NATURE

SATURDAY, DECEMBER 9, 1922.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

A Suggested Royal Commission on Museums.

FROM time to time there appear in NATURE and elsewhere notes and articles that afford conclusive evidence of the valuable work done by our museums in scholastic education, in aid of industry on its technical as well as its artistic side, in the prevention of plant, animal, and human disease, in the general spread of beauty, and in the advancement of learning. But the work that is done is sparsely scattered through a large number of museums, and the isolated examples serve rather to show what might be accomplished than to give us cause for self-gratulation. There are in the British Isles about a score of national museums (supported, that is, in large part by Imperial taxation) and probably more than 350 museums and galleries supported mainly by local contributions. It would be no great exaggeration to say that scarcely two of these establishments are maintained and governed in quite the same way. Like so many other of our institutions they have originated at haphazard and have just "growed," generally by unorganised accretion. Consequently, while some have the desire and the means to be of use in one or other of the ways enumerated, more have the desire without the means, and many have neither the desire nor the means. In no case has a museum the power and the funds to make all that use of its treasures which could be made, and which its guiding spirits probably wish to see.

For some time past there have been efforts from various quarters to remedy the waste of material, waste of money, and waste of effort that are the consequences of overlapping, competition, lack of co-ordination, inappropriate administration, unequal distribution of funds, and all the other evils inherent in this disorder. The Ministry of Reconstruction tried to bring all the municipal museums, if no others, under the Board of Education, but the museums protested. An important committee of the British Association produced a valuable report on museums and education. Lord Sudeley by pegging away has induced the Government to pay for guide-lecturers in several of its museums, and has advocated with some success the sale of picture-postcards. The Museums Association, which represents the views of museum officials themselves, urges, among other reforms, that museum curators must be highly trained men and women of broad education, and recognises that the only way to get such people is to offer an adequate salary.

These movements are very well, but if we are to make the best use of our museums something larger is required. Mr. Bailey, in a paper read at the recent conference of the Museums Association and now published in the *Museums Journal* (October 1922), supports Lord Sudeley in his demand for a Royal Commission. Mr. Bailey, who, as sometime secretary for the Circulation Collections at the Victoria and Albert Museum, knows the provincial museums on their art side better than most men, has no difficulty in making out a case for reform. He is particularly strong on the unjust and unequal incidence of the aid which, though diminished, is still given to local museums by the State through some of the national museums. The officers of the Government establishments, always so willing to help, would doubtless be glad to see the way made clearer for them. Mr. Bailey's criticism on these and other weaknesses is destructive. There are schemes enough in the air, and he does not add to them. He asks, and he has induced the Museums Association to ask, for a Royal Commission, so that any recommendations may ultimately be based on the fullest possible knowledge. We agree fully that there is need for reorganisation, and we believe that a large amount of reform might be effected without material increase of expenditure; indeed, some of the obviously desirable reforms would tend to economy. But, while we sympathise with the request of the museum folk for a Royal Commission, we fear that they are not now very likely to get it. The subject, indeed, deserves serious discussion and it would be well to have various proposals compared and investigated, so that when changes are effected they may be guided by a definite policy. Some inquiry, less expensive than that by a Royal Commission, might elicit the information and put forward an accepted ideal towards which all could work.

Any such inquiry should, however, approach the subject on the broadest possible lines. The resolution passed by the Museums Association asks for a "report upon the work of the museums of the United Kingdom in relation to industries and general culture." The importance of museums on the industrial side has been recognised by the Federation of British Industries in a recent report. "General culture" is an expression that may include much or little; presumably it is intended to comprise scholastic education. But there are the numerous activities of museums that aid the extension and application of knowledge in ways that do not seem to fall under these heads. Whatever their subject-matter, and whatever their immediate and distinctive aim, all museums work by the same method —the accumulation, preservation, and demonstration of concrete objects; they are guided by the same broad principles, and need the same kind of assistance. Though they may be co-ordinated with other social activities—industrial, educational, artistic, and the rest —they must not be confused with them. Any inquiry therefore must deal with museums as such, in relation to all their multifarious aims and activities, and must seek to bring all into one harmonious collaboration for the common weal.

Meteorological Theory in Practice.

(1) *Weather Prediction by Numerical Process.* By Lewis F. Richardson. Pp. xii+236. (Cambridge: At the University Press, 1922.) 30*s.* net.

(2) *Forms whereon to Write the Numerical Calculations described in "Weather Prediction by Numerical Process."* By Lewis F. Richardson. 23 forms. (Cambridge: At the University Press, 1922.) 2*s.*

IN the book under notice Mr. L. F. Richardson presents to us a *magnum opus* on weather prediction. The numerical manipulation of the dynamics and physics of the atmosphere is its mainspring; but there is a fine display of other works of an intricate character. Its avowed object is nothing less than the calculation of future events in weather; and this by inserting numerical values in seven fundamental formulæ, which, taken together, embody the essential analysis of the sequence of weather. Three of the equations express the time-rate of change of the easterly, northerly, and vertical components of the momentum of the air; other three express the time-rate of change of its density, water-content, and heat-content respectively. The seventh is the characteristic gas-equation for air; it contains no differentials.

The whole history of the atmosphere is to be unrolled on computing by finite differences the changes in the elements in terms of the changes of four independent variables representing space of three dimensions and time. The formulæ all relate to an individual sample of air in a column at a single point; but the calculation has to say what will happen to the whole mass in the neighbourhood of every specified locality within the region of observation. Hence representative points are chosen for which the changes of the variables are to be computed at a sufficient number of levels to give a working idea of the changes in the weather. The points are grouped in a lattice or chess-board with each square 200 kilometres long, 3° of latitude broad, and 2 decibars of pressure thick: the whole atmosphere is thus treated as made up of 16,000 slab-units each weighing about half a billion tons. What we call weather is represented by the physical changes in the slabs. The standard time-interval over which uniformity of change is preserved is six hours. Observations of pressure and temperature are taken for the centres of the "red" slabs of the chequer, which lie in columns of five deep; observations of momentum at the centres of the "white." The changes in any one slab are computed with the aid of the known conditions of the surrounding slabs: hence the calculation for any arbitrary area is limited to the interior slabs, and the area amenable for computation diminishes with each step of the process. There is a great amount of original and ingenious scientific speculation and discussion in the description of the process.

Nearly a hundred separate algebraical symbols are employed. The author sketches a fancy picture of the process of computation going on for the weather of the whole world in a great theatre or forecast-factory in the form of a hollow globe. A spherical orchestra of computers calculates the future weather from the information supplied by 2000 stations under the direction of a conductor at the centre of the globe. In order to keep pace with the weather the orchestra would consist of 64,000 performers on the slide-rule or calculating machine; and even then, with a space unit of 200 kilometres, phenomena on the small scale, such as tornadoes or local thunderstorms, might be missed. Part of the appeal of the book is for a distribution of stations to be arranged so as to give the process of calculation a better chance than the existing distribution in Europe affords.

There are twelve chapters of very unequal length. Chapter I. is a brief summary of the contents of the book; Chapter II. is a simplified example of the method of calculation by finite differences which is to be used. This preliminary canter shows incidentally that a distribution of pressure according to an assumed geometrical law, and a universal geostrophic wind corresponding therewith, lead to the conclusion that a vast system of high pressure over the Eurasian continent, covering one half of the Northern hemisphere east of the meridian of Greenwich, would result in an increase of pressure over England, which lies on the margin. This result is regarded as axiomatically contrary to fact, because "cyclones" are known to pass eastward. We are therefore invited to conclude in passing that the geostrophic idea is inadequate. That is certainly a possibility but not the only one. Since the geostrophic idea is based upon our experience of natural distributions of pressure we might with equal justice conclude that the assumed geometrical distribution is a non-natural one. Or better still, we might say that Mr. Richardson's preliminary canter has given a rigorous dynamical explanation of what is meant by "an anticyclone resisting the advance of a cyclone," a very common statement of meteorological phenomena. The reviewer preserves in memory two natural pictures of an Atlantic cyclone kept at bay by a current from the east and presenting an appearance grotesquely like a revolving ball balanced on a water-jet. A notable feature of our northern winter is a vast anticyclone over Asia which dominates the northern half of the eastern hemisphere like Mr. Richardson's pattern, although the distribution over the other quadrants of the globe is not at all like the pattern. As a matter of experience the anticyclone does frequently spread from the east over England. Our weather might not inaptly be described as a conflict between the effect which Mr. Richardson repudiates as contrary to experience and the eastward travel of cyclones which he regards as axiomatic. Not infrequently, the result of the conflict is that the cyclones, instead of going eastward over us, are headed off to the north along the Norwegian Sea—"which nobody can deny."

In view of our inadequate knowledge of the structure and circulation of the atmosphere caution in drawing conclusions is always desirable, and in this case specially so in the interests of justice, because the alleged failure of the geostrophic principle to anticipate the changes at the surface in Chapter II. reappears in Chapter VI. as the record of a previous conviction, and gets the prisoner another sentence for what is perhaps not his fault. Mathematicians in dealing with the elusive atmosphere are not infrequently inspired by Jabberwocky,

> One two, one two, and through and through,
> The vorpal blade goes snickersnack;

but they ought to make sure that they get the right Jabberwock by the neck before "galumphing back" with his head.

Chapter III. reinforced by Chapter VII. explains a suitable organisation of what are called co-ordinate differences, the principles of the chess-board or lattice. Chapter IV., a very important one, occupies more than one-third of the whole book. It is devoted to the fundamental equations and the information which is necessary in order to assign numerical values for the variables. It takes the form of about thirty short essays on great subjects, such as the effects of eddy-motion, radiation, conduction of various kinds, the flow of heat to the air from the sea, or from the ground, or from vegetation, the smoothing of observations, and many others. Chapter V. deals with the evaluation of vertical velocity, a very vital subject. Chapter VI. deals with the special conditions for the stratosphere and its equations. Chapter VIII. reviews the numerical operations to be performed and gives the final preparation for Chapter IX., which provides a "full-dress rehearsal" of the process of computation. By its aid the changes of pressure and temperature for a point near Munich and the changes of momentum at a point between Munich and Hamburg are calculated for the interval of six hours centred at 1910 May 20d. 7h. G.M.T. That day was chosen for displaying the method because a set of data for the surface and upper air was available in the publications of the Geophysical Institute of Leipzig issued by Professor V. Bjerknes. Although not quite adequate for the purpose it is an unusually full set.

The calculation occupied "the best part of six weeks" in a rest-billet in France. It included, however, the preparation of the forms which are now issued in blank for the use of others who may be attracted by the prospect of submitting the course of Nature to the process of numerical calculation. Every assistance is given by the forms and by suggestions for improving the accuracy, smoothing the data, and many other technical points of manipulation.

The trial specimen is not such a good example of the art of forecasting that it tempts the reader forthwith to become one of the great orchestra. The change of pressure at the surface works out at 145 millibars in six hours. Our barometers allow for a range of 100 millibars at most; and, as a matter of observation, the change in the region in question was less than a millibar: the wildest guess, therefore, at the change in this particular element would not have been wider of the mark than the laborious calculation of six weeks. Nor is that all. Many of the chapters end in parenthetic expressions of regret or of suggestions for improvement. There are also many supplementary paragraphs which indicate that when the author comes to make another edition, as he or some one else undoubtedly will, he will write somewhat differently. And the reader will not be sorry, for in many ways the book makes hard reading. It is full of mathematical reasoning, a good deal of which is conducted "by reference." The reader who wishes to follow it must have a very handsome library and a few step-ladders which Mr. Richardson does not provide.

A reviewer with less than the ordinary sufferance of his tribe might easily murmur: forecasting by numerical process seems so arduous and so disappointing in the first attempts that the result is a sense of warning rather than attraction. He might also wonder for whom the author is writing, and regard the book as a soliloquy on the scientific stage. The scenes are too mathematical for the ordinary meteorologist to take part in and too meteorological for the ordinary mathematician. But such complaint would be as misleading as the computed forecast. On the road to forecasting by numerical process nearly every physical and dynamical process of the atmosphere has to be scrutinised and evaluated; the loss of view into the future from the first summit is compensated many times by the insight which one gets into the working of Nature on the way. For example, the author draws from the miss of his forecast the conclusion that the observations of velocity used are a real source of error. Whether that conclusion is true or not, its further consideration is of the greatest importance in view of the multiplicity of observations of winds in the upper air and of the difficulties which their interpretation presents.

The essential obstacle in the way of bringing the facts of weather into mutual co-ordination by recognised methods of dynamics and physics is that there are so many of them, so many elements, so many variables, so many causes of perturbation. Some meteorologists look for a general solution of the problem in the discovery of new physical laws, at present unthought of, that will make things clear. Yet, even when we revel in the proud consciousness of being familiar with all the ultimate dynamical and physical laws to which the atmosphere is subject, we may yet fail in an endeavour to relate the conditions of the moment to those of the past or to anticipate the future from the present by lack of method in the arrangement of the facts.

When we look back at the triumphs of calculation of the historic past we find always that the skilful calculator has substituted an ideal, upon which it is possible to operate, for the intractable reality. The late Lord Rayleigh made the general position clear in his first volume on "Sound," where he pointed out that in order to study sound as vibration we imagine the sounding body to be completely isolated, though, if it were so, there would be no sound. Mr. Richardson in his preface properly cites the Nautical Almanac as an alluring example of forecasting by numerical process. We are reminded of Plato's maxim, "We shall pursue astronomy with the help of problems just as we pursue geometry, but we shall let the heavenly bodies alone if it be our desire to become really acquainted with astronomy." Perhaps astronomers have been disposed to press this maxim to the extreme, yet we must admit that the Nautical Almanac owes much to the ellipse in substitution for the actual orbits of the heavenly bodies. It would perhaps be difficult to imagine anything more unreal than the latest ideal of the atom.

Hence we might argue that the first step in meteorological theory should be to group the facts in such a way as to replace the reality by a reasonable and workable ideal. That view underlies the work of Hildebrandsson and Teisserenc de Bort in "Les Bases de la météorologie dynamique," in which they endeavoured to present the ascertained facts in a collected form in order to lead up to a working ideal, believing that premature analysis had always proved unfortunate. For two generations now the general ideal of our atmosphere has been that of a succession of travelling cyclonic vortices and anticyclonic areas. Hildebrandsson and Teisserenc de Bort provided a normal permanent circumpolar vortex in which travelling cyclones might be formed. But the ideal presented is still inexcusably vague and undeveloped: there is much to be done before we can say even what we ought to look for in a map if we wish to identify a vortex travelling under the normal conditions of the atmosphere and we are not yet ready to do justice to that ideal.

Prof. Bjerknes on the other hand has set out to prove that our maps can be simulated or stimulated by wave-motion on either side of a surface of discontinuity which separates equatorial air from polar air. Here we may note a tendency to follow another Greek maxim, this time of Aristotle, "for those things which escape the direct appreciation of our senses, we consider we have demonstrated them in a manner satisfactory to our reason when we have succeeded in making it clear that they are possible."

In "Weather Prediction by Numerical Process" Mr. Richardson follows a line of thought which differs widely from either of these. His main simplifications are to divide the atmosphere into his 16,000 slabs and to ignore perturbations which are on a smaller scale than a hundred miles. The rest is rigorous. The principle which lies at the bottom of his treatment of the subject is that the known laws of dynamics and physics as applied to the changes which take place are inexorable and are sufficient. The future can therefore be derived from the present by their application. They can be applied by the step by step method of finite differences with sufficient accuracy to obtain the general consequences of the present conditions: The illustration of the process is a most valuable contribution to meteorology and indicates a wholesome course of practical physics and dynamics of the atmosphere which may prove the basis of future teaching. Thus it will not only provide an acid test of meteorological theory but also be a valuable guide to the organisation of new meteorological observations.

Finally, perhaps the most important aspect of this contribution to meteorological literature is that a rigorous differential equation is not necessarily useless because it cannot be integrated algebraically. It opens the way to useful exercises less stupendous than calculating the weather, and indeed, whenever meteorology comes to be taught and learned, the book will be a rich quarry for the teacher and examiner.

NAPIER SHAW.

Parker and Haswell's "Zoology."

A Text-book of Zoology. By the late Prof. T. J. Parker and Prof. W. A. Haswell. In Two Volumes. Third Edition. Vol. I., pp. xl+816. Vol. II., pp. xx +714. (London: Macmillan and Co., Ltd., 1921.) 50*s.* net.

WHEN a demand arises for a new edition of a general text-book on some branch of science, the problem before the editor is to decide whether the new wine of recent discovery will go with safety into the old bottle. The solution depends largely upon the adaptability of the original scheme. When the treatment has been dominated by one aspect of the subject-matter, or when the science has entered on a new transitional phase of discovery involving new points of view, the new wine requires a new bottle.

Parker and Haswell's "Text-book of Zoology" illustrates this difficulty. Its outlook on the great and varied theme of animal life is fixed on the static anatomical aspect, on the intensive analysis of individual structure, and on the grouping of animals in classes according to structure. So fascinating and so adaptable to educational discipline is this pursuit that the anatomical aspect is only too apt to dominate other and equally important methods and aspects of animal study. It is against this over-emphasis of descriptive anatomical detail that teachers of zoology have been protesting for many years, with the result that in practice there is a more balanced consideration of the dynamical as opposed to the statical aspect of zoology.

In this respect the new "Parker and Haswell" is disappointing. The rigidity of its structure has prevented its editor from adapting the text of these two volumes to modern requirements, or from embodying more than a very small amount of the new matter and none of the new points of view that zoologists have discovered in the last twenty years. The chief revision is limited to three groups of Invertebrates—the Nematodes, Polyzoa, and Annelids—while the whole of the second volume—the Vertebrates and the philosophy of zoology—has, so far as can be readily ascertained, undergone little change.

Ungrateful as is the task of adverse criticism, it must be acknowledged that this revision has not gone far enough. In contrast to the vigorous handling of the Platyelmia and Annelids, the loose treatment of the Nematoda is very pronounced. The account of the life-history of the common Ascaris is both wrong and misleading, and the description and figure of the hook-worm are most inadequate. In fact, in regard to parasitology generally, one has but to compare the little book recently published by M. Caullery and reviewed in this journal with the scattered references to various parasitic groups in the present text-book, to realise the inadequacy of the method to which Parker and Haswell are bound by the rigidity of their scheme. The medical and pathogenic significance of the Protozoa and the occurrence of soil-Protozoa deserve more than the passing mention given to them on p. 51, or than the reference in vol. 2, p. 617, "a terrestrial Amœba has been described." The treatment of fresh-water medusæ is also inadequate, and the structure of the common starfish (Asterias) should have been followed by an account of its development now that Dr. Gemmill's account is fully accessible. The account of the Vertebrata is in need of more fresh and vigorous handling, especially from the embryological point of view. For example, to state without comment that a bird has three pancreatic ducts, as is done here, is to miss a fine opportunity of showing the fertilising effect of embryological interpretation. In the chapter on zoological philosophy, the barest indication is given of developmental mechanics and of regeneration, but not of the new point of view raised by American work on Drosophila. The text-book remains, in fact, a useful and well-illustrated account of exemplary anatomy. What students want is a series of small monographs on special subjects. Zoology is too big a subject to be treated adequately in a single work.

Cancer and the Public.

New Growths and Cancer. By Prof. S. B. Wolbach. (Harvard Health Talks.) Pp. 53. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1922.) 4*s*. 6*d*. net.

THE lay public nowadays is very much interested in having healthy bodies, and its will to give active co-operative help to the medical profession in achieving this ideal is one of the few features of the new post-war Jerusalem that does not find itself in ruins. Medicine has ceased to be a cult of priests practising some mystery beyond the understanding of common people, and the abandonment of a professional dress means, not so much a recognition that a soft hat and tweeds are more comfortable than a tall hat and black coat, as an open expression that medical men and the lay public are fellow-workers for the common good.

How much may be attained by intelligent and interested lay folk working jointly with doctors has been illustrated lately very clearly by the disappearance of summer diarrhœa and the general decrease in infantile mortality—results, not of the direct application of assured scientific knowledge to practical life, but of the devotion of common-sense men and women in schools for mothers and similar organisations, which followed quickly enough on the conviction that it was shameful that a child should be ailing or should die. It has been said, too, that the problem of venereal diseases was solved the day that "syphilis" appeared in the headlines of a reputable daily paper. It is, indeed, clear that real progress in healthiness is as much a question of laymen as of doctors. William James says somewhere that a good deed can be perfect only if it is well received as well as well done; it is, indeed, to this co-operation of both parties that we must look for further advance.

The knowledge of "medical" matters already enjoyed by the public in general is very much greater than it was even a few years ago. It is obviously a project of high importance that it should be enlarged and extended, and this is the purpose of the "Harvard Health Talks" of which the present small volume is one. It deals with cancer and new growths, and in 53 pages presents a great deal of information. So excellent is the purpose, that it is with some regret that we find the performance disappointing. The book fails in the way that some other books of the same kind have failed. The author has not realised the abyss which separates his training and terminology from those of his audience, and has presented them with an abbreviated version of a set of lectures to professional students rather than a discourse starting from their point of view instead of from his own. With the heartiest appreciation of the intelligence of the inhabitants of Boston and Cambridge, it is difficult to believe that they will get a good start in understanding cancer from "the unit of structure of living matter is the cell" and the rest of the conventional paragraphs of dogmatic biology that form the opening chapter: it is useless as well as unnecessary to ask the educated man in the street to begin a new subject from a point of view and in a terminology which are as Greek or worse to him. The author has evidently never wondered how the man who sits next to him in the street-car would describe the facts if he knew them.

Technically, too, there is room for substantial difference of opinion. Pigmented congenital moles are certainly not universally accepted as examples of "embryonic rests," and the sentences on p. 35 attributing irritation of the bladder to the "embryos" of Bilharzia are misleading. The practical directions with which the lecture concludes are, however, admirable: do not bother about cancer being supposed to be hereditary, avoid irritations, consult a medical man at the first suspicion of anything amiss, and "never select a doctor that you would not accept as a friend."

A. E. B.

Empire Water-Power.

Water-Power in the British Empire. The Reports of the Water-Power Committee of the Conjoint Board of Scientific Societies. Pp. ix+54. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 3*s.* 6*d.* net.

IT is just about twelve months since reference was made to the third and final Report of the Water-Power Committee of the Conjoint Board of Scientific Societies (NATURE, December 8, 1921, p. 457). In the little book before us the whole of the results of the investigations made by the committee, as set forth in the three successive reports, are embodied. This compact statement of the present position of the British Empire in regard to the development of its water-power resources will be welcome to all who are interested in the matter, either from a purely scientific or from a utilitarian and practical point of view. It represents the outcome of four years of valuable research work, carried on with unremitting activity by the committee under the capable direction of the chairman, Sir Dugald Clerk, and with the energetic and painstaking assistance of the secretary, Prof. A. H. Gibson.

