identity which is implied by equality. The sense datum upon which the experiment ultimately depends is the direct perception of relative dissimilarity of the contributory sensations. In the absence of perceptible dissimilarity the derived judgment is arrived at, stating the equality of the two stimuli. At each successive observation the observer perceives the same appearance, and in effect asserts the absence of the sensation of what can be referred to as contrast. (Proceeding otherwise he might, as in other methods of photometry, estimate and compare degrees of contrast.)

Now it is elementary knowledge that in any calculus of reasoning a relation of equality subsists between given entities by virtue of the identity under certain conditions of certain essential properties stated in the definition of the equality. In the present case the statement of equality proceeds from the inferred identical similarity of the contributory sensations, this step in arriving at the final judgment of the observer being legitimate if it be premised that insensible increments in stimulus do not affect sensation. This would be granted unless it were proposed to modify arbitrarily the connotation of terms.

Although, however, the equality may be regarded as established by this means, it should be noted that no relation between the properties not involved in the identity is established. The step made in concluding that, physically regarded, such properties as, for example, the candle power are the same is thus not rigorously supported by the observational data, and in extending the relation to these properties in order to render their physical measurement possible a logical *non sequitur* is incurred. This is the fallacy which gives rise to the paradox.

J. W. Perry.

London, N.W.1.

Lucretius's Anticipation of Mendelism.

In his review of the new edition of Munro's translation of Lucretius, in Nature for April 14, Prof. D'Arcy Thompson refers to the many scientific 'anticipations' that are to be found in that wonderful poem, which has fossilised, so to speak, some fragments of the lost world of ancient wisdom. I have never seen any mention made of a passage in the "De Rerum Natura" in which the three fundamental postulates of Mendelism are laid down as the rules of heredity, and I think it deserves to have attention directed to it.

The passage is in Book 4, ll. 1210 *et seq.*, and in the 1898 Cambridge edition of Munro's translation it runs as follows:

"Sometimes the children may spring up like their grandfathers and often resemble the forms of their grandfathers' fathers, because *the parents often keep concealed in their bodies many atoms mixed in different ways*, which, *first proceeding from the original stock one father hands down to the next father*, and then *from these Venus produces forms after a manifold chance*, and repeats not only the features but the voices and hair of their forefathers."

The three italicised passages enunciate (seriatim)

(*a*) The principle of recessive (and by implication, of course, of dominant) characters.

(*b*) The constitution of the organism out of combinations of immutable unit characters.

(*c*) The chance recombination of these in mating.

R. C. McLean.

University College,
Cardiff.

Stellar Radiation and the Nature of the Universe.

The difference between theory and practice is admirably illustrated by our solid, three-dimensional brain-minds theorising about fourth and other dimensions of space and 'matter,' and yet visualising a cyclic universe the radiations of which are related only to the superficies of matter! It seems that most of us are still unable to form actual conceptions of the *depths* of space as a condition different from the depth of a three-dimensional form of physical matter in space. Tyndall believed that the sum of Nature's energy is constant, and that "the utmost man can do in the pursuit of physical truth or in the applications of physical knowledge is to shift the constituents of the never-varying total . . . *the flux of power is eternally the same*." Tyndall surely did not imply by this that "just as much matter is created as destroyed" (Nature, April 28, p. 674). He seems to distinguish the constituents from the *flux* of power with which, say, a sixth-dimensional mind might be quite happy without our physical constituents.

We are in equal darkness regarding both the origin and destiny of radiation, stellar or otherwise. From what interiors of space or matter come the 'flux of power' or the rays investigated by physicists? Into what 'depths' do they disappear by transmutation, electro-magnetic exchange, quantum action, or by 'actions' unknown on this planet?

W. W. L.

April 28.

Prices of Periodical Scientific Publications.

The letters of Dr. Baini Prashad and Mr. Wilfrid Bonser in Nature (Mar. 31 and April 7) directing attention to the prices of certain German scientific periodicals, particularly those published by the firm of Julius Springer, Berlin, are very timely; for to many libraries the question whether they can afford to continue to purchase such periodicals must be a serious one. The Library Committee of this University has had the matter under consideration more than once in the course of the last year or two; for in view of the high cost of several of these periodicals, taken by the Library, the Committee has not infrequently been compelled to forego the purchase of important biological works. One is naturally reluctant to discontinue subscribing to periodicals of long standing and established reputation, but for many libraries and institutions with limited funds at their disposal for the purchase of biological books, this would seem to be the only way out of the difficulty. It is to be hoped that the present high charges for the journals in question will be speedily reduced.

F. C. Nicholson.

University Library,
Edinburgh.

Conversion in Science.[1]

By Prof. G. Elliot Smith, F.R.S.

On Nov. 13, 1859, eleven days before the publication of "The Origin of Species," Darwin wrote: "If I can convert Huxley, I shall be content."

Before his work was published Darwin fully realised the difficulties of the task he was undertaking in trying to convince his fellows of the reality of evolution. Hence he was anxious to secure the help of Hooker, Lyell, and Huxley. When we recall the obstacles that throughout the ages have ever hindered the advancement of learning, and in particular the efforts of isolated pioneers to obtain recognition for views that ran counter to strongly entrenched traditions, we can appreciate Darwin's good fortune in securing the sympathetic consideration of three such exceptional men as Sir Joseph Hooker, Sir Charles Lyell, and Thomas Henry Huxley. Different as they were in temperament and mental attitude, each of them in his own department was endowed, not only with wide and exact knowledge, but also with rare powers of clear insight and sound judgment. If he could convert Lyell, Hooker, and Huxley, Darwin knew that the future could take care of itself.

There never was any doubt about Hooker's attitude: for he had been so intimately associated with Darwin in the building up of the argument that they may be said to have kept step in the advance. But Lyell and Huxley had yet to be won over. If Lyell did not give his active support to the great scheme until the battle was won—largely as the result of Huxley's persistent championship—it must not be forgotten that his book, "The Principles of Geology," was, as Huxley expressed it, "the chief agent in smoothing the road for Darwin."

> "It brings home to any reader of ordinary intelligence a great principle and a great fact—the principle that the past must be explained by the present, unless good cause can be shown to the contrary; and the fact that so far as our knowledge of the past history of life on our globe goes, no such cause can be shown."

Huxley finished reading the proof of the "Origin" two days before the book was published, and on the following day Darwin received his verdict in these words: "I think you have demonstrated a true cause for the production of species, and have thrown the *onus probandi*, that species did not arise in the way you suppose, on your adversaries."

It is difficult for us at the present time to appreciate Huxley's reluctance to accept the fact of evolution. For once the morphological similarities of nearly related animals were appreciated, and the essential identities in ontogeny were admitted, what explanation was possible other than the recognition of a common origin? The idea of evolution was of course familiar to him, and had been the subject of repeated discussions with Herbert Spencer and others.

In his essay on "The Reception of 'The Origin of Species'" Huxley has given a characteristically frank account of his own conversion. While he "had long done with the Pentateuchal cosmogony," even the persistence and the dialectic skill of Herbert Spencer were impotent to persuade him to admit the reality of evolution. He justifies his stubborn refusal, not because the unconvincing arguments of Lamarck and the author of "Vestiges of Creation" antagonised him, for, as Dr. Chalmers Mitchell clearly showed in his Huxley Memorial Lecture a year ago, Huxley had a peculiarly keen sense of logic and cogency, but because "the evidence in favour of transmutation was wholly insufficient, and no suggestion respecting its causes had been made which was in any way adequate to explain the phenomena." He did not accept the hypothesis of natural selection as the adequate explanation: but Darwin's insistence on the facts revealed by selective breeding of domestic animals and plants convinced Huxley of the possibility of finding natural factors to establish the fact of transmutation. No longer did he harbour any doubt as to the reality of evolution. To quote his own words:

> "I imagine that most of those of my contemporaries who thought seriously about the matter were very much in my own state of mind—inclined to say to both Mosaists and Evolutionists, 'A plague on both your houses!' and disposed to turn aside from an interminable and apparently fruitless discussion, to labour in the fertile fields of ascertainable fact. And I may therefore suppose that the publication of the Darwin and Wallace paper in 1858, and still more that of the 'Origin' in 1859, had the effect upon them of the flash of light which, to a man who has lost himself on a dark night, suddenly reveals a road which, whether it takes him straight home or not, certainly goes his way. That which we were looking for, and could not find, was a hypothesis respecting the origin of known organic forms which assumed the operation of no causes but such as could be proved to be actually at work. We wanted not to pin our faith to that or any other speculation, but to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested. The 'Origin' provided us with the working hypothesis we sought. Moreover, it did the immense service of freeing us for ever from the dilemma—Refuse to accept the creation hypothesis, and what have you to propose that can be accepted by any cautious reasoner? In 1857 I had no answer ready, and I do not think that anyone else had. A year later we reproached ourselves with dullness for being perplexed with such an inquiry. My reflection, when I first made myself master of the central idea of the 'Origin,' was 'How extremely stupid not to have thought of that!' I suppose that Columbus' companions said much the same when he made the egg stand on end. The facts of variability, of the struggle for existence, of adaptation to conditions, were notorious enough; but none of us had suspected that the road to the heart of the species problem lay through them, until Darwin and Wallace dispelled the darkness, and the beaconfire of the 'Origin' guided the benighted."

This illuminating confession is the clearest and

[1] From the Huxley Memorial Lecture, delivered at the Royal College of Science, South Kensington, on May 4.

most searching analysis we have of the factors that play a part in the process of conversion in science. Huxley was a man of rare insight and courage: he had at his command all the information that was necessary to convince him, not only of the reality of evolution, but also of the fact that man could not be left out of the scope of the process of transmutation once he accepted it. Yet he held back. He needed a working hypothesis to convince him of the possibility that transmutation might be effected by some natural process.

Huxley's great service to learning was not simply the fact that once he was convinced of the truth of evolution he devoted himself to the task of converting the world of educated men and women, but that he concentrated attention upon the problem of man's status. By so doing he effected perhaps the greatest revolution that has ever been effected in the attitude of mankind to knowledge in general, for all learning is inevitably centred upon man and his relationship to the Universe.

It is the human aspect of the problem that I specially want to study in this lecture.

It is one thing to convert men of exceptional insight and understanding such as Hooker, Huxley, and Lyell, but quite a different matter to convince men of average ability. Darwin complained that he "found the most extraordinary difficulty in making even able men understand at what he was driving" (letter to W. B. Carpenter, 1859). In particular was he distressed by the unfair and ignorant criticisms of opponents who failed to understand his theory. In December 1860 he was forced to admit: "I can pretty plainly see that if my view is ever to be generally accepted, it will be by young men growing up and replacing the old workers, and then young ones finding that they can group the facts and search out the new lines of investigation better on the notion of descent than on that of creation." This is true of all learning that is coming for the first time under the influence of the scientific discipline. Its hope is in youth and the coming generation rather than in men already involved in the shackles of conventional views, who, as Anatole France expressed it, "are no longer curious."

This is a true picture of what usually happens in any progressive movement. The number of men competent to understand a new generalisation and apply it in practice is lamentably small. As Darwin confessed, we have to look at young men, who are free from traditional obsessions and are ready to embark on new adventures that seem hazardous to their elders. Before their views become set in a rigid mould men would welcome hypotheses that provide satisfying explanations of the growing knowledge and provocative ideas to stimulate new inquiries.

The two great obstacles that stand in the way of the acceptance of a new interpretation of evidence are exemplified in the cases of Lyell and Huxley. The former was hampered by tradition, the force of which it took eight years to overcome. Huxley was no longer under the influence of such restraints against clear thinking. His only reason for hesitancy was the fact that he could not imagine how evolution could be effected by known natural agencies. Hence when Darwin put forward a hypothesis to supply what was lacking, Huxley's conversion was, as he himself has explained, instantaneous.

Huxley has discussed with characteristic clearness and decision the much-misunderstood function of working hypotheses in science. I make no excuse for quoting him once more on a subject so directly relevant to my present argument.

In the preface to the English edition of Haeckel's book on "Freedom in Science and Teaching" (1879) he wrote:

"No profound acquaintance with the history of science is needed to produce the conviction that the advancement of natural knowledge has been effected by the successive or concurrent efforts of men whose minds are characterised by tendencies so opposite that they are forced into conflict with one another. The one intellect is imaginative and synthetic; its chief aim is to arrive at a broad and coherent conception of the relations of phenomena; the other is positive, critical, analytic, and sets the highest value upon the exact determination and statement of the phenomena themselves.

"Every science has been largely indebted to bold, nay, even to wild, hypotheses, for the power of ordering and grasping the endless details of natural fact which they confer; for the moral stimulus which arises out of the desire to confirm or to confute them; and last, but not least, for the suggestion of paths of fruitful inquiry, which, without them, would never have been followed. From the days of Columbus and Kepler to those of Oken, Lamarck, and Boucher de Perthes, Saul, who, seeking his father's asses, found a kingdom, is the prototype of many a renowned discoverer who has lighted upon verities while following illusions which, had they deluded lesser men, might possibly have been considered more or less asinine.

"Nor have I, for one, anything but cordial assent to give to his declaration, that the modern development of science is essentially due to the constant encroachment of experiment and observation on the domain of hypothetical dogma; and that the most difficult, as well as the most important, object of every honest worker is 'sich entsubjectiviren' to get rid of his preconceived notions, and to keep his hypotheses well in hand, as the good servants and bad masters that they are."

Assuming the rôle of champion of evolution, Huxley boldly attacked the most contentious issue and made "Man's Place in Nature" the cardinal issue of the conflict. The particular field that Lyell avoided, Huxley selected as his chosen battle-ground. In putting man into the centre of the picture Huxley was doing again, though in a vastly different way, what the French humanitarians did in the eighteenth century. Rousseau wrote in 1754: "The most useful and least advanced of all human knowledge seems to me to be that of man himself." However paradoxical this statement may seem, there can be no question of its truth. The question of man's origin and history, and the interpretation of human nature and behaviour, are problems that vitally affect and interest every human being. The essential subject matter of ethnology necessarily comes within the knowledge of every human being. Each individual is aware of his own thoughts and actions, and is vitally interested in the behaviour of his fellow men and women. Everyone therefore knows from his own experience the essential truth concerning the great problems concerning which scholars have been wrangling for two centuries. Why then, it will be asked, is there any difference of opinion when everybody knows the truth? The answer to this query is provided by the history of the last two centuries, for to-day the truth is still obscured by the survival of the old conflict between the followers of Descartes and those who adopted the discipline of Newton.

In the remote past, all inquiries, whether astronomical or chemical, botanical or zoological, mathematical or physical, were essentially anthropocentric. In most early speculations what man was striving after was not knowledge, but the means of safeguarding his own life and prosperity. After the demolition of astrology, when this crude type of anthropocentrism was superseded, the attainment of the strict discipline of the scientific method was determined by the extent by which men could eliminate human emotions from their inquiries.

Huxley's achievement differed profoundly from the early revolutions in thought. While the latter aimed at subordinating the forces of Nature for man's benefit, Huxley's object was to assign man to his true place in Nature, and to discover his origin as a part of the natural processes. But his interest was not restricted to the biological aspects of the problem. He boldly plunged into the discussion of the cultural aspects of anthropology and, although he quoted the familiar phrase that had been handed down from the Cartesian scholiasts of the eighteenth century, he refused to accept the theory of "the similarity of the working of the human mind" as an adequate explanation of anything more than the simplest of inventions. Writing in the same year (1865) Mr. (afterwards Sir Edward) Tylor spoke with equal emphasis in favour of diffusion as the only possible interpretation of the facts; but in 1871 a subtle change was taking place in his opinions. Then he was admitting in the preface of his "Primitive Culture" the fact of his indebtedness to Adolf Bastian. While criticising in the most scathing terms, and with a wealth of forcible illustrations, his contempt for those who had pretended to ignore the historical method and the principles of diffusion of culture, Tylor himself was drifting towards the very views he was denouncing. He was developing his theory of animism (that there was an innate tendency in mankind to attribute life and soul to inanimate objects around them), and this enunciation of a 'natural law' brought about a sudden lapse into the Cartesian error, from which ethnology is still suffering.

It is a thousand pities that, when Tylor thus abandoned the Newtonian discipline, Huxley did not continue to insist upon the true principle of ethnology which he defined so clearly in 1865. But he was too fully occupied with biology to have time for ethnology, which he left to Tylor.

I have already referred to the important part played by Lyell's principle of continuity in geology in preparing the way for the acceptance of biological evolution. Yet a century before Lyell's time, essentially the same principle of continuity had been confidently applied to human affairs by Turgot, in words described by the late Lord Morley,[2] as "among the most pregnant, as they were among the most original, in the history of literature, and reveal in an outline, standing clear against the light, a thought which revolutionised old methods of viewing and describing the course of human affairs, and contained the germs of a new and most fruitful philosophy of society." The tragedy is that the true philosophy of society enunciated by Turgot in 1750 did not revolutionise old methods of viewing and describing the course of human affairs. In spite of Lord Morley's appreciation, as just as it is eloquent, of the greatness of Turgot's achievement, men failed to apply his teaching for the salvation of humanistic studies. It is, in fact, the most urgent need of ethnology at the present time that this long-delayed reform should begin. Turgot contrasted the operation of the laws of Nature with the behaviour of mankind.

"The phenomena of nature, subjected as they are to constant laws, are enclosed in a circle of revolutions that remain the same for ever! . . . The succession of men, on the contrary, offers from age to age a spectacle of continual variations. Reason, freedom, the passions, are incessantly producing new events. *All epochs are fastened together by a sequence of causes and effects, linking the condition of the world to all the conditions that have gone before it.* The gradually multiplied signs of speech and writing, giving men an instrument for making sure of the continued possession of their ideas, as well as of imparting them to others, have formed out of the knowledge of each individual a common treasure, which generation transmits to generation, as an inheritance constantly augmented by the discoveries of each age; and the human race, observed from its first beginning, seems in the eyes of the philosopher to be one vast whole, which, like each individual in it, has its infancy and its growth." (Lord Morley's Translation.)

This is a clear and definite statement of the principles of diffusion of culture, for the recognition of which some of us are still fighting to-day, more than one hundred and seventy years after Turgot.

Two centuries ago Fontenelle, the enthusiastic disciple of Descartes, was expounding the facts of human society in terms of his master's idea of "natural laws," and was pouring scorn on the historical method and the principle of continuity. In Scotland, where Cartesian philosophy retained a hold long after it had been replaced by the Newtonian discipline in England, and even in France, the ethnological teaching of Fontenelle survived the criticism of Turgot, and in 1777 was given a concrete form by Dr. William Robertson, Principal of the University of Edinburgh, in his "History of America." He maintained that the ancient civilisation of America was of independent origin; and in support of his speculation he referred to "such a resemblance in their manners and customs as necessarily arises from a similarity

[2] Lord Morley, in his article on Turgot in "Biographical Studies."

of their condition," a form of phraseology which, after nearly a century of half-hearted lip service, suddenly acquired the force of a dogma, when, having been revived by Adolf Bastian in 1860, it was adopted in 1871 by Sir Edward Tylor. Thus modern ethnology was brought under the influence of Cartesian philosophy.

Since Newton rescued astronomy and physics from the stranglehold of Descartes' method, every branch of science in its turn has been emancipated. Ethnology alone remains in the bonds of such superstition. For more than a century, it is true, men continued to render lip service to Turgot's recognition of the fundamental factors underlying human institutions, without, however, applying them with full understanding and consistency. Under the influence of Lyell's revival of the idea in reference to geology, Tylor in 1871 reaffirmed the fundamental importance of the principle of continuity and the historical method as the essential factors in the interpretation of the facts of ethnology. Thus in the first edition of "Primitive Culture" he wrote:

> "The notion of the continuity of civilization is no barren philosophic principle, but is at once made practical by the consideration that they who wish to understand their own lives ought to know the stages through which their opinions and habits have become what they are (p. 17). History, taken as our guide in explaining the different stages of civilization, offers a theory based on actual experience. This is a development-theory, in which both advance and relapse have their acknowledged places. But so far as history is to be our criterion, progression is primary and degradation secondary; culture must be gained before it can be lost. Moreover, in striking a balance between the effects of forward and backward movement in civilization, it must be borne in mind how powerfully the diffusion of culture acts in preserving the results of progress from the attacks of degeneration. A progressive movement in culture spreads, and becomes independent of the fate of its originators" (p. 34).

Just as Huxley and Darwin in 1860 had to expose the fallacy that evolution did not necessarily imply progress, so Tylor had to explain, as Turgot had already done in 1750, that there is in man no innate impulse to compel him to embark on what we call progress. Yet this very error is the fallacy underlying present-day speculation. By a strange irony this reaffirmation of the sound principles that should find expression in all humanistic inquiries occurs in a book that was reviving the appeal to 'constant laws,' against which Turgot protested. For by claiming that mankind as a whole display an innate tendency to develop animistic beliefs Tylor was inventing a 'law of Nature' for which there is no evidence. While referring to this flagrant defiance of the principle of continuity, one is tempted to quote Tylor's own warning. For the learned author of "Primitive Culture" himself discusses (vol. 1, pp. 378 and 379) with characteristic frankness the curious phenomenon that ethnologists enunciating certain views often cite evidence stultifying their own opinions. After giving specific illustrations of this neglect of logical consistency he makes this interesting comment: "Such cases show how deceptive are judgments to which breadth and generality are given by the use of wide words in narrow senses."