Sir Dugald Clerk contributes to the volume a preface of a very thoughtful and stimulating character. He tells us that the 46 million people now living in the United Kingdom require an expenditure of energy of 10½ million horse-power for their support, and that while this supply of power is undoubtedly forthcoming, for the present, from our stock of coal, yet our reserves of natural fuel are bound to diminish, and in time to be depleted, so that we shall be obliged to fall back upon other agencies to make good the deficit. Taking the United Kingdom as a whole, there appears to be continuously available (24 hour period) a total of 1,350,000 horse-power, or if any great tidal scheme, such as that of the Severn, be included, perhaps a total of 1,750,000 horse-power. This is, of course, insufficient to replace the work done by means of coal-fired engines, but, at least, it would represent a very substantial saving in fuel.

On the other hand, this power is not all economically realisable, or rather the cost of obtaining the whole of it would be higher than is justified, as yet. In Scotland, however, some 183,000 horse-power is immediately feasible, at a cost appreciably less than that of coal-fired stations built and operated under existing conditions. Even in England and Wales, a large proportion of the quota is commercially obtainable. It is obviously a matter, then, of national concern to devise means for making use of these natural power supplies, which are running to waste, if only for the purpose of supplementing the work which is at present done by our far from inexhaustible supplies of coal.

The report covers a wider field than Great Britain; it embraces the resources throughout the British Dominions, and its carefully compiled figures will be of considerable assistance to those whose interest lies in the promotion of water-power schemes at home or abroad.

BRYSSON CUNNINGHAM.

Our Bookshelf.

Modern Electrical Theory. Supplementary Chapters. Chapter XV.: Series Spectra. By Dr. N. R. Campbell. (Cambridge Physical Series.) Pp. viii+110. (Cambridge: At the University Press, 1921.) 10*s.* 6*d.* net.

THE work now before us is one of the supplementary chapters to Dr. Campbell's book on modern electrical theory. This series of supplements is planned according to an idea which might well be used by the authors of other text-books on physics. It is unfortunate, however, that we are unable to commend the present book to those who, like the reviewer, welcomed the author's original work as a real and vital account of the subject. The book contains numerous errors which any practical spectroscopist would detect at once; and they reach their culminating point when the author, in a professedly complete list of the chemical elements the spectra of which form well-defined series, omits oxygen, sulphur, and selenium. The spectrum of oxygen is, almost in a classical sense, one of the most beautiful and ideal series arrangements known to every spectroscopist. It has not played a part in the application of the quantum theory as yet, which may provide the explanation of the circumstance that the author is unaware of this fact, as he shows more than once.

The genesis of this book is quite clear. The author has read Bohr's recent work on the "Correspondence Principle," and, like every other reader, has been very much attracted by it. He has also consulted all the Danish and German writings, and he gives a really excellent account of them in a very non-technical style. Dr. Campbell appears, however, to be unaware of the contribution of this country to the subject, and of the practical details of spectra. The second deficiency explains why all the facts of spectra which he gives correctly are those which foreign writers have quoted in support of the quantum theory. Following the usual assumption that all the significant work on the subject has been done abroad, anything written in English is mostly ignored or misquoted. It is difficult, indeed, to find an English name in the whole work. A treatise on any branch of this subject which never refers to the fundamental work of Jeans, dismisses that of Fowler with a casual mention of his least important contribution, credits Nicholson with a mere suggestion that the angular momentum in an atom might have discrete values, and finally never mentions W. Wilson, who anticipated Sommerfeld in the fundamental generalisation, while putting it on a real dynamical basis, as Sommerfeld himself has admitted in his latest edition, excites both surprise and regret. Except from one point of view, the work is misleading and inaccurate in detail. What it does give is a condensed summary of foreign work, which is excellent if read at the same time as a compendium of the actual experimental facts of spectra.

Air Ministry: Meteorological Office. The Weather Map. An Introduction to Modern Meteorology. By Sir Napier Shaw. Fifth issue (reprint of fourth). (M.O. 225*i*.) Pp. 109 + 8 plates + 8 charts. (London: H.M. Stationery Office, 1921.) 1*s*. 3*d*. net.

IT is not possible to overestimate the high value of this work. At the present time the demand for weather knowledge is very keen, the enthusiasm being stimulated by the wireless broadcasting of weather information. To appreciate fully the information received by wireless it is essential to be able to grip intelligently the scientific details involved. The work under review contains much general information on meteorology. The former edition was issued four years ago, and the earlier copies gave much assistance in the training of meteorological units in the army, so essential for many interests during the war.

The publication contains specimen weather maps, and the letterpress thoroughly explains their construction and the results which the maps provide. Weather systems and their movements are dealt with and explanations are given of the sequence of weather, the travel of the centres of disturbances, and the veering and backing of the wind. Recent research relative to the upper air is incorporated, and a thorough understanding can be secured of the distribution over the British Isles of cloud and rain consequent on the passage of a storm area across the country. Information is given as to averages and normals, and the numerous tables, diagrams, and maps in the latter half of the book are useful for reference. The cost of the earlier editions of the work was 4*d*., but the charge, 1*s*. 3*d*., for the present issue is exceedingly small, and the work should be obtained by all who would be meteorologists. C. H.

Rocks and their Origins. By Prof. Grenville A. J. Cole. (Cambridge Manuals of Science and Literature.) Second edition. Pp. viii + 175. (Cambridge: At the University Press, 1922.) 4*s*. net.

IT speaks well for the discrimination of the readers of popular science that a new issue of this thoughtful introduction to the study of rocks should be called for. Prof. Cole is equally at home in tracing the history of the development of scientific theories and in describing the relation of scenery to the geological structures of the rocks that underlie it. He discusses without too much technical detail the origin of the different types of rocks of which the earth's crust is composed, and gives a very fair résumé of the controversies which have been waged on the subject, many of which are still as active as ever. There are a number of happily chosen illustrations of rock scenery, mostly reproduced from the author's own photographs. This little volume is honourably distinguished from others of a similar character by the clearness of its style and the abundant references which will prove useful in directing the student's attention to scientific contributions that he might otherwise overlook. There are few of our geologists who have read so widely and to such good effect as Prof. Cole. J. W. E.

Farm Book-Keeping: The Principles and Practice of Book-Keeping applied to Agriculture: for Agricultural Colleges, Extension Classes, Evening Classes, and Practical Farmers. By John Kirkwood. Pp. 224. (Edinburgh: W. Green and Son, Ltd., 1922.) 6*s*. net.

ONE of the most noteworthy developments in the study of agriculture is the attention which is now paid to the economic aspects of farm working. Mr. Kirkwood's book (one of the Scottish Series of Junior Agricultural Text-books) is to be welcomed as a work which contributes to this development.

Part I. consists of nineteen concise chapters dealing with double-entry book-keeping in its application to farm management. Part II. sets forth a simple cash-book system for the benefit of those who may regard double-entry as a complicated system, and the author assures us that his simplified method of keeping accounts has stood the test of actual use.

With practical handbooks of this kind on the market there can be no excuse for the repetition of those blunders in farm management which are the accompaniment of a disregard for scientific study and a blind adherence to tradition.

Coal-tar Colours in the Decorative Industries. By A. Clarke. Pp. xiii + 166. (London: Constable and Co., Ltd., 1922.) 6*s*.

THE uses of coal-tar dyestuffs in lake-making, and in leather, fur, wood, paper, etc., colouring—*i.e.* those applications which are not covered in the ordinary treatises on fabric dyeing—are considered in Mr. Clarke's work. The treatment is, naturally, wholly technical, and very brief. A bibliography is given. To the expert the treatment will doubtless appeal, but to the ordinary scientific reader such sentences as the following indicate a language even more formidable than his own: "The level-dyeing acid dyestuffs do not exhaust well, but if they are topped with basic colours the backwaters are colourless." A glossary might have been added for the uninitiated.

The Peoples of Europe. By Prof. H. J. Fleure. Pp. 110. (London: Oxford University Press, 1922.) 2s. 6d. net.

IT was no mean task to attempt an adequate sketch of European peoples in about a hundred pages, but Prof. Fleure has been fairly successful. His volume is opportune at a time when a sound scientific basis for the discussion of the complex problems of Europe is essential, and it is a happy illustration of the value of a geographical foundation in the study of political problems. The book contains not only a great amount of information but also a wealth of ideas, and is a genuine contribution to the vexed questions of the time. There are three sketch maps and a short but useful bibliography. The lack of an index is unfortunate. R. N. R. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Spectrum of the Night Sky.

I HAVE now succeeded in obtaining a spectrogram showing the general features of the spectrum of the night sky in the south of England, with the moon below the horizon. The exposure given was about 50 hours, beginning each night not earlier than 2½ hours after sunset, and closing about midnight. There appears, therefore, to be no possibility that sunlight or moonlight intervened.

The spectrum shows the bright yellow-green aurora line very strongly. There is a continuous spectrum corresponding in distribution to the solar spectrum, and showing the dark Fraunhofer lines H and K. These are perfectly definite. The exposure is not enough to show the other Fraunhofer lines definitely, and, in any case, the instrument used is only capable of showing a few of the strongest of them.

There is no trace on this plate of the nitrogen bands, which form so conspicuous a part of the spectrum of the polar aurora. From some exposures I have made in the neighbourhood of Newcastle, three degrees farther north, I believe that the negative bands of nitrogen are a normal feature of the night-sky spectrum there. But more work is required on this point.

RAYLEIGH.

Terling Place, Witham, Essex.
November 25.

Medical Education.

IT is stated in NATURE (November 18, p. 683) that "The professional course has grown so full in the training of a medical student that it has become increasingly difficult to cover the ground and secure qualification in a reasonable time." It seems that chemistry and physics are to be placed outside the professional curriculum, but biology is to be retained. A knowledge of chemistry and physics is necessary to the doctor; and much of the recent advance in both medicine and surgery is due to discovery in these sciences. But can any one tell us of what utility, practical or intellectual, is the biology which medical students learn—facts about the classification of plants, the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on? No one is a better physician or surgeon for such knowledge; and, therefore, since it has no bearing on later study and practice, it is forgotten as soon as the prescribed examinations are passed.

For the medical man the intellectual value of biology should lie, if anywhere, in interpretation. It should cause him to think. He should learn man's place in Nature—how he resembles and differs from other living beings, and how these likenesses and differences arose. Man is in body and mind above all the educable, the trainable, the adaptive being. From birth forwards he develops mainly in response to use. He is rational and intellectual because his mind grows through functional activity. That is his special distinction; that places him in Nature. The medical student learns nothing of all this. He may be taught, incidentally as it were, that some characters are inborn, or acquired, or inheritable. But a year or so later, physiologists and pathologists tell him the quite indisputable truth that every character takes origin in germinal potentiality (predisposition, diathesis), and arises in response to some sort of nurture—*i.e.* that every character is equally innate, acquired, and inheritable. If the student thinks at all, he must conclude, as Prof. Armstrong says very truly in another connexion (NATURE November 11, p. 648), "We are mouldering away in our laboratories and when we seek to make known what we have been doing we use a jargon which we cannot ourselves understand."

The medical student may be told that Natural Selection is an interesting speculation, but that no man has seen it in operation. Again, if he thinks, he will conclude that, owing to defective opportunities for observation, no man *could* see Natural Selection in operation among the wild animals and plants which biologists study. Nevertheless, a year or two later he will perceive it in full swing in the case of tuberculosis and every other lethal and prevalent human disease, and will learn that every human race is resistant to every human disease precisely in proportion to the length and severity of its past experience of that disease. There are scores of diseases and hundreds of races and sub-races of mankind; and, therefore, in some thousands of instances —whenever and wherever close observation is possible —he will find Natural Selection causing adaptive evolution. Moreover, he will learn that just as human races alter gradually in powers of resistance, so, at the other end of the scale, bacterial races alter in virulence when removed from one kind of animal to another, a thing quite inexplicable except on grounds of Natural Selection.

The student may be taught that effective selection occurs among mutations, not fluctuations. A year or so later he will perceive tuberculosis selecting amid all shades of difference, with the result that races present all shades of evolution. He may be taught that mutations segregate and that their inheritance is alternate. A year or so later he will learn that human mutations (*e.g.* idiocy, hare-lip, club-foot) are inherited, perhaps for many generations, in a patent or latent condition, and that only their reproduction is alternate. Moreover, he will wonder, if mutations segregate, how it happens that long-lost ancestral traits sometimes reappear in *purely bred* domesticated varieties (*e.g.* pigeon, poultry, and many plants). He may be taught that evolution depends on mutations and that mutations do not blend. A year or two later he will learn that human races never differentiate while there is inter-breeding, but diverge rapidly and infallibly when separated by time and space; that, though men are fond of telling about wonders, yet in the whole of written human history (4000 years or more) no useful human mutation has been recorded, nor one that changed the type of a race; that all human varieties (*e.g.* negro and white), like all natural varieties (*e.g.* brown and polar bear), blend perfectly when crossed in all characters except those linked with sex; and, lastly, that "lost" ancestral traits never reappear except when one of the parties to the cross is derived from a domesticated variety. If he thinks at all, he will conclude that Natural Selection is founded on fluctuations, but that man, as Darwin noted, "often begins his selection by some half-monstrous form, or at least by some modification prominent enough to catch the eye or to be plainly useful to him." He may be taught that the doctrine of recapitulation is doubtful. But if he thinks at all, he will perceive that any other mode of evolution and development is totally inconceivable. And so on.

The point I wish to emphasise is that medical men, with an acquaintance with man infinitely more intimate than any biologist can have with any animals or plants, with abundance of direct, not merely circumstantial evidence, have no need for the traditional biology of biological teachers. They are in a position to construct, and for all practical purposes have already constructed, a biology of their own. The traditional teaching has with them no influence whatever except as a waste of time, and ought to be, and before long is sure to be, eliminated from a curriculum which has outgrown it.

G. ARCHDALL REID.

9 Victoria Road South, Southsea,
November 19.

Divided Composite Eyes.

IT is not uncommon to find among insects instances where each composite eye is divided into two portions, so that in appearance there seem to be four eyes instead of two. In sections, however, it is seen that both parts are connected with the same ganglion.

Sometimes the reason for the division is obvious, as in the case of certain beetles which have a prominent sort of "armoured belt" carried horizontally round the head. Here half the eye is above and half below the belt, thus giving a view of the ground as well as of objects above it.

The reason for duplication, however, is not always so apparent. In the majority of composite eyes the convex surface is covered with lenses of uniform size, but in those to which the present note relates, namely, dragon-flies, White (or Cabbage) fly, and Aphides, this is not the case.

Among the dragon-flies—a very highly developed type—each eye presents a continuous convex surface, but the lenses of the upper part are much larger than those below. The transition from large to small is quite abrupt, but as the curvature of the surface is continuous the line of demarcation is not noticeable without the use of a magnifying glass.

In the White-fly (*Aleyrodes proletella*, etc.), where the eyes are well divided, the relative position of the large and small lenses is reversed, the large lenses being below.

The eyes of Aphides present for the greater part of their area a convex surface carrying lenses of equal diameter, but not far from the posterior margin there is a small prominence bearing a few lenses on its summit and sides.

The appearance of the eyes of dragon-flies is so well known that it is scarcely necessary to give figures; but it may be remarked that the areas covered respectively by the large and small lenses differ considerably both in form and extent in different genera.

White-fly is chiefly known as a pest in greenhouses, and until its appearance in unusual numbers in the autumn of 1921, I had never given it any attention. Any one, however, who examined the perfect insect with a magnifying glass might well be excused for taking it (as did Linnæus) for a small moth, but if the course of its development is followed up from the egg to the imago it is seen to be more nearly allied to the Aphides.

Far the best account of it is given by Reaumur ("Memoires," Tome II.) in 1736, and having myself repeated his observations of its transformations, I can confirm the accuracy of his description. All Reaumur's specimens were apparently taken from the leaves of *Chelidonium majus*, but this plant is not abundant in the neighbourhood of Exeter. White-fly, however, feeds on a great variety of leaves, and I have taken it from cabbage, cucumber, tomato, campanula, veronica, and from many composites. There is a considerable difference in these cases both in the size of the perfect insects and in the density of the cottony down with which they are coated, which gives them their white appearance, but whether this implies real specific differences or is only a result of

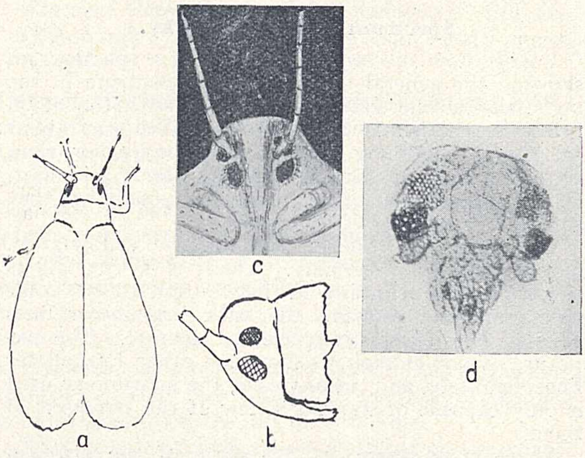

FIG. 1.—Aleyrodes.

a, Camera-lucida sketch of *A. proletellæ* × 25.
b, Head, side view.
c, Head, from below.
d, Head × 125 (60 in the reproduction), front view to show the difference in the size of the lenses in the two divisions of the eye. The contents of the head and the exterior down have been removed. The specimen was taken from cucumber. Diameter of upper lenses 0·0003 in., of lower lenses 0·0005 in.

different food, is, I believe, considered uncertain. Among my own specimens, those taken from cucumber were the smallest in size and had the thinnest coating of down. The divided eyes were closely similar in all, and the general appearance of the insect is shown in the camera-lucida sketches, Fig. 1. When the head is viewed from underneath, especially when it is so turned that only the lower pair of eyes are visible, the face is curiously owl-like, the proboscis standing for the beak.

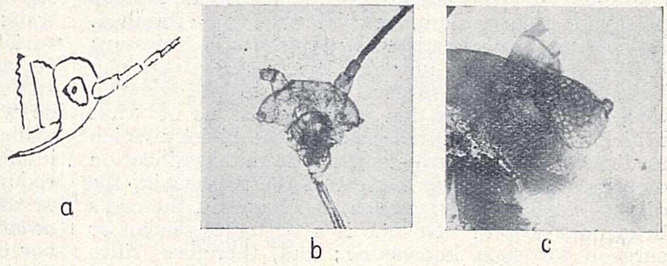

FIG. 2.—Black Aphis taken from Laburnum.

a, Head, side view.
b, Head, front view × 50.
c, Eye and part of head × 125 (60 in the reproduction), seen from above.

The eyes are shown in more detail in the photograph, Fig. 1.

There is always some difficulty in photographing such objects as require large magnification, but the structure of which does not permit of these being flattened; and though much less detail is shown in Fig. 1 *c* than can be made out by focussing each part independently, the difference in the size of the upper and lower groups of lenses is very apparent.

Several species of Aphis taken from various plants were examined, and in all of them the eyes had the peculiar feature illustrated in Fig. 2, *a*, *b*, and *c*. The prominence varied slightly in size and position in the different species, but there was always at least one lens on the summit and three or four round the sides.

Divided eyes must be, or at some period have been, of use to their possessors. Have the naturalists any explanation of what that use is? The case of the Aphis eyes seems especially difficult.

In the last century Johannes Muller expressed the opinion that in the picture formed by a composite eye each lens contributed only one impression, *e.g.* that the picture was made up of only the same number of patches of light and shade as there were lenses to form them, just as in the modern "process block" light and shade effects are produced by the varying intensities of uniformly distributed dots.

In 1894 I gave (Proc. R.S.) some theoretical reasons in support of Muller's view. This paper has been mentioned in several more recent books, but the theory itself is not quoted. It is, however, so simple and, coupled with the measurements of various composite eyes, so conclusive that it may be worth repetition in this place.

Every one knows, or ought to know, that the image formed by a perfect lens of a distant bright point consists of a bright disc surrounded by faint rings, and that the angular diameter of the disc as seen from the optic centre of the lens is of the order λ/D, λ and D being respectively the wave-length of the light and the diameter of the lens. This being the case, it is evident that no advantage in definition will be gained by providing a retina capable of distinguishing angular distances less than λ/D, *i.e.* the least distance which the lens can resolve.

If the wave-length is taken as 1/50000 of an inch, then for a lens 0·001 in. in diameter λ/D is rather more than one degree, and for a diameter of 0·0001 in., rather more than ten degrees.

If a number of small lenses are placed side by side with their edges touching on the surface of a sphere of radius R, and if the focal length of the lenses is small compared to this radius, images of outside objects will be formed on a concentric spherical surface (with a radius somewhat less than R); in these images, only those objects can be separated of which the angular distance apart is greater than λ/D.

If, then, the focal surface is covered by a retina which provides only one sensitive point for each lens to act on, the maximum definition will be secured if the subtense of each lens at the centre of the sphere is also λ/D, that is if $D/R = \lambda/D$, and this is the relation found to hold in the most highly developed composite eyes. It may be said, therefore, that the construction of these eyes is one of the most definite references to the wave-length of light to be found in organic structures. The actual values of D lie between something over 0·001 in. and a little less than 0·0003 in.[1] The definition, therefore, even in the most favourable cases, is very poor compared with that given by the simple eyes of vertebrates, where a single lens forms an image on a retina closely packed with sensitive points, while in the composite eye each retinal point is capped with its own lens.

To form a composite eye with the same defining power as the human eye, for example, the lenses would have to lie on a spherical surface of 18 ft. radius.

It would be interesting to know how or why the two types have come into existence. A. MALLOCK.

9 Baring Crescent, Exeter, November 7.

[1] I have taken some trouble in arriving at this lower limit, measuring directly for this purpose the values of D for the smallest Diptera (and their parasitic Hymenoptera), Ephemera, and others.

Action of Cutting Tools.

IF Mr. Mallock's friction theory of cutting-tool action is valid, and if cutting tools are ever effectively lubricated, it would follow that the dry tool should have an angle different from that of the lubricated tool. But this is contrary to universal practice. The inference would then be that either the friction theory is unimportant and extremely incomplete, or that lubrication as practised by engineers is very ineffective. The latter view seems more correct, for the following reasons.

When a tool has been cutting for some time, metal accumulates on the point of the tool and adheres sometimes so firmly that it cannot be removed, without risk of breaking the tool, except by grinding. This agglomeration of metal may be said without looseness to be welded to the tool just as in cases of bearing seizure the metals are welded together. This is especially obvious in heavy work, and it can be seen in a lesser degree in moderately light work. When contact is so intimate and pressure so great as to cause such cohesion it is difficult to conceive that lubrication in the usual sense of the term can exist at the point of a cutting tool.

Moreover, engineers in many countries have striven to introduce lubricant to the cutting face by means of high-velocity jets and by drilling holes in the nose of the tools, but without success.

Lastly, the temperature at the tool face is extremely high. Turnings which pass over the surface are hot enough to cause serious burns, and large tool cross-sections are necessary to conduct the heat away from the nose of the tool. It has been observed that modern high-speed steel will cut at a dull red heat; and while this is an abnormal condition, there is evidence enough to show that the temperatures existing in average machining work are higher than can be met by special lubricating systems under less strenuous pressures. These considerations seem sufficient to rebut the idea of cutting-tool lubrication in most cases, and to suggest that the chief value of so-called cutting oils is in their cooling properties. Even turpentine, which is useful in cutting hard steel, may have much of its value in its latent heat of evaporation. Certainly to obtain a good finish on hard steel with turpentine often requires a spring tool and light cuts, in which case there is the equivalent of chatter in a mild form, and this is conducive to lubrication.

In the discussion on Prof. Coker's paper it was stated that the point of the tool was not in contact with the work, and Dr. Lanchester very trenchantly asked, What was the good of having the tool sharpened? But it is well known on heavy work or with tools of inferior temper that work must be stopped periodically and tools reground. The idea that the point of a tool is not in contact with the job is perhaps a natural one, and rests on a difficulty hitherto unexplained. It is common observation that a tool wears most some little distance from the edge, and the edge may last a good deal longer than the part behind it. But this is no proof that the edge is not in contact; and if the edge were not in contact, the action of cutting tools would be even more perplexing than it is.

The explanation of this point may lie in the fact that the turning has less relative motion near the edge of the tool than at some distance behind, and the justification for this view is seen in a closer examination of the motion of a turning. The neutral axis of a turning has a constant speed approximately equal to the cutting speed, but when the turning begins to bend there is a speed of rotation added to the speed of the neutral axis, and this rotational speed varies as the thickness of the turning. As the turning does not begin to curl or bend until after it passes the edge, it is not difficult to see why the edge should wear well and give the impression that it had not been in contact. The fact that the point of the tool is in contact with the work may be inferred from the fact that in many circumstances steel is welded on to the point, and but for the greater relative motion behind the cutting edge where the scouring action is excessive, this deposition of metal would probably be more extensive.

We are then driven back on another part of the problem. Why do shavings curl? The analogy with rivet heads is unconvincing, for shavings are universally flat in a lateral direction, which—having regard to variety of tool profiles—is evidence of the extraordinary stresses involved and of the flow they produce—the stress on the upper face of the tool is of the order of 100 tons per square inch in quite ordinary practice. A more direct and convincing explanation is the following. Consider a piece of the shaving as in the diagram (Fig. 1). There is the downwards shearing force S at the principal plane of shear and an opposite reaction R at the tool face. These produce a turning couple which has more than one effect. In most cases the effect of this couple is

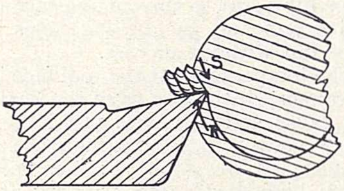

FIG. 1.

to distort the emerging element into a wedge the base of which is extended by plastic flow at the tool face and the upper part is shortened as in bending. The tendency is to place the lower or bearing surface of the shaving in tension as in a beam, and if the material has a low tensile strength as in cast iron, the shavings break, but even these brittle materials show a slight curl in the small particles removed by the tool. Friction at the tool face, as Mr. Mallock points out, resists curling, but it is probably not the governing factor. In the discussion on Prof. Coker's paper, Mr. H. I. Brackenbury put forward the very important observation that slow speeds are conducive to curling and high speeds produce straight shavings—this in tough steel. Having regard to the fact that cutting-tool action is a problem in plastic flow, the viscosity of the metal is probably important; and as the temperatures at the moment of cutting are very high, conductivity and tensile strength when hot may be decisive factors. The ratio of shearing strength to tensile strength enters into the phenomenon of curling, but as parts of the shaving are flowing it is not easy to get clear views on what is taking place.

H. S. ROWELL,
Director of Research.
Research Association of British Motor and Allied Manufacturers.
15 Bolton Road, Chiswick, W.4.
November 9.

An Empire Patent.

MR. HULME's letter in NATURE of November 11, p. 633, raises objections to the Empire Patent on grounds which would occupy too much space to traverse fully, but I would venture to question his general condemnation of the present patent system. A system such as he proposes, which would grant a monopoly only to such persons as were actually working an invention, would be unjust to an inventor without capital to exploit his ideas. Moreover, considerations of novelty could not entirely be left out. Presumably Mr. Hulme would leave this to be decided by the Courts; but litigation is costly, and I imagine that few concerned with the business side of patents would be willing to dispense with a search for novelty on the part of the Patent Office, the advantages of which appear to be sufficiently obvious. The limitation, for practical reasons, to British patent specifications does not detract from those advantages, for, assuming the patent system to be of some value, it is most likely that subject-matter of a patentable nature will be disclosed in the first place in a patent specification. Mr. Hulme's objections to the search appear to be based largely upon United States experience, but the opinion he quotes may be due to difference of efficiency in administration in the two countries, particularly when we consider that American search is theoretically not so limited as here.

The arrangements as to "working" laid down in the Patent Act of 1919, which ensure that any patent granted in this country must be worked here on a commercial scale, would, it is to be presumed, apply to an Empire Patent.

In conclusion, may I be allowed a word of warning on the too facile application of biological considerations to human society? Mr. Hulme's assumption that a flattening of the population curve is an unfavourable symptom would not be endorsed by sociologists, and tends to discount whatever force there may be in his biological deductions *re* Patent Laws.

ERNEST E. TOWLER.
35 St. Andrews Square,
Surbiton, November 15.

The Movement of the Positive After-image.

THERE is no doubt that movement of the positive after-image takes place without movement of the eyes as Mr. H. S. Ryland states (NATURE, November 18, p. 668). His experiment is complicated by the fact that all portions of the light shown have not the same intensity, causing a corresponding difference in the after-image.

There appears to be, at any rate while the eyes are being used, a steady circulation of photo-chemical material from the periphery to the centre of the retina. The following experiment shows very simply the movement of the positive after-image without moving the eyes. If two rectangular strips of white paper about three inches long and a third of an inch wide be placed on a piece of black velvet and separated by a distance of an inch, definite positive after-images may be obtained of the two strips by viewing them with one eye, the eye being directed to a point midway between the two strips of paper, the other being closed and covered with black velvet, for the shortest possible time, the eye being simply opened and closed. Two clear-cut positive after-images will first be seen; these rapidly become blurred and gradually approach each other, the central portions of each appearing to bulge towards each other and to combine first; the upper and lower portions disappear first, the two after-images gradually combine in the centre of the field of vision, the last phase being a white circular blur, which slowly disappears with a whirlpool movement. It will be noticed that the after-images do not become negative.

F. W. EDRIDGE-GREEN.
London, November 18.

Acoustic Research.

THE editorial article on the subject of "Acoustic Research," in NATURE of October 28, p. 565, conveys an impression which seems to need correction.

In justice to the life-long labours of the late Prof. W. C. Sabine, now gathered into a volume of "Collected Papers on Acoustics" (Harvard University Press), it should be said that the practical problem of predicting the acoustics of an ordinary auditorium in advance of its construction, or of correcting one already built, was solved by Prof. Sabine some twenty years ago. The essential feature to be considered in such a problem is the reverberation, and Sabine's papers on this subject are full and complete. Other acoustic questions are, of course, sometimes involved, such as the transmission of sound through walls, the effect of resonance, etc. Several of these had also been the subject of prolonged experimental investigation by Prof. Sabine at the Jefferson Physical Laboratory at Harvard, but some of the results were withheld until the work could be completed. His untimely death interrupted this programme, and since then the work has been continued here, and at the Acoustical Laboratories, Illinois, under the direction of Dr. Paul E. Sabine, as described in Mr. Munby's article in the issue of NATURE of October 28, p. 575.

Architects in the United States have become aware of the importance of Sabine's results, and scores of cases could be cited in which the application of the principles worked out by him has led to complete success. The opinion that "the laws regulating the production of a successful building for hearing and speaking have yet to be worked out" implies a lack of respect for Sabine's profoundly accurate and thorough work, which I am sure no one will maintain who has taken the trouble to acquaint himself with the subject.

THEODORE LYMAN.

Harvard University, Cambridge, Mass.,
November 14.

[The intention of the article to which Prof. Lyman refers was to promote increased attention to acoustic research; and we regret that a phrase in it should be regarded by him as implying a lack of respect for the pioneer work done by the late Prof. Sabine. While readily admitting the value and completeness of Prof. Sabine's papers, the continued useful activities of his acoustic laboratory would seem to indicate that in the general sense intended the expression used in reference to the need for further investigation was justified. It may be true that rules have been worked out upon which a perfect acoustic building can be constructed; the practical problem presented to the architect, however, often takes the form of the provision of acoustic success with prescribed limitation in the matter of design, and it is in this direction that further knowledge is needed.—EDITOR, NATURE.]

Separation of the Isotopes of Zinc.

PURE zinc has been subjected to distillation in a high vacuum, and after three fractionations of the distillate the latter shows a lower density than the original zinc. The residue has been reduced by evaporation to one-twentieth of the original volume and shows an increased density. The method of separation is similar in principle to that of Brønsted and Hevesy for mercury.

Two sets of distillations have been carried out. In the preliminary set, last winter, the distillations of the distillate were carried out too rapidly and too great a quantity was distilled. The results for the distillate indicated no separation, whereas the separation of the residue, which was effected under better conditions, showed an increase in density. Another set of distillations was therefore carried out this summer under improved conditions (using liquid air condensation and a more careful regulation of the temperature and the quantity distilled). The final distillate is lighter and the final residue heavier than the original zinc. The determination of the density of a metal, as ordinarily performed, is no criterion of the average atomic mass per unit volume. The main part of the work has therefore been directed towards making it so; the only alternative appears to be the determination of the atomic weight to an accuracy of about 1 part in 10,000. The presence of flaws, of impurities, of allotropes, and of metal in a different physical state do not sufficiently explain the results; the discussion of these four points will be included in the publication of the work.

Taking the density of the initial zinc as unity, the density of the distillate is 0·99971, and of the residue 1·00026. These numbers appear to be outside the error of 14 determinations of the density of 7 separate samples of the initial material, for the greatest divergence between the numbers obtained only amounts to 0·00015. On recasting the residue and the distillate the difference is maintained.

The separation indicated by these figures would imply a change in atomic weight of about 3½ units in the second place in the atomic weight. This is considerably less than might have been expected if the metal was composed of equal quantities of an isotope of an atomic weight of 64 on one hand, and of isotopes 66, 68, and 70 on the other hand.

ALFRED C. EGERTON.

The Clarendon Laboratory, Oxford,
November 21.

A Curious Feature in the Hardness of Metals.

BY combining Meyer's formula

$$L = ad^n$$

with that for the ordinary Brinell test

$$H = L \div \frac{\pi D}{2}(D - \sqrt{D^2 - d^2})$$

the following relationship is obtained:

$$H = \frac{2}{\pi D} \cdot a^{\frac{2}{n}} \cdot L^{\left(1-\frac{2}{n}\right)} \left\{ D + \sqrt{D^2 - \left(\frac{L}{a}\right)^{\frac{2}{n}}} \right\}.$$

In this the second term ceases to have a real meaning when

$$D = \left(\frac{L}{a}\right)^{\frac{1}{n}}.$$

Beyond the load corresponding to a value

$$L = aD^n$$

the hardness becomes imaginary, or, in other words, the load will be sufficient to force the ball through the material continuously. This fact may well be of considerable importance in connexion with such questions as the penetration of a plate by a projectile, in punching operations, and even in lathe work.

In the case of a steel of 0·2 per cent. carbon and 0·6 per cent. manganese with a Brinell hardness number of 140, using a ball of 10 mm. diameter, and a load of 3000 kilograms, the values of a and n will be about 74 and 2·29 respectively. Under these conditions the load at which perforation of the steel will occur will be 14,400 kilograms, when the hardness will have fallen to 92.

Further work in this direction is being carried out by one of us; but the fact that there is a high load at which the ordinary hardness measurements cease to apply, and the possible significance of the fact, seemed sufficiently interesting to warrant early publication.

HUGH O'NEILL.
F. C. THOMPSON.

The Victoria University of Manchester,
November 15.

The Use of a Pancreatic Extract in Diabetes.[1]

By Sir C. S. SHERRINGTON, G.B.E., P.R.S.

IN the words of its charter, repeated at the admission of each new fellow, the Royal Society is described as instituted "for Improving Natural Knowledge." A main means for that "improving" is discovery. In the case of natural knowledge the main road to discovery must lie in research. There are several ways in which research can be encouraged, and one of them lies in providing suitable workers with the means to devote their time freely to investigation. The society is fortunate in possessing now, to a somewhat greater extent than formerly, funds that may be considered as permanently allocated to this fundamental object; for though its existence extends now to more than two and a half centuries, financial help directed to this eminently important aim has come only relatively recently. That it should have now begun may be a sign of the arrival of an Age in some respects new; the beginning of a trend towards wider public interest in and sympathy with research.

Of events in biological science in the past year I may mention one that is attracting attention at this time. In the Physiological Laboratory of Toronto University has been prepared a pancreatic extract possessing striking power over the carbohydrate metabolism of the body. Potent as it is, experience with it is still limited. Work of urgency is required with what may prove to be a desired remedy; the first programme is further investigation of the extract's full properties, with caution as to raising hopes which practice may but partly fulfil. Such are the considerations which weigh with the Canadian—and the discovery is from a Canadian university—to whom the discovery is due. In this country the Medical Research Council has undertaken public-spirited direction of the extract's preparation and of further determination of its properties.

The physiological steps of the discovery may be briefly outlined thus:—Destruction of the pancreas is well known to produce in the dog a diabetes-like condition, rapidly fatal. The liver's store of glycogen is lost, and cannot be renewed by even liberal supply of its normal source, carbohydrate food. Sugar formation from proteins ensues, with rapid wasting of the tissues; at the same time the blood is surcharged with sugar, and the tissues are unable to make use of sugar. In a normal animal, glucose put into the circulation raises the ratio of carbon dioxide expired to oxygen absorbed, because the tissues consume the sugar. But glucose similarly introduced into the depancreated diabetic animal does not raise the respiratory quotient; the tissues no longer consume the sugar. The inference has long been that the pancreas produces some substance enabling the body to make use of sugar—some substance that in fact should control certain forms of diabetes. At Toronto there seems to have been secured the extraction of that substance.

The pancreas consists of two structures intimately commingled. One, secreting cells set round ducts into which they pour the pancreatic juice, is potently digestive: the other, scattered in tiny islets, is seemingly unrelated to the ducts though closely related to the blood channels. The want of success of pancreatic extracts in mitigating a diabetic condition might be due to digestive powers of the juice cells destroying an anti-diabetic substance of the islet-cells. Dr. F. G. Banting determined to avoid this possibility by preparing extracts made from the pancreas after its trypsin-yielding cells had been selectively brought to atrophy by ligation of the gland ducts. He and Mr. Best, a collaborator who joined him, overcoming formidable difficulties of technique, succeeded in preparing the required material, and in examining the effect of extract upon diabetic depancreated dogs. They found the sugar fall both in the blood and urine, and that the animals, instead of dying in three weeks, remained, while treated, in excellent condition.

The further prosecution of the work afterwards engaged other collaborators: to mention them in alphabetical order, Collip, Hepburn, Latchford, MacLeod, and Noble; of these Prof. MacLeod, himself director of the Toronto Physiological Laboratory, is well known as a skilled authority in experiments on carbohydrate metabolism, and Dr. Collip is professor of bio-chemistry in the University of Alberta, though temporarily working at Toronto. With team work, advance has proceeded relatively quickly, and successful extracts are now obtained from ordinary ox and other pancreas.

Of much physiological interest is the fact that the active principle in the extract seems one *normally* controlling the blood-sugar in health, for its injection rapidly lessens the blood-sugar in normal animals. The extract, added to a simple perfusion fluid containing a little glucose and streamed through the isolated rabbit heart, increases three- or fourfold the heart's uptake of sugar from the fluid. The extract sometimes evokes serious nervous disturbances seemingly associated with extreme fall in the amount of the blood-sugar.

Administered to diabetic depancreated animals, the extract brings reappearance of the liver's glycogen store, while bringing down the sugar excess in the blood and the excretion of sugar and acetone in the urine; and it enables the diabetic organism to consume sugar. It also lessens or prevents hyperglycæmia produced in animals in several other ways.

Gratifying success has already attended the use of this extract in the relief of diabetic patients; much further research is, however, yet needed for development of the methods of extraction and of the routine use of the active principle.

The important physiological advance thus just reached comes as a fit reward to those who have achieved it. It is, of course, the striking result of steady work pursued by many various workers through many earlier years. Such work, we may remember, lay often open to charge by the unenlightened of being merely academic and fruitless, its reward being at the time simply the intrinsic scientific interest of the facts obtained. The Toronto investigators we may be sure would say with Pasteur, "To have the fruit there must have been cultivation of the tree." Part of the merit of the recent successful investigation has been its appreciation of possibilities indicated by previous work. But that merit is after all only a preliminary to the main achievement. The actual achievement is the deserved success of a bold attack conducted with conviction and determination and carried through in the face of formidable experimental difficulties.

[1] From the presidential address delivered to the Royal Society on November 30.

The West Indian College of Tropical Agriculture.

By Prof. J. B. Farmer, F.R.S.

The opening of the West Indian College of Tropical Agriculture by His Excellency Sir Samuel Wilson, the Governor of Trinidad and Tobago, on October 16, was an event not merely of local, but also of Imperial interest, for it constitutes a memorable landmark in the progress of agriculture throughout the British possessions in the tropics.

The idea of such a college in the West Indies owes its inception largely to Sir Francis Watts, Imperial Commissioner of Agriculture, and the project met with support both in the West Indies and at home by men alive to the pressing need for improved facilities for agricultural education and research in the tropics.

After much preliminary exploration of various possibilities it was finally decided that the College should be located in Trinidad, and few, if any, will now question the wisdom of this decision. The Government of Trinidad has presented a magnificent site of 85 acres, at St. Augustine, which appears ample for present and, so far as can be foreseen, for future developments also. The site lies about 7 miles east of Port of Spain and is situated just south of the Main East Road, close to the junction station for the eastern and southern branches of the railway. In the opinion of the present writer, the College has secured the finest site the island could offer. Not only is the land open and well drained, but it is sufficiently exposed to the trade wind, which blows through the greater part of the year, to ensure an agreeable and healthy climate.

Further important advantage accrues to the College from its close proximity to one of the principal experimental stations and farms under the control and management of the Trinidad Department of Agriculture, the director of which, Mr. W. G. Freeman, is also a member of the governing body of the College. Thus, not only will students be able to follow the raising of such staple tropical products as sugar, cocoa, rubber, coconuts, etc., on neighbouring estates under ordinary plantation methods and conditions, but they will be able to study the same crops grown experimentally, and under rigidly scientific control. They will also become acquainted with many other tropical products not usually grown in Trinidad itself, such as cotton, camphor, spices, and so on. Furthermore, at River Estate, another large experimental station, also under the Department of Agriculture, students will have the opportunity of studying methods of propagation and cultivation of cocoa and other plants under climatic conditions sufficiently different from those prevalent at St. Augustine as to afford valuable means of comparison. Apart from the intrinsic value, both economic and scientific, of the well-planned series of experiments at River Estate, the researches there are conducted on a really large scale, and scale is a matter of no small importance when starting out on agricultural investigations.

For the present the College is housed in a building of moderate size which was already in existence on the site. It has been suitably altered and equipped, and it will provide sufficient accommodation for a limited number of students pending the erection of the new permanent buildings which it is intended shall be commenced forthwith. Residences will also be provided for the staff, and it is hoped that hostels for students may be built if, and when, funds become available. Recreation grounds for students and staff, together with refectory, common-rooms and bathrooms, are already in existence on the site.

The future of the College is well assured. In addition to granting the site, the Government of Trinidad and Tobago have given 50,000*l.* towards the cost of erection and equipment of the College, and that Government, together with the Governments of Barbados, the Leeward Islands, and the Windward Islands, are contributing an annual subvention of a half of 1 per cent. of their revenues. The Imperial Government is also providing the sum of 15,000*l.* spread over a term of five years, on the understanding that the work of the existing Imperial Department of Agriculture in the West Indies shall be carried on by the College. The latter gains in prestige by this amalgamation, for the work of the department, begun by Sir Daniel Morris and continued by Sir Francis Watts, is widely and most deservedly appreciated throughout the West Indies. Substantial contributions have also been promised by Messrs. Fry and Messrs. Cadbury, the Empire Cotton Growers' Association, and the British Cotton Growing Association, while special mention should be made of a handsome private donation by Mr. J. W. Stephens, of Trinidad. It will be seen that the enterprise has already aroused practical interest, and this augurs well for the future.

The value to the Empire of a College so favourably situated to meet the present urgent demands for training in tropical agriculture should be sufficiently obvious to every one, and its influence will not be limited to the West Indian islands alone, but cannot fail to make itself felt over far wider areas. One may perhaps be permitted to hope that this wider interest will find an expression in returns of a practical nature.

The first year's prospectus of the College has recently been issued, and copies can be obtained from Mr. A. Aspinall at the London office of the College, 14 Trinity Square, E.C. It will be noted that the academic year has been made to conform with that of British universities, and it is a fortunate circumstance that the agricultural and climatic conditions in Trinidad happen to render such an arrangement a suitable one. The following courses and facilities for study have been provisionally arranged:

(1) Diploma course.

(2) One-year course in elementary agricultural science.

(3) Courses for agricultural officers, scientific and administrative.

(4) Post-graduate research.

The diploma course will extend over three years, and its object will be to give a thorough training in the science and practice of tropical agriculture to those students intending to become either tropical planters, investigators or experts in different branches of agricultural science or technology. These students will be required to have passed the College entrance examination, the standard of which is intended to be that of the matriculation examination of an English university, and evidence of having passed such a matriculation examination, or other equivalent test, may be accepted by the College in lieu of its own entrance examination.

The one-year course is intended for those who require a less extensive acquaintance with the scientific aspects of agriculture, and the standard required from such entrants will be based mainly on a satisfactory school record indicating that they are able to profit by the instruction offered.