The late Sir Edward Tylor thus missed the great opportunity of giving full expression to the principles enunciated by Turgot. He was deflected from his purpose by his enthusiasm for the theory of animism—a lapse into the methods of Cartesian scholasticism that was fatal to a consistent exposition of the Newtonian method which Turgot had introduced into the study of mankind. If Tylor had not indulged in the speculation in animism that led him to accept the revival of this type of scholasticism by Bastian, he might have revolutionised the whole range of humanitarian studies, and have achieved in ampler measure what Lecky claimed for the great teachers of the seventeenth century, "destroying the old prejudices, dispelling illusions, rearranging the various parts of our knowledge, and altering the whole scope and character of our sympathies."

Air Conditioning in Industry.

By N. E. JACKSON.

AIR conditioning, as the term implies, is the treatment of air necessary to give certain conditions of heating, cooling, moistening, or drying of air contained in a given space. It may be more exactly defined as the application of scientific principles and engineering practice for the obtaining of specified and predetermined physical effects upon materials, human beings, or the atmospheric conditions in buildings, by treatment with air the temperature, humidity, and purity of which is definitely controlled. This treatment must, however, only be regarded as a means of securing a certain objective, either physiological effects on human beings, or physical effects on materials.

The general properties of air are well known. It should, however, be clearly understood that air is capable of very extensive treatment, such as heating and cooling, humidifying and dehumidifying. Its avidity for moisture is considerable; the higher its temperature, the more water vapour it is capable of absorbing. Thus at a temperature of 45° F., one cubic foot of air when saturated holds in suspension 3·44 grains of moisture. At 100° F., one cubic foot of saturated air holds 19·98 grains of moisture in suspension.

Air conditioning is resorted to in a great many important industries which require special atmospheric conditions for the carrying out of some of the many processes involved. A few of its applications are enumerated below.

ARTIFICIAL SILK.

In this more recent and highly specialised branch of the textile field, correct atmospheric conditions are absolutely essential. Fairly high humidities coupled with moderately high dry-bulb temperatures are required in the spinning rooms, otherwise crystallisation of the filament is likely to occur. In the reeling rooms, similar conditions must be maintained to avoid breakage of the yarn, whilst the sorting rooms must certainly be conditioned to ensure the silk maintains its correct moisture content, 11 per cent. of its weight being the maximum permitted.

Dryers.

Dryers, generally constructed on the tunnel principle, are used in many trades, both with the object of speeding up production and ensuring uniformity of product.

In the brickmaking industry dryers are very essential, and when it is realised that a 10 lb. brick may contain from ¾ to 1¼ lb. of initial moisture, it is seen that for maximum output something more than natural drying by wind and sun is necessary. The time taken to dry bricks on the shed floor is 50 per cent. longer than with a modern tunnel dryer, and the cost of shed floor drying twice as great as with the modern apparatus; so in this trade the advantages of progressive drying are very obvious.

In timber drying by artificial means greater production (that is, more rapid seasoning) and a more uniform product are obtained. In progressive drying by hot air, the wet or 'green' material enters the dryer at the opposite end to the hottest air, so that the material is dried out gradually. If the reverse process is followed (as might be thought advisable on first consideration), the hotter air has a tendency to dry only the surface of the material, leaving the interior still wet.

The table following gives some of the more important articles in everyday use and their respective drying temperatures and length of time required for efficient drying.

Table I.

Drying Conditions.

Material.	Temp. (Degrees F.).	Drying Period.
Leather and hides	90°	2 to 6 days
Starch and salt	180°–200°	12 hours
Dried fruits	140°–180°	6 hours
Tobacco	85°–200°	..
Soap	100°	2 days
Wood (average timber)	105°	..
Rags	180°	18 hours
Pottery	120°	..
Bricks	150°–200°	30 to 60 hours
Cereals	180°	..
Beans and rice	140°–150°	..
Sugar (cane)	150°–200°	20 to 30 minutes
Coffee	160°–180°	24 hours
Glue	70°–90°	2 to 4 days
Paper	140°–150°	..
Rubber	80°–90°	1 to 2 weeks
Wool	105°	..

It will be noticed that in no case does the temperature at which drying is carried out exceed 200° F., whilst the drying periods vary enormously with the different products dealt with.

Food Stuffs.

Cool air is very essential for rapidly cooling pastry in order to prevent the contents of pies, and so on, from soaking into the pastry and spoiling its appearance, therefore making it unmarketable. In the fermenting department of a brewery a ventilating and cooling plant is very necessary, a large volume of cooled air being required to disperse rapidly the carbon dioxide given off from the vats, and to keep the temperature in this department below 66° F. to prevent the yeast going bad. Again, in the manufacture of chocolates with fancy fillings, after these have been coated with hot liquid chocolate they are placed on trays, and cleaned and purified air is blown over the trays. The air must be cooled in warm weather, the temperature in the coating department not being allowed to exceed 65° F., or a damaged and therefore unsaleable product results.

There are numerous other processes in food preparation that can only be properly carried out by the provision of air-conditioning equipment, generally automatically controlled to ensure exact temperature and humidity requirements.

Heating and Ventilating Buildings.

Many buildings are nowadays heated by the delivery of previously warmed air through a system of ductwork to the various rooms, the advantage being that rooms are heated and at the same time ventilated, instead of depending upon the opening of windows for ventilation, and on individual radiators or steam or hot-water pipes for the heating. The ideal system of heating by warm air is one which incorporates the previous moistening of the air, thus raising its relative humidity and preventing the parching effect of heated air, which, if not properly humidified, causes excessive evaporation of moisture from the skin of the individual.

Certain temperature and humidity conditions have been advocated by the medical profession as being most suitable for human requirements. Generally, in Great Britain, a room should be heated to a temperature between 55° F. and 65° F., the relative humidity ranging between 50 per cent. and 63 per cent. It is only by the maintenance of temperatures and humidities within the given range that ideal healthy conditions prevail in rooms occupied by human beings. By providing correct artificial atmospheres, the working efficiency of occupants of offices, etc., is considerably increased, there is less absence due to illness, and a great minimising of the tendency to respiratory and catarrhal diseases, so prevalent in overcrowded cities and manufacturing towns. In hospitals there is far less risk of contagion where there is a plentiful supply of fresh air at a suitable temperature.

(*Continued on p.* 763.)

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Research on the Control of Aeroplanes.[1]

By Prof. B. MELVILL JONES.

AN essential factor in the control of anything, whether it be a motor-car, a ship, or an aeroplane, is some means of applying the necessary force in the desired direction. The car requires its steering wheel, the ship its rudder. But this is not the only factor which decides the character of the control, whether quick or slow, difficult or easy. Other factors inherent in the craft to be controlled have to be considered. One such factor is inertia. A motor-car has very little inertia compared with the forces which can be exerted through the road wheels; consequently, it responds at once to a movement of the steering wheel, and the turning stops immediately the wheel is centralised. A ship has great inertia compared with the force exerted by the rudder; consequently the rudder must be applied some time before an appreciable turn is started, and reversed *against* the movement long before the ship has swung to its new course. The character of the control of a ship is thus entirely different from that of a car, on account of this factor of inertia, which has nothing to do with the controls themselves.

Another factor is the stability or instability of the motion when the controls are not moved. A stable motion is one which, if slightly disturbed, will settle back into its original form; an unstable motion is one which, after a slight disturbance, will depart further and further from the original form. In a modern car, the pivots about which the wheels turn in steering are arranged like the casters of a chair, so that the wheels have a slight tendency to turn to the side towards which the car is trying to slip. If the car moves round a curve, the centrifugal force makes it try to slip outwards, and the wheels, left to themselves, turn outwards and straighten the path. Such a car is stable and easy to drive straight; if the wheels had the opposite tendency, it would be unstable, and the driver would have continually to be correcting tendencies to swerve to one side or the other. An unstable car is not impossible to control, and may even, by practice, come to be controlled by unconscious reflex action, with no more fatigue than is felt in walking, but experience has shown that it is better to make it stable. It should not, however, be too stable, for then it will be heavy to steer round corners at high speeds, when the centrifugal force is large, and it will try to run down hill, so that, when travelling on the side of the camber of the road, it will have continually to be held out of the ditch.

The motor-car thus illustrates some important points which are common to the control of any kind of craft: although the control of an unstable craft may not be impossible, stability is on the whole desirable, but too great stability may introduce other undesirable qualities and may be as bad or worse than instability. A condition which might be described as benevolent neutrality is generally sought.

Again, a craft may be stable, in the sense that it tends to return when disturbed from a straight path, but it may overshoot on the other side farther than the original deviation, so that an oscillation of increasing magnitude may arise. Such an increasing oscillation is said to contain a negative damping term. Conversely, an oscillation which tends to decrease is said to contain a positive damping term. An example of a negatively damped oscillation occurs when a yacht's dinghy, loaded by the bows, is towed by a short rope. As the tow rope is shortened the dingy starts to yaw from side to side with increasing violence and may ultimately be swamped.

A negatively damped oscillation is difficult to control; an inexpert hand on the controls generally makes it worse. It is even possible to convert a truly stable motion into an increasing oscillation by inexpert use of the controls; this is generally due to lag, or the time interval between the impulse to control and the muscular response.

Long before successful man-carrying aeroplanes were developed, a division of opinion on matters of control was apparent. One side, which contained on the whole the practical men who tried to fly themselves, was mainly concerned with providing control organs and acquiring the skill to use them.

[1] Discourse delivered at the Royal Institution on Friday, Feb. 10.

The other side, which contained mainly the theorists and the constructors of uncontrolled models, were mainly concerned with the stability of the uncontrolled craft. This division of opinion continued well into the War, and traces of it are still present. A short historical sketch of this controversy may serve to make the present situation more clear, and the sketch can be used to illustrate certain important points in the control problem.

The great problem before the protagonists of the control school was to remain alive long enough to achieve sufficient practice and to perfect their apparatus. Their difficulty was greater than they could guess. Nature laid a trap for them, the full cunning of which we are only just beginning to realise. To understand this trap we must look a little into the matter. The first essential of steady flight is that the air shall exert a lift on the wings equal to the weight of the aeroplane. This lift depends upon speed through the air and upon the incidence, or angle, at which the wings strike the air. A typical relationship is shown in Fig. 1. If, in this example,

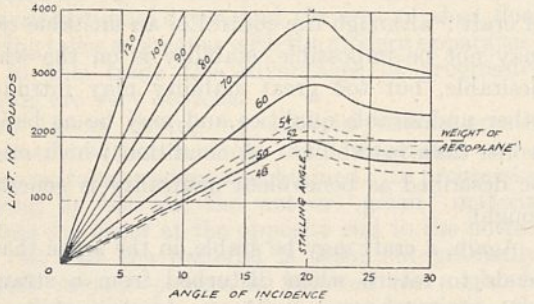

FIG. 1.—The aerodynamic lift, at different speeds and wing incidences, of an aeroplane which stalls at 50 miles per hour. (Numbers on curves show speed in miles per hour.)

the aeroplane weighs 2000 lb., it cannot be supported at speeds less than 50 m.p.h. At high speeds support can be obtained at a small incidence, but if the speed drops slowly towards 50 m.p.h., a point is reached at which the incidence will have to increase rapidly, and just above 50 m.p.h. flight will be possible at two alternative incidences, one considerably larger than the other. The minimum possible speed is called the stalling speed; the critical incidence, at which the minimum speed is just possible, is called the stalling incidence, and an aeroplane flying above this incidence is said to be stalled. So long as the speed is considerably greater than the stalling speed, the achievement of stability and control is relatively easy, but as the speed falls and the stalling angle is approached, changes occur in the air-flow about the wings which, unless special precautions are taken, render the aeroplane violently unstable and simultaneously destroy the power of control.

Now the nature of the trap is perceived. The early pioneers perhaps succeeded, with the help of the wind, in taking off at a speed greater than the stalling speed, which for their machines was very low. Possibly they carried out many flights without stalling and, delighted with the ease of control, were emboldened, on some favourable day, to glide to a considerable height above the ground. Sooner or later they were bound to stall and, if high up at the time, to kill themselves; for the motions following a stall are peculiarly violent, and liable to lead to heavy impact with the ground.

Herein lay the wisdom of the Wrights, the greatest exponents of the control school of thought. Warned by the experience of others, they suspected some such trap, and never in all their early work allowed themselves to get more than a few feet from the ground. They must have experienced the stall or the approach to the stall, for they discovered what is now known to be the simplest, though not the only counter to it—a powerful rudder. That was the turning-point in aeronautics, when the Wrights managed to get trained in control without being trapped and killed by the stall. After this, increased engine power and experience enabled the stall to be avoided more easily, and deaths from this cause became relatively less frequent, though it has still remained the principal cause of fatal accidents up to the present time. Early progress, however, lay all in the improvement of normal flight, and the study of the stalled condition was not taken up seriously until after the War.

The Wrights achieved their success with an aeroplane which was definitely unstable in several ways, counteracting the effects of this instability by acquired skill. Early design naturally followed this lead, and stability came to be regarded by many of the pioneer flyers as of no practical interest and indeed as a kind of bogy, invented by scientists for their own glorification. After a few important but not fundamental changes from the form in which the Wrights created them, control organs crystallised by about 1911 into a form typified by the BE 2 Aeroplane, produced in the Government Factory at Farnborough, under the guidance of Geoffrey de Havilland. Since that time the method of control, except for the introduction of balancing devices to lighten the pilot's effort on large aeroplanes, has scarcely altered, and the interest in the story shifts to the side of stability.

In 1896, Langley had worked out the general principles of stability sufficiently to make a model, driven by a small steam engine. This model was so stable and well balanced that it flew a distance of more than three-quarters of a mile.

About the same time, Lanchester, working with smaller gliding models, succeeded in unravelling the complicated factors which influence the stability of an aeroplane in normal flight (below the stalling angle), and his results, which he collected in a volume published in 1908, contained in essence most of the principles of practical importance which we employ to-day in the calculation of stability.

About 1911 two interesting things happened. Capt. Dunne made and flew successfully his remarkable tailless aeroplane with swept-back wings, which was undoubtedly extremely stable, probably far too stable for comfortable flying; and Prof. Bryan published a book in which he showed how calculations upon the stability of aeroplanes could be brought into line with conventional mathematics.

Dunne's line of development was not followed up, but we shall see something of the sort cropping up again towards the end of this lecture. Bryan's book was the foundation of modern methods of calculating stability.

Bryan's idea was to measure the effects of simple disturbances, such as rolls or pitches, separately, and thus to obtain a number of characteristic quantities, or 'derivatives' as they are called, which could be used in the calculations of stability. He did not have the means to make the necessary measurements, but the scientists of the National Physical Laboratory, who were already in possession of wind tunnels, set to work to determine these quantities for small models and to make the necessary calculations along the lines which he had indicated. The experimental campaign so started has been in progress ever since.

The application of this systematic study of stability to man-carrying flying machines was first made in the Government Factory at Farnborough by Busk. He modified the unstable BE 2A into the stable BE 2C by relatively small changes in the position of the centre of gravity and in the area and arrangement of the fixed surfaces on the end of the tail. This was a distinct step forward, and much notice was taken of it in the Press, where the opinion was freely expressed, mainly by non-flyers, that the safety of flying was now assured. This view was wrong; the provision of stability alone is not sufficient for safety, as Busk and his fellow-workers well knew. Safety is mainly concerned with the taking off and landing of aeroplanes, when a rapid response to control is even more important than stability.

The opposing school of thought—lineal descendants of the pioneer flyers—were naturally aggravated by this widely advertised and erroneous view of the relation between safety and stability, and the breach between the two schools widened still further, culminating in two extreme examples, the very stable SE 5, produced in the Government Factory at Farnborough, and the very unstable Camel designed by Sopwith. These two machines, diametrically opposed in every feature relating to stability, shared between them the brunt of the single-seater fighting during the later stages of the War; opinion ran high concerning their relative merits and the lines of thought which they represented. Readers of that remarkable diary "War Birds" will find the view of the supporters of the SE 5 forcibly expressed, but I have heard the other side equally strongly maintained. These two machines marked the culminating point in the controversy to which reference has been made. Later development has been all towards compromise, slightly on the stable side of neutrality: benevolent neutrality as I have called it.

Though the experimental technique and the mathematical calculations necessary for a thorough study of control and stability are difficult and elaborate, the main results are simply and easily stated.

The pitching motions of an aeroplane depend upon what is called its weathercock stability. An aeroplane hung up in a wind so that it can rotate about a horizontal axis through its centre of gravity has weathercock stability if, like a weathercock, it desires to face the wind and returns to its original attitude on being disturbed. As with a weathercock, this kind of stability is increased either by moving the pivot—in this case the centre of gravity—forward, or by increasing the area of the tail.

A free flying aeroplane which has this form of stability will, if disturbed from steady flight, first rotate rapidly so as to restore the incidence to the equilibrium value and then execute a series of long slow pitching movements, similar to a ship travelling over ocean waves. The length of these waves from crest to crest is between ½ and 1 mile, and the time taken some 30 seconds. These movements are so slow that they have little influence on control.

The weathercock *unstable* aeroplane, if pivoted like a weathercock, would very quickly turn round and face backwards. If this happened in free flight it would be unflyable, except by a pilot with the skill of a juggler, but it does not happen. Suppose the aeroplane is flying freely and the nose is accidentally deflected upwards; being unstable it will throw up its nose still farther, but at the same time the increased incidence will cause it to leap upwards with great suddenness. The direction of motion is thus *rotated upwards* faster than the aeroplane itself, so that the first quick adjustment is a fall of the incidence to nearly its original value. Afterwards the upward tilt and upward trend of the path increase relatively slowly, until the aeroplane slows up and stalls. There is, however, ample time for the pilot to correct this subsequent motion, provided that his attention has not wandered. This is the reason why the Wrights and others were able to fly aeroplanes which were unstable fore and aft.

So long as the instability is not too great, the aeroplane, like the motor-car, can be controlled effectively whether it is stable or unstable. As in the motor-car, too great stability is definitely objectionable, partly because heavy forces are then required to execute rapid manœuvres and partly because heavy forces, or adjustments of some sort, are required to 'trim' the aeroplane for different speeds. For alterations in speed must be accompanied by changes in incidence, which in a very stable machine will require large control forces. A neutral aeroplane, on the other hand, if trimmed for one speed will be in trim for other speeds within a wide range. The problem here before the designer is so to adjust the centre of gravity and the tail areas as to produce a very slightly stable aeroplane.

The rolling and yawing motions of an aeroplane can also be simply described, though in detail they are very complicated.

When the aeroplane rolls the falling wing meets the air at a larger incidence than the rising wing and experiences a greater lift; a very large couple opposing the roll is thus generated. This is the predominating factor in the lateral control, for it prevents rapid rolling and gives the pilot time to observe what is happening and correct it. This is the reason why the Wrights could control an aeroplane which was laterally unstable.

If the aeroplane has a 'dihedral angle'—tips of the wings higher than the middles—side slip tends

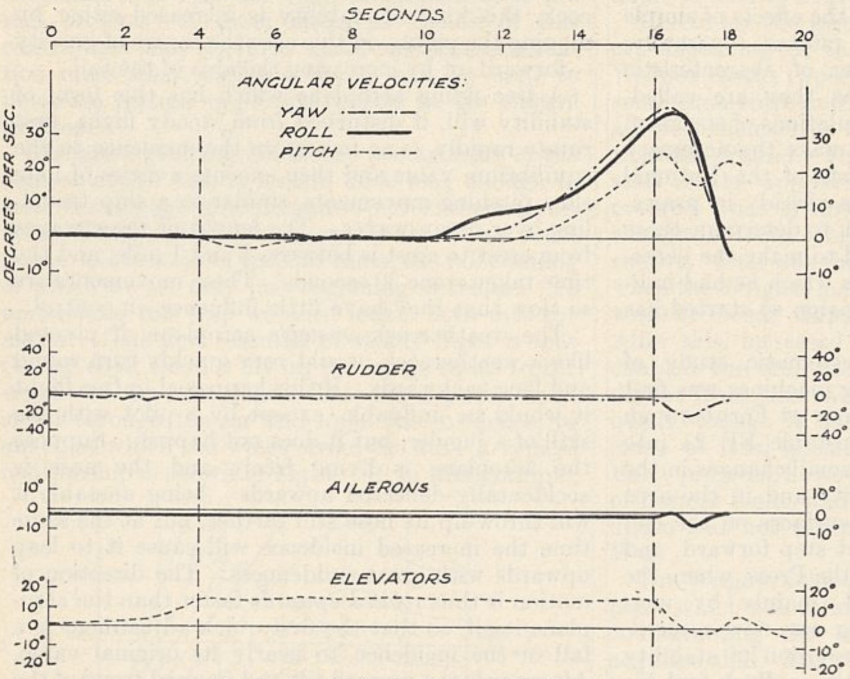

FIG. 2.—Controls fixed. The unstable rolling turn.

to raise the wing towards which the slip is occurring. If it has a large vertical fin on its tail, it will turn or yaw towards the slip. In normal flight the dihedral angle has a powerful stabilising influence, because if one wing falls below the other, side slip will occur towards that wing, and a couple will be generated raising the wing.