Special facilities will be afforded to officers selected for the tropical agricultural services, whether under government or otherwise, such as should enable them to obtain (through courses planned to meet individual needs) familiarity with the applications to tropical conditions of the principles they will have already acquired in Europe or elsewhere. It is difficult to exaggerate the value and importance of such training to men of this class before they proceed to take up the duties of the posts to which they may have been appointed. Hitherto there has existed a gap, largely unbridged, between the university at home and the work that awaits the scientific officer in his district, where the conditions that embrace his problems and affect their solution are so widely different from those within the range of his previous experience. The new College enables this hiatus to be short-circuited, and it should now be possible for a man in a few months to build effectively on his previous knowledge of principles. In short, he is now in a position to obtain easily, and under exceptionally favourable conditions, just that kind of wide outlook over, and reasonably intimate familiarity with, the material and environment of his prospective problems so necessary for ultimately attacking them with good prospects of success.

Perhaps, however, a word of caution may not be out of place here. In order to secure the best type of scientific officer, whether for government or for other services, it is fundamentally important that he should have received that kind of broad and thorough scientific training which only a first-rate and well-equipped university is in a position to give. It is not contended, and it must not be expected, that the training now available for scientific officers at the West Indian Agricultural College can *replace* this university type of education. What it can and will do is to utilise the results of that education, and to make it of more immediate and practical value. The motto of the College, *Via colendi haud facilis*, emphasises the difficulty of agricultural problems, and they are not going to be best attacked unless the best means are employed in the process. The combination of the home university and the tropical college unquestionably offers the best means at present in sight.

Finally, in its provision for research students the College is pursuing an excellent course. The West Indies, with the fine botanic gardens of Trinidad and Dominica, offer unrivalled opportunities to the botanist using Trinidad as a centre, and it would be difficult to find better facilities anywhere in the tropics. The relative freedom from noxious pests, the absence of the annoyance caused by the leeches of the eastern jungles, the variety and wealth of the vegetation, together with the striking ecological character it exhibits, combine to form a most attractive prospect for any young man who desires to secure that indispensable acquaintance with tropical vegetation without which no botanist can be said to be fully qualified to hold one of the more important chairs in the universities at home.

But it is, after all, by its success in promoting the welfare of agriculture, and of the industries that arise directly out of it, that the College will be finally judged. In this last connexion it is well to learn that technological courses are contemplated to prepare men to take their part in manufacturing processes. Some of these, for example sugar, are already of considerable importance in the West Indies and elsewhere. The establishment of a sugar school will constitute the first step in this direction, and gifts of up-to-date plant and machinery have already been generously promised by several engineering firms in Great Britain.

It will be obvious from the foregoing sketch—necessarily but an imperfect one—that the institution is making a good start. Sir Francis Watts and the little band of professors, all of whom have made their mark in various directions, will carry with them the best wishes of every one interested in the success of the great enterprise on which they have embarked.

The Flow of Steels at a Low Red Heat.

RECENT developments in chemical engineering have called for the provision of metallic containers capable of withstanding considerable stress at high temperatures and for long periods. The investigation of the mechanical properties of steels and alloys at these temperatures has accordingly become a matter of very direct practical importance. The existing literature of the subject almost invariably consists of graphs, in which tensile test results are plotted against the temperature at which the test was made, care being taken to eliminate the disturbing, but very important, factor of time, by carrying out each test under as nearly the same conditions as possible, the duration of each test being at most a few hours, with an actual loading time of a few minutes. It cannot fairly be claimed that such information gives more than a general indication of the relative ability of different materials to meet the working conditions usually encountered by the exhaust valve of an aero-engine or the retorts, catalyst tubes, etc., of the engineer. Certainly it does not enable a designer to construct a container which can be depended upon to maintain its shape indefinitely, at super-atmospheric temperatures when in a state of stress.

To remedy this defect in existing knowledge, Mr. J. H. Dickenson, of the Research Laboratories of Messrs. Vickers, Ltd., Sheffield, has carried out an experimental investigation, and communicated his results at the September meeting of the Iron and Steel Institute. His general conclusion is, that all the steels upon which he has worked behaved very much like highly viscous fluids at temperatures well below the critical range (700° C.) and cannot be said to have any definite strength at a red heat, and that the property of principal importance to the engineer who wishes to subject highly heated steel to stress is the equivalent of the viscosity of a fluid. For the solution of a problem of immediate practical importance, he has ascertained for each of a number of steels the temperature at which the rate of flow does not exceed a very small and practically negligible amount under a uniform stress of 8·5 tons per square inch. The particular problem was the manufacture of large catalyst tubes for a synthetic ammonia process. These tubes were to be maintained at a temperature of about 600° C. under an enormous internal pressure, a long life under these conditions being essential to the economic success of the process. After due consideration it was decided to make them of a nickel-chromium alloy which was known to possess high resistance to oxidation and deformation when under stress at high temperatures.

Laboratory tests were carried out on this alloy, on pure carbon steels, on a high chromium steel, and a high-speed steel. For details of the actual experiments the original paper must be consulted. It must be noted, however, that although the mechanical conditions chosen for the tests appear to have been considered with great care, there were considerable variations in the temperature of a given test-piece which amounted to as much as ± 25° C. from a mean figure. Tests of two kinds were carried out: (*a*) those at constant load and constant temperatures, and (*b*) those at constant load and uniformly rising temperature. The extension temperature diagrams of the (*b*) series show that up to 400° C. all the steels extended alike. Thereafter, however, the curves diverged, a considerable amount of flow taking place in each case, at temperatures well below that finally reached. The range of temperature investigated extended up to nearly 1000° C.

The diagrams of the (*a*) series present some remarkable results, of which perhaps the most striking was that of the test-piece of nickel-chromium alloy (Vikro), which extended continuously from the first day of loading (at 625° C.) but only broke after 36 weeks. The diagrams bring out well the enormous influence of time in determining the temperature up to which each type of steel can support a given load (in this case 8½ tons per square inch), and by implication a load which can be borne at any given temperature. As an example, a nickel-chromium alloy withstood the above stress under a rapidly applied load at 965° C., whereas the same specimen cannot be expected to endure the same stress for considerable periods without suffering sensible deformation at a temperature exceeding 600° C. Working conditions such as those outlined demand a knowledge of the latter figure.

Mr. Dickenson concludes from his tests that the extension and eventual rupture of the test-piece under unvarying load is due almost entirely to viscous flow. Whether plastic flow affects the shape of the curves, and if so, whether the data will prove sufficient to enable the plastic to be separated from the viscous flow, is a question to which he has not yet found an answer. His curves are also interesting for the light which they throw upon the differing degrees of resistance to mechanical deformation at high temperatures, which the various steels exhibit. Moreover, in selecting material for resistance to stress at these temperatures, the nature of the stressing action must be taken into account.

In the second half of his paper, consideration is given to the very important factor of resistance to "scaling" exhibited by steels at the temperatures in question. It has been known for some time that remarkable resistance to oxidation is offered by certain nickel-chromium alloys, and, in a somewhat less degree, by high chromium steels. Mr. Dickenson has carried out systematic experiments on eight typical steels, in nine temperature ranges from 550°-600° up to 1075°-1175° C. The best results were given by a nickel-chromium alloy called "Vikro." Interesting photomicrographs are furnished, showing the varying character of the scale in the various alloys. Mr. Dickenson's research will be welcomed by chemical and metallurgical engineers, for it contains valuable information for which they have long been waiting. It is much to be hoped that he will see his way to continue his experiments.

The Manufacture of Acids during the War.[1]

By Prof. T. M. LOWRY, F.R.S.

THE three technical reports before us deal with the manufacture of sulphuric, nitric, and picric acids during the war. The reports are compiled on similar lines to those of the four earlier volumes which have already been reviewed in these columns (NATURE, April 29, 1922, p. 541); and since the methods and workmanship of Mr. W. Macnab are now well known, it is not necessary to describe in detail the type of information which they contain. It may, however, be of interest to review briefly the general situation as regards supplies of acids which had to be met by the Department of Explosives Supply, and the way in which the problem was solved by the workers of that Department, as disclosed in these three reports.

NITRIC ACID.

Although oxidised nitrogen was the key of the supply-problem in explosives—both propellant and H.E. (just as chlorine was the basis of the supply-problem in gas-warfare in its successive phases of chlorine, phosgene, CCl_3NO_2, $S(C_2H_4Cl)_2$, or mustard gas, etc.)—the report on the manufacture of nitric acid is undoubtedly the least important of these three, since it is much to be hoped that this country will never again be dependent on overseas

[1] Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 5: "Manufacture of Sulphuric Acid by Contact Process." Pp. vi+128+plates. (London: H.M. Stationery Office, 1921.) 25*s*. net. No. 6: "Synthetic Phenol and Picric Acid." Pp. vi+97+plates. (London: H.M. Stationery Office, 1921.) 15*s*. net. No. 7: "Manufacture of Nitric Acid from Nitre and Sulphuric Acid." Pp. vi+86. (London: H.M. Stationery Office, 1922.) 10*s*. 6*d*. net.

sources for its whole supply of fixed nitrogen. No more eloquent testimony to our unpreparedness in this direction could be given than the fact that, while a whole volume is devoted to the manufacture of nitric acid from nitre and sulphuric acid, there is no corresponding report on the supply of fixed nitrogen from the air, for the all-sufficient reason that there never was a supply to describe. Since, however, the two factories of Gretna and of Queen's Ferry alone were making during the war 1300 tons of nitric acid per week, and since, moreover, the loss by submarines of nitre ships from Chile was the cause of incessant anxiety, lest the whole output of explosives should be arrested by even a temporary stoppage of supplies, it was of very great importance that the utilisation of the nitre should be carried out with the highest degree of efficiency.

As usual, detailed attention resulted in economies which, in an earlier stage, would have appeared to be almost impossible. Striking evidence of the elaborate care that was called for in this very large-scale production is afforded by the fact that twenty pages of the seventh report are devoted to a description of the plant and process used for washing the sacks in which the nitre was brought from Chile! This resulted, not only in the saving of a substantial percentage of the precious nitre and in the elimination of a very serious fire risk, but also gave a higher value to the bags themselves; thus, whereas an unwashed bag could be sold for 2d., there were obtained, after washing, 60 per cent. of sound bags at 4¼d. each, 39 per cent. of slit bags at 3d., and 1 per cent. of ragged bags at 9·25*l.* per ton of 1400 bags.

A more obvious source of loss arose from the decomposition by heat of a certain proportion of nitric acid into water, nitrogen peroxide, and oxygen, especially towards the end of the distillation. It is this factor which gives rise to the one important complication of the plant, namely, the provision of towers in which the nitrous fumes can be reconverted into nitric acid by contact with oxygen and water. Since this oxidation is relatively slow, it is essential to provide adequate space in the towers, in order that the gases may not pass through them too quickly. Another important point in manufacture is to secure as large a proportion as possible of nitric acid of high strength, since, as the distillation proceeds, more and more water comes over with the acid. In practice the acid was collected in two batches, the receiver being changed when the density of the distillate fell to 1·465, while the fire was extinguished when the density fell to 1·340, although a little more acid distilled over from the hot charge before the retort was tapped. In a typical case, a series of six charges gave 5·05 tons nitric acid in the form of 90 per cent. acid and 3·55 tons in the form of 83·3 per cent. acid, giving a total yield of 86·6 per cent. recovered by condensation; to this must be added, however, an estimated recovery of 5·5 per cent. in the absorption towers, giving a total yield of 92 per cent. The balance of 8 per cent. is due mainly to loss of gases from the towers, especially during the brief period of violent interaction which takes place at an early stage of the distillation; there is also a small loss of nitric acid in the nitre-cake, from which the last traces of acid cannot profitably be removed. In some instances, however, a yield of more than 97 per cent. was reached, the total loss being therefore less than 3 per cent.

An interesting problem arose from the production as a by-product of vast quantities of nitre-cake. This was sometimes thrown away, *e.g.*, by dumping in the sea, since it was difficult to find a commercial outlet for it. It was therefore a profitable process, during an early period of the war, to neutralise nitre-cake with the poorer qualities of caustic soda, and to sell the product to the glass-makers as a substitute for salt-cake. At a later stage, however, manufacturers were persuaded to make more and more use of nitre cake in place of sulphuric acid, and the cake gradually acquired a market value, except at the more outlying factories. On the other hand, the direct-conversion process for the manufacture of ammonium nitrate from sodium nitrate and ammonium sulphate led to the production of vast quantities of sodium sulphate as a by-product, for which no sufficient outlet existed, with the result that two vast glistening pyramids were accumulated as a new object of interest to be seen by travellers on the G.W.R. just before reaching Swindon. As a result of these two factors, the neutralisation of nitre-cake was changed abruptly from a commercial operation, on which a useful profit might be earned, into one in which the product was of less value than the raw material. Under these conditions the infant industry was abandoned as abruptly as if the ashes of Vesuvius had fallen upon it and converted the plants into a modern Pompeii.

SULPHURIC ACID.

The manufacture of sulphuric acid involved a two-fold problem: first, the provision of sufficient supplies of chamber-acid, the manufacture of which was as well established as that of nitric acid from sodium nitrate; and, second, the manufacture of oleum, a far more difficult operation, which might indeed be compared with the fixation of nitrogen, except that the production of oleum had been carried on during many years (although on a restricted scale corresponding with the small normal demand for this material), while the fixation of nitrogen was an altogether novel enterprise in this country. Although several new chamber plants were constructed, they have not formed the subject of a report, perhaps because the production of chamber-acid was very largely left to contractors. On the other hand, new capacity for the manufacture of oleum on a large scale was provided in several Government factories, and the experience gained in constructing and working these plants is described in the fifth report of the series.

The oleum plants were of two principal types. The first plants (*e.g.* that at Oldbury) were constructed on the Mannheim system, in which the oxidation of sulphur dioxide to the trioxide is effected by the use of ferric oxide and of platinum in series. In the later plants platinum alone was used as a catalyst. The plants at Queen's Ferry, Gretna, and Avonmouth were constructed on the Grillo system, in which the platinum is supported on a base of calcined magnesium sulphate; but a plant on the Tentelew system, which is in some respects intermediate between the other two systems, since it employs platinum as the only catalyst, but in the more familiar form of platinised asbestos, was also taken over and worked at H.M. Factory, Pembrey. The Mannheim and Tentelew plants were constructed to burn iron pyrites; in the large Grillo plants, sulphur was burnt, among other reasons, in order to reduce the size of the towers used to purify the gases. This purification has been from the beginning the most essential feature in the successful manufacture of sulphuric acid by the contact process, and is substantially the same in all the different systems. It was, however, found that, even after the most careful purification of the gases, the proportion of sulphur dioxide converted to the trioxide was lower in the Mannheim and Tentelew plants than in the Grillos, where the efficiency often reached 94 per cent. instead of something less than 90 per cent.

While, however, the report describes in detail many elaborate technical features which were essential in order to secure high yields and efficiencies, it is of interest to find that the apparently simple operation of burning the pyrites provided an opportunity for securing improved yields, that may be compared in its simplicity with the washing of nitre bags, since it was found that careful attention to the method of building up and raking the fires resulted in the reduction of the sulphur content of the spent ore from 8 to 2 per cent. This feature proved to be so important that, in addition to an accurate time-table specifying exactly when the fires were to be raked, charged, and dropped, there was actually drawn up at the Queen's Ferry factory a chart to show exactly how the prong of the rake should be dragged or pushed through the fire in order to produce the best results, and this diagram is regarded as of sufficient importance to be reproduced in the report. The report also contains a precise specification of the way in which the fire-bars must be moved in order to remove the burnt pyrites from the furnace. It was by attention to such details as these that the high efficiencies ultimately achieved in the different factories were reached.

Perhaps one reason why chamber plants did not receive more attention was that, even when T.N.T. could be manufactured without oleum, it was still found to be advantageous to supply in this form the sulphuric acid required to make up for the losses sustained during working, *e.g.*, in the form of fumes and in the various washing waters, since in this way it was possible to avoid the final stage in the concentration of the sulphuric acid, *e.g.*, from 92 to 96 per cent., which was also the most expensive and the most wasteful part of the process.

PICRIC ACID.

The manufacture of picric acid presented a third type of problem. At the beginning of the war this acid was the only approved filling for H.E. shells, for Land Service as well as for the Navy. The demand for the acid soon outstripped the available supplies of coal-tar phenol, and it therefore became necessary to make use of coal-tar benzene as the raw material. This could be converted into picric acid by passing either through monochlorobenzene and dinitrochlorobenzene or through sodium benzenesulphonate and synthetic phenol. In this country the latter process was adopted almost exclusively. In France the chlorination process was also used, although in many cases the manufacture was arrested at the penultimate stage of dinitrophenol—a milder explosive, which gave rise to many fatalities before its toxic properties were realised and controlled with the help of proper physiological tests.

The manufacture of synthetic phenol lends itself to considerable variations in plant and process, and the sixth report contains diagrams illustrating five different variations worked out by different manufacturers. The subsequent conversion of the phenol into picric acid also included a considerable range of variants, which are set out fully in the report. It may, however, be of greater interest to refer briefly to the final chapters of the history of picric acid manufacture, in which the personal influence of the late Lord Moulton was a dominating feature. Convinced from a very early date that vast quantities of explosive would be required, he had laid down as a fundamental proposition the view that these could be obtained only by using ammonium nitrate as the main basis of the shell-filling programme. In this connexion the limited supplies of T.N.T. were of particular value, since this compound could be diluted with ammonium nitrate to five times its original weight, and even then gave an explosive mixture which was of greater power than, although not quite so violent as, T.N.T. or picric acid. The insensitiveness of this mixture, which ultimately became one of its most valuable properties, made it very difficult at first to secure effective detonation, and a maximum output of picric acid was therefore demanded in order to secure complete detonation of the largest possible proportion of shells. Many efforts were made to dilute picric acid in the same way as T.N.T., and in France (where picric acid was adhered to until the end of the war, in spite of its high cost) it was diluted with a wide range of other nitro-bodies; but the dilution of ammonium picrate with ammonium nitrate was never sufficiently successful to provide a service filling.

When, therefore, the detonation of the mixture of T.N.T. and ammonium nitrate had been improved until its equality with picric acid was at last established, there was no reasonable alternative but to abandon altogether the use of this acid, which cost three times as much, and, moreover, required nearly eight tons of imports, instead of less than two tons, in order to give one ton of finished explosive. Very severe criticism was levelled against Lord Moulton's action in spending more than a million pounds in erecting a factory for the manufacture of picric acid, which was abandoned almost as soon as it was finished; but this criticism was really only a proof of the ignorance of the critics, since the policy on which it was based was one that effected a saving of several million pounds per year, in addition to effecting a reduction of imports which was at the time of vital importance. In this, as in other problems, Lord Moulton saw clearly almost from the beginning what must be done to achieve success, and the closing down of the Avonmouth factory was the final vindication of the policy which he had adopted, and then followed persistently, in spite of all the obstacles that it had to encounter, until he had accomplished his purpose.

Prof. Max Weber.

CELEBRATION OF SEVENTIETH BIRTHDAY.

THERE are few living zoologists whose researches have taken so wide a range as have those of Prof. Max Weber of Amsterdam, whose seventieth birthday has been celebrated in Holland during the present week. As naturalist-traveller by land and sea in many parts of the world, he has brought together vast collections for study by his pupils and colleagues; as anatomist and histologist, he has studied the structure and elucidated the affinities of very diverse groups of animals from flat-worms to mammals; he has written the best text-book of mammalian anatomy and conducted one of the most important oceanographical expeditions of recent times; nor has he disdained to labour as a "mere systematist" at the description and cataloguing of species of Crustacea, fishes, and reptiles.

To select for mention the most significant among contributions to knowledge so numerous and so varied is no easy task. Among the first that come to mind are Weber's demonstration that the pattern formed by the hair-follicles in the skin of various mammals can be interpreted as derived from the scaly covering of reptilian ancestors, and the evidence he has adduced for the dismemberment of the order Edentata.

As a zoogeographer, Max Weber's studies on the fauna, and especially on the freshwater fishes, of the East Indian Archipelago will have a permanent value, whether or no "Weber's line" is to replace "Wallace's line" as the accepted limit between the Oriental and the Australian regions.

An enterprise of a very different kind carried out under Max Weber's personal leadership was the exploration of the Malayan seas in the years 1899 and 1900 by the Dutch steamship *Siboga*. The stately series of reports on this expedition, which have been appearing under his editorship since 1902, form a contribution to the science of the sea scarcely surpassed in importance save by those of the *Challenger* expedition. Dealing with only a restricted area of the ocean, but paying far more attention to the fauna and flora of the shallower waters than the naturalists of the *Challenger* were able to do, it is not too much to say that the *Siboga* expedition has given a new aspect to many problems of the distribution of marine animals in tropical seas.

It remains to be added that Madame Weber (*née* van Bosse) is a botanist of distinction, who has contributed monographs on many of the groups of seaweeds collected by the *Siboga*; she has also described the minute algæ which find a curious habitat on the hairs of sloths.

W. T. C.

Prof. D'Arcy W. Thompson has sent us the following letter signed by other British naturalists and himself:

DEAR PROFESSOR MAX WEBER,

You celebrate your seventieth birthday to-day, and we, who are your colleagues and are but a few of your many friends in England, join together to congratulate you and to wish you many years to come of work and happiness. By your long life of teaching and research, by your leadership of the *Siboga* Expedition, by your great handbook of the Mammalia, and by innumerable other important publications, you have come to be the acknowledged leader of zoology in the Netherlands and to be recognised far and wide as one of the most distinguished naturalists of our time. Your solid learning has upheld the great scientific traditions of your country, your investigations have influenced and stimulated many of us, your broad interests, your singleness of purpose, the simplicity of your life, and your genius for friendship have set an example to us all.

December 5.

A. ALCOCK.

E. J. ALLEN.	SIDNEY J. HICKSON.
CHAS. W. ANDREWS.	JAS. P. HILL.
J. H. ASHWORTH.	WM. EVANS HOYLE.
W. BATESON.	J. GRAHAM KERR.
GILBERT C. BOURNE.	E. W. MACBRIDE.
W. T. CALMAN.	W. C. MCINTOSH.
GEO. H. CARPENTER.	DORIS L. MACKINNON.
WM. J. DAKIN.	P. CHALMERS MITCHELL.
ARTHUR DENDY.	C. LLOYD MORGAN.
J. C. EWART.	EDWARD B. POULTON.
F. W. GAMBLE.	R. C. PUNNETT.
J. STANLEY GARDINER.	C. TATE REGAN.
WALTER GARSTANG.	G. ELLIOT SMITH.
JAMES F. GEMMILL.	OLDFIELD THOMAS.
SIDNEY F. HARMER.	D'ARCY W. THOMPSON.
J. R. HENDERSON.	D. M. S. WATSON.
W. A. HERDMAN.	A. SMITH WOODWARD.

Obituary.