An aeroplane which has too large a vertical fin on its tail and too little dihedral angle will have what is called spiral instability; if slightly disturbed from straight flight, it will continue to roll and turn from its course, and ultimately descend in a spiral curve. This motion is, however, so slow in developing that it is of no importance so long as the pilot is in control, but like other forms of instability it is undesirable, particularly when long flights are contemplated.

Another motion possible to an uncontrolled aeroplane consists of a complicated rolling and yawing oscillation, generally of about six seconds period. This will become unstable and render the aeroplane practically unflyable if the vertical fin in the rear is too much reduced. Thus the exact proportions of these fin surfaces is a matter of great importance; if they are too small, the relatively quick oscillations will become unstable, with disastrous results; if they are too large, the slow spiral instability, which on the whole is undesirable, will occur. The problem is eased by giving a good dihedral angle, for this widens the limits permissible in fin size, without incurring either of these defects.

One other fact of interest has only lately come to light. If the dihedral angle is too small, the short period oscillation to which reference has been made may become of the type which is caused to increase by a control which contains a lag. As there is always some lag between the pilot's intention and his performance, this latent defect may cause trouble; even though it may not be so bad as actually to cause the oscillations to increase, it may lead to great difficulty in damping them down. In bumpy weather, therefore, the oscillations may be continuous from one air bump to the next, with disastrous results both on the strength of the pilot and the stomachs of the passengers. The improvement in the bad weather qualities of some of the later cross-channel aeroplanes is attributed partially to increased dihedral.

No more need be said now about control in normal flight. In what precedes an attempt has been made to explain why the provision of good control qualities is more a question of proportioning the aeroplane and adjusting its load properly than of devising new control organs.

This brings us to about the end of the War. More data have accumulated and measurements have been refined, but most of the foregoing statements

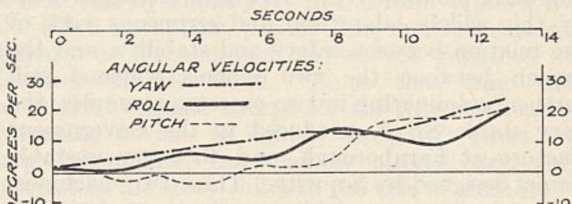

FIG. 3.—Controls fixed. The increasing oscillation.

might have been made then. The trap which killed the early pioneers still, however, continued to take its toll of life, though in a much lower proportion to the hours flown. Ample power had become available to allow the normal flying speed to be so much greater than the stalling speed that accidental stalling became rare, except when a pilot was deliberately flying slowly with the object of making a landing. When it did occur, however, the same consequences followed as with the early pioneers: but the danger was increased, because

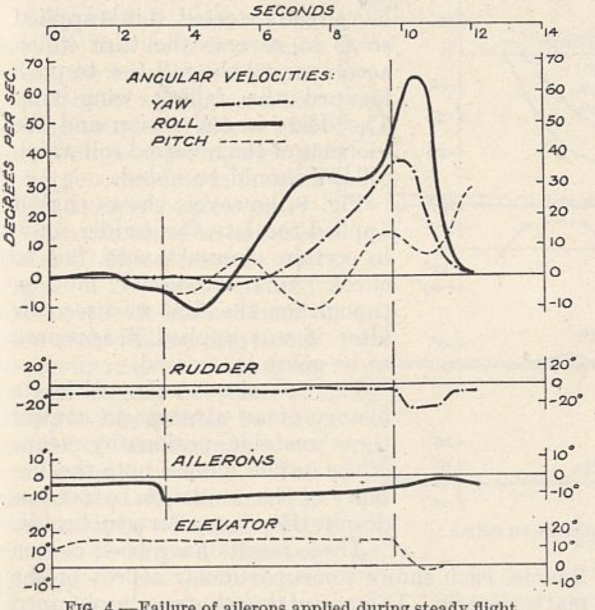

FIG. 4.—Failure of ailerons applied during steady flight. (Note apparent success at first.)

of the higher loading and consequent heavier impact of the later machines. Throughout the history of flying to the present day this has been, and still remains, the most frequent cause of fatal accidents.

Shortly after the War, the British Research Committee for Aeronautics started a research campaign into the causes and cures of this trouble. The research was carried on in wind tunnels, by theoretical work, and in actual flight at heights sufficient to rob the stall of its danger, with the result that the principles underlying the matter are now understood and several ways of eliminating the danger are known.

One small part of this campaign of research is being carried on by the University Air Squadron at Cambridge. Our task is to endeavour to obtain precise experimental records of the motions of stalled aeroplanes, both when left to themselves and when the pilot is trying to control them. The apparatus which we use was developed and constructed at the Government Research Establishment at Farnborough and lent to us for the purpose. It consists of a box containing three gyroscopes which are slightly deflected against a spring control when the aeroplane is turning. The deflexion of each gyroscope is proportional to the rate at which the aeroplane is turning about some particular axis, and they are arranged so that, between them, they measure the three rates of turn about three axes mutually at right angles. These three records are recorded continuously upon a moving photographic film. Three other instruments record independently the movements of the three controls—elevator, rudder, and aileron—and all these records are synchronised from a central clock, which records half-second intervals on all the films.

Figs. 2-9 show some graphs drawn from records selected from more than a hundred sets which we have obtained. These results, which will now be described, have all been predicted, at least in their general features, by calculations based on wind-tunnel observations of the forces acting upon models supported in various ways in the wind tunnels of the National Physical Laboratory and the Royal Aircraft Establishment. The wind-tunnel experiments and calculations were made long before precise records in free flight had been obtained, but for lecture purposes I shall reverse the chronological order of the events and describe the results first before explaining why they occur.

Fig. 2 shows a record of one such flight. The experiment began at the vertical line marked 4 seconds, when the elevator was pulled right back and the incidence of the wings (not shown in the figure) was between 19° and 20°. From that time the controls were held fixed until 16 seconds, when the experiment ended. This experiment began exceptionally favourably, with no rotation of any importance occurring. Straight flight continued undisturbed until 10 seconds, when some slight disturbance started the unstable motion characteristic of this aeroplane at this incidence. Increasing rates of rolling and yawing, both to starboard, were then recorded, which in six seconds

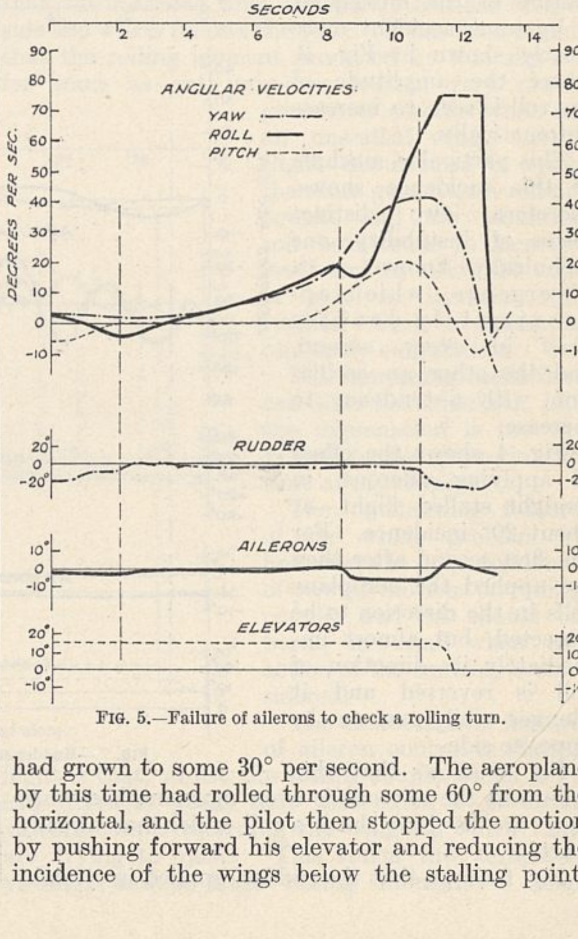

FIG. 5.—Failure of ailerons to check a rolling turn.

had grown to some 30° per second. The aeroplane by this time had rolled through some 60° from the horizontal, and the pilot then stopped the motion by pushing forward his elevator and reducing the incidence of the wings below the stalling point.

The rapid check to the roll which followed this last control movement should be noted. The reason why a rapid roll at a low incidence is impossible has already been explained.

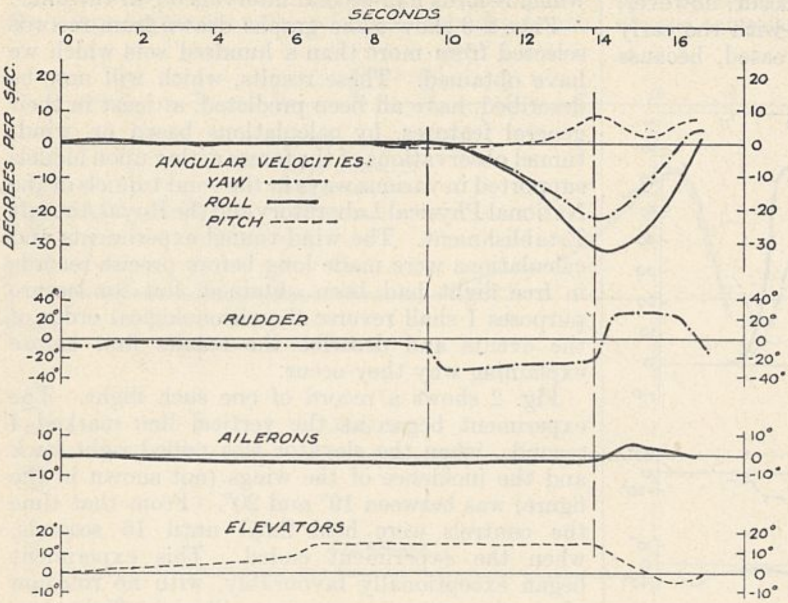

FIG. 6.—Effect of rudder applied during steady flight. (Note indirect influence on rolling.)

Superimposed on this unstable motion is a slight rolling oscillation; this feature of the movement is by some accident more clearly shown in Fig. 3, where the amplitude of the roll is seen to increase automatically.

This particular machine at this incidence shows, therefore, two distinct forms of instability, one technically known as a divergence, which approximately doubles itself in every second, and the other an oscillation with a tendency to increase.

Fig. 4 shows the effect of applying ailerons, in straight stalled flight, at about 20° incidence. For the first second after they are applied the aeroplane rolls in the direction to be expected, but almost immediately its direction of roll is reversed and it plunges wildly over on the opposite side.

Fig. 5 shows that this failure of the ailerons is even more marked when they are used to check a roll which has already started.

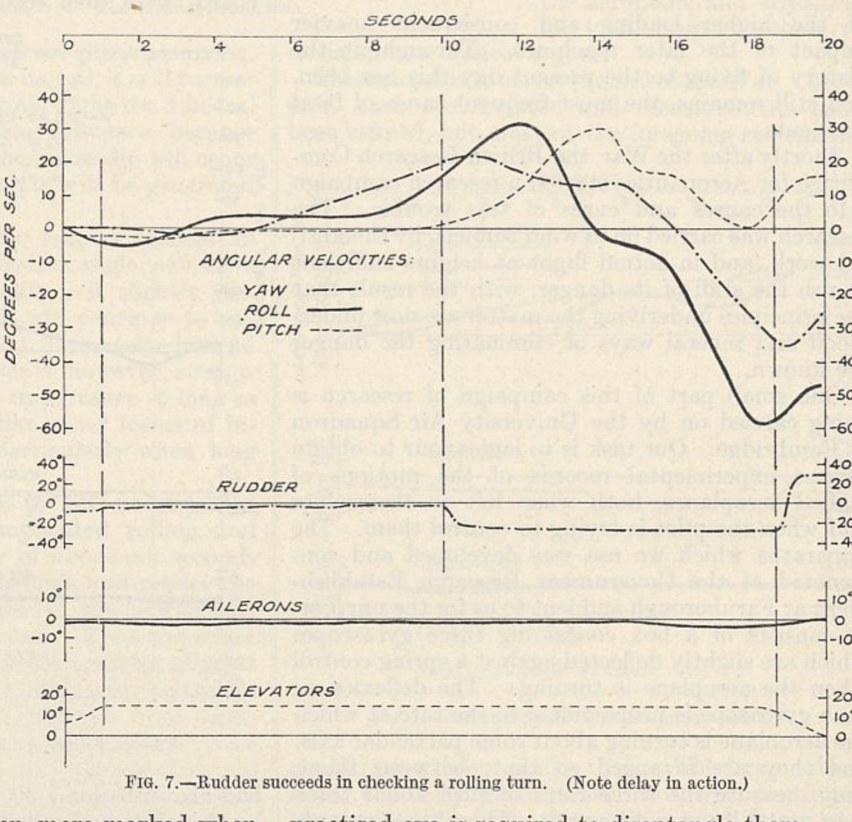

FIG. 7.—Rudder succeeds in checking a rolling turn. (Note delay in action.)

Fig. 6 shows that the rudder, applied in straight flight, has the desired effect of turning the aeroplane, but that it also causes it to roll in the sense that the wing which is being pushed forward rises.

Fig. 7 shows that the rudder can be used to check a roll which has already started, if it is applied so as to reverse the turn which accompanied the roll (*i.e.* to push forward the falling wing tip). The delay in the action and the violence of the reversed roll which follows should be noted.

Fig. 8, however, shows that if applied too late the rudder may, in certain circumstances, fail to check this unstable motion, though for the first two seconds after it was applied it appeared to be going to succeed.

Fig. 9 shows the ultimate history of an attempt to control these unstable motions by means of the rudder alone; note the liability of the oscillation to increase despite the pilot's efforts to check it.

These results have been chosen because each shows some particular aspect of the matter clearly. In many of the other results obtained these various aspects are so mixed together that a practised eye is required to disentangle them.

The utter uselessness for any practical purpose of control with the above characteristics requires no emphasis.

As has been stated, these results can all be explained, in general terms, by mathematical analysis based on data obtained from wind tunnels, and though the analyses are intricate the broad explanation can be given simply.[2]

The primary cause of the trouble lies in the change, when the aeroplane stalls, of the effect of rolling upon the rolling couple. Instead of a large couple opposing the roll being generated, as in normal flight, a slight couple is generated in the sense to increase the roll. This is because (see Fig. 1 at 20° incidence and above) the increased incidence of the falling wing tip no longer increases the lift upon it, but slightly decreases it. There is thus nothing but the inertia of the aeroplane to prevent rapid rolling. The complicated effects of inertia, such as those we observed in relation to ships at the beginning of the lecture, are thus introduced, and the valuable factor of time for the pilot to think is absent.

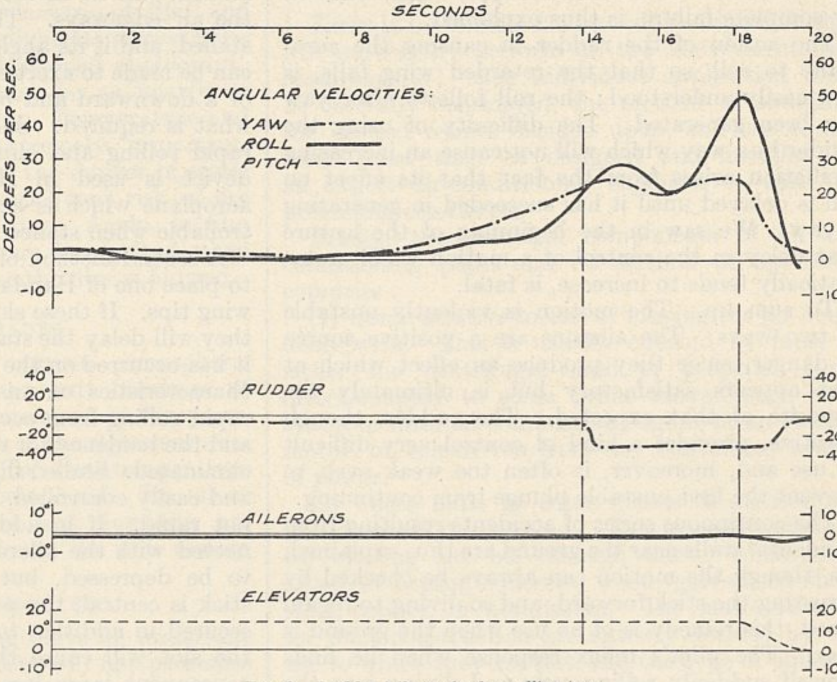

FIG. 8.—Rudder fails to check a rolling turn.

The instability of the motion is easily explained. When a stalled wing rolls there is not only a slight couple increasing the roll, but in addition a couple tending to retard the falling wing. This is because drag increases very rapidly with increase of incidence on a stalled wing. Now in stalled flight, even a small rate of yaw generates a large rolling couple depressing the retarded wing. This is partly because the advancing wing is travelling faster than the retarded wing and partly because of the side slip which follows the yaw. (It has been found that the rolling moment produced by side slip is, for some as yet unknown reason, very much greater on a stalled than on an unstalled wing.) Any slight disturbance in yaw therefore generates a rolling couple, and the resulting roll both tends to increase itself and to cause the rate of yaw to increase still further. Such a process is obviously cumulative.

The increasing oscillation can also be explained, but the explanation is too involved to be given in the time at my disposal.

The outstanding feature of the whole problem is, however, the great influence of yawing motions on rolling couples, and this should be borne in mind when the action of the controls is considered.

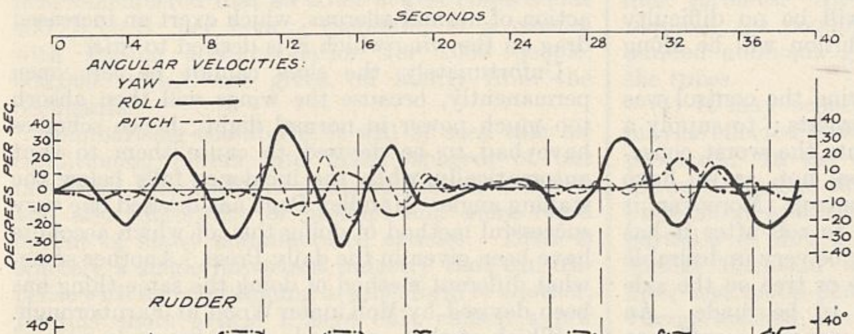

FIG. 9.—Attempt to control the roll by means of rudder alone.

The characteristic feature of aileron control in stalled flight is that, whilst the rolling couple which they can exert is weak, they also exert a powerful yawing couple retarding the wing tip which they are trying to raise. This starts the aeroplane yawing, and a large rolling moment is soon

[2] The explanations which follow will be more easily understood with the help of a model aeroplane which can be held in the hand and moved in the ways described. Failing a model aeroplane, a piece of card in the form of a T to represent wings and body should suffice.

indirectly generated by the yaw, which entirely swamps the direct action of the ailerons. The apparent success, in Figs. 4 and 5, of the ailerons, for the first second after their application, followed by complete failure, is thus explained.

The action of the rudder in causing the aeroplane to roll, so that the retarded wing falls, is now easily understood; the roll follows after yaw has been generated. The difficulty of using the rudder in a way which will not cause an increasing oscillation arises from the fact that its effect on roll is delayed until it has succeeded in generating a yaw. We saw in the beginning of the lecture that delay in the control of a motion which automatically tends to increase, is fatal.

To sum up. The motion is violently unstable in two ways. The ailerons are a positive source of danger, since they produce an effect which at first appears satisfactory but is ultimately the opposite of that expected. The rudder, though effective, provides a kind of control very difficult to use and, moreover, is often too weak even to prevent the first unstable plunge from continuing.

The continuous series of accidents resulting from accidental stalls near the ground are thus explained, for, though the motion can always be checked by thrusting the stick forward, and so diving to regain speed, this remedy is of no use when the ground is near. The pilot's reflex response when he finds himself suddenly rolling over and diving into the ground is to pull the stick back and to the side away from the roll. This, as we have seen, has disastrous results.

There are two lines along which a cure can be effected. One is to eliminate the instability and the other to improve the control. After what has been said above, there will be no difficulty in realising that the final solution will be along both lines.

The simplest way of improving the control was that originally used by the Wrights: to supply a powerful rudder. This prevents the worst consequences of stalling, but it does not, as we have seen, provide a satisfactory control. Moreover, it can only cause the aeroplane to roll after it has started it yawing, and this may be very undesirable if there happens to be a house or tree on the side towards which the yaw has to be made. An effective rudder, however, though not a sufficient cure, is a *necessary* factor in any complete cure.

Another solution is to provide some form of control at the wing tips, which will lift the wing powerfully and simultaneously push it forward, rather than push it backwards, as does the standard aileron. The yawing action of the aileron will thus indirectly reinforce the direct rolling action, instead of opposing it as at present. There are several ways of doing this; one is to provide a surface beyond the wing tips which, even when the main wings are stalled, will be inclined downwards so as to meet the air edgeways. This surface will not itself be stalled, and if its angle is controlled by the pilot it can be made to exert either an upward and forward or a downward and backward force, which is just what is required. Such surfaces will also prevent rapid rolling and eliminate the instability. This device is used in Hill's Pterodactyl, a tailless aeroplane which is said to be as stable and controllable when stalled as in normal flight.

A second method of achieving the same result is to place one of Handley Page's slots in front of the wing tips. If these slots are left permanently open they will delay the stall on the tips until long after it has occurred on the remainder of the wings; the characteristics of unstalled wings which prevent rapid rolling from occurring will thus be retained, and the tendency for rolling to cause yawing will be eliminated. Stalled flight then becomes very stable and easily controlled, though the rate of control is not rapid. If in addition the slots are interconnected with the ailerons, so as to close on the side to be depressed, but to remain open when the stick is central, the power of rapid control will be secured in addition to stability, for the closing of the slot will cause the wing tip to stall, with a consequent large loss of lift and increase of drag by comparison with the other tip on which the slot remains open. The large direct rolling moment generated in this way is thus reinforced by the indirect effect of the yawing moment resulting from the increased drag on the wing tip which it is desired to *depress*. This is the reverse of the action of normal ailerons, which exert an increased drag on the wing which it is desired to *raise*.

Unfortunately, the slots cannot be left open permanently, because the wings will then absorb too much power in normal flight; hence schemes have had to be devised to cause them to shut automatically, when the incidence falls below the stalling angle. Handley Page has devised one very successful method of doing this, of which accounts have been given in the daily Press. Another somewhat different method of doing the same thing has been devised by McKinnon Wood at Farnborough.

Which of these methods will ultimately prevail is as yet uncertain, but that a complete cure in a practical form can be found is now beyond doubt, and we can confidently look forward to a time when, its principal danger having been eliminated, flying will be ready to take its place in the world's transport, on terms which, in respect of danger, will compare not unfavourably with the older and more established methods.

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Photographic Industries.

The importance of air conditioning in this industry is very great. Absolutely pure, dirt-free air is required in the manufacture of film and sensitised papers, as the slightest atmospheric impurity is reflected in the developed photograph. The air filtration plants must be as nearly as possible 100 per cent. efficient. Temperature and humidity conditions are extremely important, especially the latter, owing to the danger of static electricity in winding and consequent risk of fire should the film become too dry. Again, in film studios, a dry pure atmosphere is required when 'shooting' pictures, otherwise the film is blurred.

Printing Trades.

In newspaper printing, correct atmospheric conditions are essential to prevent breakage of the paper due to too much moisture in the press-room, and also to keep the ink at the right temperature, and the rollers pliable. Too low a temperature causes these rollers to become hard. In colour printing, correct temperature and humidity are very necessary, or the colours do not remain distinct.

Theatres, Cinemas, etc.

Here again air conditioning plays an important part. Discriminating playgoers will not patronise a theatre or cinema which is chilly in winter and insufferably close in summer. Absolute comfort can only be ensured by proper heating and ventilating equipment, coupled with some means of air purification, and air cooling in warm weather. This question of air cooling is very obvious when it is remembered that an adult at rest emits about 400 B.Th.U. per hour; therefore, in a cinema with seating accommodation for 2000 people, 800,000 B.Th.U are given off hourly from the occupants.

Summarising the above, it will be seen that air conditioning enters into many spheres of our industrial life, both for ensuring human comfort, and also uniformity of product and more rapid output of many manufactured articles. There is scarcely a single important industry that can dispense with air conditioning in some form or another. In this short article I have only chosen a few examples at random.

Table II. gives a few typical uses to which air conditioning may be put, together with air changes, temperatures, and humidities usually employed.

Table II.

Type of Building.	Air Changes per Hour.	Temp. (Degrees F.).	Relative Humidities.
Offices	1 to 3	58°–62°	50 to 63 per cent.
Theatres	2 „ 4	60°	50 „ 63 „
Hospitals	2 „ 8	60°–70°	50 „ 63 „
Schools	2 „ 4	55°–65°	50 „ 63 „
Churches	1 „ 2	58°	50 „ 63 „
Factories (average)	1 „ 3	55°–70°	45 „ 65 „
Factories (textile)	3 „ 30	55°–72°	65 „ 85 „
Photographic trades	2 „ 20	60°–80°	55 „ 80 „

Air-Conditioning Equipment.

There is no standard air-conditioning plant that will universally perform all the above-mentioned requirements; each individual application must be carefully considered, the method of obtaining the desired results decided upon, and the equipment must then be designed and installed by an expert air-conditioning engineer, to suit the prevailing conditions.

Briefly, the principal components of an air-conditioning plant and its method of operation comprise:

(1) Some positive means of moving the air being dealt with. This is usually effected by fans, of either the centrifugal-cased or propeller type, direct-coupled to some prime mover, such as a steam or internal-combustion engine, or an electric motor, or belt-driven from any convenient source of power.

(2) There must be some means of distributing the air where it is wanted. This is usually effected by blowing the air through ducts, constructed either of bricks, concrete, wood, galvanised sheet steel, copper, or aluminium. The materials used for duct construction are entirely decided by the use to which they are put, and the type of building in which they may be installed.

(3) There will be some form of heater for raising the temperature of the air; this usually takes the form of a battery of plain or gilled tubes over which the air is passed, the tubes being fed with either live steam or exhaust steam from engines and turbines. Alternatively, if the battery is required for cooling the air, then brine or expanded ammonia gas must be pumped through the tubes.

(4) It may be necessary to filter the air; this may be effected by the dry, viscous, or wet filtration processes. In the dry method, the air is either drawn or forced through canvas bags, or metal-plate filters with rough cloth linings, to which the particles of dirt adhere, or sometimes for very special filtration a combination of canvas-bag filter and metal-plate filter may be used. In the viscous method, the filter consists of a metal frame containing coils of wire immersed in oil, the dust in the air being arrested by the film of oil. In the wet filtration method the air either passes through copper gauze screens, the screens being flooded by a continuous stream of water, or else it is cleaned in a proper air washer and humidifier.

(5) Air is humidified in several ways, all of which demand the intermixing of the air with a steam or water spray. The usual humidifier, which also acts as a wet filter and air washer, comprises a body casing of sheet metal, of either galvanised steel or copper. This casing is mounted on a settling tank containing water. The air enters one end of the humidifier, where it comes into intimate contact with a bank of water sprays or atomisers. These atomisers are supplied with

water under pressure from a centrifugal pump, the effect being that the air is thoroughly intermixed with a very fine cloud of water particles and is therefore washed and saturated. The air then strikes against zig-zag baffle plates or eliminators, which remove all its entrained moisture, and leaves the humidifier at a relative humidity of 100 per cent. and is 98 per cent. pure and clean.

The above brief description of the chief components of an air-conditioning plant is by no means complete, but it may serve to indicate what are the essentials of some installations used in industry.

The Royal Academy's Exhibition.

THE opening of the Royal Academy Exhibition at Burlington House is a seasonal event which interests most of us, even if we are not endowed with special artistic perceptions. In art, as in science, there is specialisation into particular spheres; and therefore great variety of effort, with the necessary limitations, must be displayed in the works exhibited by an Academy. As in science also, creative ideas cannot be expected to be conceived so frequently as commonplace performances.

In portraiture there are, at this year's exhibition, as usual, a good many 'personalities.' Somehow, we always regard these frequencies with vague detachment, schooling ourselves into approval or disapproval. Contrasts are inevitable, but perhaps complete antithesis is exemplified in Sir William Orpen's study of Mr. Lloyd George (290), and that of Mr. Stanley Baldwin, by Oswald Birley (434), the one distinctive enough, yet flamboyant, and the canvas full of accessories; the other of marked sobriety of treatment, wholly pleasing. So much for our rulers. But Orpen's Sir George Maxwell (193), a ruler in lesser measure, and a gift to him, in tribute of service, from the Chinese community of Malaya, is a great possession. George Harcourt has painted Dr. Cyril Norwood (237), almost full length, for Marlborough College, with accuracy, and the dignity befitting a distinguished schoolmaster. There is a suggestion of an academical robe, otherwise we have the philosophy of clothes in meticulous display, which upper forms will note. Sir Arthur Keith, by W. W. Ouless (100), disappoints us in aspects of intellectual virility; surely here was a sitter who could wear no mask. On the other hand, we might apprehend possible trials with Sir Gowland Hopkins, but his portrait by George Henry (243), for the Bio-Chemical Laboratory, Cambridge, is good, if of rather ruddy tone. However, man does not live by calories alone. Richard Jack gives us a capital example in his Prof. A. G. Perkin (382), scarlet and green much in evidence. The catalogue places him outside the humanities, and names him "Perkins." Sir Arthur S. Cope supplies a conscientious presentment of Dr. Alfred Palmer (374) for the University of Reading. George Harcourt's oil of Mr. Llewelyn B. Atkinson, lately president of the Institution of Electrical Engineers, we find disappointing, lacking reminiscence. Lavery paints Dr. Nicholas Murray Butler with subdued and faithful effect. The late Thomas Hardy (in three-quarter) looks straight out at one on a canvas by R. Grenville Eves (55). It should please the novelist's admirers. Many will approve also of Fiddes Watt's "George Summers, Huntsman, Duke of Buccleuch's Hounds" (448), excellent and arresting in characterisation. Other portraits of special interest include the Master of Sidney Sussex (W. W. Russell), Sir Herbert Warren (Glyn Philpot), and Lord Hewart (Lander), painted for University College, Oxford.

Among landscapes Ernest Parton's "A Morning on the Kennet" (129) is of high order; also La Thangue's "A Sussex Stream" (181), where we have brilliant water, and a boy with net and bottle. Farquharson's "November" (165), "Winter" (268), and "A Winter Evening" (394) are specially good of their kind, while W. T. Wood's "Winter at Burpham, Sussex" (331), should be seen. Slade's "Sussex Weald from the Devil's Dyke" (537) portrays that much-discussed expanse, formal but faithful.

Apart from the natural aspects of landscapes the botanist may give attention to the numerous examples of flower studies, in mixed bunches, or selected, which are hung. Merit varies; and ugly vases on chessboard patterns do not enhance effect. We like Hayward's "Lenten Hellebore" (44), depicted in a tankard-shaped receptacle, and Wood's "Drooping Roses" (48).

Quite a number of old barns and their interiors are here, which is all to the good. They well repay study, especially Steel's "Unthank Hall Barn, Derbyshire" (64). Many ancient barns are now marked for destruction under the transport march; and, going off at a tangent, we are much interested in A. J. Munning's presentations of horses, particularly his "Solario" (84).

The Architectural Room claims mostly the attention of those interested in the style and progressive ideals of designers. On the whole there is much of an encouraging character. We like Mr. A. N. Prentice's "New Public Library for Westminster City Council," in course of erection on the site of Sir Isaac Newton's old home, Orange Street, and in proximity to the offices of this journal. Sir Edwin Lutyens's "Ambassador's Entrance: British Embassy, Washington," buildings of low pitch, dignified and restful, make one feel that residence in such quarters would duly regulate the blood pressure of diplomacy. The "New Mercantile Bank, Singapore," by P. H. Keys and F. Dowdeswell, is stately and satisfying. Designs for various English engineering, chemical, and zoological laboratories may also be seen.

News and Views.

IN his Royal Institution discourse on "Research on the Control of Aeroplanes," which appears as a Supplement to this week's issue of NATURE, Prof. B. Melvill Jones gives a very lucid exposition of a problem that has long been a subject of controversy among aeronautical experts, young though the science be. Broadly speaking, the question at issue is, whether safety in flight should be achieved along the lines of construction for aerodynamic stability, or along the lines of pilot controllability. The theoretical experts have rather inclined to the former, the practical flying men always to the latter; and Prof. Jones, who has played the part both of pilot and theoretician, is well qualified to appraise both viewpoints. It is not difficult to appreciate the influences that have stirred the theoretical experts. Bryan's masterly exposition of the disturbed motion of an aeroplane regarded as a rigid body and his analysis of the conditions that make for stability caught the imaginations of the interested mathematicians, trained as they were in the Newtonian school of simplified abstractions from reality, and for a long period determined the direction of aeronautical research.

THE fact remained, however, that to the pilot the aeroplane was never even remotely a rigid body, for he himself, as part of it, was continually operating its controls and guiding it to his will. A highly stable aeroplane was rather a nuisance to him, for he did not wish to rely on a self-willed machine, but on himself. The mathematicians, recognising the fallibility of the pilot and consequently tending to ignore him as a control, wished to depend rather on the machine. In the last resort it was the multiplicity of accidents on landing, that is, at low speeds of flight, that stimulated a searching and critical analysis into the aerodynamics of flight under these conditions and into the natural and sometimes disastrous responses of the pilot himself to rolls and dives. As Prof. Jones shows in his lecture, these have served to illuminate the whole problem of stability and control, to expose their respective limitations and to indicate that the final solution must partake of both factors. Incidentally, Prof. Jones's lecture illustrates two other points. In the first place, it demonstrates the extent to which experimental finish has been procured in the study of an intricate scientific problem under conditions of operation infinitely more difficult than those normally attendant in a laboratory experiment; and in the second place, it has brought out that the aeroplane industry, principally in the person of Mr. Handley Page, has played no small part in the elucidation and solution of these scientific problems.

THE Society for the Preservation of the Fauna of the Empire has undertaken a great and important work, and the inroads which have been made in recent years upon the wild stock of many British colonies and dependencies show that it has entered the field none too soon. It is a commonplace that the spread of civilisation, with its breaking in of wild territory, felling of forests, and draining of marshes, uproots and decimates the aboriginal fauna, and it is as patent that destruction even more rapid may follow upon unrestrained slaughter in the name of sport or commercial ventures. Even where laws are made to restrain these activities within reasonable bounds, and in almost all parts of the British Empire such laws now exist, it is difficult without a prohibitively large staff of wardens to enforce the law. Consequently, in many regions, of land and sea, destruction moves ahead of the natural replenishment of the stock, towards the inevitable goal of extermination. The Society properly accepts the view that the progress of civilisation cannot be stayed, and that the legitimate interests of sport must be safeguarded. It wisely concentrates its efforts, therefore, upon the sheltering of a nucleus of the wild life of any region in great reserves or national parks. An excellent pamphlet on "The Passing of Wild Life" describes the Society's point of view, and insists upon the need of public support and of immediate action in the creating of reserves. Copies of the pamphlet may be had from the Secretary of the Society, c/o Zoological Society of London, Regent's Park, London.

SIR ROBERT HADFIELD, Bart., has been elected a foreign associate of the National Academy of Sciences of the United States of America. The announcement has a fitting complement in the award by the Iron and Steel Institute, referred to below, of the Bessemer Gold Medal to Mr. Charles Schwab, one of the leaders of the steel industry of the United States. Incidentally, it may be mentioned that the Bessemer Gold Medal was awarded to Sir Robert Hadfield so long ago as 1904. Sir Robert's latest honour brings him into distinguished company. The National Academy of Sciences held its first scientific meeting in 1864, and immediately took advantage of a by-law permitting the election at any one meeting of not more than ten foreign associates, by electing this number; the names included Faraday and Brewster. Since that time, the National Academy has grown steadily in importance and in numbers. The membership roll has now increased to more than two hundred, but the list of foreign associates is less than twenty. Sir Robert's election brings the number of British men of science on this roll of honour up to twelve; it includes the two living past-presidents and present president of the Royal Society. The last British worker to be elected was Sir Frank Dyson, Astronomer Royal (1926).

ON May 3, at the annual general meeting of the Iron and Steel Institute, the Bessemer Gold Medal was presented to Mr. Charles Schwab, president of the American Iron and Steel Institute and the president of the Bethlehem Steel Corporation. Mr. Schwab was born in Williamsburg, Blair County, Pa., on Feb. 18, 1862, and started his distinguished career in the Edgar Thomson Steelworks of the Carnegie Company by driving stakes at a dollar a day. By his own energy and ability he rose in seven years to be chief of the Engineering Department of the Carnegie Company. The great Homestead Steelworks plant, designed by him, and erected under his supervision, was arranged to be a practically continuous mill, so that the raw materials went in at one end and the finished products came out at the other. In 1896 he was made a member of the board of managers of the Carnegie Companies, and in the following year was elected as its president. The problem in the United States at that time was the manufacture of more steel, better steel, and more rapid production. In this, Mr. Schwab achieved the best practical results. Smaller concerns were combined until the Company attained an impregnable position in relation to raw materials, modern equipment, and skilful management. Further commercial development on economic lines was made possible by a fusion of interests between the larger companies, and the United States Steel Corporation came into being with Mr. Schwab as president. Mr. Schwab resigned this post after three years and obtained a controlling interest in the Bethlehem Steel Corporation, of which he is now chairman of the board of directors. The Bethlehem plant at that time was largely engaged in the manufacture of munitions. Under the control of Mr. Schwab it has become one of the best steel works in the world, and at the present time the manufacture of munitions takes up less than 5 per cent. of the productive capacity of the plant.

The annual May Lecture was delivered before the Institute of Metals in London on May 8 by Prof. C. H. Desch on "The Chemical Properties of Crystals." Prof. Desch discussed the various ways in which atoms may be held together in a crystal: by the simple exchange or sharing of electrons, or by residual forces. In rock salt the molecule has disappeared, but there are many substances built up of molecules in the solid as well as in the liquid state. In a few simple cases it has been found possible to calculate the forces of attraction in a particular face of a crystal, and in that way the differing chemical properties of different faces can be explained. Such differences account for the varying habit of crystals of the same substance grown under different conditions. When a metal is attacked by an acid, distinct 'etch-figures' are produced, and the shape of these must be intimately related to the internal structure of the metal crystals. The figures vary in the most curious way when the solvent is changed, as is shown by large single crystals of copper. The compounds of metals with one another have puzzled chemists, as they do not follow the ordinary rules of valency, and have many anomalous properties. The modern view of the constitution of the atom makes it possible to explain them, and the relations which have been found between the forces of cohesion and of chemical affinity make it likely that there is a gradual transition from the simplest solid compounds, such as salts, through intermetallic and other compounds, to solid solutions, which are regarded as mixtures. The chemical properties of crystals are most easily illustrated by substances which do not consist of closely packed atoms, but have an open structure, such as graphite. Looseness of structure is also important for diffusion in solids, on which many technical processes depend.

Dr. F. H. G. Van Loon, formerly professor of psychiatry and neurology in the Medical School of Batavia, read a paper on "Primitive Instinctive Reactions in Pathological and Normal Malay Life," at a meeting of the Eugenics Society held on May 4. Dr. Van Loon illustrated his paper by a kinematograph film of a case of latah, the curious Malay insanity in which the patient copies any movements made in front of her. The problem with which Dr. Van Loon dealt is of much wider interest. He has been studying mental differences in race, not through the well-known avenue of mental tests, but by means of the insane behaviour shown when the normal intelligence and control are thrown out of gear by disease. He compared amok and latah, for example, with manifestations of insanity such as those against which legislation has been enacted in England to allow a judge to prevent undue litigation by an insane person who is frequently bringing cases into court. Clearly there is a wide distinction between such 'reasoning' madness and a more primitive and animal-like reaction, for running amok corresponds very definitely to the behaviour of some animals acting under the instinct of extreme fear; the hallucinations which are the first symptoms of amok are such as to induce terror. He also showed that these primitive and animal-like instincts come out in the white races when acting as a group. Mob psychology brings the group down to the primitive instincts which are rarely observed in the white individual; and a European or American mob, when it 'sees red'—virtually goes mad—behaves with all the primitive and brutal barbarity shown in the insane patients of primitive races. The obvious conclusion is that fundamental differences of race are of a hereditary nature.

A well-attended meeting was held, by permission of the Royal Society of Medicine, at 1 Wimpole Street, on May 2, for the purpose of furthering a scheme for founding in Oxford a science museum of instruments and exhibits to illustrate the history of science and medicine. Sir Humphry Rolleston, in taking the chair, spoke of the new life given to the famous museum of Elias Ashmole at Oxford by the splendid gift of the Lewis Evans historical collection. After referring to the whole-hearted support given to the scheme by the late Sir William Osler, he invited Dr. R. T. Gunther, to whose energy and enthusiasm is due the fact that the project is assuming practical shape, to give an account of ways and means.