H. J. ELWES, F.R.S.

MR. HENRY JOHN ELWES passed away on November 26, after a life full of activities spread over seventy-six years. Born heir to landed property and great wealth, his life at first promised to be that of the typical English gentleman. He was sent to school at Eton, and served for five years in the Scots Guards; afterwards he became one of the greatest travellers of modern times, led on by his love of natural history, entomology, horticulture, trees, and big game shooting. He visited Asia Minor, Tibet, Nepal, India, China, Formosa, Siberia, Caucasia, North and South America, and most if not all the countries of Europe. As a landowner, he was interested in sheep, and studied all the various breeds. He rendered important services to entomology by his enormous collections, which are now housed at South Kensington. He was a keen gardener, and introduced many beautiful and rare plants, a considerable number of which are figured in the *Botanical Magazine*. His "Monograph of the Genus Lilium" is a standard work. He aided several of the great scientific societies in many ways, and became president of the Royal Entomological Society of London and of the Royal English Arboricultural Society.

Mr. Elwes wrote numerous papers on gardening, agriculture, entomology, ornithology, and forestry. It is perhaps in the latter subject that his public services were greatest. Fascinated by the study of trees, he brought out the greatest work on arboriculture that has been published since Loudon's monumental book, which appeared in 1838. He did much for the establishment and maintenance of the School of Forestry at the University of Cambridge, the fine building and wonderful collection of timbers in it owing much to his munificence.

Mr. Elwes was a man of splendid physique, endowed with great powers of observation and organisation; and he was a fine naturalist. His influence was always cast in favour of scientific methods. His many friends mourn the loss of a splendid and stimulating personality.

J. H. GURNEY.

THE death of Mr. John Henry Gurney will be greatly deplored by all who knew him, for he was of a singularly lovable nature, and thought no ill of any one. By this sad event, Norfolk loses her foremost naturalist—one who by work and patronage has for many years done much to advance the study of Nature in his native county. Mr. Gurney, who was seventy-five years of age, died at his residence, Keswick Hall, near Norwich, after a short illness, on November 9.

Mr. Gurney came of a family intimately associated for some generations with public affairs in Norfolk, which has been noted also for its philanthropy, and in some of its branches for a love of natural history. This devotion to the study of Nature was developed in a remarkable degree in John Henry Gurney and in his father. The latter was, in his day, the greatest authority on the birds of prey; and the son at an early age commenced to follow in his father's footsteps by devoting his attention to the study of birds, which eventually became one of the main interests of a useful life. Since the days of that remarkable man, Sir Thomas Browne (1605–1682), Norfolk has been pre-eminent among English counties for its succession of distinguished naturalists interested in local faunal investigations. Many have shared in the advance of its ornithological knowledge, including such outstanding names as Alfred Newton, Stevenson, Southwell, and the Gurneys, father and son. The latter was indefatigable in his researches and made more than 100 literary contributions to the county avifauna, including 28 annual reports, each of which brought the knowledge of the subject up-to-date; of these, the last, dealing with 1921, appeared only a few months ago.

We are indebted to Mr. Gurney for several books, the chief of which was "The Gannet, a Bird with a History"—a valuable and exhaustive contribution which will always remain a classic on its subject. Another interesting volume was entitled "The Early Annals of Ornithology." This concerns largely the British aspect of the subject, and includes much information of interest relating to birds culled from the le Strange household accounts for the years 1519–1578. In quest of bird-lore he visited Spain, Algeria, Switzerland, and Egypt, and the results of his observations appeared in the *Ibis* and the *Zoologist*, or, in the case of the last-named country, in book form under the title "The Rambles of a Naturalist."

Mr. Gurney was one of the original members of the Norfolk and Norwich Naturalists' Society, founded in 1869, and was its president in 1881–2, 1888–9, 1898–9, and in 1919–20; he was also chairman of the Norfolk Wild Birds Protection Committee, and a member of the committee of the Norwich Museum, to which institution he was a generous donor. He was a Fellow of the Linnaean and Zoological Societies, and a member of the British Ornithologists' Union.

W. E. C.

CANON EDMUND MCCLURE, whose death occurred on November 18, at the age of eighty-five years, was editorial secretary of the Society for Promoting Christian Knowledge from 1875 to 1915, during which period he controlled the great mass of publications issued by the Society. He graduated in honours both at the old Queen's University, Belfast, and at Trinity College, Dublin. He held a curacy at Belfast for ten years, and was then collated to an honorary canonry at Bristol. Among his scientific and historical works he published a Star Atlas, adapted from the German of Klein; translations of Hommel's "Hebrew Tradition," and Kittel's "Babylonian Excavations"; he also had a share in a history of the society which he served so long, and in "British Place Names." Though he did little original work, his influence on scientific and historical literature was important.

IT is announced in the *Chemiker Zeitung* of November 21 that Prof. Leo Tschugaeff died from typhus on September 26 last. Dr. Tschugaeff, who was fifty years of age, was professor of inorganic chemistry at Petrograd. He was well known for his researches, including the dimethylglyoxime reaction for nickel. The issue of November 16 reports the death on November 4 of Prof. Alfred Möller, since 1896 director of the Forestry Academy of Eberswalde, who was known for his work on mycology.

WE much regret to announce the death on November 30, at sixty-nine years of age, of Sir Isaac Bayley Balfour, K.B.E., F.R.S., late professor of botany in the University of Edinburgh and Regius Keeper of the Royal Botanic Garden, Edinburgh; also on the same day, at seventy-five years of age, of Sir Norman Moore, Bt., sometime Physician to St. Bartholomew's Hospital and president of the Royal College of Physicians.

Current Topics and Events.

AT the anniversary dinner of the Royal Society it is customary to include among the guests some public men of distinction in other fields than those with which scientific men are concerned. Among such guests this year, at the dinner held on November 30, were Mr. Justice Darling, who proposed the toast of "The Royal Society," and Mr. L. S. Amery, First Lord of the Admiralty, who responded to the toast of "The Guests." If the assembly had consisted of leading representatives of literature or art, music or the drama, neither of these speakers would have professed, facetiously or otherwise, want of knowledge of the functions of the institution they honoured by their presence, or of the meaning of subjects surveyed by it. Mr. Justice Darling, for example, said he had heard of the Royal Society as he had heard of the equator, and had been told that the society "concerned itself with medicine and biology, and particularly natural knowledge and natural philosophy, but the moment the knowledge became unnatural—and so far as he could see most of it was—then the society had nothing more to do with it." Of course, the society was founded for the promotion of *natural* knowledge by inquiry as against *supernatural* by revelation or authority. Mr. Justice Darling should understand the distinction, for he referred to Francis Bacon several times in the course of his remarks, though always incorrectly, as "Lord" Bacon. As Sir Charles Sherrington, who presided, said, "The field of truth which the society explores is in the realm of natural knowledge, and the manner of the exploration of this field is in research." Sir Ernest Rutherford was right when, in responding to the toast of "The Medallists," he referred to the spirit of adventure possessed by every scientific pioneer. In no other department of intellectual activity is this spirit more manifest, and in none are such fertile provinces being opened. To us it seems strange, therefore, that so little is commonly understood of the origin and purpose of such a body as the Royal Society, now in its 260th year, or of the achievements of modern science represented by it.

DURING the war, when the country was short of munitions, manufacturers at their wits' end for supplies of chemicals, and medical men had to use such drugs as were available instead of those most suitable for their patients, no one had any doubt that the making of these things was a key industry and that when the war was over the Government must see to it that the importer of fine chemicals from Germany should be replaced by the British manufacturers of such products. After much tribulation the Safeguarding of Industries Act was passed to achieve this end; but thanks to the political and legal discussions that have accompanied and followed its passage and the national failing of a short memory, many people have become doubtful whether there is such a thing as a key industry. Even chemists begin to wonder whether they know a fine chemical when they see one. In these circumstances it is all to the good that somebody should restate the case; and this the Association of British Chemical Manufacturers has done in a pamphlet entitled "Shall the State Throw Away the Keys?" The publication contains numerous examples of the dependence of our staple industries on a steady supply of fine chemicals, and shows that such national and Imperial functions as the care of public health and the proper administration of tropical colonies cannot be carried on without them. Some of the most essential of these materials are now made in this country; but, as Sir William Pope points out in a foreword to the pamphlet, much remains to be done, and further developments in this direction cannot fail "if public opinion realises that a flourishing fine chemical industry is a vital necessity to the prosperity of our Empire and insists that national support is given to the young enterprise." This pamphlet should be of considerable assistance in creating an intelligent public opinion on this subject.

ON December 22 occurs the bicentenary of the death of Pierre Varignon, who will be remembered for the publication in 1687—the year Newton's "Principia" appeared—of the "Projet d'une nouvelle mécanique," the first treatise in which the whole science of statics was deduced from the principle known as the parallelogram of forces. Varignon was the son of an architect at Caen and was born in 1654. His bent for mathematics was stimulated by Descartes' work on geometry. His book immediately attracted attention, and in 1688 he was made professor of mathematics at the Collège Mazarin and a member of the Academy of Sciences. In 1704 he followed Duhamel in the chair of mathematics at the Collège de France. He suffered a good deal from ill-health, and his larger work, "Nouvelle Mécanique," did not appear till 1725. Of this treatise De Morgan once wrote, "This work was born long after its own death, and three years after its author's. The Projet of 1687 enabled all the world to act upon it; so that when the finished work was published it had long been superseded. The great feature of this work, as of the Projet, is the prominence given to the composition of forces. Varignon and Newton were forcing this commodity into the market at the same time and independently." Varignon was one of the earliest and most powerful advocates in France of the use of the differential calculus and was a correspondent of Leibniz and the Bernoullis.

EXCAVATIONS at Alfoldean, near Slinfold, a camp on Sussex Stane Street, the route by which Roman soldiers marched from Chichester to London, are described in the *Times* of November 9. Remains of officers' private quarters and of a cànteen have recently been found. Among other finds was a great collection of pottery, nearly all broken, specimens of many kinds of glass, and nine copper coins ranging in date from Vespasian to the fifth-century Tetricus. Mr. Winbolt, who is in charge of the excavations, will report the results to the Sussex Archæological Society. Another discovery, at Wisley, Surrey, is an ancient village dating between 50 B.C. and A.D. 50, which is recorded in the *Times* of November 15. It is stated that in the hut dwellings fragments of broken pottery were discovered. In 1904 a great deal of pottery was discovered and the kiln in which it was burnt, while years ago, at the foot of the village, a dug-out canoe, evidently belonging to it and associated with flint implements, was found. The canoe is now in the Weybridge Museum.

THE Elizabethan building in Croydon known as the Whitgift Hospital, dating from 1599, is once more threatened with destruction; the Town Council has given notice of a Parliamentary bill to acquire and dispose of the Hospital and Oratory for streets improvements. The matter has yet to be passed, however, by a town's meeting and afterwards by the burgesses, before it can proceed. Several times during the past twenty-five years the building has been threatened, but every effort has so far been counteracted by the local Preservation Committee and the Croydon Natural History and Scientific Society. The Royal Institute of British Architects, which has now joined forces with the local scientific society, has adopted the view that the widening of the main road through Croydon can be achieved without any interference with the buildings. In 1912 a scheme to this effect was accepted by the Croydon Council, and approved by the Local Government Board. At a conference of interested societies called by the Institute, the local and national importance of preserving Whitgift Hospital as a valuable relic of Elizabethan architecture was emphasised, and it was decided to support the 1912 scheme as providing a practical and effective road improvement which meets traffic requirements. Steps are to be taken to place these views before the proper authorities. It is to be hoped that the principle of avoiding, wherever possible, interference with historic and beautiful buildings may be increasingly supported by public opinion.

FOR nearly sixteen years Lord Carnarvon, with the assistance of Mr. Howard Carter, has been engaged in carrying out excavations in part of the site of ancient Thebes on the west bank of the Nile at Luxor. Their work has now been rewarded by an astonishing success, the details of which are described by a correspondent in the *Times* of November 30, while in the next issue Sir E. Wallis Budge explains the importance of the discovery. A sealed chamber has been opened containing the tomb of Tutankhamen, son-in-law of Amenhetep IV., now better known as Aakhenaten. The latter king, whose reign is dated at the end of the 14th century B.C., became notorious for his attempt to revive the ancient cult of the sun's disc, a movement which met with such serious opposition from the orthodox worshippers of Amen-Ra, king of the gods at Thebes, that he was obliged to retire to the place now known as Tell-al-Amarnah, where he acted as priest of Aten, or the disc. The tomb furniture of Tutankhamen is of extraordinary interest and value, including his magnificent State throne, one of the most beautiful works of art ever discovered, and a mass of splendid articles which have been as yet only imperfectly examined. Sir Wallis Budge suggests with good reason that a monograph containing a full account of this remarkable discovery should be published; "Such a book, carefully planned and written by Lord Carnarvon and Mr. Howard Carter, would crown a very fine archæological triumph, and earn the gratitude of Egyptologists, archæologists, artists, and others throughout the world." It only remains to congratulate Lord Carnarvon and Mr. Howard Carter on the success that has attended their long course of excavation, and has produced one of the most remarkable discoveries made in Egypt in recent times.

A VERY remarkable and most valuable collection of scientific instruments of historical interest is at present on view in the Portrait Gallery of the Bodleian Library, Oxford. This collection has been formed by Mr. Lewis Evans and contains some two thousand instruments, the oldest dating from the tenth century, and among the youngest being some designed by the great-grandfather of the present owner. Mr. Evans has offered the whole of it as a free gift to the University of Oxford, on condition that suitable space and situation, meeting with his approval, be found for showing it. In the meantime the collection is to remain for exhibition in the Bodleian till the end of the summer of 1924; but it can scarcely be doubted that this magnificent gift will be gratefully accepted. By far the greater part of the collection consists of astrolabes and sundials, many of the former being of exquisite workmanship. Among them is a Persian astrolabe made by Ahmad and Mahmud, dated A.H. 374 (A.D. 984), suitable for finding the time of the day by the sun or at night by 37 stars, for finding the latitude of a place, etc. Another Persian astrolabe, ornamented with gold and silver, is dated A.D. 1227, while an equally beautiful one was made at Toledo in A.D. 1067. Passing by a number of astrolabes of European make, including one made at Oxford about 1676, we find a great variety of pocket dials, some of them having compass needles to be sensitised with loadstones, in fine mountings; also drawing and surveying instruments, and finally a library, numbering about a thousand volumes, dealing with dialling, astrolabes, and other instruments. Further particulars about this wonderful collection will be found in the *Bodleian Quarterly Record*, No. 35.

A VISIT of members of the Circle of Scientific, Technical, and Trade Journalists and representatives of the technical press to the extensive modern repair shops of the London General Omnibus Co., Ltd., at Chiswick, took place on November 27. These large works, which cover more than 30 acres and deal with the repair of a fleet of 3000 motor-buses, travelling more than 100 million car-miles in a year, have some most interesting features. The works can handle 120 vehicles weekly. The whole process of overhaul and repair is conducted on scientific lines, each vehicle being stripped, the individual parts distributed for repair, and finally reassembled on a moving conveyor in a manner reminiscent of the methods of the Ford Motor Co. One highly interesting apparatus is the special washing-machine, capable of accommodating five components such as gear boxes at a time, a caustic washing solution being pumped in at high pressure so as to wash out thoroughly all grime and grit. Three such machines are in use. There is a well-equipped canteen where 1000 men can be served with dinner in fifteen minutes, and a model first-aid department. Following the inspection of the works, an address on the "Safety First" movement in England was delivered by Mr. H. E. Blain, assistant managing director of the London Underground Railways and L.G.O. Co. group, and hon. secretary both of the London

"Safety First" Council and the British Industrial "Safety First" movement. Mr. Blain traced the growth of this movement which has made "Safety First" such a familiar term in this country, describing the work of the Drivers' Educational Committee, which has more than 7000 drivers entering annually for its awards and medals, and the equally important work done by the Schools Propaganda Committee.

AT the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Thursday, December 14, at 8 P.M., Prof. C. H. Desch will deliver a lecture entitled "The Metallurgical Applications of Physical Chemistry."

THE council of the Royal Agricultural Society of England has decided to revive the offer annually of a gold medal for an essay giving evidence of original research on any agricultural subject or on any of the cognate agricultural sciences.

AT a general meeting of the members of the Royal Institution held on December 4, Sir Arthur Keith was elected secretary in succession to the late Col. E. H. Grove-Hills. Profs. Urbain (Paris), Ehrenfest (Leyden), Knudsen (Copenhagen), Bjerknes (Christiania), and Dr. Irving Langmuir were elected honorary members.

A NEW feature in the activities of the Institute of Metals is the admission of student members. The main qualifications required of the new class are that they shall be between 17 and 25 years of age and that they shall be studying metallurgy; they will be admitted to all the usual privileges of full members with the exception that they cannot vote at meetings. Both the entrance fee and the annual subscription are substantially less than those paid by members. The new departure should do much to stimulate and guide, by contact with older and more mature men of science, the younger research workers in our laboratories and works.

AT the annual general meeting of the Faraday Society held on November 20, the following officers and council for the year 1922–1923 were elected:—*President*: Sir Robert Robertson; *Past Presidents*: Sir R. T. Glazebrook, Sir Robert A. Hadfield, Bart., Prof. A. W. Porter; *Vice-Presidents*: Prof. C. H. Desch, Prof. F. G. Donnan, Dr. J. A. Harker, Prof. T. M. Lowry, W. Murray Morrison, Prof. J. R. Partington, and Dr. G. Senter; *Treasurer*: Robert L. Mond; *Council*: W. R. Bousfield, Cosmo Johns, Dr. R. Lessing, Prof. W. C. McC. Lewis, Prof. J. W. McBain, Dr. H. Moore, C. C. Paterson, Dr. J. N. Pring, Prof. A. O. Rankine, and Dr. E. K. Rideal.

AT a General Meeting of the University of Durham Philosophical Society held on November 28, the following officers were elected:—*President*: The Earl of Durham; *Vice-Presidents*: Sir Theodore Morison, Sir Charles Parsons, Profs. T. H. Havelock, P. J. Heawood, H. J. Hutchens, Mr. Wilfred Hall; *Secretaries*: Messrs. J. W. Bullerwell, B. Millard Griffiths; *Committee*: Profs. H. G. A. Hickling, H. V. A. Briscoe, J. Wight Duff, R. F. A. Hoernle, J. L. Morison, C. J. Hawkes, F. B. Jevons, Drs. J. A. Smythe, D. Woolacott, A. A. Hall, G. R. Goldsbrough, Messrs. G. W. Caunt, A. W. Bartlett, J. L. Burchnall, S. J. Davies, S. Hoare Collins, A. D. Peacock, and W. Clarke; *Editor*: Prof. G. W. Todd; *Librarian*: Dr. F. Bradshaw.

THE Frank Wood medal of the Society of Glass Technology has been presented to Mr. G. G. Middleton, B.Sc. Tech., and Mr. H. W. Howes, B.Sc. Tech., the successful students in 1921 and 1922, respectively, in the Department of Glass Technology at the Sheffield University. In 1919 the Society decided to recognise the services Mr. Frank Wood had rendered in connexion with its foundation and handed over to the University a hundred guineas, with the condition that the income should be utilised to provide some reward to students in the glass technology department. It was decided that the reward should take the form of a medal, and that it should be associated with the name of Mr. Frank Wood, in whose honour it had been established.

A NEW edition (No. 76) of their catalogue of second-hand scientific apparatus has been issued by Messrs. C. Baker, 244 High Holborn, W.C.1. The list is divided into the customary convenient sections, and we may direct attention in particular to two of them, dealing with microscopes and astronomical apparatus respectively. Both contain a large and varied assortment of items ranging from large modern instruments to the smallest accessories.

ANOTHER of the useful and well-arranged catalogues of Messrs. W. Heffer and Sons, Ltd., Cambridge, has reached us. Its No. is 217 and it contains the titles of upwards of 1500 works arranged under the headings Mathematics and Physics (Journals and Transactions, Books printed before 1800 and Books printed after 1800), Chemistry, Chemical Technology and Metallurgy. Many books formerly the property of the late Prof. R. B. Clifton are offered for sale.

MESSRS. WATSON AND SONS, LTD., Sunic Honse, 43 Parker Street, Kingsway, London, W.C.2, announce that the British Thomson-Houston Co., Ltd., and the General Electric Co., Ltd., are now associated with them. This connexion implies the development of X-ray and electro-medical apparatus constructed on established electrical engineering lines, and, with the aid of the research laboratories of these companies, the incorporation of the most recent advances in physics.

WITH further reference to the remarks which have appeared in these pages on the subject of the sense of smell in birds, Mr. W. E. M'Kechnie of Chepstow Place, London, W.2, raises the question as to whether the usually well-developed olfactory mechanism in birds may not have quite a different sensory function, such as the detection of fine differences in the strength, temperature, and humidity of the air-currents encountered during flight. This was Cyon's theory, but it rests on no sure foundation of fact. In their experiments on the homing capacities of Noddy and Sooty terns, Watson and Lashley found that these powers were not affected when the nasal cavities were occluded with wax and varnished over: the birds so treated retained their remarkable faculty of finding their way back to their nests, over an unknown course, from a considerable distance.

Our Astronomical Column.

A BRIGHT NEW STAR.—A telegram just received (December 4) from the International Central Bureau of Astronomical Telegrams at Copenhagen, reports the discovery of a new star on December 1, by Zivierel of Rumania. The star is given as of the first magnitude, and its position in R.A. $18^h 48^m$, and North Declination 28° 0′. It is situated just on the border between the two constellations Lyra and Hercules, but as many charts differ as to the position of the actual boundary, some uncertainty may arise as to whether the star will be called Nova Lyræ or Nova Herculis. All new stars are situated either in or on the borders of the Milky Way, and the present one is no exception, lying just on the border. The Nova will easily be picked up on a fine night, because it lies just to the south of the conspicuous constellation of Lyra, made prominent by the brilliant star Vega. The constellation is in the north-western portion of the sky in the early part of the evening. The Nova makes very nearly an equilateral triangle with the two stars ν Lyræ and β Cygni and is brighter than both these stars; α Lyræ, or Vega, is of magnitude 0·14, so will approximate closely to the brightness of the Nova, assuming that the latter is still of the first magnitude. This Nova is the brightest which has appeared since that of Nova Cygni, which was discovered in 1920.

COMETS.—A new faint comet, 1922 *d*, was discovered by Mr. Skjellerup at the Cape on November 25, being the second that he has found this year. Mr. Wood has telegraphed the following elements from Johannesburg: they show a strong resemblance to those of Comet 1892 VI., which are given for comparison; as it was under observation for three months without deviating appreciably from a parabola, identity is impossible, but the two comets may have had a common origin.

T =	1923 Jan. 1·14 G.M.T.	1892 Dec. 28·1.
ω =	260° 31′	252° 42′
Ω =	261 8	264 29
i =	23 4	24 47
log q =	9·9759	9·9893

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A. h.	m.	s.	S. Decl.	log r.	log Δ.
Dec. 8.	12	5	48	22° 9′	0·0141	9·9426
12.	12	28	56	25 35		
16.	12	52	32	28 39	9·9937	9·9556
20.	13	16	28	31 20		

The comet should be looked for a little east of south and very low down, just before dawn. It is near ϵ Corvi on December 8, subsequently crossing Hydra into Centaurus.