Dr. Gunther remarked that Ashmole's Museum, opened in 1683, is the oldest natural history museum in Great Britain. The building was originally devoted partly to the exhibition of specimens and partly to the meetings of the Oxford Philosophical Society. The ground floor was furnished as the oldest public chemical laboratory in the country. The upper floor has now been recovered as a museum, but the remainder should surely be restored to something more resembling its original purpose than its present use as a book store. The meeting was addressed by Dr. Knobel speaking for astronomy, Dr. Calman for zoology, Prof. Gibson for pharmacology, Sir G. Fordham for cartography, and Prof. Boycott for medicine. Three resolutions in favour of establishing such a museum in the Old Ashmolean building, which already houses the Lewis Evans Collection and valuable supplementary exhibits, were carried unanimously. A further resolution, "That this meeting approves the formation of a society of 'Friends of the Old Ashmolean' for the purposes of assisting in the restoration of the Old Ashmolean building as a public *Ashmolean Museum of the History of Science* (comparable to the *Ashmolean Museum of Art and Archæology*), and for providing by means of annual subscriptions an income for the purchase of desirable objects of scientific interest for the Lewis Evans Collection," proposed by Sir D'Arcy Power and seconded by Dr. F. A. Dixey, was also carried unanimously.

On May 4 the annual Romanes Lecture was delivered at Oxford to a large assembly by Prof. D. M. S. Watson, on "Palæontology and the Origin of Man." Prof. Watson pointed out that the minor periods of geological time are determined by palæontological remains. The changes produced by evolution tend generally to greater efficiency in relation to the mode of life. But though the general course of succession in any given group is often beyond question, the actual line of descent remains frequently in doubt. Pithecanthropus had bony superciliary ridges and a very small brain; Piltdown man (Eoanthropus) had an ape-like lower jaw, but slight brow-ridges; the brain was still small. The Heidelberg jaw was man-like. Neanderthal man had strongly developed ridges, and so had the Rhodesian skull, though it differed in other respects. The course of human evolution is thus uncertain. Prof. Watson said that Dryopithecus is probably in the line of human ancestry, but evolution has doubtless proceeded on greatly divergent lines. Many of these have depended on mental development, that is, on the arrangement of molecules in the nervous system; and so have transcended the province of the palæontologist, whose business is only with the obvious morphological facts.

Mr. Rollo Appleyard gives a complete account, in the *Electrical Review* for April 27, of the Penzance cable station of the Western Union Telegraph Co. This is the first time that a full description has been published of a submarine cable station fully equipped with modern types of amplifying and repeating apparatus. It is of great interest at the present time in connexion with the competition between radio and cable companies. The main cables of the Western Union Telegraph Co. are divided into two groups, one ending in Valentia and the other at Penzance. The introduction of cables sheathed with permalloy has enormously increased the speed of working. Every cable in the Company's Atlantic system is a link in one of nine through routes. All the manual work of the cables is done at terminal stations such as London or Liverpool and New York or Boston. The whole of the intermediate relaying is now automatic. There is no possibility of accumulation of traffic anywhere except at the terminal stations. The introduction of through working has greatly increased the accuracy and speed of transmission. The limit of manual working used to be about 150 letters per minute. Now a loaded cable having four channels works normally at 1300 letters per minute with much higher accuracy. It is interesting to remember that progress in cable design began by reducing the electrostatic capacity. The loading of cables with induction coils was then suggested, and finally the discovery of permalloy made uniform loading possible. At the present moment the Company is experimenting with modified loading to see if duplex working, which would double the speed, is possible. Unfortunately, trans-Atlantic telephony by submarine cable is not yet in sight.

Dr. W. R. Browne, assistant professor in the Department of Geology and Physical Geography of the University of Sydney, has been elected president of the Linnean Society of New South Wales.

The George Darwin Lecture will be delivered by Mr. W. H. Wright, of the Lick Observatory, at the ordinary meeting of the Royal Astronomical Society on June 8. The subject of the lecture will be "The Photography of Planets."

Sir Frank Dyson, Astronomer Royal, will deliver his presidential address to the Institute of Physics at 4.30 p.m. on May 15, taking as his subject "Physics in Astronomy." The address will be given in the rooms of the Institute at 1 Lowther Gardens, Exhibition Road, South Kensington, London, S.W.7.

The following have been elected honorary members of the Institution of Civil Engineers: His Royal Highness The Duke of York, Sir Alexander B. W. Kennedy, the Right Hon. H. P. Macmillan (Lord Advocate of Scotland), Mr. Samuel Rea, (Pennsylvania, U.S.A.), Sir Ernest Rutherford, and the Right Hon. Lord Wemyss.

The Linnean Gold Medal for 1928 has been awarded by the Linnean Society to Dr. Edmund Beecher Wilson, Da Costa professor of zoology in Columbia University, New York, and a distinguished worker in the fields of animal embryology and cytology. Prof. Wilson's early work dealt with descriptive embryology; in the 'nineties, he took a great part in founding the new science of experimental embryology, and many of his experiments, especially those on *Amphioxus*, *Nereis*, *Patella*, and *Dentalium*, remain classical. He is known to a world-wide circle as the author of that admirable text-book "The Cell in Development and Heredity." First published in 1896, a greatly enlarged third edition appeared in 1925 (reviewed in these columns on May 9, 1925,

p. 669). It is a model of what a text-book should be—encyclopædic, trustworthy, and judicial—and shows the hand of a master.

PROF. G. W. RITCHEY will deliver the Thomas Young Oration to the Optical Society on Wednesday, May 16. The subject of his address will be "The Modern Reflecting Telescope." Prof. Ritchey will give an account of his experience in making and using the great telescopes of Yerkes and Mount Wilson Observatories, and of the new cellular mirrors. The meeting will be held at the Imperial College of Science and Technology, South Kensington, commencing at 7.30 P.M., and will be open to all who are interested in this subject. Tickets will not be required.

THE Council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1927–28:—Telford Gold Medals to Dr. Oscar Faber (London) and Mr. G. L. Watson (Newark, New Jersey). Telford Premiums to Prof. John Goodman (Skipton); Mr. James Williamson (Wallington); Mr. R. M. Wynne-Edwards (Vancouver); and jointly to Mr. F. C. Vokes (Birmingham) and Mr. C. B. Townend (Birmingham).

THE Rockefeller Medical Fellowships for the academic year 1928–29 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1, 1928. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than £350 a year for a single fellow, with extra allowance for a married fellow, payable monthly in advance. Travelling expenses and some other allowances will be made in addition. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

AT the annual meeting of the members of the Royal Institution, held on May 1, the annual report of the committee of visitors for the year 1927, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory committee was also read. The following were unanimously elected as officers for the ensuing year:—*President*, The Duke of Northumberland; *Treasurer*, Sir Arthur Keith; *Secretary*, Sir Robert Robertson. *Managers*, Lord Blanesburgh, Sir James Crichton-Browne, Dr. J. Mitchell Bruce, Mr. A. Carpmael, Prof. F. G. Donnan, Sir James Dundas-Grant, Viscount Falmouth, Sir Robert Hadfield, Mr. J. S. Highfield, Mr. W. E. L. Johnston, Sir Henry Lyons, Mr. C. H. Merz, Mr. S. W. A. Noble, Sir Richard Paget, and Dr. G. C. Simpson. *Visitors*, Prof. E. N. da C. Andrade, Mr. A. Glegg, Commdr. A. C. Goolden, Mr. W. Vaux Graham, Mr. K. R. Hay, Sir Lawrence Jones, Dr. V. W. Low, Mr. W. Macnab, Mr. E. S. Mond, Dr. W. A. Milligan, Dr. C. C. Paterson, Dr. E. H. Rayner, Mr. H. M. Ross, Mr. S. Skinner and Mr. W. J. Tennant.

A LARGE earthquake was recorded at Kew Observatory on May 2 at 21 hr. 59 min. 42 sec. G.M.T. The epicentre is estimated to have been 1620 miles away and probably in the Grecian Archipelago. The intensity of the disturbance was about one-half of that produced by the earthquake which occurred in the same region on Mar. 31 and caused destruction at Smyrna.

A NEW enterprise on the part of the Ordnance Survey is announced in *Geography* (Spring 1918), which consists in the reproduction of one-inch maps of the country originally published 1801–1830. The series which the survey is prepared to reprint covers England south of a line through Chelmsford, St. Albans, Oxford, and Stroud, and certain other sheets, including the Humber, Lincolnshire, the Wash, Pembrokeshire, and the Gower area. In most cases four sheets cover a county. If the demand justifies the printing of an edition of 100 or more copies of each sheet, the price will be 5*s*. a sheet. These maps should prove valuable to students of geography and economic history.

IT is announced in *Science* that Dr. Henry Augustus Pilsbry, chief of the Department of Mollusca at the Academy of Natural Sciences of Philadelphia, has been awarded the Academy's Joseph Leidy Memorial Award for 1928 "in recognition of his researches on the phylogeny of the terrestrial mollusca, in which field he is universally regarded as a leading authority, and for his work on the classification of the Cirripedia which constitutes the most notable contribution to the subject in recent years." The award consists of a bronze medal and honorarium, given once in three years for outstanding work in the natural sciences. It was founded in 1923, and its first recipient, in 1925, was Dr. H. S. Jennings, of the Johns Hopkins University.

SIR JOHN ROSE BRADFORD contributes to the May issue of the *Nineteenth Century and After* an article on William Harvey, in which he gives an interesting account of the discovery of the circulation of the blood, of the state of medical knowledge at the time, and of Harvey's connexion with the Royal College of Physicians, London. In the coming week, the Royal College of Physicians will celebrate the tercentenary of the appearance of Harvey's "Exercitatio Anatomica de Motu Cordis et Sanguinis," which was published at Frankfurt in the spring of 1628 when its author was fifty years of age (see also NATURE, Mar. 31, p. 507).

THE twenty-third International Congress of Americanists will be held in New York City during the week beginning Sept. 17 next. An organising committee has been formed, of which Dr. Franz Boas is chairman, and Mr. P. E. Goddard, of the American Museum of Natural History, is secretary. The Congress will be divided into six sections, dealing with the ethnology of America, the archæology of America, the origin, distribution, and ethnography of the American Indian, native languages, the discovery and early history of America, and finally, geographical and geological questions with special reference to human activities. The titles of papers and abstracts for submission to the Congress should be in the hands of the secretary not later than June 1.

IN spite of the advances in medical knowledge and practice, maternal mortality has continued at a high level, and has shown little tendency to decline. The subject is engaging the concern of the Ministry of Health, and in a circular (No. 517) issued in 1924, the attention of local authorities was directed to the importance of providing facilities for assistance in the diagnosis of puerperal fever and puerperal pyrexia, and for the treatment of patients who are unable to secure adequate treatment for themselves. In a further circular (No. 888) recently issued, the Minister of Health again directs attention to these necessary services, and expresses the hope that in all areas all maternal deaths will be investigated by a competent and experienced medical officer.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A Paterson research scholar in the Cardiographic Department of the London Hospital—The House Governor, London Hospital, E.1 (May 15). A professor of philosophy in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (May 22). An assistant lecturer in zoology and geology in the University College, Southampton—The Registrar, University College, Southampton (May 28). Research chemists at research establishments of the Department of Scientific and Industrial Research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (May 28). A student probationer (zoologist, botanist, or physiologist) at the Marine Biological Laboratory, Plymouth—The Director, Marine Biological Laboratory, Plymouth (May 30). The Grote chair of philosophy of mind and logic at University College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 14). The Sir William Dunn chair of pathology at Guy's Hospital Medical School—The Academic Registrar, University of London, South Kensington, S.W.7 (June 15). A temporary reader in organic chemistry in the University of Dacca, East Bengal—The Registrar, University of Dacca, East Bengal (June 26). An assistant lecturer in chemistry at the Battersea Polytechnic—The Principal, Battersea Polytechnic, S.W.11.

Our Astronomical Column.

BRIGHT METEOR FROM HALLEY'S COMET.—On the morning of May 6, at 1 h. 40 m. G.M.T., a meteor quite equal to Jupiter was seen by two observers at Bristol, and the flight was recorded from 317° - 1° to 187° + 10°, which is equal to about 125 degrees. Such a lengthy course is very seldom recorded for a meteor of any kind. The path recorded shows the radiant was probably at 337° - 4° and from the position computed for meteors from Halley's comet (May 4). There is little doubt, therefore, that this small fireball was a particle from the famous Halley's comet. Though the full moon was shining strongly at the moment the object appeared, the latter presented a fine spectacle as it occupied five seconds in its transit and threw off a bright trail of sparks. As viewed at more southern stations and from the English Channel, the meteor must have been a very conspicuous object, and it is hoped that some additional observations of its path will come to hand. This shower, discovered by Tupman in 1869–70, is specially interesting from its association with Halley's comet.

COMETARY SPECTRA.—Mr. N. T. Bobrovnikoff has recently published several papers on this subject (*Astro. Jour.*, October and December 1927; *Pop. Astr.*, January 1928). Halley's comet showed marked changes of type during the apparition; when near the sun reflected sunlight predominated; at distance 1·2 from the sun, the violet type of spectrum due to inherent light predominated. A sudden change happened on May 24; the bands of CN IV disappeared, those of C + H became much weaker, those of C IV somewhat weaker. Barnard at the same time noted a swelling up of the nucleus. A note is made of the tendency of the head of this comet to repeat its behaviour at successive returns; many of the drawings made by Bessel in 1835 resembled phases seen in 1910; bright jets from the nucleus were also drawn in 1682 and 1759.

The comet Pons-Winnecke last summer exhibited the violet type of spectrum, which could be traced as far into the ultra-violet as in the case of Altair, which was in the same region of the sky. The bright knots of the spectrum of the head indicated the following diameters: C + H, 5000 km.; CN IV, 3600 km.; C IV, 3000 km.; continuous spectrum, 2000 km. A change in the spectrum occurred between June 10 and 19, CN IV being first brighter, then fainter than C + H. This was one of the first comets to be examined spectroscopically, by C. Wolf in 1869; he noted the three bands of the Swan spectrum.

THE EINSTEIN DEFLEXION OF LIGHT IN THE ECLIPSE OF SEPTEMBER 1922.—*Lick Observ. Bull.*, No. 397, contains the full discussion, by Prof. W. W. Campbell and R. J. Trumpler, of the photographic investigation undertaken in West Australia. The diagram gives very convincing evidence of the closeness with which the observed deflexions of star-places agree with those calculated on Einstein's law. A discussion follows as to the possible effect of abnormal terrestrial refraction owing to the fall of temperature during totality; it is convincingly shown that the effect would be very small compared with the observed shift. It is also shown that Courvoisier's yearly refraction could not be traced and was apparently not present. It may be pointed out that as some people are still unconvinced by the evidence, the Einstein effect is to be further investigated at next year's eclipse in Sumatra by Dr. Jackson and Mr. Melotte.

Research Items.

PIT RIVER INDIAN TRIBES, CALIFORNIA.—An attempt to reconstruct the culture and distribution of Indian tribes of north-eastern California, before the coming of the whites, in field work carried out in 1926, is made by Mr. F. B. Kniffen in vol. 23, No. 5, of the *University of California Publications in American Archæology and Ethnology*. The Achomawi and Atsugewi were oriented around the Pit River in a region with a certain general unity of climate and resource which contained a series of semi-isolated habitable tracts. There were certain unifying factors in a common culture and a largely common language which encouraged trade, exchange of food privileges, and unity against a common foe. Even within groups, however, political unity was generally circumstantial rather than natural. The population was roughly in the neighbourhood of 3000. The Indian has now been pushed back to the rocky edges of the valleys or works for the white rancher. They once claimed as their own a vast territory extending from Mount Shasta and Goose Lake to the Madeline Plains and Mount Lassen on the south, and from the Warner Range on the east to Montgomery Creek on the west; but it was especially along the Pit River that the centres of attraction were found. The valley areas offered an amazing variety of animal and vegetable food, the vegetable being capable of being either consumed immediately or stored for winter. The Indians recognised eleven groups, each composed of those living on a single site or on several nearby sites, nine of them being collectively termed Achomawi in anthropological literature, though they had no collective name for themselves. The two Atsugewi groups differed from the Achomawi in language and, while friendly with some, were at enmity with others. The four western groups of Achomawi and the Atsuge buried their dead, built round winter houses, used dug-out canoes, possessed the full Californian acorn technique, owned food-tracts privately or by families, but recognised no chieftainship over the group as a whole. The five eastern groups and the Aporige cremated their dead, built their winter houses over rectangular or oval excavations, had no canoes or acorn complex, and recognised a group chief, but no private ownership of food-bearing tracts of land.

MODEL HOUSES OVER GRAVES IN OCEANIA.—In *Man* for April, Mr. Patrick Buxton describes a burial custom followed in Nanomea in the Ellice Group, now that the older customs have died out owing to the introduction of Christianity. Formerly it was the practice to bury the dead in houses in the village. Now that burials take place in a cemetery, a small house is erected over the grave. The body is buried in the ground and white coral is strewn over the grave. Above this a small house is erected, the largest observed being about 5 ft. high and having a ridge-pole about 6 ft. long. Nothing quite like this has been recorded from any other part of Polynesia, although the erection of huts in the burying ground and the strewing of black and white pebbles over the grave have been noted. Mr. Buxton also records two remarkable rock-cut basins of unknown use and date from Tanna, New Hebrides. They are cut in two large masses of rock—a very soft red tuff—which have been roughly squared and faced. In each has been cut a basin. In one case the basin is circular, about 26 in. in diameter and 6 in. deep, with two overflows and circular depressions around the margin. In the other, the basin is rectangular, and about 26 in. by 9 in. long and 6 in. or 7 in. deep. Each held water. No similar objects have been recorded by any other visitor to the island.

PLUMAGE AND SEXUAL DEVELOPMENT.—On many of the mud-flats of British estuaries, as well as on the sandbanks of Holland, groups of waders remain during the summer months, while their kin have departed for the arctic regions, to which the breeding range is confined. These laggards are generally regarded as young and immature birds, and yet although in the majority the plumage indicates immaturity, in a very small percentage of cases, the full summer plumage is apparent. Dr. G. J. van Oort, in order to investigate the possibility of correlation between coloration of plumage and development of the gonads, collected a number of the delayed birds during the summer months, and now reports upon the Knot and Turnstone (*Tijdsch. Ned. dierk. Vereen.*, p. 25; 1928). In the twenty-two examples examined, he found that in both species the testes of the majority were inactive, and that in such birds the plumage varied greatly, but that all possessed some feathers of the adult summer plumage. On the other hand, in the few individuals in which the testes were active and many spermatocytes had been formed, the plumage is identical, or nearly so, with the normal adult summer plumage. Dr. van Oort reaches the conclusion that the full summer plumage cannot develop unless spermatogenesis has started and many spermatocytes have been formed.

DRAWINGS OF INDIAN FISH.—Dr. Sundra Lal Hora (*Jour. As. Soc. Bengal*, vol. 22, pp. 93-125; 1926) states that in the library of the Asiatic Society of Bengal there are bound volumes of zoological drawings made by Mackenzie, Buchanan-Hamilton, and Lord in the early part of the nineteenth century. The volume of the manuscript drawings of Mackenzie at present contains 2 plates of pencil sketches and 55 plates of coloured drawings, although originally there were 65 plates. Among the twenty-six illustrations of fishes in this volume there are two of a globe fish from St. Thomé River, near Madras. It is probable that the globe fish referred to belongs to the genus *Kanduka*, recently described from the Ganges delta. It would appear that the Society came in possession of these manuscripts in December 1822. There are four volumes of Buchanan-Hamilton's drawings. It is suggested that the originals found their way to the India House and are the same in the main as the set described by Günther in *Zoological Records* for 1869, and that the drawings in Bengal are only replicas. In the first volume there are 22 plates of fish illustrations, representing 51 species, and the rest of the plates are of mammals; the second and third volumes are drawings of birds made by Mr. Gibbons; and the fourth are those of fishes, representing 150 species. Lord's manuscripts are those of fishes in the collection of Sir Alexander Burnes. There are 47 illustrations; of these 35 are of whole animals, 9 outline sketches showing the fish from above, and 3 of special parts. In the 'forties, efforts were made to publish these drawings with the author's notes, but unfortunately the notes were lost and the publication was not completed.

THE FALL ARMY WORM.—Among the insect fauna of North America the Fall Army Worm (*Laphygma frugiciperda*) is of especial interest, since it is one of the few insects that frequently disperse and breed throughout the greater part of the United States, only to perish at the end of the season. It is only in the warmer parts of Florida and Texas that this insect remains a permanent resident, and it redistributes itself elsewhere through annual migrations of the moths. A very complete account of its biology and control is given in the *Technical Bulletin*, No. 34 (Feb. 1928) of the U.S. Dept. of Agriculture, written by Mr. P. Luginbill, of the Bureau of Entomology. The caterpillars feed upon a wide range of plants, but are more especially addicted to various grasses, and they rank as a pest of the first order. Periods of cool weather and rainfall favour the spread and multiplication of this species, while these same conditions are known to be deleterious to the multiplication of its natural enemies—notably predaceous and parasitic insects. The abundance or scarcity of these enemies determines to a very large extent whether or not there will be an outbreak of the Fall Army Worm in a particular season : local outbreaks are often checked entirely by such natural agencies. In view of the importance of this aspect of the economy of the Army Worm, a very full and interesting account is given of the relationship between it and its parasites and hyperparasites.