The following is a continuation of the ephemeris of Baade's Comet for Greenwich midnight: this is still a fairly easy object with moderate telescopes.

	R.A. h.	m.	s.	N. Decl.	log r.	log Δ.
Dec. 11.	21	55	35	23° 33′	0·3643	0·3460
15.	22	5	27	22 44	0·3663	0·3549
19.	22	15	13	21 57	0·3684	0·3639
23.	22	24	55	21 14	0·3707	0·3730

Perrine's Periodic Comet was found by Rakamuna on Nov. $29^d, 6^h, 50^m$, G.M.T.; in R.A. $8^h 5^m, 32^s$; N. Decl. 0° 28′. Its daily motion is +16 sec., south 44′. The probable date of perihelion was about Oct. 20. The magnitude of the comet is 13·0.

PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.—The October number of the Publications of the Astronomical Society of the Pacific contains a number of interesting communications. First there is a very clear and concise account of the work of the late J. C. Kapteyn, whom the writer, Mr. F. H. Seares, describes as one of the most distinguished astronomers of his generation. Kapteyn, as he says, presented the unique figure of an astronomer without a telescope, but reading through this notice it will be seen how he formed programmes for telescopic work, and how successfully he discussed the observations made. Director S. A. Mitchell, of the Leander McCormick Observatory, gives a list of the trigonometrical parallaxes of a number of stars of spectrum types A and B (headings of the tables reversed in error), data very much wanted for the initial work in determining parallaxes of other stars of the same type by the spectroscopic method. A summary of the year's work at the Mount Wilson Observatory is given by the director and assistant director, Dr. G. E. Hale and Mr. Walter S. Adams respectively. As announced in NATURE of October 7, a 50-foot interferometer telescope is being specially built for the Observatory, and it is hoped to determine with it the diameters of about thirty stars brighter than the fourth magnitude. Dr. R. G. Aitken contributes an interesting account of the two notable astronomical meetings, namely the International Astronomical Union at Rome and the celebration of the centenary of the Royal Astronomical Society in London. In the notes, among other subjects, mention is made of the success of the Crocker Eclipse Expedition from the Lick Observatory.

ANCIENT OBSERVATIONS OF AURORA.—A.H. Swinton directs attention in the Journal of the British Astronomical Association to some passages in early English chronicles which describe brilliant coloured streamers in the night sky; in all probability these were displays of auroræ, an assumption that is strengthened by the fact that in most cases the dates of the displays are separated by multiples of the sunspot cycle. They therefore become valuable for indicating probable dates of sunspot maximum. Working backward from the well-established maximum of 1860·1 with the two assumed periods (A) $11^y·156$ (B) $11^y·055$, the following tabular values are obtained. The time of year is stated in one case only, namely, 743 Jan. 1; in the other cases the middle of the year is assumed.

Observed Date, A.D.	Tabular Date.		Observed minus Tabular.		Number of Cycles from 1860.	
	A	B	A	B	A	B
555·5	554·9	555·6	+0·6	−0·1	117	118
567·5	566·0	566·7	+1·5	+0·8	116	117
743·0	744·5	743·5	−1·5	−0·5	100	101
776·5	778·0	776·7	−1·5	−0·2	97	98
794·5	789·1	798·8	+5·4	−4·3	96	97
979·5	978·8	975·7	+0·7	+3·8	79	80

Assumption A appears on the whole to be the better; in neither case is 794·5 well represented; the original record of this does not give the year in A.D. reckoning, but states that it was "the tenth year of the reign of Brihtrick, King of Wessex."

Prof. Hirayama's list of Chinese sunspots (quoted by Prof. Turner in Mon. Not. R.A.S., vol. 74, p. 99) indicates spots on the following dates: 499 Jan. 31 (3 spots seen), 826 Mar., 832 Apr. 25, 837 Dec. 25, 842 Jan. 3, 864 Feb., 874 Jan., 974 Mar. 6. These, except the second and fourth, suggest dates of maximum in fair accord with the auroral data.

Research Items.

SURVEYS IN SPITSBERGEN.—In the *Geographical Journal* for November Mr. R. A. Frazer gives an account of some work which he did on the edge of New Friesland in company with Mr. N. E. Odell and Dr. T. G. Longstaff in August 1921. The party travelled north-eastward for about 25 miles from the head of Klaas Billen Bay into the highland ice of the interior. Crossing the watershed between the western and eastern drainage areas, they surveyed the salient features in a small area lying between the Mount Svanberg group to the south and the peaks around Mount Chernichev to the north. Weather and travelling conditions were bad, and time was short, but the work which was accomplished fills one of the gaps in the skeleton survey of the Russian Arc of Meridian Expedition of 1898–1902.

DESICCATION IN THE LAKE CHAD REGION.—In an article in the *Geographical Journal* for November on the Lake Chad region, Mr. F. W. H. Migeod returns to the much debated question of desiccation on the southern edge of the Sahara. According to Mr. Migeod there is abundant evidence of the advance of arid conditions southward into the belt of fertility in Bornu. The dry area has been steadily increasing at a great rate for at least three-quarters of a century, and apparently at a slower rate for many centuries. Mr. Migeod cites evidence from the drying up of rivers and ponds, but on the other hand he found no personal evidence of the exhaustion of wells in the part of Bornu which he visited. The evidence from changes in forest growth he does not find conclusive, but with regard to human migration, he points to the significant fact that every successive capital of the Bornu empire during the last six centuries has been south of its predecessor. The general trend of migration is southward, and whenever a new village is founded it is always in a position south of the previous site.

PROBLEMS OF MENDELIAN RATIOS.—Mr. R. A. Fisher gives an elaborate mathematical treatment (Proc. Roy. Soc. Edin. vol. 42, Part 3) of certain problems connected with Mendelian ratios. He concludes that the ratio of frequency of the various types in a Mendelian population will be stable only when selection favours the heterozygote, such factors only tending to accumulate in the stock, while other factors will tend to be eliminated. He also develops formulæ for determining the rate of mutation which is necessary to maintain the variability of a species under different conditions. We are not competent to discuss his mathematics, but some of his biological statements are perhaps open to criticism. For example, he assumes that recessive factors tend to be harmful or harmful factors recessive, whereas in man the majority of harmful factors are dominant. He also repeats the current fiction that the mutations of Œnothera are explained by the crossing-over of balanced lethal factors.

ABSORPTION OF WATER BY ROOT AND STEM TIPS.—Prof. Priestley and his students have now published the fourth in their series of studies on the anatomy and physiology of the endodermis and related structures in plants. The present contribution (*New Phytologist*, vol. 21, No. 4) considers the water relations in the growing root and stem tip. Experiments of de Vries in forcing water into roots were confirmed and extended, showing that the endodermis prevents leakage of water from the stele into the cortex. At the same time the meristematic root tip before the endodermis is organised was shown to be impervious to water under ordinary pressures. This is apparently owing to the peculiar non-cellulose composition of the cell walls in this region, in contrast to the corresponding region of the stem tip. The impervious character of this region accounts for the failure of water-leakage from root tips, and is contrary to the views of a French worker who believes that the root tip below the root-hair zone is an absorptive region.

COAL IN SOUTH AFRICA.—Memoir No. 19 of the Geological Survey of the Union of South Africa, issued recently, forms the first volume of a study of the coal resources of the Union of South Africa compiled by Mr. W. J. Wybergh. The coalfields dealt with are those of Witbank, Springs, Heidelberg, and the coalfields of the Orange Free State; they are all described in considerable detail, numerous analyses are given, and the general character and properties of the coals are fully discussed. It may be of interest to reproduce the author's estimate of the existing coal resources of the Union, although, as he points out, considerable deductions may have to be made from these figures for losses in working.

Witbank Coalfield	7,926,206,000 tons
Springs area	485,000,000 ,,
Nigel area	65,000,000 ,,
Vischkuil-Delmas area fairly proved	218,400,000 ,,
Vischkuil-Delmas area conjectural	1,411,200,000 ,,
Heidelberg South Rand area	8,064,000,000 ,,
do. other areas	965,544,000 ,,
Orange Free State above	100,000,000,000 ,,
Total	119,135,350,000 tons

THE NEW BRAUN TUBE.—Two years ago Mr. J. B. Johnson of the Research Laboratories of the Western Electrical Co., and the American Telephone and Telegraph Co., exhibited to the American Physical Society a Braun cathode ray tube operating at low voltage, and an abstract of a more complete description of the tube in its present improved form will be found in the September issue of the *Journal of the Optical Society of America and Review of Scientific Instruments*. The cathode consists of a strip of platinum covered with an oxide, the anode of a tube of platinum 1 cm. long and 0·1 cm. diameter, only 0·1 cm. from the tip of the cathode. Between cathode and anode is a metal shield with a small hole in it through which the electrons from the cathode pass. Beyond the anode are the two pairs of deflector plates at right angles to each other, which can be connected to the two sources of electromotive force which are to be compared. The electrons finally impinge on a fluorescent screen and their deflection is of the order 0·1 cm. per volt applied to the deflector plates. When the plates are replaced by coils, the same deflection is obtained per ampere turn in the coils. In the paper referred to, the hysteresis loop for iron in an alternating field and the characteristic curve for an oscillating valve tube are given. At the exhibition of the tube before the Institution of Electrical Engineers on November 16, the anode current and grid voltage curve of a valve was shown. As the cathode ray has to produce ionisation as it moves sideways, it is not possible to obtain a sharp spot at frequencies of more than 10^5 per second, but below that figure the slight pressure of mercury vapour in the tube ensures a sharp image. With the oxide cathode an electromotive force of 300 volts is sufficient to run the tube.

The Royal Society Anniversary Meeting.

ON St. Andrew's Day, November 30, the Royal Society held its anniversary meeting and Sir Charles Sherrington delivered the customary presidential address, in the opening part of which he dealt with matters affecting the society itself and science generally. Speaking of research, Sir Charles Sherrington referred to the benefaction received last year under the will of the late Miss L. A. Foulerton, who by gift had already founded the Foulerton studentship. The utilisation of the bequest came under the consideration of a large and representative committee, which recommended the creation of one or more research professorships, within the field of science specified in the bequest.

The newly instituted research professorship, together with the Mackinnon, Sorby, Tyndall, Moseley, and Foulerton research studentships, all of which are of comparatively recent date, constitute something of a scheme, although they have arisen somewhat desultorily. The studentships with one or more professorships now form a series, extending, at one end, from opportunities for workers of promise to carry their careers towards fulfilment, to, at the other end, provision for men of proved achievement to devote themselves unreservedly to research. A noteworthy feature in the administration of all these research foundations is that the recipient is in no case restricted to a particular institution. The Royal Society has no laboratory of its own, and in consequence takes advantage of the facilities for research already in existence; thus its function is rather to supplement and reinforce work already in progress.

Prof. E. H. Starling has been appointed the first Foulerton professor.

Sir Richard Threlfall and Dr. D. H. Scott, on behalf of a number of subscribers, presented to the society a portrait of Sir Joseph Thomson by Mr. Fiddes Watt.

In presenting the society's medals, Sir Charles Sherrington referred briefly to the work of each recipient. The awards are as follows :—

COPLEY MEDAL. Sir Ernest Rutherford.—Recently, Sir Ernest Rutherford and his pupils have been especially concerned with the deflections of α particles in their passage through matter, and as a result of his experiments he has been led to the view that the positive electric charge in the atom is confined to a minute nuclear region in the atom, that that region comprises nearly the whole mass of the atom, and that it has a charge equal to the electronic charge multiplied by the atomic number of the element. In this work the α particles were located by the scintillations which they produced on a zinc sulphide screen. It was found that when the screen was beyond reach of the original α particles a number, relatively small, of scintillations still remained. In some cases these additional effects are due to hydrogen atoms ejected from the nuclei of the different elements by the bombarding α particles; this disruption takes place at the expense of energy latent in the disrupting atom.

RUMFORD MEDAL. Prof. Pieter Zeeman.—Prof. Zeeman's discovery of the splitting up of spectroscopic lines under the influence of magnetic force had important results, among others, that it enabled astronomers to trace magnetic effects at the surface of the sun. Among his subsequent contributions to science is an investigation dealing with the propagation of light in moving bodies. In all earlier experiments the dispersion of light in the medium was neglected, and the irregularities in the flow of the liquid constituting the moving body, prevented accurate measurements. To obtain greater accuracy Zeeman investigated the effects in solid substances, such as quartz or glass, giving these bodies an oscillatory velocity, and applying an instantaneous photographic method, the exposure taking place when the velocity was at its maximum.

ROYAL MEDAL. Mr. Joseph Barcroft.—For the last twenty years Mr. Barcroft has been prominent for his researches on the respiratory function of the blood and its relation to the activity of the tissues. He has with various collaborators worked out the changes in the normal consumption of oxygen accompanying functional activity in various representative organs—salivary gland, kidney, cardiac and skeletal muscle, and liver. He has also worked out and thrown new light on the meaning of the dissociation curve for oxygen exhibited by blood and by pure hæmoglobin, and on the influence of dissolved salts upon that curve.

ROYAL MEDAL. Mr. Charles Thomas Rees Wilson.—Previous work having shown the important part played by dust particles in the condensation of supersaturated vapour, Mr. Wilson showed that the ions produced by the passage of X-rays act in a similar manner, thus showing the discrete nature of the ions apart from their electrical effects. Later, he was able on the same principles to render visible, and to photograph, the actual path of an α particle through a gas. More recently, while studying the phenomena of atmospheric electricity, he has measured the surface electrification of the ground, and thence the potential gradient, at any moment, and has also recorded its variation from instant to instant. Observations during the progress of thunderstorms have enabled him to estimate the amount of electricity passing in a lightning flash.

DAVY MEDAL. Prof. Jocelyn Field Thorpe.—Ethyl cyanoacetate has been investigated by Prof. Thorpe very fully. As a result there appeared an illuminating series of papers on the formation and reactions of imino compounds, giving rise to a variety of derivatives of naphthalene, hydrindene, pyridine, etc., and on the isomerism displayed by the glutaconic acids. His paper on "Spiro Compounds" was the first of a series dealing with the effect produced by the alteration of the tetrahedral angle, consequent on ring formation, on the formation and stability of a second ring joined to the existing ring by a quaternary carbon atom common to both.

DARWIN MEDAL. Prof. Reginald Crundall Punnett.—Prof. Punnett was the first to find the correct interpretation of "coupling and repulsion" in inheritance, now termed "linkage." It was known that sometimes factors belonging to distinct allelomorphic pairs were transmitted as if partially linked, but that also in other families the same factors might show repulsion. Prof. Punnett conceived that these two phenomena must depend on parental combination. Most of the modern interpretations of sex-limited inheritance have grown out of this discovery.

BUCHANAN MEDAL. Sir David Bruce.—*Trypanosoma Brucei*, the causal organism of tsetse-fly disease, is so named after its discoverer, Sir David Bruce, who likewise first showed its causal connexion with that disease and with nagana. Bruce took a leading part in the elucidation of trypanosome infections, and in the adoption of counter measures against them, and also traced the incidence in man of Mediterranean fever to transmission through the milk of goats. During the war he carried out the collection and analysis of data regarding tetanus on a scale never previously attained, and later was instrumental in establishing the origin of trench fever and its transmission by lice.

SYLVESTER MEDAL. Prof. Tullio Levi-Civita.—The investigations by Levi-Civita in pure geometry were the necessary foundations for the important physical discoveries of Einstein and Weyl. Levi-Civita has also shown himself one of the most fertile and original of investigators in differential geometry and theoretical mechanics.

HUGHES MEDAL. Dr. Francis William Aston.—Dr. Aston, by the use of an ingenious method of focussing positive rays, has shown that a large number of the elements are complexes consisting of two or more kinds of atoms, having identical chemical properties but differing in atomic weight by one or more units. Except in the single instance of hydrogen the atomic weight of each constituent is, to the limit of accuracy, a whole number on the basis of oxygen =16.

Live Specimens of Spirula.

By Dr. JOHS. SCHMIDT, Leader of the *Dana* Expeditions, Copenhagen.

FEW animals have been of more interest to zoologists than the little cuttle-fish Spirula. Related to the extinct Belemnites, and characterised by having an interior, chambered shell, it occupies an isolated position among recent species. Dead shells (see Fig. 2) are found on the sea-shores particularly of warmer seas, where they may drift ashore in great numbers, but the animal itself has hitherto ranked among the greatest zoological rarities, of which only very few museums possess a specimen.

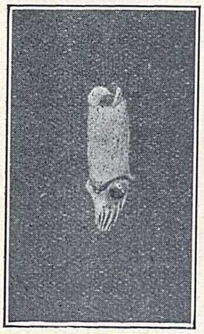

FIG. 1.—Live specimen of Spirula, moving down toward the bottom of the aquarium. While so moving, the head is directed forward (downward), the fins at the rear are thrust out vertically, and the funnel is turned upward (this last is not visible here, the figure showing the specimen in dorsal view). About half natural size. Photo by K. Stephensen.

On the third *Dana* expedition we captured considerable numbers of Spirula in the North Atlantic, and were also fortunate enough to observe many specimens alive. I propose then, in the following, to describe some of our observations, throwing light upon the habits and occurrence of the species.

Appearance.—The following remarks apply to living specimens, a point which should be emphasised, as both colour and shape are often appreciably altered by preservation. The body, or mantle, is shaped like a cylinder cut away abruptly at the back, the head and arms protruding from the front part. As seen in Fig. 1, the arms are most often kept close together, as for example when the animal is in motion, giving the anterior part of the body a conical shape. At the hinder end are two fins, roughly semicircular. Their basal parts are not parallel, but converge toward the ventral side of the animal. The fins can be pointed straight out behind (Fig. 1), or laid flat in against the hinder part (Fig. 2). In the centre of the latter, between the two fins, there is a circular disc (the terminal disc) having in the middle a small bead-like organ. At the outer edge of the disc is a ring of pigment; otherwise it is colourless. The small central bead is a light organ.

The colour differs from that of other cuttle-fish. The mantle has a peculiar whitish sheen, most resembling that of asbestos. A further similarity to the mineral lies in the fact that the surface of the mantle is often somewhat frayed or fluffy. The greater part of the mantle is without pigment; some colour there is, however, of a rusty red, in a narrow band along the anterior margin of the mantle, especially on the dorsal side. There is also pigment on the hinder end of the body and at the base of the fins. On touching a live specimen, the rusty colour at the hinder end will often almost disappear, the chromatophores contracting to little dark specks. Arms and head exhibit the silvery sheen and also pigment, the latter dense and of a rusty brown. The extremities of the arms, however, especially of the two longer ones, are somewhat lighter and lacking pigment. The funnel also is pigmented, but not at its mouth.

Movements, etc.—The movement of the Spirula is characterised throughout by the presence of the interior, chambered shell, which is situate at the posterior end of the body, and tends to lift this portion in the water. A specimen recently dead, or a live one not inclined to active movement, will therefore, if placed in an aquarium with sea water, rise to the surface, and remain suspended there head downwards, with the lighter, posterior part uppermost. If moved from this position, it will immediately swing back to it again, like a weighted tumbling figure.

On board the *Dana* we frequently observed live specimens of Spirula. When taken from the net and placed in an aquarium, they would at first invariably remain suspended at the surface of the water, motionless, and to all appearance lifeless. As a rule, however, death was only simulated. Left to themselves, they would generally come to life, and soon begin breathing and other movements. The respiratory movements are effected by rhythmical contractions of the mantle, whereby water is forced out through the funnel. As the mouth of this is turned towards the rear—*i.e.* upwards—the water flows up along the ventral side of the mantle. This vertically ascending current of water is easily noticeable, from its disturbing the frayed surface of the mantle.

Like other cuttle-fish, Spirula often makes swift, jerky movements, dashing off suddenly in any direction: upwards, downwards, or from side to side. These rushes were generally made by "backing," *i.e.* the animal moved with its hinder end forward, having first "reversed" the funnel, so as to turn its opening forward towards the head, at the same

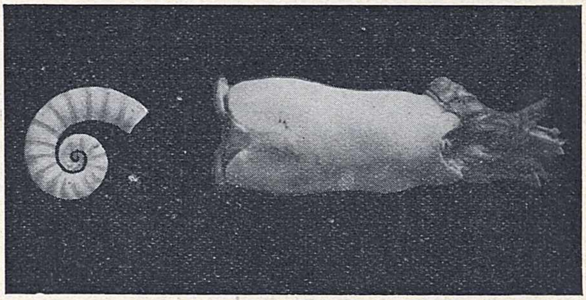

FIG. 2.—Preserved specimen of Spirula, about 39 mm. long (the head slightly damaged). The shell seen at the side, which has 35 chambers, shows the relative size of the shell in a specimen as illustrated. The animal is seen from the ventral side: the inner shell can be discerned showing through. About natural size. Photo by K. Stephensen.

time flattening the fins close in to the posterior end, approximately as shown in the preserved specimen, Fig. 2. Less frequently Spirula was observed in the aquarium making a forward rush with its head to the front—*i.e.* without reversing the funnel. It is possible, however, that this latter mode of progress is the usual one—for example, when in pursuit of prey.

In addition to these jerky movements, the animal also makes others at a slower rate. It may often be seen in the aquarium moving vertically downwards from the surface, head first. During the descent the fins are held vertical (see Fig. 1) and move with a rapid waving or fluttering motion which, in conjunction with the current of water from the funnel, now facing upwards (to the rear), carries the animal down towards the bottom. Sometimes it will come to a standstill in mid-water, at others it will not stop until it has reached the bottom, but so long as it remains below the surface the fins are kept in motion as described, and the funnel is pointed upwards. It may rise again slowly to the surface without altering its vertical position; the fins are then sometimes seen in motion, sometimes pressed in close to the hinder end.

In order to ascertain whether this movement of the fins was necessary to maintain the animal in the vertical position, which it adopted for the most part in our aquaria, we cut off one of the fins from a specimen, selecting a large and powerful individual for the purpose. It was at once evident that the lack of a fin in no way affected the maintenance of the vertical position; what did result was that the animal was now unable to keep under water. When placed at the bottom of the aquarium, it invariably rose again to the surface. On one occasion, when guiding it to the bottom, we happened to bring the creature into contact with the glass wall, when something new was seen. On touching the wall, it spread out its arms and clung to the glass, and was now able to keep under water. We tried to move it away from the glass by prodding it with the handle of a lancet. It relinquished its hold, but only to attach itself to the lancet handle in the same way. Evidently the eight short arms are highly sensitive to touch—the two longer less so, if at all. On this occasion also we had a sight of the animal's black, horny beak, and learned that it is capable of inflicting a powerful bite, as the handle of the lancet showed.