Vegetative Propagation by Seed.—In *Science*, vol. 62, No. 1733, Dr. Chas. F. Swingle directs attention to an account of four apple seedlings (variety, Transparent de Croncels) which have developed from unfertilised ovules of emasculated and bagged flowers to the bearing stage. The apparent identity of these plants with the seed-mother tree, together with the results of Kobel's cytological studies, seems to warrant the conclusion that under certain conditions (not yet defined), unfertilised ovules of this variety of apple may set viable seeds, genetically constituting true vegetative reproduction. These results differ from the somewhat similar observations of Frost, that in *Citrus* the stimulus proceeding from fertilisation seems necessary for the production of such 'asexual' seeds. The importance of apogamic seeds as a possible means of obtaining uniform clonal rootstocks should at once be apparent. Although under the conditions of his experiments Kobel was unable to get a sufficiently high percentage of these apogamic seeds to make them a factor in the production of uniform rootstocks, still his results point to the desirability of continuing and extending such experiments with as many different varieties of apple under as many different conditions as possible, in the expectation that the complex of varietal and environmental conditions necessary for vegetative propagation by apogamic seeds will be discovered. (See also "Zytologische Untersuchungen an Prunoideen u. Pomoideen," *Archiv Julius Klaus-Stiftung f. Vererb., Soz., u. Rassenhygiene*, vol. 3, No. 1, 1-84, 1927. Zürich.)

'Fallen Stars' of the Benghazi Steppe.—In a note published in the *Atti della Pontificia Accademia delle Scienze* for 1927, D. Vito Zanon describes small globules resembling drops of resin found in the steppe to the south of Benghazi. These globules are mostly orange-yellow or brownish-red, but occasionally white outside, and are so hard that the blow of a hammer is necessary to break them. The interior has the yellow colour of the finest amber and is shining and glassy, with a conchoidal or sub-vitreous fracture. It was at first thought that this material, the Arab name for which signifies 'fallen star,' consisted of amber, but chemical analysis indicates the presence of albumin and, in the inner portion, of lecithin. The obvious inference is that the spherules are eggs, presumably of a small reptile, which have been prevented by the high temperature of the soil from putrefying or undergoing other changes except drying and slight external deformation. A curious feature observed is the inclusion in the material of large numbers of both fresh-water and marine diatoms of many different forms. These were doubtless wind-borne, and were imprisoned when the egg-substance had been rendered so spongy by the action of surrounding moisture as to become permeable to atmospheric dust.

Weed Killers and Garden Paths.—Results of weed killer trials on garden paths, in which the effectiveness of a number of chemicals was compared with that of several proprietary weed killers, are described by A. Hill in the *Scottish Journal of Agriculture* (vol. 11, p. 203). Although common salt, washing soda, iron sulphate, sulphuric acid, carbolic acid, and sheep dip all gave disappointing results, copper sulphate applied as a fine powder at the rate of 1 lb. per 100 sq. ft. proved entirely successful, a plot treated twice in June 1924 remaining free from weeds up to November 1927. Weather conditions, however, were of the greatest importance, the best results being obtained if the path was treated on a sunny day after rain, and fine weather followed the application. If heavy rain followed the treatment, the effectiveness of the dressing was greatly reduced. Various types of proprietary weed killers also gave good results provided several applications were made, but they were less effective than the copper sulphate, and further, if they contained arsenic, caused a blackening of the paths. A non-poisonous weed killer (1 per cent. solution) in which sodium chlorate was the active constituent, also proved useful provided dry weather followed the application, but, as is apt to occur with some other weed killers, there was a tendency later for the path to become covered with moss. Iron sulphate was decidedly better than copper sulphate or caustic soda for eradicating moss, though the latter is recommended for removing green growth from concrete paths in shady positions. For this purpose the alkali is applied as a powder and allowed to absorb moisture from the air ; the path is then swept with a stiff brush and finally well flushed with water.

Whaling Research.—On April 2, at the Æolian Hall, London, Prof. A. C. Hardy lectured before the Royal Geographical Society on the work of the R.R.S. *Discovery* in the dependencies of the Falkland Islands. Prof. Hardy outlined the objects and scope of the *Discovery* Expedition, details of which have already appeared in our columns. It is evident that both the shore party and the staffs of the *Discovery* and the *William Scoresby* have collected a vast amount of material, and a considerable period of time must elapse before the actual results of their research will be available. Prof. Hardy, however, was able to give the broad conclusions of the results of an intensive plankton and hydrographic survey of the whaling grounds round South Georgia that are of extreme interest. The euphausians, which form the bulk of the food of the whale in that locality, were found to be concentrated on the north-east side of South Georgia ; on the west side of the island was a very rich zone of diatom plankton, which encircled the island on either side some distance from the shore. The island is placed at right angles to the westerly drift of water coming from Drake's Straits, and Prof. Hardy indicated how this current would set round either side of the island to meet some distance behind it, leaving an area of 'dead' water on the north-east side. This current, striking the shelving bottom on the west of the island, would cause upwelling of phosphate-rich water which could support a heavy crop of diatom life ; these diatoms would be carried round either end of the island, and by eddies into the sheltered water where the euphausians occurred. This dead water would thus form a sheltered nursery for the euphausians. The theory suggested fits well with the results of the phosphate analyses obtained. Work is still continuing at the shore station and in the *William Scoresby*.

Collisions Between Electrons and Molecules.—A big advance towards solution of the difficult problem of the motion of an electron projected towards a neutral molecule has been made by Dr. I. Langmuir and Mr. H. A. Jones in a long series of experiments carried out in the Research Laboratory of the General Electric Company at Schenectady. The simplicity of the apparatus employed, which was essentially a cylindrical thermionic tube containing a trace of gas, with the grid replaced by a space charge of positive ions, and a pair of auxiliary electrodes inserted, was in marked contrast to the heavy analysis involved in the reduction of the observations. Their main results are collected into three tables in the March number of the *Physical Review*. The first (p. 399) is a list of ionisation and resonance potentials for the gases used (mercury, neon, argon, helium, hydrogen, nitrogen); it is remarkable that the resonance potential important for the discharge is not necessarily the lowest excitation potential of the gas. The second (p. 402) gives the free paths for inelastic collisions of electrons with speeds equivalent to a number of potentials between 30 volts and 100 volts; these prove to be very close to the values calculated on kinetic theory from the viscosities of the gases. The third (p. 403) includes both data on the probability of various types of collisions and the average deflexion of an electron when it excites or ionises a molecule, and the maximum number of ions that can be produced by an electron with a specified initial velocity. The paper contains in addition considerable information about the groups of electrons which are present in an ionised gas, and confirms earlier records of the existence of several sets, each with a Maxwellian distribution of velocities.

The Green Auroral Line.—The recent *Bulletin of the American Physical Society* (No. 3 of the current volume) includes an abstract of a paper by J. Kaplan, in which it is stated that the spectrum of the after-glow of nitrogen which has been mixed with a few per cent. of oxygen shows only two of the lines of the latter in the visible region. One appears to be the auroral line, and the other is in the red at 6655 A. The absence of other lines due to oxygen, which is accompanied by a strong development of the alpha bands of nitrogen, indicates that the two which are present are produced in some very simple way (*v.* also Nature, May 5, p. 711). The actual mechanism which is effective in the upper atmosphere is discussed by Dr. G. Cario in the April issue of the *Journal of the Franklin Institute*. He criticises Prof. McLennan's views, and offers the suggestion that the action occurs in two stages, in the first of which ultra-violet solar radiation induces a photochemical dissociation of molecular oxygen into atoms in a normal singlet state, whilst in the second the atoms are excited to the upper level of the green line transition. Dr. Cario states that he has experiments in progress designed to test this hypothesis.

Silver Nitrate Concentration Cells in Acetonitrile and Benzonitrile.—The Nernst formula for concentration cells, which has been confirmed for aqueous solutions, is known to hold for several non-aqueous solutions such as silver nitrate in ethyl alcohol. In the *Journal of the Chemical Society* for February, F. K. V. Koch gives measurements of electromotive forces which show that at 0° C. and 25° C., silver nitrate concentration cells in acetonitrile and benzonitrile also support this formula. These solutions appear to conform to the solution laws almost as nearly as aqueous solutions.

Effect of Catalysts on the Combustion of Carbon Dioxide and Oxygen.—In the *Journal of the Chemical Society* for February, W. E. Garner and C. H. Johnson describe a very interesting apparatus, which they have used to investigate the rate of emission of radiation, the duration and extent of ionisation, and the speed of flame during the explosion of carbon monoxide and oxygen mixtures. Various substances were employed as catalysts, and it was found that those containing hydrogen decrease the infra-red emission, but increase the flame speed and ionisation. Very small quantities of water vapour have a large effect upon the amount of energy radiated. The ionisation persists for a much longer period in the absence of hydrogen-containing substances, but does not appear to be due to 'after-burning,' since the extinction of flame and steady radiation coincide. With dry gases it is also possible to distinguish a combustion phase responsible for the emission of infra-red energy, and a second phase characterised by ionisation and the emission of visible radiation. It suggested that this luminescence may be due to the slow recombination of ions. These effects are most marked with mixtures containing small quantities of carbon tetrachloride, but disappear in the presence of hydrogen.

'Sunviray' Ultra-violet Lamp.—This small arc lamp, made by Messrs. Ajax, Ltd., for home use, which was described in Nature of April 21, p. 641, has been greatly improved in design by the substitution of a rotary switch in place of the knife switch of earlier models. This eliminates the risk of a shock from the exposed electrodes at that point. It is regretted that in the previous description the lamp was incorrectly described as the 'Uviray'—the correct name is as given above. The arc is between cored carbons and will run on either D.C. or A.C. without change of adjustment.

Movements of the Heaviside Layer.—Experiments with radio waves have proved fairly satisfactorily that there is a refracting and reflecting layer (Heaviside layer) in the upper atmosphere. Experiments carried out by the engineers of the Bell Telephone Laboratories, New York, have shown that the radio signals received at a distance of 50 miles indicate quite clearly interference between rays probably refracted by this layer and those which come directly along the surface of the earth. The time interval between the interfering waves enables us to find the length of the path of the indirect waves. A study of the experimental results by R. A. Heising appears in the *Bell Laboratories Record* for February. He concludes that at night the apparent height of the refracting region varies between 150 and 400 miles. Since ultra-violet light from the sun produces free electrons at altitudes so low as 16 miles, the apparent height of the refracting region is much lower by day than by night. He concludes that the refracting region does not remain in a fixed position but moves up and down. He has observed a rise of six miles per minute and a fall of twenty-five miles per minute. The rapid movement of the refracting region at night appears to be the cause of the rapid fading of those waves which travel well during the night time. If the refracting layer were fixed and the frequency of the waves from the transmitting station fixed also, fading would not occur. Any transmitting station operating with variable frequency will probably produce bad quality reception at the receiving station if there is more than one transmission path between the two. The greatest care, therefore, should be taken when designing a broadcast station, to prevent variation of the carrier frequency during the course of an audio wave.

The Nature of Manual Dexterity and its Relation to Vocational Testing.

By Prof. T. H. Pear, J. N. Langdon, and Edna M. Yates.

Recent research to discover suitable tests of manual dexterity has concentrated upon two kinds, the sample or 'trade' test, and the 'analytic' test. The first kind explains itself; the second attempts to analyse the candidate's manual dexterity into simpler and, if possible, unitary dexterities. It then separately examines his capacities for them.[1]

To the immediately practical mind the sample test has advantages so obvious that it would appear foolish to supplant it. But the defects of its virtues are many. Though it measures a candidate's ability in the actual occupation for which he is wanted, it leaves quite undetermined a beginner's *capacity* for learning such a job; and ability is often acquired only at the expense of time and money. Except, therefore, for low-grade dexterities, the sample test will be useless for selecting those persons who, though they are not yet proficient in a particular job, are specially fitted for it. Furthermore, the risk of spoiling tools or machinery, and the physical danger in allowing potential failures to undertake complicated sample tests, are obvious.

Of these defects, the failure of the sample tests to discover capacity, as distinct from ability, is of chief psychological interest. For though such a failure must obviously occur with high-grade, complex skills, it is not certain that a sample test of low-grade dexterity, comprising only a few simple movements, would not test capacity.

Dissatisfaction with the sample test has encouraged attempts to discover simple or unitary capacities underlying more complicated forms of dexterity. Generally speaking, testing the simple muscular dexterities in the analytic procedure is far from simple, and requires a trained psychologist. This necessity, however, is admitted in many quarters. In Germany especially the analytic test is much in favour.[2]

Yet there is little evidence concerning the important question, whether the 'simple' factors which, after an analysis of any instance of muscular dexterity, are chosen to be tested, really compose that dexterity. While it seems that in a highly complicated skill the whole performance is not the mere sum of its parts, this seems less certain of a low-grade skill, which appears to be merely the simultaneous or successive combination of simple movements. For what is actually known concerning the functional inter-relationships of the simpler motor capacities suggests that they are not so intimate as was formerly supposed. Perrin,[3] Muscio,[4] and the present writers[5] have found very low correlations between simple motor performances. The manner in which they are 'tied together' is not certainly known.[6] As Prof. Edward L. Thorndike has pointed out from the result of experiments, "We see the possibility of a disciplinary effect[7] where superficial observation would have expected none, the difficulty of transfer in a case where speculative and verbal thinking would have assumed that it was easy, and, in general the ignorance that we suffer from, concerning the internal constituents of almost every act of learning."

Obviously, therefore, in searching for a test of *capacity* for manual dexterity (low-grade skill) it is necessary to examine, in the light of any procurable evidence, the relative claims of the sample and analytic tests.

Experimental Tests used.

The investigation described below was carried out with the support of the Industrial Fatigue Research Board in the psychological laboratory of the University of Manchester. It concerned a simple instance of manual dexterity closely resembling an actual process in the chain-assembling industry. Its main aim was to discover whether there is any transfer of training acquired in one kind of dexterity, to another in which there has been no such training.[8] It offers evidence, however, bearing upon the validity of the 'analytic' procedure in the vocational testing of manual dexterity.

A group of 28 subjects was trained intensively for eight days on an operation in which links were removed from and others replaced on spindles, the handling of which involved the rotation of a turntable. Improvement in general was more than fifty per cent. of the initial score. Before training was commenced, the performance of each subject was measured in various tests designed to show the presence or absence of transfer. These tests were selected in accordance with an observational and introspective analysis of the operation with the links and spindles described above. It will be seen from the following that many of them are simple tests of manual dexterity and may be of some interest in connexion with vocational selection.

(1) *Match insertion.*—The match-insertion board used in psychological testing was employed. Matches were taken one at a time from a standard position and inserted in the small holes, the score being the number of matches inserted in a two-minute period.

(2) *Placing matches in a box.*—Thirty matches were arranged in a row on the table, and were picked up one at a time and placed neatly in a match-box. The score was the time taken.

(3) *Placing rings on a rod.*—The subject took rings, one at a time, from a bowl, and slipped them over a rod. The score was the number dealt with in two minutes.

These three tests were performed with right and left hands separately.

(4) *Steadiness.*—The apparatus is described in Whipple's "Manual of Mental and Physical Tests," vol. 1, p. 152. It is the usual tracing board, with a slit bounded by converging metal strips. Along one edge is mounted a millimetre scale. The subject was instructed to draw the stylus along the slit without making contact with the sides. At the first contact the subject stopped and repeated the process. This was repeated eleven times. The score in each case was the distance traversed before contact, and the final score was the median of these eleven.

(5) *Steadiness.*—The metal plate pierced with holes of different diameters, as described in Whipple's "Manual," was employed. The subject had to hold the stylus in each hole in turn for 15 seconds. The total time before contact was made was recorded, and the score was the median of 7 trials.

(6) *Arm movement.*—The blindfolded subject was required to make a movement of the arm, the extent

[1] Cf. Prof. C. Burt's chapter on vocational tests in "Industrial Administration," edited by Muscio.

[2] Cf. F. Giese, "Psychotechnische Eignungsprüfungen" (Halle).

[3] "An Experimental Study of Motor Ability," *Journal of Experimental Psychology*, 1921.

[4] "Motor Capacity with special reference to Vocational Guidance," *British Journal of Psychology*, October 1922.

[5] In an unpublished report to the Industrial Fatigue Research Board.

[6] Cf. Pear, "Skill in Work and Play," pp. 22-3.

[7] *I.e.* transfer of training from one performance to a different one.

[8] J. N. Langdon and Edna M. Yates, *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*, vol. 72, and "An Experimental Investigation into the Transfer of Training in Skilled Performances." *British Journal of Psychology*, April 1928.

of which was measured by apparatus which precluded all save a rotary movement. He was then instructed to make another movement of the same extent as before. The score was the coefficient of variation of ten such trials.

(7) *Moede's impulse meter.*—The subject holds a hammer in his right hand and is instructed to strike a specially devised anvil. The force of the blow is measured on a scale. (An illustration is given in the apparatus catalogue of E. Zimmermann, Leipzig.) He is then told to strike the anvil again with just the same force as before. He repeats this ten times in all. Here again the score was the coefficient of variation.

(8) A group test of intelligence, No. 33 in the National Institute of Industrial Psychology's series.

Provision of Adequate Incentives.

It is a valid criticism of many experiments upon the acquirement of skill that one is uncertain if the motives urging the learners to try their best are adequate. Since many of the tasks are very simple and may become monotonous, boring, or irksome, the stimulus is lacking which a recognised test of intelligence naturally offers to university undergraduates or graduates, who are the usual volunteer 'subjects' for such experiments.[9] The Industrial Fatigue Research Board made it possible to supply a financial motive for adequate performance; the subjects, unemployed boys aged fifteen to eighteen years, from the local Labour Exchange, were employed full time. They were paid a minimum wage of 12*s*. per week plus a piece-rate depending upon daily performance. A similar piece-rate was paid for success in the 8 tests described. The work therefore was to them extremely important. They were under close observation all the time. It is thus perfectly certain, both from their behaviour and from their own account of the work, that the incentive to try hard was adequate.

The correlations obtained between each of the tests and the abilities in the operation with the links and spindles at the end of 8 days' training will now be given. In addition, the scores of the first, second, and third periods of ten minutes' practice, and also the mean score per period of the first day's training, were correlated with the mean score per period of the last day's training.

The table shows that the supposedly analytic tests show little correlation with the practised operation. The coefficients are all lower than that between rank in the second period of ten minutes' practice and rank in the mean performance on the final day of training. The coefficient derived from the second period of ten minutes' practice when correlated with the practised operation is identical with that from the first day's practice when correlated with the operation. It is higher than that derived from the first period of 10 minutes' practice when correlated with the final practised ability in the operation with the links and spindles.

Conclusion.

In this investigation, involving simple manual dexterity or low-level skill of a kind similar to that required in industry, the present experimental results do not support the hypothesis of a close relation between the simple performances in the analytic tests and the more complex performance involved in the practised operation itself. This agrees with the major result of the investigation reported elsewhere, that there is no evidence for transfer of training from the practised operation to performances in the 'simple' tests.

Results pointing in a similar direction but obtained upon a smaller number of subjects have been recently published by Dr. Hans Kellner.[10]

If such results are further confirmed by experiment they would justify the use, as a selective test for an occupation at a *low* level of skill, of a sample 'try out' in the operation itself. But this would have to be done only after an initial trial had been given to secure adaptation to the experimental conditions. Even here it must be emphasised that the correlation between the second (adapted) performance and the final (practised) ability is very low.

Correlation with Ability in the Operation with the Links and Spindles at end of 8 Days' Practice.

Test.	Correlation coefficient.	Probable error.
First 10-min. period in the operation with links and spindles	0·43	0·11
Second 10-min. period in the operation with links and spindles	0·57	0·09
Third 10-min. period in the operation with links and spindles	0·52	0·10
Mean score of first day in the operation with links and spindles (sixteen 10-min. periods)	0·57	0·09
Match insertion. R. hand	0·24	0·13
Match insertion. L. hand	0·24	0·13
Placing matches in box. R. hand	0·46	0·11
Placing matches in box. L. hand	0·16	0·13
Placing rings on rod. R. hand	0·30	0·12
Placing rings on rod. L. hand	0·28	0·12
Steadiness (1)	0·34	0·12
Steadiness (2)	0·06	0·13
Impulse meter	0·23	0·13
Arm movement	0·22	0·13
Intelligence	0·21	0·13

Despite this fact, however, a 'try-out' on the operation appears to be fairly useful in diagnosis. For in the present investigation, after a preliminary trial for adaptation, it was found that of those boys who were in the upper half of the distribution in the 'try-out,' 86 per cent. were in the upper half of the distribution on the last day of training.

The investigation also throws light upon another common and natural view not supported by the present figures. This opinion is that in selection for a performance involving low-grade skill, an error in the choice of operatives would not be serious.

In the present investigation, at the conclusion of the 8 days' training, the difference between the best and the worst performance was 126 links per period. There were 16 such periods per day. Therefore, even in this short working-day, between the best and the worst performance there was an average difference of more than 2000 links. In other words, the practised ability of the worst worker was only 64 per cent. of the best. This offers strong evidence of the need for selection even in occupations requiring a low degree of skill. The present figures favour the 'sample' as against the 'analytic procedure' for selecting operatives for such occupations.

[9] Cf. F. C. Bartlett, "Psychology and the Soldier," pp. 69-76; Burnett and Pear, "Motives in Acquiring Skill," *British Journal of Psychology*, vol. 16, pp. 77-85.

[10] *Psychotechnische Zeitschrift*, December 1927, pp. 153-161.

Danish Plaice Investigations in the Baltic Sea.[1]

For many years the problem of how the stock of plaice in the Baltic Sea is recruited has occupied biologists of that region. Peterson's view, expressed in 1894 (*Report Danish Biol. Stat.*, **4**, p. 13) and again in 1906 (*Cons. Internat. Rap. et Proc. Verb.*, **5**), was that the numbers were renewed by immigration from the German coasts around Kiel Bay. A. C. Johansen came to the conclusion that the deep water of the Baltic itself was the real home of the O-group in the eastern Baltic, whilst Reibisch concluded that this was not sufficient to account for the renewal of the whole stock, and that an immigration of *adult* plaice took place from the Kattegat and the western Baltic.

As the result of a systematic investigation carried out in 1925, H. Blegvad, however, holds the view that the renewal of the stock of plaice is brought about by the appearance of *young stages* on the shores of the Baltic proper. The supply from this source is erratic. He shows that the temperature and salinity of the bottom water during the early months of the year exhibit a distinct correlation with the numbers of the fry which are able to become established. When the temperature and salinity were relatively high during this period, a favourable fry year resulted, as, for example, in 1923 and 1925, whereas 1922 and 1924 (with the reverse conditions) were bad years.

A. C. Johansen goes into this matter more thoroughly, but deals with the adjacent waters of the southern Cattegat and the Belt Sea. A similar correlation is observable here also. The question then arises, Is this influence direct or indirect? Johansen is inclined to believe that it is mainly indirect, and that the paucity of young plaice in certain years is due to the presence of comparatively fresh water, deficient in plankton, which flows out from the Baltic during the winter months. If this hypothesis should be further confirmed, he suggests that a forecast of the yield in any particular year will be obtained most cheaply and easily by estimating the plankton in those waters and not by fishing for the young. The need for a solution of this problem is becoming more and more urgent on account of the very large increase in the intensity of fishing in the Baltic which has come about in recent years. Thus, although the Danish catch in 1917 was only 31,485 kgm., in 1924 it reached 2,909,011 kgm.

[1] Report of the Danish Biological Station to the Board of Agriculture, **32**; 1926: On the Renewal of the Stock of Plaice in the Baltic Proper. By H. Blegvad. Edited by Dr. C. G. Joh. Petersen. Pp. 37. **33**; 1927: On the Fluctuations in the Quantity of Young Fry among Plaice and certain other Species of Fish, and Causes of the Same, by A. C. Johansen; On a Spawning Place for Winter Spawning Herring in the Northern Part of the Belt Sea, by A. C. Johansen; On the Annual Fluctuations in the Age-Composition of the Stock of Plaice—Investigations from the Danish Biological Station, 1923–26, by H. Blegvad; Studies on the Biology of the Oyster (*Ostrea edulis*), II-IV, by R. Spärck. Edited by Dr. A. C. Johansen. Pp. 65. (Copenhagen: G. E. C. Gad, 1927.)

University and Educational Intelligence.

Cambridge.—Mr. F. E. Baxandall and Mr. C. P. Butler have been reappointed as senior observers, and Mr. W. Moss as junior observer, at the Solar Physics Observatory, and Mr. H. E. Green has been reappointed as assistant observer at the Observatory.

London.—A public lecture will be delivered at the East London College, Mile End Road, E.1, at 5 o'clock on Wednesday, May 16, by Dr. W. A. Goddyn, of the Rijks Herbarium, Leyden, on "Lotsy's Hybridisation Theory, demonstrated on South African Material."

Prof. Ross G. Harrison, of Yale University, will deliver a lecture on Monday, May 21, at 5.30 p.m., at University College. The subject of the lecture will be "Modern Trends in the Study of Animal Development."

St. Andrews.—An additional lectureship in philosophy has been instituted, and the University Court has resolved to appoint to this lectureship Mr. A. R. Knight, of the Institute of Industrial Psychology, London. The work of the new lecturer will be principally in the Department of Psychology and Experimental Psychology. The Court has appointed Dr. F. Bath, formerly of King's College, London, as lecturer in mathematics in the University and assistant to the professor of mathematics in University College, Dundee.

Vacation courses for teachers and students in England and Wales, arranged for the year 1928, differ but slightly from those of last year. The list issued by the Board of Education (H.M. Stationery Office, pp. 23, price 6*d.*) shows among those arranged by the Board several courses for teachers of science: in rural science, botany, and biology (but not, this year, in laboratory arts) at Cambridge, in physical chemistry and engineering at Oxford, and in physics at Harrow. Courses for foreigners have been organised by the University of London, by University College, London, by the University of Oxford, and by University College, Exeter. Among the subjects of the twelve courses arranged by university bodies in connexion with the work of the Workers' Educational Association, economics, literature, history, and psychology figure in all or almost all cases: natural science, generally biology, in five. In the list of courses organised by associations, the Association for the Provision of Science and Specialist Teaching finds no place this year: nor does the Dalton Association.

Adult education in America is developing rapidly. Some account of its recent growth is given in *Bulletins 18* and *21* of 1927 of the United States Bureau of Education, entitled "Public Education of Adults in the years 1924–1926" and "Public Evening Schools for Adults." Some of the activities described are concerned with attempts to promote by means of what used to be called 'Americanisation classes' the elementary education of illiterates. In such classes, organised by State departments of education, 315,000 students were enrolled in 1925–26. In public evening schools in cities of 10,000 or more inhabitants the enrolment was, in 1924, nearly a million. The most remarkable achievement in popularising such education is that of Gary, Indiana, where more than 12,000 men and women—one-sixth of the adult population—attend courses provided in the public schools. The total budget for evening schools, as reported by 412 towns, exceeded five million dollars, being at the rate of 15 dollars per student. Extension courses offered by colleges and universities are very various and are constantly assuming new forms. 'Radio talks' are increasingly used, and more and more institutions are installing, or procuring the use of, broadcasting plants and employing them in connexion with correspondence courses. So striking are the signs of growth of the adult education movement that the Bureau of Education's specialist in this subject anticipates developments during the second quarter of the century that will match the marvellous growth in the field of secondary education in the first quarter. A similar belief in a coming great revival in Great Britain was expressed by Prof. Robert Peers, of University College, Nottingham, in a public lecture on adult education delivered by him at King's College, London, some time ago.

Calendar of Customs and Festivals.

May 14.

St. Machudda or St. Cartagh (a.d. 637), one of the most noted of Irish saints, of whom many legendary stories are told. A celestial fire descended on his mother before his birth. As happened with many Irish saints, there was a lack of water at his baptism; but a spring burst from the ground for the office and flows to this day. Many miraculous acts are attributed to him, such as turning water into milk, and causing an apple tree to spring from the ground and bear fruit forthwith in a trial of strength with a pagan, Magus.

May 15.

St. Dymphna.—Seventh century. One of the most famous of medical saints, invoked in cases of possession, epilepsy, and lunacy, at Gheal, N. Brabant. She was the daughter of an Irish king who, inconsolable at the death of his wife, sought his daughter in marriage, and when she escaped to Gheal, followed and killed her. On May 15 her relics are carried in procession, followed by all the inhabitants and the lunatics, and on each day of the octave the lunatics, and those who seek the intercession of the saint for their friends and relatives, crawl around her shrine on all fours.

St. Cæsarea.—Date uncertain. An Italian saint from the neighbourhood of Otranto who, when persecuted by her father in the same manner as St. Dymphna, took refuge in a cave which opened in the cliff and closed again behind her. On Ascension Day and through the octave the cave opens and the saint is seen seated, while rays of light shoot forth from the cave. During the same period the people of the neighbourhood fetch water from a medicinal spring in a cave of St. Cæsarea near by.

May 16.

St. Carantog.—Sixth century. Son of a Prince of Cardigan. When the saint was conveying across the Severn a magnificent altar of stone sent by Christ from Heaven for a chapel which he had founded under the guidance of a dove, it was lost overboard. Confident that God would cast it up on the shore, he appealed to King Arthur for it to be restored to him. Arthur had intended to convert the altar into a table for himself and his knights, but returned it to the saint on his fulfilling the condition that he should capture a serpent which was devastating the Carr, a marshland district in Wales.

May 14-16. Rogation Days.

May 17. Ascension Day.

By the first Council of Orleans in the sixth century, it was enjoined upon the whole Church that the Rogation Days, previously only a preparation for Ascension Day, should have joined to them supplication for a blessing on the fruits of the earth. Rogation Week was also known popularly by the names of Cross Week, from the bearing of the Cross in procession, Grass Week, from the abstinences observed, such as salads, etc., being substituted for flesh, and Gang or Procession Week, from the perambulations for the purpose of blessing the fields. With this is associated the practice of making the circuit of the parish, otherwise " Beating the Bounds," and a curse on whomsoever moved a boundary was part of the Rogation Service.

As a popular custom, the civil purpose of fixing the bounds has overshadowed the religious side of the observance. In London the closing of the gates of the Temple to general traffic on Ascension Day is an affirmation of the boundaries which is more conspicuously observed in the formal procession of dignitaries to beat the bounds of the adjacent parish of St. Clement Danes. It is usual for the processions to be accompanied by boys carrying willow wands or staves. At Lichfield they bore green boughs, while at Wolverhampton children bore long poles decked with flowers. On Ascension Day at Nantwich, a hymn blessing the Brine was sung. An ancient pit called the Old Brine was decked annually with garlands. In Derbyshire, at Terrington, Ascension Day was observed as a holiday, and the five wells were elaborately dressed with flowers and overhung with boughs: the wells were visited in procession after services in church, and a hymn or psalm sung at each.

In many localities cakes and ale were provided for those taking part in the procession, while various devices were followed to impress the boundaries on the people, especially the boys. Sometimes a boy's head was bumped on a boundary stone; in Dorset someone was ducked in a brook, while at Exeter boys dammed streams in the streets and splashed passers-by with the water. At Wolverhampton 'gospel trees' marked the boundaries, and at Stanlake the gospel was read on a barrel-head in a cellar in the Chequer Inn, reported once to have been a hermitage or the site of a cross. About Keston and Wickham, in Kent, a number of young men used to assemble together and, making a hideous noise, run into the orchards, circling each tree and reciting a verse calling on God to send " Every twig, apple big, every bough applee now." For this " Youling " they expected a gratuity of money or drink.

The circling movement is important in many, especially of the more primitive, boundary observances. In the elevation of the Ceri at Gubbio each Cero circles three times before the specially favoured houses it visits, and in some of the observances of southern India the priest or officiant circles three times around the boundary stone. Apart from the act of circumambulation, the striking features of the custom in England, which connect it with primitive observance, are its essentially religious character, the meal of which the members partake, the carrying of an emblem of vegetation, and the marking of the boundary by some process painful to the individual, undoubtedly a remembrance of human sacrifice.

A suggested origin in the *Terminalia* or the *Arvalia* of ancient Rome must be referred to still earlier practice—the casting out of evil and the renewal of the benign magical influence of the deity. Hence at the festival of the goddess Mariamma in South India, the entrails of a sacrificed sheep are hung around the neck of a naked man of the scavenger class, who perambulates the boundaries, clearly representing both god and victim. The Tamils offer blood and rice on the boundary stones to renew the divine influence. Hence also the elaborate processions of the temple cars on special occasions. With these last must be compared the processions of the *alberi* and the *carrocci*, the poles and cars, which take place in a number of the Italian towns; and the elevation of S. Ubaldo, S. Antonio, and S. Georgio on the Ceri at Gubbio on May 15, the vigil of the first named, of which the elaborate ceremonial may possibly go back to the ritual prescribed in the Eugubine Tablets of Roman times, still preserved in the town. The similar processions of giants such as those at Lille, Bruges, and elsewhere, and recorded as having taken place in England until modern times, it has been suggested by Sir James Frazer, are to be derived from a practice such as the Druidical sacrifice of human beings in a wicker framework.

Societies and Academies.

LONDON.

Geological Society, April 18.—**G. H. Mitchell**: The succession and structure of the Borrowdale Volcanic Series in Troutbeck, Kentmere, and the Western Part of Long Sleddale (Westmorland). The area lies in the eastern part of the Lake District south of the High Street range. It is drained by the Rivers Sprint, Kent, and Trout Beck, all of which flow in a southward direction. Nine subdivisions are recognised in the rocks described. They have been subjected to severe earth movements. Two systems of folding are recognised, an earlier one of pre-Bala age and a later one of Devonian age. The former system, of simple character, shows axes trending in a north-north-easterly and south-south-westerly direction. In the latter the folding was intense, with an east-north-easterly and west-south-westerly strike, while the pitch of the folds was determined by the folds of pre-Bala date. The rocks are steeply folded in the south-east of the area, and the folds are even overturned to the north. Northwards the folding is less severe, and is marked by the presence of a broad anticlinal fold. No faulting of earlier date has been recognised. The rocks are strongly cleaved, the strike of the cleavage coinciding with that of the Devonian folding.—**L. J. Chubb**: The geology of the Marquesas Islands (Central Pacific). The Marquesas Islands, with one doubtful exception, are of volcanic origin. The southernmost, Fatu Hiva, consists of a caldera composed chiefly of lava-flows, within which an ash-cone has been built up. The western half of the whole structure has disappeared, apparently owing to submergence by faulting. Motane is a small ash island. Tahuata is larger, and it also is composed chiefly of ashes in its northern part; its south-eastern side has been faulted down. In Hiva Oa there are three great craters in the western part, some of the coasts are faulted, and there is an elevated plateau at a height of 1300 to 1500 feet above sea-level. Nuka Hiva has a structure similar to that of Fatu Hiva, and it bears a plateau at an elevation of 2600 feet. It is considered that the group is situated, not on a crustal fold, but on a system of intersecting fissures. Elevation has occurred followed by subsidence. All the islands are surrounded by a shore-shelf, now standing, owing to a recent fall in sea-level, 3 or 4 feet above high-water mark. The poor development of coral-reefs in the group is due chiefly to periodic chilling of the water by extensions of the cold Peruvian Current, connected with cyclic climatic changes.

Linnean Society, April 19.—**R. D'O. Good**: The geography of the Sino-Himalayan genus *Cremanthodium* (Compositæ). The range of *Cremanthodium* is roughly within the triangle made by joining the Indus valley where it enters the N.W. Frontier Province, Lake Koko Nor in Kansu, and Lake Tali-fu in Yunnan. This total area is divisible into three main topographic regions—the western or Himalayan mountains, the eastern or western Chinese mountains, and the plateaux of Tibet. A statistical study of the distribution of the species shows that: (1) 14 species are found in both western and eastern mountains. (2) 4 species are found only in the Himalayan mountains (all in the eastern half of the range). (3) 30 species are found only in the Chinese mountains (almost all in the southern half). (4) The greatest concentration of species is in Yunnan. (5) Only two or three species extend on to the Tibetan plateaux. The present areas of greatest species population in the genus are within the zone of very high monsoon precipitation, but this distribution results largely from the configuration of the mountains, and the elevation of the Himalayas has probably caused the progressive desiccation of the northern mountains of western China.—**F. O. Bower**: The size-factor in plant morphology, with special reference to the stele. Physiological interchange is conducted through limiting surfaces, external or internal, and it may be assumed that, provided the surface be unbroken, such interchange will be proportional to the area of the surface involved. Accordingly, in an enlarging body, if the original form be retained, a practicable size-limit will ultimately be reached. In the ordinary vascular plant there are three important limiting tissue-surfaces: (i.) the outer contour; (ii.) the endodermal sheath, which delimits the primary conducting tracts from the enveloping tissues; (iii.) the collective surface by which the dead tracheal system faces upon the living tissues that embed it. The present discussion deals only with (ii.) and (iii.), and all secondary or cambial developments are left out of consideration. The common form of axis in primitive plants is conical, enlarging upwards; and the conducting system enlarges with the axis. Thus it will constantly be called upon to meet a diminishing proportion of surface to bulk. This is carried out chiefly by: (*a*) penetration of the primitively solid tracheidal tract by living cells, or replacement of those that are central by parenchyma; (*b*) its enlargement of surface by fluting, or segregation into parts; (*c*) involution of the endodermis, which is apt to follow the changes in the tracheidal tract, but does not always do so. Comparison of various plants shows that the stele may react to the size-factor independently of the insertion of appendages. This is seen in marked degree in roots; it is also evident in aphyllous and microphyllous forms, but where the appendages are large these exercise a correspondingly great influence upon the stelar development.

DUBLIN.

Royal Irish Academy, April 23.—**Thomas J. Nolan and Michael T. Casey**: The nature of the pigment of the elder berry (Part 1). The anthocyan pigment of the elder berry has been isolated as the chloride in the form of a powder with strong bronze reflex showing a pattern between crossed Nicols. The picrate is a brick-red product crystallising in flat prisms. The anthocyan chloride is readily soluble in water and in hydrochloric acid of various strengths. From the chloride, by hydrolysis with strong hydrochloric acid, the colour base chloride has been obtained in the form of prisms with rounded ends. The product contains no methoxyl groups and resembles delphinidin closely in its colour reactions with alkalis and with ferric chloride, its ease of isomerisation, its power to reduce Fehling's solution, and its difficultly soluble picrate. Direct comparison with a sample of delphinidin chloride, however, shows that it differs markedly from the latter in its reactions towards water and 10 per cent. hydrochloric acid, the elder berry anthocyanidin chloride being practically insoluble in water.

PARIS.

Academy of Sciences, April 2.—**Gabriel Bertrand and Georges Nitzberg**: The preparation, by the sorbose bacterium, of a new reducing sugar containing seven atoms of carbon. α-glucoheptite can be oxidised under the influence of the sorbose bacterium into a new reducing sugar with the formula $C_7H_{14}O_7$, α-glucoheptulose. It is probably ketonic, and further experiments regarding its constitution are in progress.—Constant Lurquin: The statistical analysis of successive differences of deviations.—Georges Calugaréano: Polygene functions of a complex variable.—Henri Milloux: Some properties of the roots of meromorph functions.—Georges Valiron: Some properties of meromorph functions.—S. Mandelbrojt: A fundamental point in the theory of the series of Dirichlet.—Portevin: The determination of the internal strains in circular metallic cylinders.—Pierre Salet: The errors due to the personal equation in observations of the angular position of double stars. Reply to a criticism of the prism method by de Glasenapp.—Albert Nodon: Relation between the regular oscillations of terrestrial electric and magnetic fields and the diametral solar foci.—E. Kogbetliantz: The velocity of propagation of attraction. A laboratory experiment is suggested which would be capable of measuring the velocity of propagation of the Newtonian attraction, if it is comparable with the velocity of light.—Conti, de la Ville le Roulx, and Coret: The selection of communications of departure and arrival in telephonic networks with a central battery.—Pierre Jolibois, Henri Lefebvre, and Pierre Montagne: The reversibility of a reaction produced by a spark or by the electric current. Starting either with carbon dioxide or a mixture of carbon monoxide and oxygen under suitable pressures, after sparking for some time the same equilibrium was reached, about 74 per cent. of the mixture remaining uncombined.—P. Laffitte: The influence of the temperature on the formation of the explosive wave. A description of experiments carried out with mixtures of hydrogen and oxygen and of methane and oxygen, the temperature of explosion varying from 15° C. to 350° C. The results clearly prove that the elevation of the initial temperature of a gaseous combustible mixture retards the formation of the explosive wave.—A. Seyewetz and D. Mounier: The action of light on diazo-compounds. The amount of nitrogen gas evolved was taken as measuring the effect of exposure to ultra-violet light. With diazo-sulphonilic acid, the gas evolved was proportional to the time of exposure. In acid solutions (*p*H less than 7), the diazo compounds examined were very sensitive to light; in alkaline solution (*p*H above 7), the light effect was much reduced. With rise of temperature, the sensibility is greatest in alkaline solution and reduced in acid solution.—Marcel Godchot and Mlle. G. Cauquil: Molecular transposition in the cycloheptane series. Phenyl-magnesium bromide reacts with *a*-chlorocycloheptanol giving phenyl-cyclohexyl carbinol, $C_6H_{11}\cdot CH\cdot(OH)\cdot C_6H_5$. The probable mechanism of the change from a seven-carbon ring to a six-carbon ring is discussed.—J. Bougault and J. Leboucq: The 1 and 2 substituted semicarbazides. 1-Benzylsemicarbazide and 2-benzylsemicarbazide.—P. Teilhard de Chardin: The nature and the succession of the post-palæozoic eruptions in northern China.—M. Baudouin and Morel: A unique case of palæo-pathology. An arrow-point in a human dorsal vertebra. In a cave at Sainte-Énimie (Lozère), amongst bones of the neolithic period, two were of special interest. One shows clear indications of chronic osteo-arthritis, the other an entire vertebra in which a flint arrow-head is firmly imbedded.—Const. A. Kténas and P. Kokkoros: The phases of the parasitic eruption of Fouqué-Haméri (Santorin) in 1928.—P. L. Mercanton: Nocturnal radiation at Lausanne.—H. Chermezon: The ensiform leaves of some Cyperaceæ.—Paul Chabanaud: The urohyal of some fishes of the Solea family.—Raymond-Hamet: The pseudo-non-excitability of the cardiac pneumogastric produced by uzarine and by extract of uzara.—Léon Binet and René Fabre: Variations of the amount of uric acid in the blood according to the state of the respiratory function: hyperuricæmia due to asphyxia. Mechanical asphyxia in the dog determines a marked increase in the proportion of uric acid present in the blood. The effect is temporary, and the uric acid assumes its original figure fifteen minutes after restoring normal respiration. The removal of the spleen does not affect the phenomenon.—Mme. M. Phisalix and F. Pasteur: Ultra-violet rays destroy the rabicidal power of the venom of *Vipera aspis*.—R. Douris and J. Beck: The action of mineral colloids on normal and syphilitic blood sera. In place of the unstable colloidal reagents employed in the serum diagnosis of syphilis by precipitation, the use is suggested of colloids of constant chemical composition and possessing the same physical state. The colloid reagent (sulphur, sulphides, etc.) are produced in the liquid under examination by a chemical reaction. Silicic acid has given the best results.—Fauré-Fremiet and Mlle. Choucroun: The measurement of the thickness of thin protoplasmic plates.