When left to itself the Spirula will remain suspended for hours at the surface, or lower down in the water, always in a vertical position, and with arms more or less closed in. When violently disturbed, the animal may occasionally discharge a small cloud of greyish ink. We managed to keep some specimens alive for more than two days in our small aquaria, with no aeration of the water. Generally, however, they lived only a little more than a day.

On several occasions we were able to perceive that the small bead-like organ at the posterior end is a light organ. It emits a pale, yellowish-green light, which, from the normal position of the animal in the water, is directed upward. In contrast to the light displayed by so many other marine organisms (crustacea, etc.), which flares up and fades away again, the Spirula's little lamp burns continuously. We have seen the light showing uninterruptedly for hours together.

Mode of Life.—The third *Dana* expedition has made captures of Spirula in 65 hauls from 44 stations, and in every case with implements used pelagically, without touching the bottom. The depths at which our specimens were taken varied from about 2-300 metres to about 2000. The greatest quantities were found at depths from 300 to 500 metres; none were taken in the upper 200 metres of the sea, though the nets were constantly drawn within this range.

Our investigations thus indicate that the species is bathypelagic, *i.e.* pelagic in deeper water layers, and so confirm the supposition advanced by J. Hjort (Murray and Hjort, "Depths of the Ocean," p. 595, London, 1910). A. Agassiz ("Three Cruises of the *Blake*," ii. p. 61, Boston and New York, 1888), who has examined a specimen of Spirula "dredged . . . from a depth of 950 fathoms," is of opinion that "from the condition of the chromatophores of the body, it evidently lives with its posterior extremity buried to a certain extent in the mud." This conclusion is doubtless erroneous. It would be unreasonable to suppose that the creature should thus bury its hinder part—which is lighter, owing to the shell, and also carries the light organ—in the bottom. It seems far more likely that the specimen brought up in the *Blake's* dredge was not taken from the bottom at all, but captured higher up in the water when hauling in.

Size, etc.—The 95 specimens of the third *Dana* expedition vary in length from 5 to 47 millimetres (maximal length of the mantle). On arranging the measurements graphically, they fall more or less evenly distributed along the millimetre scale, with nothing to suggest the presence of different "year-classes" in the material. Judging from this, it might seem as if the propagation of the species was not restricted to a short period of the year.

At one station (St. 1157, N. of Cape Verde Islands) we found the following :—

Depth (in metres).	Length of specimens (in millimetres).
250	9, 17, 20, 22
300	7, 17, 20, 21, 22, 27, 28
500	15, 41
1000	7, 15, 19, 22

At other stations, specimens more than 40 mm. long were found both in the deepest hauls and in those nearest the surface of all the hauls containing Spirula.

The species seems to attain maturity at a length of about 30 mm. (length of mantle). At this length the males begin to be hectocotylised, and the specimens more than 30 mm. which we opened were found to have mature sex organs (the females with large, oblong, honey-coloured ova, besides smaller eggs).

As previously mentioned, the Spirula has a chambered inner shell. As the animal grows the number of chambers increases, and a turn of the shell takes place. The figures below show how the number of chambers increases with growth of the animal.

Length of mantle (mm.).	Number of chambers in shell.
12	16
20	22
38	34 (mature male)
44	38 (mature female)

Approximately, then—but only approximately—an increase of one millimetre in length answers to the formation of one fresh chamber.

While the *Dana* was at the Virgin Islands in the West Indies (St. Thomas and St. Croix), as also at Bermuda, we often found considerable numbers of Spirula shells on the shore. Most of the shells were damaged, but so far as could be determined the intact specimens generally had between 30 and 40 chambers, *i.e.* representing, from the above, fully-grown mature specimens. From this I must conclude that at any rate the bulk of the shells found washed up on the coasts are those of fully-grown Spirula which have died of old age. When the animal is dead, and the soft parts rotting away, the shells, being lighter than water, will thus normally rise to the surface, and drift about with the surface currents, to be eventually washed ashore. *This bathypelagic species, then, becomes after death a surface form, its remains constituting a normal ingredient in the drift of the warmer seas.*

Fig. 2 serves to show the relative size of the shell as compared with that of the animal itself. The shell here illustrated has 35 chambers, and the length (of mantle) is 39 mm. Most of the undamaged shells we found on the shore were of this size.

Distribution.—The first complete specimen of Spirula known to science was taken by the *Challenger* near the Banda Islands, west of New Guinea, and a few others were captured by subsequent expeditions (one by the *Blake* at Grenada, W.I., another by the *Valdivia* in the Indian Ocean, and seven by the *Michael Sars* in 1910 in the neighbourhood of the Canary Islands). The chart, Fig. 3, shows the localities where Spirula was taken by the present expedition. There were, as a matter of fact, more stations than are shown, but some lie so close together that it was impossible to indicate them on so small a chart. The stations where hauls were made which might have taken Spirula if present, but gave negative result, are marked by a cross. Our captures amounted to 95 specimens in all.

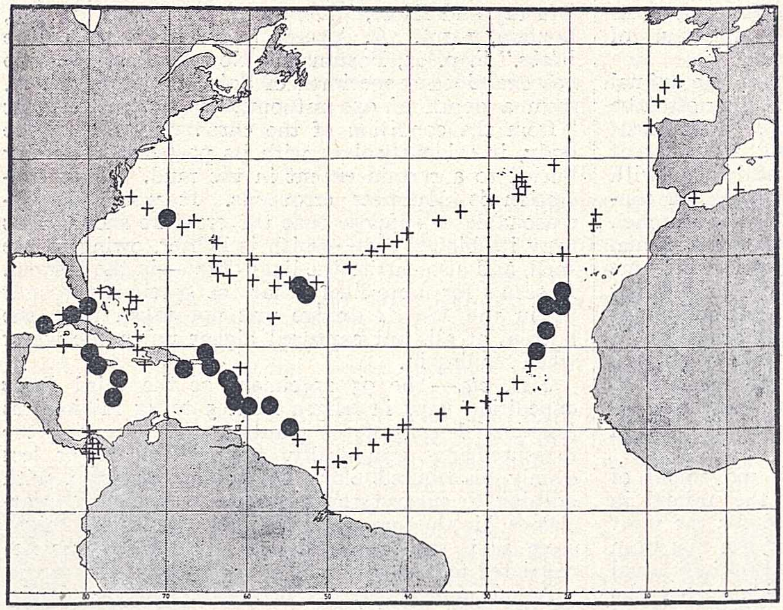

FIG. 3.—Chart showing occurrence of Spirula at stations of the *Dana* expedition. The black spots denote finds of live specimens, the crosses indicating stations where implements suited to its capture were used, but no specimens taken.

It will be seen that Spirula occurred between 10° and 35° N. Lat.: in the eastern part of the Atlantic from the Canary Islands to north of the Cape Verde Islands; in the Western Atlantic from Guiana and northward to the Virgin Islands and Puerto Rico, throughout the Caribbean; and also in the Gulf of Mexico and the Florida Straits, in the Sargasso Sea, and between Bermuda and the United States of America. From our previous investigations carried out with the *Thor*, we may conclude that the species is not found in the Mediterranean, or off the west coast of Europe from Spain to Iceland.

Solar Radiation at Helwan Observatory.

THE observations of solar radiation made at the Helwan Observatory in the years 1915 to 1921, which have recently been published,[1] lead to results of far-reaching importance.

With regard to the standardisation of instruments the position is satisfactory. The equipment of the Observatory includes two Ångström pyrheliometers made in Upsala as well as one made by the Cambridge Scientific Instrument Company, which was standardised by Prof. H. L. Callendar. There is also an Abbot silver-disc pyrheliometer. The observations indicate that if a correction of plus one per cent. is applied to determinations by the Upsala standard it comes into agreement with the Callendar and Abbot standards. A progressive deterioration in the Ångström instrument in daily use has been found, which is attributed to the deposit of dust on the blackened strips and a consequent reduction in absorbing power.

The usual practice at Helwan has been to take several observations in the course of a morning, with the sun at different heights, with the object of determining the "solar constant," the strength of the solar heat stream outside the earth's atmosphere. The usual assumption in reducing such observations is that the scattering and absorbing power of the atmosphere remains the same during the series of readings. The "solar constant" is arrived at by a process of extrapolation. In an earlier bulletin Mr. Knox-Shaw has directed attention to doubts as to the validity of this assumption, and has shown that if the air becomes less clear as the day progresses then a negative correlation between the computed "solar constant" and the computed transmission coefficient is to be expected.

It is now found that there is such correlation not only at Helwan, but also at other places for which observations have been published. The correlation coefficient averages about 0·6, and the value of the determinations of the solar constant by the extrapolation method is therefore much discredited. Further evidence of its unsuitability is furnished by the lack of correlation between the values of the solar constant found at different stations on the same day. It will be for the Smithsonian Institution to show that destructive criticism on the same lines will not affect the spectrobolometer observations on which the evidence for the day-to-day variations of the "solar constant" depends.

In the year 1919 Prof. Abbot developed a new method of observation based on the well-known fact that the more the sunlight is obstructed by dust, etc., the greater will be the glare surrounding the sun. The question has been investigated by the use of a "pyranometer" (fire-above-measure), as the instrument for determining the strength of radiation from

[1] Ministry of Public Works, Egypt: Helwan Observatory, Bull. No. 23. Observations of Solar Radiation, 1915–1921, by H. Knox-Shaw. Price 2 P.T.

the sky is termed. The type developed by Abbot and Aldrich is described in Smithsonian Misc. Collections, vol. 66, No. 7, 1916, but the name would be suitable for Mr. Dines's instrument (*Meteorological Magazine*, vol. 55, p. 189, 1920); by analogy the Callendar radiograph, which gives a record of the heat carried by the luminous rays from sun and sky and received on a horizontal surface, should be a pyranograph.

Prof. Abbot measures the heat from the sun, and also the heat from the sun plus the heat from the sky within 15° of the sun with one of these instruments, and by applying appropriate factors obtains the "solar constant." Mr. Knox-Shaw has examined a series of observations made at Calama in Chile and reduced by Prof. Abbot's staff by this method. He finds that they show no correlation between the computed values of the solar constant and the transmission coefficient. It is to be hoped that the validity of this new method will be confirmed, as it will make the regular determination of the strength of solar radiation practicable at many stations where the more elaborate routine could not be adopted. At Helwan the sun is to be observed with the Ångström apparatus once a day at a specified altitude. For the application of Abbot's method the Ångström readings will have to be supplemented by those of a pyranometer.

Natural Gas Gasoline.

The Production of Light Oils from Natural Gas.

By H. B. Milner.

NATURAL gas may be of two distinct types—dry gas or wet gas. The former consists essentially of methane, with practically no other members of the paraffin series, the latter being composed of methane with varying amounts of ethane, pentane, hexane, and heptane, and certain dilutants such as nitrogen, carbon dioxide, carbon monoxide, sulphuretted hydrogen, and sometimes helium. Dry gas is normally associated with coal or decomposing vegetable matter and is rarely met with in the presence of petroleum; wet gas, on the other hand, is essentially the gas present in oil pools, either in the free state or dissolved in the oil under pressure.

The production of natural gas gasoline—as it is called—constitutes a comparatively recent development of the petroleum industry, particularly in the United States. The gas employed for this purpose is that which so frequently accumulates in the top of oil-well casings, or which, under pressure varying from a few to several hundred pounds, is forced along the flow lines leading from the casing head. Composed of lower members of the paraffin series than ordinary petrol obtained by refining crude oil, natural gas gasoline is far more volatile and inflammable, and therefore its use *per se* is normally inadmissible. But mixed with some of the heavier fractions derived from crude oil, it forms a fuel ranging from 0·660 to 0·750 in gravity, in all respects suitable for internal combustion engines of the automobile type.

There are three recognised processes for extracting oil from natural gas—the compression process, the absorption process, and the combined compression and absorption system. The compression process consists in the liquefaction by pressure and refrigeration of the heavier paraffins present in the gas, and is usually employed where the initial density of the gas exceeds 0·8, *i.e.* where the gas is rich in the heavier hydrocarbons. The plant employed entails a compressor, condensing or cooling coils and collecting tanks. The average yield of oil by this process is 2·5 gallons per m. cubic feet; 73 per cent. of the output of natural gas gasoline for 1920 in the United States was produced by the compression process.[1]

The absorption process has the advantage that it is applicable to "lean" gas, *i.e.* gas yielding anything from 0·1 to 0·5 gallons per m. cubic feet, and by this process much so-called dry gas has been utilised which would otherwise have been wasted, being of too low a grade to be treated profitably by the compression process. The absorption system necessitates passing the gas through an oil of higher gravity than ordinary petrol, from which it is recoverable by fractional distillation. The combination process is a more recent development, whereby the gas is compressed under low pressure to a smaller volume, then absorbed by seal oil and subsequently recovered by distillation. This process has been employed recently by pipe-line companies in the United States to recover gasoline from low grade wet gas accumulated in gas distributing lines. The average yield of oil by the absorption process is 0·2 gallons per m. cubic feet.

The principal States in America producing natural gas gasoline are Oklahoma, West Virginia, California, and Texas, besides eight other States giving a subordinate output. The bulk of the products is sent to the northern States and California, where in the latter case the oil is mixed with petrol obtained from low grade crude oils. Much of the Canadian natural gas gasoline is being blended with petrol obtained from Mexican crude oil, and in this way, also, many oil wells which would otherwise be derelict are, by their yield of low grade wet gas, giving good results, quite apart from the better known and more valuable gas wells.

Some idea of the remarkable growth of the industry in America can be gauged from the fact that whereas only 7½ million gallons of gas gasoline were produced in 1911, nearly 400 million gallons were produced in 1920. This constitutes more than 7 per cent. of the total production of gasoline in the United States for that year.

Quite apart from any statistical evidence, it is clear that this new industry now firmly established in America will, by its steady progress, have a far-reaching consequence on the available supplies of fuel-oil for world consumption in the future. Many fields which have hitherto been poor producers may quite conceivably be rendered sound from a commercial standpoint by the utilisation of the natural gas now allowed to run to waste. In such countries as Russia, Persia, Burma, Egypt, and Trinidad, the processes are, by reason of the large quantities of natural gas available, especially applicable, though little, if anything, has so far been done in this direction. Wherever natural gas can be controlled at the casing head, the possibility of its treatment for the recovery of light oil should be taken into account. In the fields cited above, especially in Trinidad, the value of such recovery lies not so much in the actual production of petrol, but in the enhanced value attained by low grade crude oil fractions as a result of careful mixing.

1 "Natural Gas Gasoline in 1920," by E. G. Sievers. Min. Res. Unit. States, 1920, Part II., pp. 289-300. (Unit. States Geol. Survey.)

The Teaching of Physics to Engineering Students.

THE American Physical Society recently set up a committee to consider and report on special problems and difficulties in the teaching of physics, and the first report issued by the committee, prepared by Prof. A. W. Duff of the Worcester Polytechnic, Mass., deals with the teaching of physics to students of engineering. It summarises the opinions expressed by a large number of teachers and engineers in replies to a long list of questions addressed to them by the committee. All agree that the object of a physics course is to provide the student with a sound knowledge of the fundamental principles on which engineering depends, and that he should be shown how these principles find their application in common experiences of everyday life, so that at a later stage his knowledge of principles should be in a form immediately available for the solution of new practical problems. He must acquire the habit of searching for the principles underlying a mass of phenomena and of drawing safe conclusions from those principles. Lectures should be well thought out and the matter presented in clear form.

Some teachers think the class should be required to prepare sections of the text-book for repetition or for discussion in class, although this is felt by many to be a school method not desirable in engineering colleges. The problems set for exercise should be of a practical nature and not deteriorate into numerical substitution in a formula. Laboratory work is essential, but too great a degree of precision of results should not be demanded, the object of the work being to elucidate principles rather than attain a high order of accuracy. The relative importance of the objects to be attained in teaching physics to engineers is considered to be—first, the scientific habit of thought; second, knowledge of the laws of physics; third, initiative and ingenuity; fourth, knowledge of facts and methods; and, fifth, accurate observation.

The evidence as to present teaching in America shows that physics gets the proper proportion of time only in the best engineering colleges, and that in all cases it suffers from the inability to reason logically which most boys display on leaving school. The diversity of symbols used for the same quantity by different writers, and the difference between the engineering and scientific units, are two further difficulties under which the subject labours. A great majority of the teachers and engineers consulted were in favour of establishing a journal dealing with new instruments, methods and experiments, recent research, applications of physics, and the theory of teaching.

University and Educational Intelligence.

BELFAST.—Dr. R. C. Gray, a graduate of the University of Glasgow, has been appointed lecturer in physics in the Queen's University.

CAMBRIDGE.—It is proposed to create a University lectureship in crystallography for Mr. A. Hutchinson, Pembroke College.

A revised report on draft ordinances for the admission of women to the titles of degrees has been presented by the Syndicate appointed to prepare them. The chief modifications proposed are (1) that research students shall be supernumerary to the limit of 500 imposed on the number of women students receiving instruction in the University; (2) that a woman candidate for honours, who fails to qualify for an honours degree and is "allowed the Ordinary" shall be qualified for the title of a degree; (3) that women students be allowed to enter for pass examinations in agriculture or in architecture so long as there are no Tripos examinations in these subjects. The scale of fees has been revised in view of criticisms raised at the discussion on the first report. The Syndicate makes it clear that it is not proposed to introduce a Regulation formally admitting women to instruction in the University. It is preferred to assume that the present practice of admitting women will be continued.

LEEDS.—Applications are invited for the professorship of chemistry shortly to be vacant by the resignation of Prof. Smithells. The salary is to be 1200*l.* per annum, and the appointment will take effect on October 1, 1923. Applications for the post are to be sent to the Registrar, who will supply further information if desired.

LONDON.—An assistant lecturer in Physical Chemistry is required at University College, at a yearly salary of 300*l.* Physicists possessing a knowledge of chemistry, as well as chemists, are eligible for the post. Applications, accompanied by testimonials, record of degrees, published work, and teaching experience (if any), must reach the Secretary of the College by, at latest, Wednesday, December 20.

ACCORDING to a report prepared during the month of August for the League of Nations on "The condition of intellectual life in Austria," the professional classes and all who depend for their livelihood on intellectual work have, since the revolution of 1918, sunk into a position in which they form, in an economic sense, the lowest stratum of the community, their work being invariably worse paid than manual labour. Their physical and mental powers are consequently being sapped by insufficiency of food, and their numbers are being reduced by actual starvation. Among the organisations whereby they are striving to protect their common interests is a Central Council of Austrian Intellectual Workers, having its seat at the University of Vienna, and associated with this is an "office for providing books and instruments." This body is endeavouring to establish agreements with associations in other countries whereby second-hand or surplus books and periodicals may be obtained under conditions ensuring their fullest possible utilisation and providing for the determination of the value of Austrian books offered in exchange. One such agreement has been concluded with the Universities Library and Student Relief for Europe affiliated to the Universities Committee, Imperial War Relief Fund, General Buildings, Aldwych, W.C.2. Through this committee the universities of the United Kingdom have, during the past two years, contributed substantially towards relieving the necessities of professors and students of Austrian as well as other European universities. It is now urgently soliciting further help in money or in kind.

THE setting-up in 1918 of the standing committee of Vice-Chancellors and Principals was one of the most noteworthy events in the long history of the universities of the United Kingdom. Up to that date each university had been a law unto itself, formulating its own policy and drafting its own ordinances with little regard for the needs or the doings of the others, save in a few matters which could only be handled by the universities collectively, such, for example, as an appeal to the Chancellor of the Exchequer or the institution of the Ph.D. degree. Outstanding interests such as these were dealt with by conferences, *ad hoc*, summoned by the Universities Bureau. At their quarterly meetings the executive heads have considered a vast number of matters of common interest, ranging from entrance tests to regulations for higher degrees, from student fees to salaries of members of staffs. After mutual consultation they report the proceedings of the committee to their respective councils and senates, which alone have power to give expression to its views, if they endorse them. When the salaries of teachers, meagre before the war, were felt by even the most enduring to be totally inadequate to meet the increased cost of living, the Association of University Teachers was formed for the purpose, in the main, of protecting the material interests of its members. We gather from the address recently delivered by its new president, Prof. J. W. McBain, of the University of Bristol, that the Association now contemplates a wider field of usefulness. It is proposed to appoint sub-committees to prepare reports on a variety of topics, to send these reports to the local associations for discussion, and finally, after the central council have hammered them into shape, to place them on record as the opinion of the Association for the benefit of the public both within and without the universities.

DR. SAMUEL P. CAPEN, the able director for several years past of the work of the American National Council on Education, was installed last month as Chancellor of the University of Buffalo. Dr. Capen, who attended the Universities' Congress at Oxford in July 1921, is well known as an authority on higher education in America. In the course of his inaugural address at Buffalo he dealt with some of the problems of urgent national importance with which educational administrators in America are confronted. Institutions of higher education of nearly every type except agricultural colleges are, he says, overcrowded, the pressure being most pronounced in the colleges of arts and sciences, where the onrush of students has threatened the efficiency of instruction. The increase in secondary school enrolments throughout the country indicates that the situation is bound to become more acute. More disconcerting than the increase in numbers in the colleges of arts and sciences are a falling off in the standard of intellectual vigour of their students, and a centrifugal tendency driving the more energetic of them to courses with such distinctly vocational aims as commerce, journalism, home economics, and industrial chemistry. A university, Dr. Capen says, is a place maintained at great expense to foster the philosophic point of view and stimulate constructive thinking, and its resources should not be consumed by those who are incapable of such things. It may be impracticable at present to devise tests which would prevent their admission, but it is relatively easy to identify them when they have been for a little while in college and "if the faculty can stand the strain" to eliminate them. As early as possible in the college course there should be provision of opportunities for independent study as in the case of honours students in British universities (whose work, by the way, is, Dr. Capen says, superior in quality to that which any American college student is required to perform), and none should be allowed to graduate who have not "demonstrated capacity for independent study and registered definite mastery of some field of study." Thus he would have American colleges adopt and apply generally to all candidates for degrees the British universities' system of honours schools.

Calendar of Industrial Pioneers.

December 10, 1631. Sir Hugh Myddelton died.—A successful London goldsmith and banker, Myddelton projected and carried through the scheme for bringing water to London from springs at Chadwell and Amwell in Hertfordshire. The New River Works were begun in 1609 and completed in 1613, the canal being 10 feet wide and more than 38 miles long. There are memorials to Myddelton at Islington, Holborn, and the Royal Exchange.

December 10, 1896. Alfred Bernhard Nobel died.—The founder of the five Nobel prizes, for which he bequeathed a sum of 1,400,000*l*., Nobel was born in Stockholm, October 21, 1833, worked for a time in his father's torpedo works at St. Petersburg, and after returning to Sweden took up the study of explosives. Dynamite was patented by him in 1867, in 1876 he patented blasting gelatine, and in 1888 he produced ballistite. With his brothers he established factories in various countries and took a share in the exploitation of the Baku oil-fields.

December 11, 1906. Jacques Augustin Normand died.—A descendant of a family of shipwrights who constructed ships at Honfleur in the 17th century, Normand became head of the well-known firm at Havre in 1871, and as such had a great share in the development of fast torpedo craft. In 1880 he built eight torpedo boats for the French Government, and in 1895 constructed the *Forban*, which for a time was the fastest vessel in the world. She was 144 feet long, and on trial on September 26, 1895, while developing 3975 horse power, reached a speed of 31·029 knots.

December 11, 1909. Ludwig Mond died.—Born in Cassel, March 7, 1839, Mond studied chemistry under Kolbe, Kirchhoff, and Bunsen, and first came to England in 1862. He introduced into England the ammonia-soda process of Solvay in 1873 with Brunner, founded important works at Winnington near Northwich, and about 1879 invented the Mond producer gas plant and discovered a method of manufacturing pure nickel. He was one of the greatest industrial chemists of his time and a generous benefactor of science. He founded the Davy-Faraday Laboratory at the Royal Institution.

December 12, 1849. Sir Marc Isambard Brunel died.—Originally an officer in the French Navy, Brunel fled from France during the Revolution, and after a short time spent in America came to England in 1799. Among his greatest achievements were the invention of the famous block-making machinery for Portsmouth Dockyard and the construction during the years 1825–1843 of the Thames Tunnel, considered at the time to be one of the sights of the world.

December 13, 1882. William Thomson Henley died.—From a porter in the London Docks, Henley rose to be one of the largest makers of telegraph cable. Starting in business as an instrument maker in 1838, he made apparatus for Wheatstone, exhibited an electro-magnetic machine at the Exhibition of 1851, and altogether made some 14,000 miles of submarine cable.

December 16, 1816. Charles, third Earl Stanhope died.—An ardent politician, and the brother-in-law of Pitt, Stanhope was also known for his love of the physical sciences and his inventive ingenuity. He constructed calculating machines, patented a process of stereotyping, introduced the Stanhope press, and attempted to drive a ship by steam.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 23.—Sir Charles Sherrington, president, in the chair.—T. E. **Stanton**: On the characteristics of cylindrical journal lubrication at high values of the eccentricity. The arc of contact of the film was limited in extent in the experiments and the intensity of pressure was considerably higher than in normal practice; the arcs of contact varied from 14 to 35 degrees and the maximum intensities of pressure from 1·4 to 3·5 tons per sq. inch. In all the cases observed, the pressure distribution in the film has been in accordance with the hydrodynamical theory of Osborne Reynolds. By means of a careful determination of the pressure distribution in the film, and a measurement of the radius difference of bearing and journal, sufficient data have been obtained to calculate the viscosity of the lubricant and the attitude and eccentricity of the bearing. The values of the viscosity of the lubricant so calculated were in good agreement with those determined in a viscometer, and it was concluded that the calculated values of the eccentricity were trustworthy. In the case of a journal 2·5 cm. diameter, the least distance apart of the surfaces was found to vary from 0·0012 to 0·0024 mm.—J. H. **Jeans**: The propagation of earthquake waves. Earthquake waves are regarded as being compounded of a number of free vibrations of a non-homogeneous gravitating earth. In 1885, Lord Rayleigh discussed a certain type of surface waves which would travel over the earth's surface with a velocity of about $0{\cdot}92\sqrt{(\mu/\rho)}$. It is now shown that there are additional, and far more numerous, surface waves which travel with velocities $\sqrt{(\mu/\rho)}$ and $\sqrt{((\lambda+2\mu)/\rho)}$. If such waves are generated by an earthquake at any point close to the earth's surface, they will refocus themselves upon this point after intervals which are integral multiples of $2\pi a\sqrt{(\rho/\mu)}$ and $2\pi a\sqrt{(\rho/(\lambda+2\mu))}$, the numerical values of these quantities being about 223 and 126 minutes respectively. In 1917, two series of earthquakes, each originating from the same centre, had their times given approximately by formulæ of the type—

$$t=t_0+n_1\times 125{\cdot}8+n_2\times 222{\cdot}0 \text{ minutes.}$$

It is possible that the return of waves sent out by one shock may produce a second shock by a kind of "trigger" action.—F. A. **Lindemann** and G. M. B. **Dobson**: A theory of meteors and the density and temperature of the outer atmosphere to which it leads. All major meteoric phenomena can be accounted for consistently if the luminosity of the meteor be attributed to the collision of volatilised meteoric vapour with the air molecules. From observed meteoric data the density of temperature of the air at great heights is derived in four independent ways which give consistent results. The density above 60 km. appears to be very much greater than corresponds to an isothermal atmosphere at 220° Abs., and the temperature appears to be in the neighbourhood of 300° Abs. The radiative properties of ozone may account for this high temperature.—F. C. **Thompson** and E. **Whitehead**: On the changes in iron and steel at temperatures below 280° C. Iron shows abnormalities of rate of increase of electrical resistance and electric potential against platinum at well-marked temperatures. Below 280° C. these temperatures are: 55°, 100°, 120°, 140°, 220°, and 245° C. Of these, those at 120° and 220° C. are the most important. Under the same conditions, carbide of iron possesses two well-marked points at 160° and 200° C. These may be distinct points, or the ends of a single transformation range. The etching of cementite has been studied. Broadly the reagents which darken cementite are strongly alkaline; no acid and only one neutral solution will do this. A solution has been discovered which will enable the two forms of cementite to be differentiated micrographically, but since β-cementite will change to the α form in a few days at room temperature, this etching is not always satisfactory. When samples of iron and high carbon steel are quenched from 280° C., the electrical resistivities differ from those obtained by slow cooling. As the material tempers these values gradually alter, till after some days they practically coincide with those obtained by slow cooling.—C. F. **Jenkin**: The fatigue failure of metals. A theory of the mechanism of fatigue failure in metals is offered. The theory is demonstrated by a simple model which possesses the assumed properties of the crystals forming the metal. The model, when tested like a metal test-piece, gives stress/strain curves, hysteresis loops, and the complete series of fatigue ranges of exactly the same character as those given by the metal test-piece. A method of mechanically treating a mild steel test-piece is described, which, according to the theory, should raise its fatigue range about 20 per cent.; another treatment is described which should lower the fatigue range of medium steel by about 25 per cent.—S. **Brodetsky**: The line of action of the resultant pressure in discontinuous fluid motion. The general solution of the problem of discontinuous fluid motion past any barrier can be expressed in terms of the variable introduced by Levi-Civita, by means of which the part of the barrier in contact with the moving fluid is transformed into a semi-circle. The form of the barrier is defined by the coefficients in a Taylor expansion. Although the components of the resultant pressure on the barrier have been calculated in terms of these coefficients, the line of action has not been found previously. The moment of the resultant pressure about a certain point is a simple function of the first four coefficients of the above expansion.—R. A. **Houstoun**: An investigation of the colour vision of 527 students by the Rayleigh test. Lord Rayleigh discovered in 1881 that if homogeneous yellow is matched with a mixture of homogeneous red and homogeneous green, some persons require much more red, others much more green in the mixture than the normal. Such persons have been called "anomalous trichromats." Apparatus similar to Rayleigh's was employed in the present survey. In the case of the 104 women, the frequency curve is almost a perfect case of normal variation; in the case of the men, the normal curve is present, and outside it lie the colour blind and the anomalous trichromats; the anomalous trichromats are much fewer in number than would be expected from Rayleigh's original paper.

British Mycological Society, November 18.—Mr. F. T. Brooks, president, in the chair.—M. C. **Rayner**: Calluna "cuttings." Adventitious roots produced from the leafy region of the stem showed infection by the mycorrhizal fungus from the shoot tissues. The results are completely at variance with those of Christoph.—Miss G. **Gilchrist**: Bark canker disease of apple caused by *Myxosporium corticolum*. The disease is characterised by the formation of large longitudinal scars on the sides of branches which increase rapidly towards the end of summer, and the production of wound gum. The fungus seems to be a weak parasite, except under certain conditions when the trees may be killed outright. Infection may occur from a dead spur, grafting wounds or from the region of the ground.—R. J. **Tabor**: A new fungal disease of cacao and coffee. The fungus, which is a Phycomycete, shows the amphigynous type of fertilisation similar to certain species of Phytophthora and has a conidial stage similar to that of Muratella.—Miss E. S. **Moore**: The physiology of the dry-rot disease of potatoes in storage caused by *Fusarium cæruleum*. The existence of seasonal and varietal differences in susceptibility was confirmed. The amount and type of fungus growth is related to the carbohydrate and nitrogen supply, to the reaction of the medium and the temperature of incubation.—A. **Castellani**: Mycology in tropical medicine. The history of our knowledge of fungal diseases and the chief human parasites and their effects were considered.

Zoological Society, November 21.—Sir S. F. Harmer, vice-president, in the chair.—A. Smith **Woodward**: A skull and tusks of a mammoth from Siberia.—D. **Seth-Smith**: The shed lining of the gizzard of a hornbill.—Ivor G. S. **Montagu**: On a further collection of mammals from the Inner Hebrides.—F. R. **Wells**: The morphology and development of the chondrocranium of the larval *Clupia harengus*.—R. I. **Pocock**: The external characters of the beaver (Castoridæ) and some squirrels (Sciuridæ).—G. M. **Vevers**: On the cestode parasites from mammalian hosts which died in the Gardens of the Zoological Society of London during the years 1919–1921; with a description of a new species of Cyclorchida.—A. **Loveridge**: Notes on East African birds (chiefly nesting-habits and stomach-contents) collected 1915–1919.—E. A. **Stensiö**: Notes on certain Crossopterygians.—Ekendranath **Ghosh**: On the animal of Scaphula (Benson), with a description of a new species of Scaphula.—J. H. **Lloyd** and Edith M. **Sheppard**: A contribution to the anatomy of a hammerhead-shark (*Zygœna malleus*).—R. H. **Mehra**: Two new Indian species of the little-known genus Aulodrilus (Bretscher), aquatic Oligochæta belonging to the family Tubificidæ.—J. **Stephenson**: The Oligochæta of the Oxford University Spitsbergen expedition.—R. J. **Ortlepp**: The nematode genus Physaloptera, Rud.

Royal Meteorological Society, November 22.—Dr. C. Chree, president, in the chair.—A. H. R. **Goldie**: Circumstances determining the distribution of temperature in the upper air under conditions of high and low barometric pressure. An analysis was given of 165 observations of upper air temperature made from aeroplanes, data being classified according to whether the air was "equatorial" or "polar." The main conclusions are—(*a*) that in high-pressure systems there would usually be found, either a surface layer of polar air and above it equatorial air with the high stratosphere associated with low latitudes, or equatorial air all the way up; (*b*) that in low-pressure systems there would usually be found either (i.) all polar air and the low stratosphere of high latitudes, or perhaps (ii.) equatorial air which had been "let down" by retreating polar air, or (iii.)—near the centre of cyclones—a mixture of polar and equatorial air. These features alone would go far towards explaining (1) the absence of correlation between temperature and pressure near the surface, (2) the high positive correlation from 3 to 8 kilometres, (3) the greater height of the stratosphere over high than over low pressure, (4) the negative correlation between temperature and pressure in the stratosphere.—Rev. José **Algué**: The Manila typhoon of May 23, 1922. This typhoon traversed the central part of the Philippines in a north-westerly direction on May 20 to 23, the centre having passed practically over Manila on the morning of May 23. Manila missed the worst of the storm, and, although the barometric minimum in the present case, 742·3 mm. (29·22 inches), was lower than in the typhoons of August 31, 1920, and July 4, 1921, the damage done was much smaller; the maximum velocity of the wind, even in a few isolated gusts, was not more than 60 miles per hour. The rate of progress of the typhoon between Surigao and Maasin was 8 or 9 miles per hour; from Romblon to Boac it moved at the rate of only 5·6 miles per hour; when nearing Manila, it increased again to about 8 miles per hour; and from Manila to Iba the rate of progress was greater than 10 miles per hour. It appears that the typhoon filled up on May 26 in the China Sea east of Hainan.

PARIS.

Academy of Sciences, November 13.—M. Emile Bertin in the chair.—Paul **Vuillemin**: The morphological value of antitropic emergences. The mechanism of their production by desmonastic displacement. —Paul **Lévy**: The determination of the laws of probability by their characteristic functions.—M. **van der Corput**: Some new approximations.—W. **Sierpinski**: The existence of all classes of measurable (B) *ensembles*.—Pierre **Fatou**: Meromorphic functions of two variables.—Luc **Picart**: Statistics of faint stars in a limited region of the Milky Way.—Charles L. R. E. **Menges**: Fresnel's coefficient.—A. **Perot**: A rapid method of determining the elements of terrestrial magnetism. The principle utilised in the apparatus described is the production of induced currents in a coil rotating in the earth's field and the compensation of these currents by the production of a suitable magnetic field round the rotating coil. The accuracy claimed is about 0·1 per cent., and the actual measurement requires only ten minutes.—L. **Décombe**: The calculation of the magnetic moment of a star, starting with its axial moment of inertia, its time of rotation, and the universal constant of gravitation.—J. **Cabannes**: The polarisation and intensity of the light diffused by transparent liquids. Einstein's theory of the diffusion of light by liquids, based on the assumption that fluids are continuous media the properties of which vary slowly from one point to another, has not been confirmed by experiment. The modified theory developed by the author, assuming the existence of molecules, is shown to be in better agreement with fact. The depolarisation of diffused light by liquids furnishes a fresh proof of the discontinuity of matter.—Elis **Hjalmar**: Researches on the series of the X-rays.—P. **Fleury**: An electrical furnace with molybdenum resistance *in vacuo*. Molybdenum as a resistance material has certain advantages over tungsten; it is less fragile, more easily wound, does not contract strongly on first heating like tungsten, and is cheaper. Details are given of the construction of such a furnace, 4 cm. in diameter and 14 cm. high, giving a temperature of 1650° C. with a consumption of 2100 watts. At 1750° C. (2600 watts) the alundum tube fused.—H. **Fischer** and P. **Steiner**: The ultra-violet absorption spectra of pyridine and isoquinoline.—Georges **Chaudron** and Louis **Blanc**: The estimation of oxygen in steel. A comparison of results obtained by reduction of the steel with hydrogen either alone, or with the addition of various copper, tin, and antimony alloys. Both methods gave the same results.—L. J. **Simon**: The neutralisation of tartaric acid in presence of metallic chlorides. The neutral zone and buffer solutions.—P. **Loisel**: The radioactivity of the springs of the region of Bagnoles-de-l'Orne and its relation to the geological structure. There is a distinct relation between the radioactivity of the springs and the geological structure of the district. This conclusion is based on the measurement of the radioactivity of the water from twenty-eight springs.—J. B. **Charcot**: The geological study of the sea floor of the English Channel.—René **Souèges**: The embryogeny of the Caryophyllaceæ. The last stages of the development of the embryo in *Sagina procumbens*.—P. **Bugnon**: The vascular differentiation for the leaf traces in *Mercurialis annua*.—Joseph **Bouget**: The variations of coloration of flowers realised experimentally at high altitudes.—G. L. **Funke**: Supplementary summer shoots (trees and shrubs).—St. **Jonesco**: The anthocyanic pigments and phlobatanins in plants.—L. **Berger**: The existence of sympathicotropic glands in the human ovary and testicle: their relations with the interstitial gland of the testicle.—A. **Pézard** and F. **Caridroit**: Sex-linked heredity in the Gallinaceæ. Interpretation based on the existence of the neutral form and the properties of the ovarian hormone.—Alphonse **Labbé**: The distribution of the animals of the salt marshes with respect to the concentration of hydrogen ions.—Edouard **Chatton** and André **Lwoff**: The evolution of the infusoria of the Lamellibranchs. The genus Pelecyophrya, intermediate between Hypocoma and Sphenophrya.—Mme. M. **Phisalix**: The hedgehog and virus of rabies. The hedgehog has remarkable powers of defence against rabies: it attenuates or, in some cases, destroys the virus.

Official Publications Received.

Report on the Administration of the Meteorological Department of the Government of India in 1921–22. Pp. 14. (Simla: Government Central Press.) 4 annas.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands: Report on Experiments with Varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis, and Montserrat in the Season 1920–21. Pp. ii+43. (Barbados.) 1*s*.

Livingstone College. Annual Report and Statement of Accounts for the Year 1921–22. Pp. 24. (Leyton, E.10.)

The National Institute of Agricultural Botany. Third Report and Accounts, 1921–1922. Pp. 20. (Cambridge.)

Diary of Societies.

SATURDAY, DECEMBER 9.

GILBERT WHITE FELLOWSHIP (in Romano-British Gallery, British Museum), at 2.30.—W. Dale: A Demonstration.

MONDAY, DECEMBER 11.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Brown Coal and Lignites (Cantor Lecture).
SURVEYORS' INSTITUTION, at 8.—Major E. Meacher: Food Production during the War.—H. German: The Agricultural Position and the Possibility of stimulating Economic Production in the Future.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Prof. J. W. Gregory: The Alps of Chinese Tibet and their Geographical Relationships.

TUESDAY, DECEMBER 12.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.
INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Eng.-Capt. J. A. Richards: Manufacture of Solid Drawn Steel Tubes.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—A. S. Newman: Description of the "N.S." Kinematograph Camera, with Special Reference to an Electric Drive.—Dr. G. I. Higson and F. C. Toy: The Factors which determine Gamma Infinity.
JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—Capt. H. Riall Sankey: The Utility of Theory to the Practical Man (Presidential Address).
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. C. Singer: The Early Microscopists.
ILLUMINATING ENGINEERING SOCIETY (Joint Meeting with Institution of Gas Engineers, Institution of Electrical Engineers, and Institution of Municipal and County Engineers) (at Royal Society of Arts), at 8.—H. T. Harrison and others: Discussion on Recent Developments and Modern Requirements in Street-Lighting.
SOCIOLOGICAL SOCIETY (at Leplay House, 65 Belgrave Road), at 8.15.—H. W. Nevinson: Life in Bankrupt Vienna.

WEDNESDAY, DECEMBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.45.—Lt.-Col. P. H. Johnson: Improvements in the Efficiency of Roadless Vehicles.
ROYAL SOCIETY OF ARTS, at 8.—Sir Sidney F. Harmer: The Fading of Museum Specimens.

THURSDAY, DECEMBER 14.

LINNEAN SOCIETY OF LONDON, at 5.—W. O. Howarth: The Occurrence and Distribution of *Festuca rubra* in Britain.—H. W. Pugsley: A New British *Calamintha*.—Dr. Lily Batten: The Genus *Polysiphonia*, a critical revision of the species, based upon anatomy.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. C. Dixon: Some Limiting Cases in the Theory of Integral Equations.—Prof. G. H. Hardy and J. E. Littlewood: Some Problems of Partitio Numerorum. V.: A Further Contribution to the Study of Goldbach's Problem.—A. E. Jolliffe: (i.) Collinear Apolar Triads on Cubic Curves; (ii.) The Inflexions and Inflexional Tangent of the Two-cusped Quartic.—T. Stuart: (i.) The Rational Parametric Solutions of—

$$x_1^4+x_2^4+x_3^4+x_4^4=2A^2w^2.$$

(ii.) The Factors of $2^{103}-1$, $2^{109}-1$.—E. C. Titchmarsh: An Expansion in a Series of Bessel Functions.—Prof. G. N. Watson: The Theorems of Clausen and Cayley on Products of Hypergeometric Functions.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Caldwell: Electric Arc Welding Apparatus and Equipment.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith: A Large Aperture Lens not corrected for Colour.—T. Smith: The Optical Cosine Law.—Dr. J. S. Anderson: Demonstration of the Measurement of the Internal Diameters of Transparent Tubes, and a Simple Differential Refractometer for Liquids.—E. R. Watts and Son, Ltd.: Exhibition and Description of a Constant Bubble (unaffected in length by changes of temperature).
SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street), at 8.—Dr. Jane Hawthorne: Birth Control as it affects the Working Mother, to be followed by a discussion.
CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. C. H. Desch: The Metallurgical Applications of Physical Chemistry.
INSTITUTE OF METALS (London Section) AND INSTITUTION OF BRITISH FOUNDRYMEN (at Institute of Marine Engineers), at 8.—Dr. P. Longmuir: Brass Foundry Practice.
CAMERA CLUB, at 8.15.—W. Sanderson: Florence and some Cities of the Etruscan League.

FRIDAY, DECEMBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Commissioner F. de L. Booth Tucker: The Settlements of Criminal Tribes in India.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. Lumley: Reclamation Plant and its Operation.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. T. Marchmont: Notes on Printing Machinery.

SATURDAY, DECEMBER 16.

BRITISH ECOLOGICAL SOCIETY (Annual Meeting) (at University College), at 10.30 A.M.—Dr. R. Lloyd Praeger: Dispersal and Distribution (Presidential Address).—Dr. Cockayne's Work on the Tussock Grassland of New Zealand (Lantern and Specimens).—J. Ramsbottom The Mycology of the Soil.—W. H. Pearsall: Plant Distribution and Basic Ratios.
BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—S. J. F. Philpott: The Analysis of the Work Curve.—H. Gordon: Hand and Ear Tests.

PUBLIC LECTURES.

SATURDAY, DECEMBER 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Ancient Egypt and the Bible.

MONDAY, DECEMBER 11.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—F. W. Twort: The Nature of Ultra-microscopic Viruses. (Succeeding Lectures on December 12, 15, 18, and 19.)
CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Robert Armstrong-Jones: Fatigue and how to Combat it, for the City Worker.

TUESDAY, DECEMBER 12.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. T. J. Jehu: Fossils and What They Teach (Swiney Lectures). (Succeeding Lectures on Tuesdays, Thursdays, and Fridays—12 in all.)
INSTITUTE OF INDUSTRIAL ADMINISTRATION (at London School of Economics), at 8.—R. Twelvetrees: Standardisation of Repairs in Relation to Industrial Economy (to be followed by a Discussion).

WEDNESDAY, DECEMBER 13.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. C. W. Saleeby: Sunlight and Childhood.

THURSDAY, DECEMBER 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—W. G. Spencer: Vesalius and his Delineation of the Framework of the Human Body (Thomas Vicary Lecture).
ROYAL SOCIETY OF MEDICINE, at 5.15.—Sir Arthur Newsholme: Relative Values in Public Health; (2) Degrees of Preventability of Disease, etc.
UNIVERSITY COLLEGE, at 5.30.—Prof. T. Okey: Carducci.
CENTRAL LIBRARY, FULHAM, at 8.—F. T. Roche: The Influence of Finance on Industry.

SATURDAY, DECEMBER 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Animals without Teeth.