Brussels.

Royal Academy of Belgium, Jan. 7.—A. de Hemptinne: Hydrogen activated by the electric discharge. Under certain conditions the chemical activity of non-ionised activated hydrogen can be demonstrated. The effects produced depend partly on the state of the body on which it is acting.—J. Verhaeghe: The arc spectrum of uraninite from Kasolo (Belgian Congo). An attempt was made to strike an arc between electrodes of the mineral instead of the usual carbon electrodes, but a background of continuous spectrum rendered exact measurement of the lines impossible. The secondary minerals were freely soluble in hydrochloric acid, and the chlorides thus obtained were introduced into the arc. A tabular statement of the lines measured is given. Elements not previously shown by chemical analysis include titanium, iridium, vanadium, thorium, and tungsten.—L. Godeaux: The asymptotic lines of a surface and ruled space.—Constant Lurquin: The methods of calculation of the mean deviations of probability.—P. Swings: Some formal analogies between certain orbits.

Rome.

Royal National Academy of the Lincei, Feb. 5.—F. Severi: Simple and double algebraic integrals (4).—U. Cisotti: The rotor of tensors.—G. Scorza: Major determination of the intercedent relation between the row and the type of a group.—G. Giorgi: The functions of matrices.—C. Somigliana: The definition of normal gravity.—N. Parravano and G. Malquori: Equilibrium of the reduction of tungsten disulphide by means of hydrogen. The equilibrium expressed by the equation, $WS_2 + 2H_2 \rightleftarrows W + 2H_2S$, is reached more rapidly when the reaction proceeds from left to right. The mean value of Q, calculated by means of Nernst's approximate equation from the dissociation pressures of tungsten disulphide, is 73,400 cal.—S. Franchi: An exceptional vein of augitic porphyrite in the triassic dolomites of the upper valley of the Neva (Ligurian Alps).—P. Nalli: Geodetic co-ordinates.—S. Cherubino: The characteristic matrices of the symmetrics on real Abelian varieties.—Ernesta Porcu-Tortrini: Calculation of any functions of matrices of the second order.—A. J. McConnell: Parallel transport of a vector along a finite circuit. Discussion of the variation of a vector subjected, as suggested by Levi-Civita, to parallel transport along a closed circuit in a space of N

dimensions, gives a double integral as the expression for this variation.—L. Fantappiè: The linear functionals of the functions of two complex variables (1).—G. Krall: Upper limits of dynamic cement.—P. Straneo: Kutta and Joukowski's theorem, Cisotti's supposed exception to this theorem is the result solely of the mode of interpreting the hydrodynamic phenomenon in the region of the irregularity, that is, at the edges of the lamina, where the velocity becomes infinite. The formal ambiguities leading to such interpretation may be eliminated by suitable consideration of the question *ab initio*.—E. Persico: Molecular velocities, conditions of excitation, and probability of transition in a degenerating gas (2). The formula previously deduced for expressing the distribution of kinetic energy among the molecules of a degenerating gas and the distribution of the molecules in the various quantic states, is applied to the two cases of slight and complete deterioration. It is found (1) that the number of molecules with kinetic energy exceeding $1 \cdot 04\ kT$ is greater, and the number of molecules with lower kinetic energy less, than required by Maxwell and Boltzmann's theory, and (2) that the molecules are divided among the different states of excitation solely on the basis of their volume and independently of the energy of the separate states. The same formula serves also to determine how Einstein's law is modified by the probability of transition from one quantum state to the other.—R. Brunetti: Polychroism and orientation of the ions in crystals of rare earths. The results of investigations on the absorption spectra of pentahydrated praseodymium sulphate at the ordinary temperature and at the temperature of liquid air, and of neodymium bromate at the ordinary temperature, lead to the conclusion that the spectra of the trivalent ions of the rare earth metals forming part of a symmetrical crystal contain (1) frequencies corresponding with linear vibrations in a direction close to that of the principal axis of the crystal, and (2) frequencies, in general distinct from the preceding, corresponding with vibrations occurring in the plane approximately orthogonal to the principal axis and decomposable into two vibrations equal in intensity and normal to one another in this plane.—R. Bilancini: The anemological regime of the Gulf of Spezia. The results obtained during the four years 1914–17, from ascents to heights of 3600 metres of about one thousand pilot balloons liberated at the aerological station in Varignano, on the Gulf of Spezia, show that, in general, the wind velocity increases with the height, the extent of the increase being greatest in summer and least in autumn and winter. The mean velocity is greatest in winter and least in summer, the value in the spring being approximately equal to that in the autumn at low altitudes but increasingly greater at higher altitudes.—G. Malquori: Thermal dissociation of cadmium nitrate. Anhydrous cadmium nitrate undergoes reversible decomposition at 325° C. in accordance with the equation,

$$2Cd(NO_3)_2 \rightleftarrows 2CdO + 4NO_2 + O_2,$$

the only two solid phases observed being the nitrate and the oxide. Nernst's equation gives the value 55,881 cal. for the heat of decomposition of the salt. —A. Galamini: The physiological action of alcohol. Further observations on rats fed with an insufficient aprotein, acarbohydrate, hyperlipinic diet.—M. Tirelli: Modifications of the chondroma and lacunoma in the intestinal cells of *Gambusia holbrooki* during the various phases of functional activity and during fasting.—M. Benazzi: The existence of particular interstitial cells in the connective tissue of the uterus of the rat.

Official Publications Received.

BRITISH.

The Journal of the South African Veterinary Medical Association. Vol. 1, No. 1, August 1927. Pp. 85. (Johannesburg.)

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1927. Pp. xii+53. (London.)

University of Glasgow. Report on the Hunterian Collections for the Year 1926–27. Pp. 8. (Glasgow.)

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1925–26. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. (Forty-second Issue.) Pp. xxi+81. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2*s.* 3*d.*

The Passing of Wild Life. Pp. 8. (London: The Society for the Preservation of the Fauna of the Empire.)

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 12, No. 45, March. Pp. x+12+118+118+xxx. (Sheffield.) 10*s.* 6*d.*

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1103 (Ae. 280): The One-foot Wind Tunnel at the National Physical Laboratory; including Particulars of Calibration made with a Pitot Tube and Vane Anemometer at Low Speeds. By L. F. G. Simmons and L. J. Jones. (T. 2428.) Pp. 9+10 plates. 9*d.* net. No. 1107 (Ae. 284): Further Experiments on a Model of the 'Bantam' Aeroplane with special reference to the 'Flat' Spin. By H. B. Irving and A. S. Batson. (A.2.a. Stability Calculations and Model Experiments, 127.—T. 2362.) Pp. 26+11 plates. 1*s.* 3*d.* net. (London: H.M. Stationery Office.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 39, Part 1, April 25th, 1928. Pp. 102. (London: Edward Stanford, Ltd.) 5*s.*

Legislative Assembly: New South Wales. Report of the Director-General of Public Health, New South Wales, for the Year 1926. Pp. vi+169. (Sydney, N.S.W.: Alfred James Kent.) 7*s.* 6*d.*

FOREIGN.

Det Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser, Bind 7, Nr. 2: On some Biological Principles. By C. G. Joh. Petersen. Pp. 54. (København: Andr. Fred. Høst and Son.)

Sudan Government. Report on Agricultural Research, Season 1926–27, and Programmes of Work for 1927–28; submitted to the London Supervisory Committee, October 1927. Pp. 185. (London: Sudan Government Offices.) 2*s.* 6*d.*

Proceedings of the United States National Museum. Vol. 73, Art. 2: Two new Nematodes of the Family Strongylidae, Parasitic in the Intestines of Mammals. By Benjamin Schwartz. (No. 2723.) Pp. 5+2 plates. Vol. 73, Art. 3: Further Consideration of the Shell of Chelys and of the Constitution of the Armor of Turtles in General. By Oliver P. Hay. (No. 2724.) Pp. 12+2 plates. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Technical Bulletin No. 41: The Sugar-Cane Moth Borer in the United States. By T. E. Holloway and W. E. Haley and U. C. Loftin; with Technical Descriptions by Carl Heinrich. Pp. 77. (Washington, D.C.: Government Printing Office.) 25 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Instructions for Tide Observations. By G. T. Rude. (Special Publication No. 139.) Pp. vii+70. (Washington, D.C.: Government Printing Office.) 20 cents.

CATALOGUES.

General Catalogue, 1928. Pp. 90. A List of New Books, Summer 1928. Pp. 28. (London: Chatto and Windus.)

Continental Holiday Cruises. Pp. 16. Holiday Tours to Madeira or Canary Islands. Pp. 6. Special Tour to South Africa. Pp. 6. (London: The Union-Castle Mail Steamship Co., Ltd.)

Students' Balances and Weights. (List No. 71E.) Pp. 4. Surplus Stock. (List No. 101F.) Pp. 12. Laboratory Coats, Aprons and Short Jackets. (Circular 251B.) Pp. 2. Genuine Becker Balances. (Circular 263A.) Pp. 4. (London: A. Gallenkamp and Co., Ltd.)

Catalogue of Books on Geology, Ornithology and General Natural History, including Conchology, Entomology, Fishes, Mammalia and Minor Classes. (No. 159.) Pp. 36. (London: Dulau and Co., Ltd.)

Diary of Societies.

SATURDAY, MAY 12.

BIOCHEMICAL SOCIETY (in Department of Brewing and the Biochemistry of Fermentation, Birmingham University), at 11.45.—S. H. Edgar: The Composition of the Blood in Acute Rheumatism of Childhood.—E. M. Hume, H. H. Smith, and I. Smedley-MacLean: The Biological Examination of Irradiated Zymosterol for Vitamin D.—J. Butterworth and T. K. Walker: A Study of the Mechanism of the Fermentation of Citric Acid by *Bacterium pyocyaneus*. Part 1.—Prof. A. R. Ling: Researches on the Polysaccharides.—F. W. Norris: The Hemicelluloses of Cereals.—A. G. Norman: The Chemistry of the Pectins. —W. L. Dulière: The Estimation of Creatine in Alkaline Solution.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at New Malden), at 1.30.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (Annual General Meeting) (at Neville Hall, Newcastle-upon-Tyne), at 2.30.—R. White: The Use of Carbon Monoxide Gas Masks in Mines.—*Papers open for further discussion*:—Notes on the Conversion of Main Pumping from Steam to Electricity, with Special Reference to the Plant Installed at Messrs.

The Stella Coal Company's Clara Vale Pit, by L. H. Forster; Roof Control on Longwall Faces, by J. F. C. Friend.
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Bath), at 5.30.—Annual Meeting.
INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District Meeting) (at Totnes).

MONDAY, MAY 14.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Col. Sir Henry Lyons and others: Notes on Early Geographical Instruments.
BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 8.—A. G. Hughes: The Scientific Interests of Little Children.

TUESDAY, MAY 15.

INSTITUTE OF PHYSICS, at 4.—Annual General Meeting.—At 4.30.—Sir Frank Dyson: Physics in Astronomy (Presidential Address).
ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15—D. Caradog Jones: The Cost of Living of a Sample of Middle-Class Families.
ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Month of April 1928.—W. C. Beebe: Under-sea Studies of Tropical Coral Reefs.—Dr. W. T. Calman: On the Prawns of the Family Atyidæ from Tanganyika.—Prof. A. Meek: On *Sagitta elegans* and *Sagitta setosa* from the Northumbrian Plankton.
LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—Dr. E. J. Salisbury: The Plant Population of Britain.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—E. W. Mellor: A Few Films.
INSTITUTION OF WELDING ENGINEERS (at Caxton Hall), at 7.30.—P. L. Roberts: Standardisation of Welding.

WEDNESDAY, MAY 16.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Gilbert Walker: On Periodicity and its Existence in European Weather.—D. Brunt: Harmonic Analysis and the Interpretation of the Results of Periodogram Investigations.—Dr. C. E. P. Brooks: Periodicities in the Nile Floods.
OVERHEAD LINES ASSOCIATION (at Institution of Electrical Engineers), at 5.30.—D. C. Redfern and others: Discussion on Standard Overhead Lines: Their Advantages and Number of Different Standards Required.
ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Dr. H. Moore: The Mode of Formation of the Image in the Microscope.—G. F. Marrion and Dr. A. S. Parkes: The Effects of Inanition and Vitamin B Deficiency upon the Testes of the Pigeon.—Miss M. E. Shaw and Dr. F. W. R. Brambell: An Aberrant Ovary in a Frog.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. G. W. Ritchey: The Modern Reflecting Telescope (Thomas Young Oration).
FARADAY SOCIETY (Annual General Meeting) (at Chemical Society), at 8.—Prof. C. H. Desch: Diffusion in Solids (Presidential Address).
ROYAL SOCIETY OF ARTS, at 8.—W. Worby Beaumont: Modern Motor Car Design: Some Criticisms and Some Suggestions.
FOLK-LORE SOCIETY (at University College), at 8.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—J. W. Perring: Notes on Electroplating and Polishing Plant.
BRITISH PSYCHOLOGICAL SOCIETY (General Meeting) (at Royal Anthropological Institute), at 8.15.—W. Line: Some Experimental Data concerning the Growth of Visual Perception.
ROYAL SOCIETY OF MEDICINE (Dermatology and Surgery Sections), at 8.30.—Prof. Sicard (for Section of Dermatology), T. Higgins (for Section of Surgery), Sir Sidney Alexander, Dr. Goldsmith, and others: Special Discussion on Treatment of Varicose Ulcers by Intravenous Injection.

THURSDAY, MAY 17.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.
CHEMICAL SOCIETY, at 5.30.—F. M. Hamer: Neocyanine.—I. Vogel: Syntheses of Cyclic Compounds. Part III. The Reduction of Some Unsaturated Cyano-esters with Moist Aluminium Amalgam. A New Synthesis of Mono-substituted Malonic Acids and of $\beta\beta\beta'\beta'$-Tetramethyladipic Acid. Further Evidence for the Multiplanar Configuration of the Cycloheptane Ring.—F. Fichter and E. Brunner: The Action of Fluorine upon Aqueous Solutions of Chromium and Manganese Salts.
INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—Annual General Meeting.
INSTITUTION OF ELECTRICAL ENGINEERS (Annual General Meeting), at 6.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Dr. G. W. Bray: Vitamin B Deficiency in Infants—its Possibility, Prevalence, and Prophylaxis.

FRIDAY, MAY 18.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Annual General Meeting.
NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at Royal Society of Arts), at 5.30.—F. M. Earle and A. Macrae: Choosing a Career.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—A. C. Banfield: Demonstration of Retouching.
GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. J. Bull and I. G. Jardine: A Section in Drift North of Upminster, Essex.—Miss B. R. Saner: On Some Features of the Taplow Terrace between Charing Cross and the Valley of the Fleet.—E. E. S. Brown: On an Unusual 'Pipe' in the Blackheath Beds at Bromley Hill.—Dr. S. W. Wooldridge: An Unmapped Outlier of the Boyn Hill Terrace at Herne Hill.—F. Gossling: A New Section in the Blackheath Beds of the Addington Hills.
ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Morley Roberts: The Sea in Fiction.

PUBLIC LECTURES.

MONDAY, MAY 14.

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 15, 16, and 18.)

TUESDAY, MAY 15.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.—Prof. J. B. Leathes: The Human Kidney and the Physiological Study of Human Urine. (Succeeding Lectures on May 16, 22, and 23.)
LONDON SCHOOL OF ECONOMICS, at 5.—Prof. S. D. Wicksell: Some Aspects of Population Problems. (Succeeding Lectures on May 16 and 18.)
UNIVERSITY COLLEGE, at 5.—Prof. L. J. Henderson: Blood: a Study in General Physiology. (Succeeding Lectures on May 17, 18, 22, 24, and 25.)
BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.1), at 8.15.—Major W. Elliot: Sunlight—Natural and Manufactured, and its Use in Modern Medicine (Chadwick Lecture).

WEDNESDAY, MAY 16.

ROYAL SOCIETY OF MEDICINE, at 4.30.—Prof. K. F. Wenckebach: The Heart and Circulation in a Tropical Avitaminosis (Beri-beri) (St. Cyres Lecture).
EAST LONDON COLLEGE, at 5.—Dr. W. A. Goddyn: Lotsy's Hybridisation Theory, demonstrated on South African Material.

THURSDAY, MAY 17.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. H. Hartridge: Poisoning by Coal Gas and Products of Combustion.

FRIDAY, MAY 18.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Sir William J. Pope: Recent Progress in Stereochemistry. (Succeeding Lecture on May 25.)
KING'S COLLEGE, at 5.30.—R. G. Collingwood: Roman Britain and Recent Excavations. (Succeeding Lectures on May 25 and June 1.)
OXFORD UNIVERSITY, at 5.30.—Prof. A. M. Carr-Saunders: Professions: their Organisation and Place in Society (Herbert Spencer Lecture).

SATURDAY, MAY 19.

PHYSIOLOGICAL SOCIETY (at Cambridge).

CONGRESSES.

MAY 11 TO 15.

CHEMICAL INDUSTRY CONFERENCE (organised by Society of Chemical Industry in connexion with its London Section, Chemical Engineering Group, and Institution of Chemical Engineers).
Friday, May 11 (at Les Gobelins Restaurant, 1 Heddon Street, W.1), at 8.30.—F. H. Carr: Some Chemical Engineering Aspects of the Fine Chemical Industry.
Saturday, May 12.—Visit to Rothamsted Agricultural Experiment Station.
Monday, May 14 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Arthur Duckham: The Fuel Industries and the Work of the Chemical Engineer.—Prof. G. T. Morgan: The Chemical Study of Low Temperature Tar.
At 2.30.—Sir Alexander Houston: Water Purification.—J. H. Coste: The Pollution of Tidal and Non-Tidal Streams.
May 15 (at Institution of Civil Engineers), at 10.30 A.M.—Sir Alfred Mond, Bt.: Scientific Research as applied to Industry.—Sir John Russell: The Part played by British Workers in the Application of Fixed Nitrogen to the Soil.
At 2.30.—Lt.-Col. G. P. Pollitt: Developments in the Heavy Chemical Industry.

MAY 12.

ANNUAL CONFERENCE OF THE UNIVERSITIES OF GREAT BRITAIN AND IRELAND (at the University, Liverpool), at 10 A.M.—The Contribution of the Universities to the Preparation of Teachers for their Vocation:—(*a*) Sir Charles G. Robertson, Prof. J. Strong, and others: Discussion on What is the Essential Service which a University can render to the Education of the Intending Teacher? (*b*) Mrs. S. D. Simon, Prof. T. P. Nunn, C. F. Mott, and others: Discussion on What should be the Relation of Universities to the Specialised Professional Training of Teachers?

MAY 14 TO 16.

ITALIAN SOCIETY OF MEDICAL RADIOLOGY (at Florence).

MAY 19 TO 23.

CONGRESS OF RADIOLOGY OF THE UNION OF S.S.R. (at Kiew).—Subjects of Discussion:—The Consequences of the Changes of Elements of Cells under the Influence of Radiation. Classification and Radiodiagnosis of Diseases of Joints. Functional and Anatomical Changes of the Gastro-intestinal Canal after Operative Intervention. X-ray-therapy of Diseases of the Circulatory System. Temporary Sterilisation with X-rays. Radiodiagnosis of Intestinal Diseases.

MAY 25 TO 27.

FRENCH SOCIETIES OF OTO-NEURO-OPHTHALMOLOGY (at Marseilles).